

CHARACTERIZATION AND IDENTIFICATION OF GENETIC RESISTANCE TO  
*Puccinia graminis f. sp. tritici* IN *Triticum aestivum* AND *Hordeum*  
*vulgare*

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**Title**

Characterization and identification of genetic resistance to *Puccinia graminis*  
f. sp. *tritici* in *Triticum aestivum* and *Hordeum vulgare*

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## ABSTRACT

Wheat stem rust, caused by *Puccinia graminis* f. sp. *tritici* (*Pgt*), is a major threat to wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) production. The emergence of the highly virulent Ug99-lineage stem rust races has stimulated research toward the identification and characterization of rust resistance genes in wheat and barley. Populations were developed to elucidate the inheritance and location of *Pgt* resistance genes in the common wheat landraces PI 626573 and PI 362698.

The resistance present in PI 626573 was shown to be conferred by a single dominant gene (*SrWLR*) and was mapped to a 1.9 cM region on the long arm of chromosome 2B. This region is known to contain *Sr9h* which is effective against Ug99. *SrWLR* provides resistance to *Pgt* race RKQQC and *Sr9h* does not, suggesting *SrWLR* may be a new gene or allele of *Sr9*. Subsequent work has delimited the *SrWLR* region to 0.36 cM using a synteny-based approach.

QTL analysis of the PI 362698 population using *Pgt* races identified significant ( $P < 0.1$ ) resistance QTLs on multiple chromosomes. QTLs identified on chromosome 3B map to a similar location as *Sr12* which does not provide resistance to Ug99-lineage races, suggesting a new allele or novel resistance gene. The QTLs identified on chromosomes 2B and 6A are thought to be *Sr16* or an allele of *Sr28* and *Sr8a*. *Sr57* is known to be present in PI 362698 and is thought to be associated with *Pgt* QTLs detected on chromosome 7D. QTLs on chromosomes 5A and 5B are in regions where *Pgt* resistance genes have not been previously identified.

Relative qPCR, fluorescence microscopy, and infection type approaches were utilized to phenotype barley for seedling resistance to *Pgt* race MCCFC at multiple time points. Statistical differences ( $P < 0.05$ ) were found between accessions at 24 hours post inoculation using qPCR and displayed similar hierarchical ordering to microscopy observations. At early stages, the

susceptible cultivar Steptoe had less fungal DNA than barley accessions containing resistance genes suggesting potential pre-haustorial resistance contributions. Temporal variation in resistance ranking suggests the qPCR assay may be valuable for dissecting pre- and post-haustorial resistance mechanisms.

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## LIST OF ABBREVIATIONS

BSA.....	Bulk segregant analysis
cM.....	Centi-Morgan
DNA.....	Deoxyribonucleic acid
DPI.....	Days post inoculation
ETI.....	Effector-triggered immunity
HPI.....	Hours post inoculation
MAMPs.....	Microbial-associated molecular patterns
PAMPs.....	Pathogen-associated molecular patterns
<i>Pgt</i> .....	<i>Puccinia graminis</i> f. sp. <i>tritici</i>
PTI.....	PAMP-triggered immunity
QTL.....	Quantitative trait locus
R-gene.....	Resistance gene
R-protein.....	Resistance protein

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## LITERATURE REVIEW

### Introduction

Cereals, such as wheat and barley are a major source of food and income worldwide. Cereals collectively produce approximately three times more dry edible matter than tubers, pulses, fruits, sugar, meat, milk, and eggs combined (Harlan 1992). Wheat accounts for 20 percent of the world's food with an annual estimated production of 630 million tons; and accounts for the majority of cereal grains consumed by people in developing countries (Singh et al. 2011). The United States annually produces approximately 58 million tons of wheat; with North Dakota producing approximately 7.1 million tons of hard red spring wheat and 1 million tons of durum wheat (United States Department of Agriculture 2015). Barley is the fourth most grown cereal worldwide with an annual average production of 136 million tons and is used for animal feed, malting, and human consumption (Akar et al 2004; Murphy 2007). The United States annually produces approximately 4.4 million tons of barley, with North Dakota producing approximately 1 million tons (United States Department of Agriculture 2015). North Dakota is consistently one of the top producers of hard red spring wheat, durum wheat, and barley in the United States. North Dakota's wheat and barley crops are valued at an estimated \$1.8 billion and \$250 million, respectively (North Dakota Wheat Commission 2015; United States Department of Agriculture 2015). Environmental adaptability, ease of production, and large growing area has all contributed to wheat and barley's global success as cropping systems. Currently, wheat and barley is grown throughout the world from 67° N to 47° S latitude and is annually planted on an estimated 215 and 70 million hectares, respectively (Akar et al. 2004; Braun et al. 2010; Singh et al. 2011). Due to expected steep population growth, the demand for wheat is estimated to increase by 60% by 2050. Furthermore, predicted climate changes may reduce cereal production

area by as much as 29% in developing countries (Rosegrant et al. 1995). This demand will also increase due to the emergence and reemergence of highly virulent pathogens, such as wheat stem rust. Wheat stem rust has historically been a major disease affecting multiple cereal crops resulting in severe yield losses (Chaves et al. 2013; Leonard and Szabo 2005; Roelfs 1985a, 1985b; Singh et al. 2008, 2011). In the United States the disease has been well managed for decades; however the recent emergence of new virulent races in Eastern Africa since 1998 has instilled a new sense of concern (Roelfs 1982; Singh et al. 2008, 2011).

## **Wheat Stem Rust**

**Taxonomy and Lifecycle of the Wheat Stem Rust Pathogen.** Rust fungi belong to the phylum Basidiomycota which is characterized by the formation of basidiospores on basidia, septated hyphae, and dolipores connecting the hyphal cells (Gäumann 1928). The phylum Basidiomycota is a very diverse phylum that consists of many plant pathogenic fungi (Gäumann 1928). One of the unique orders of fungi within the Basidiomycota is the Pucciniales, formally known as the Uredinales (Aurthur 1934; Gäumann 1928; Savile, 1984). This order contains the rust fungi which are unique obligate biotrophs that may have as many as five spore stages within their life cycle (Aurthur 1934; Gäumann 1928). These spore stages consist of the basidiospore, pycniospore, aeciospore, urediniospore, and teliospore (Aurthur 1934; Gäumann 1928). The traditional taxonomy of the rust fungi was established using teliospore morphology to separate the various families (Aurthur 1934). Within the Uredinales the family Pucciniaceae is characterized by stalked teliospores (Aurthur 1934). The family contains 17 genera which are separated by cell morphology. The genus *Puccinia* is the largest genus within the family Pucciniaceae and is characterized by the teliospore consisting of two cells (Aurthur 1934; Leonard and Szabo 2005). To classify the various genera into species, it is necessary to look at the hosts

of the fungus. Some of these fungi, such as the cereal rusts, have a similar host range but are distinguishable based on symptomatology (Aurthur 1934; Savile 1984).

*Puccinia graminis* is characterized as a macrocyclic heteroecious rust (Leonard and Szabo 2005; Peterson 1974). *P. graminis* requires moderate moisture allowing for dew formation on the host plants surface and generally warm temperatures (27-30 °C) for optimal infection (Roelfs 1985a; Singh et al. 2008). The life cycle of *P. graminis* consists of a sexual cycle of all five described spore classifications (basidiospores, pycniospores, aeciospores, urediniospores, and teliospores) for rust fungi and an asexual cycle consisting of urediniospores (Leonard and Szabo 2005; Peterson 1974; Roelfs 1985a). Yearly infection begins with infection of the alternate host via basidiospores in the early spring. The development of pycnia and pycniospores occurs allowing for sexual recombination. Aecia and aeciospores then form allowing for the primary infection of the cereal grass host. At this point, urediniospores and uredinia are produced on the primary host allowing for the asexual cycle to occur. Finally, the sexual cycle is concluded by the formation of telia on mature uredinia. Teliospores produced from the telia overwinter in warmer climates and germinate to produce basidiospores (Roelfs 1985a).

A defining characteristic of *P. graminis* is a broad host range in both the alternate and primary hosts (Leonard and Szabo 2005; Roelfs 1985a; Singh et al. 2011). The primary alternate host for *P. graminis* species is the common barberry (*Berberis vulgaris* L.); however some additional barberry species, *Mahonia* species, and barberry and *Mahonia* hybrids (X *Mahoberberis*) are also susceptible (Roelfs 1982). In the late 19<sup>th</sup> century, *P. graminis* was further subdivided pathogenically by cereal hosts in to seven *formae speciales* (Anikster, Y. 1984; Johnson 1961; Leonard and Szabo 2005; Niks 1986). The *formae speciales secalis* is pathogenic on barley and rye (*Secale cereale* L.), *avenae* on oats (*Avena* spp.), *agrostidis* on



*Agrostis* spp., *poae* on bluegrass (*Poa* spp.), *airae* on tufted hairgrass (*Deschampsia cespitosa* (L.) P.Beauv.), and *epigaei* on reed grass (*Calamagrostis* spp.; Johnson 1961; Leonard and Szabo 2005). The most economically important of the *formae speciales* is *tritici*. *Puccinia graminis* f. sp. *tritici* Erikss. & E. Henning (*Pgt*), the causal agent of wheat stem rust, is pathogenic on the cereal grasses, common wheat (*Triticum aestivum* L.), durum wheat (*T. turgidum* subsp. *durum* (Desf.) Husn.), barley (*Hordeum vulgare*), triticale (*X Triticosecale* Wittmack), and other wild wheat progenitors (Singh et al. 2011). *Pgt* can be further divided into races by virulence on its cereal host (Leonard and Szabo 2005; Johnson 1961; Roelfs 1982). The sub-division of *Pgt* into races is crucial for understanding and following changes in the pathogen population, as well as, directing breeding efforts in the host crops (Leonard and Szabo 2005; Johnson 1961; Roelfs 1982).

Wheat stem rust is characterized by small chlorotic flecks that progress into diamond shaped brick red lesions eight to ten days after inoculation on its cereal host (Leonard and Szabo 2005). Stem rust signs occur primarily on stem and leaf sheaths, but may also occur on leaves and glumes (Leonard and Szabo 2005). Yield losses caused by wheat stem rust is associated with the fungus reducing photosynthetic area of the plant, loss of nutrients and water through epidermal breakage, and lodging due to stem breakage in severe infections (Roelfs 1985a).

**Wheat Stem Rust in the United States and the Emergence of Ug99-lineage races in East Africa.** The economic importance of the primary hosts and the wide distribution of the alternate hosts have allowed *Pgt* to disseminate easily from its evolutionary origins in the Middle East (Peterson 2001; Roelfs 1985a). *Pgt* may be found in every wheat and barley producing region in the world (Jones and Clifford 1983). The coevolution between *Pgt* and its hosts has

allowed for the pathogen to adapt to numerous environments, which has resulted in multiple epidemics across the world.

During 1878, 1904, and 1916 the United States experienced severe wheat stem rust epidemics in the Midwest resulting in great yield losses (Roelfs 1985b). During the epidemic of 1916, an estimated yield loss of 5.4 million tons occurred (Campbell and Long 2001; Roelfs 1982). The losses incurred by Midwestern growers during the epidemic of 1916 inspired the creation of the barberry eradication program in the United States (Campbell and Long 2001; Roelfs 1982). The barberry eradication program, which began in 1918 and ended in the 1980's, has had large effects on wheat stem rust management and pathogen diversity. The mass eradication of the alternate host removed the sexual stage of the pathogen's life cycle, which has resulted in the extension of the duration of resistance (R) gene efficacy and the reduction of pathogen diversity (Campbell and Long 2001; Roelfs 1982). During the beginning of the barberry eradication program an average of 17.5 *P. graminis* races were detected on a yearly basis in the Great Plains states, which decreased to an average of 5.2 races by the end of the program in the 1980's (Roelfs 1982). Surveys of asexually reproducing populations of *P. graminis* detect an average of one race per 148 isolates; in sexually reproducing populations this ratio changed to approximately one race every 4.3 isolates (Roelfs and Groth 1980). The barberry eradication program has also allowed pathologists to predict the most common race from year-to-year as it is most often the most common race from the previous year (Roelfs 1982). The preclusion of genetic variation in the pathogen population attained through sexual recombination and the ability to predict the most common races on a yearly basis has increased the duration of efficacy for deployed R-genes (Campbell and Long 2001; Roelfs 1982). A sexually recombining population is present in the Pacific Northwest and has produced virulent

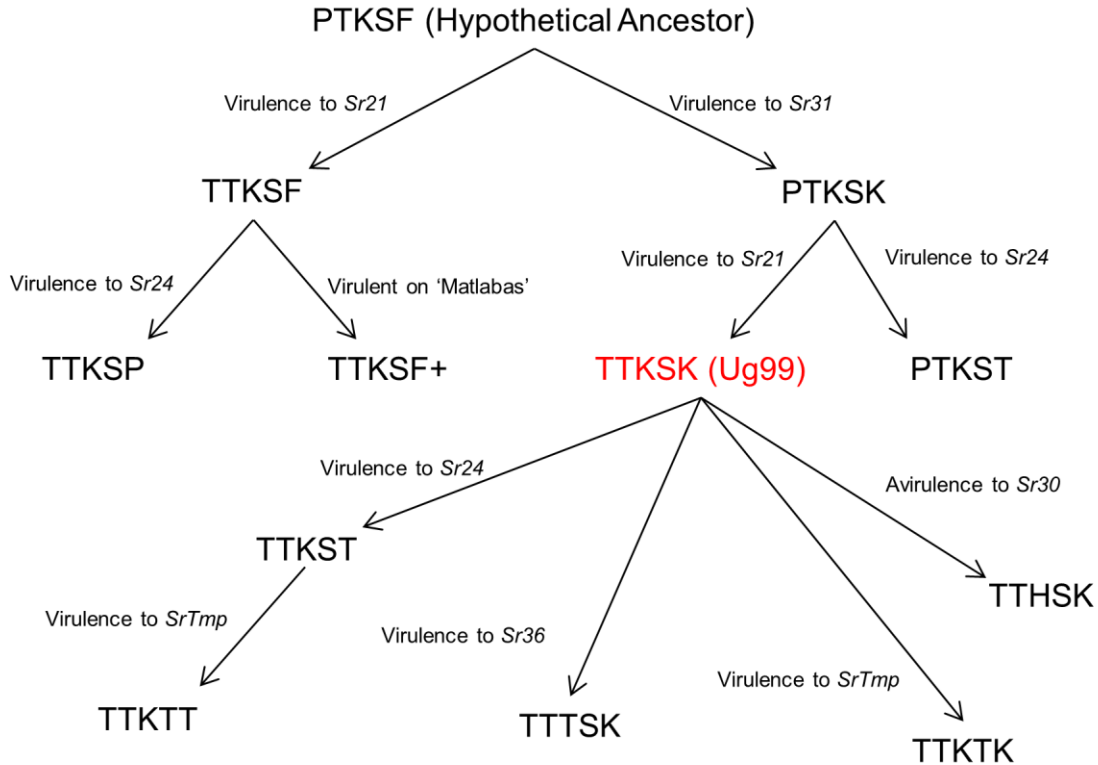
races of *Pgt*; however the Rocky Mountains have limited movement of these new races into the Midwestern states (Jin 2011). Due to the removal of the alternate host, *Pgt* mainly persists in the asexual stage of its life cycle in the United States, overwintering on winter habit wheat in southern Great Plains states and Mexico (Kolmer et al. 2007). Each year urediniospores from Mexico and the southern states are blown to wheat and barley fields along the “*Puccinia* pathway” (Kolmer 2001). The travel of the urediniospores from the south has delayed the onset of disease by months and made disease progress in the northern Midwestern states predictable, as well as, severely reducing the likelihood of epidemic occurrence compared to the early 1900’s (Kolmer 2001; Kolmer et al. 2007; Roelfs 1982).

Despite the active removal of the alternate host, wheat stem rust epidemics did occur during the barberry eradication program. Major epidemics driven by a change in the predominant races occurred in 1935, 1937, 1953, and 1954 (Roelfs 1985b). Historically, the 1935 epidemic is the most severe wheat stem rust epidemic recorded in North Dakota. During the epidemic, North Dakota growers incurred 56.5% and 15% yield losses for wheat and barley, respectively (Chaves et al. 2013; Roelfs 1978). The epidemic of 1937 was not as severe with yield losses only reaching 25% and 8% for wheat and barley, respectively (Steffenson 1992). The epidemics of 1935 and 1937 were caused by an ideal climate for disease development and the emergence of the virulent *Pgt* race 56 (MCC; Roelfs 1978). The stem rust resistant wheat cultivars ‘Redman’, ‘Regent’, ‘Renown’, and ‘Thatcher’ and barley cultivars ‘Kindred’ and ‘Peatland’ were deployed to counteract the virulence present in race 56 and were very effective throughout the late 1930’s and 1940’s (Brueggeman et al. 2002; Kolmer 2001; Zurn et al. 2015). The epidemics of 1953 and 1954 were the results of the predominance of susceptible cultivars to the dominant *Pgt* race 15B (TMB) which had slowly increased in prevalence since its initial detection in 1939 (Kolmer

2001; Kolmer et al. 2007; Roelfs 1978). Wheat yield losses in North Dakota were 37.7% and 42.9% during the 1953 and 1954 epidemics, respectively (Steffenson 1992). Losses in barley during these epidemics were undetectable due to the deployment of the durable stem rust resistance gene *Rpg1* in the early 1940's (Steffenson 1992).

The United States has not experienced any major wheat stem rust epidemics since the 1950's, however new races have emerged as the predominant races. Since the late 1950's, *Pgt* race 15B has decreased in prevalence and was replaced by race TPMK (Kolmer et al. 2007). Selection pressure on the rust population from the copious use of *SrTmp* in the northern Great Plains led to the changes in race frequency (Kolmer et al. 2007). Because of the emergence of race TPMK, the R-gene *Sr6* was greatly deployed in winter and spring wheat cultivars. As a result, the frequency of race TPMK has declined severely in the United States wheat stem rust population (Kolmer et al. 2007). This is consistent with the boom and bust model explaining coevolution in host-pathogen interactions (McDonald and Linde 2002). In 1989, the race QCC emerged from the sexual population of *Pgt* found in the Pacific Northwest (Jin 2011; Steffenson 1992). Race QCC is avirulent on many wheat cultivars; however it is virulent on *Rpg1* in barley (Jin 2011; Steffenson 1992). The emergence of race QCC stimulated research toward the discovery of the *rpg4/Rpg5* wheat stem rust resistance complex in the barley accession Q21861 (Brueggeman et al. 2009; Steffenson 1992; Wang et al. 2013). Race TTTT emerged in 2000 due to the large deployment of *Sr6*. Despite high virulence to the wheat differential set, race TTTT is found in low frequencies because of resistance present in North American wheat cultivars from *Sr24*, *Sr31*, and *SrWld1* (Kolmer et al. 2007). Since 2003, the predominant *Pgt* race has been QFCS (Jin 2011). Race QFCS is thought to overwinter on wild grass because many of the wheat cultivars are resistant.

In 1998 a new highly virulent wheat stem rust race was discovered in Uganda; the following year it was identified as race TTKS following the North American naming system (Pretorius et al. 2000; Singh et al. 2008, 2011). In the following years this race became colloquially known as Ug99 and is estimated to be virulent on approximately 90% of the world's commercial wheat crops and breeding material (Singh et al. 2008, 2011). Ug99 was the first race to overcome the wheat stem rust R-gene *Sr31*, first introgressed from a rye 1BL.1RS translocation (Fig. 1; Pretorius et al. 2000; Singh et al. 2008, 2011). Similar to the North American race QCC, Ug99-lineage races are also virulent to the barley wheat stem rust resistance gene *Rpg1* and avirulent to the *rpg4/Rpg5* resistance complex (Brueggeman et al. 2009; Wang et al. 2013). It is hypothesized a sexually recombining stem rust population exists in East Africa due to the presence of the alternate host *Berberis holstii* Engl.; however no conclusive evidence has shown this interaction has any major effect on the races present in the region (Park et al. 2011; Wanyera 2012). Since 1999 the Ug99 lineage has become virulent on *Sr24* in 2006, *Sr36* in 2007, *Sr9h* in 2012, and *SrTmp* in 2014 via stepwise mutation, allowing for the pathogen to remain virulent on resistance genes deployed in the region (Fig. 1; Borlaug Global Rust Initiative 2015; Jin et al. 2008, 2009; Pretorius et al. 2012; Rouse et al. 2014a; Singh et al. 2011). Similar to the United States, selection pressure imposed by R-genes deployed in Africa has had a large effect on the population frequency of Ug99-lineage races (Johnson 1961; Roelfs 1982; Singh et al. 2011). Ug99-lineage races now account for the majority of races detected on a yearly basis in many East African countries (<http://rusttracker.cimmyt.org>).



**Figure 1.** Postulated evolution of the Ug99-lineage race group. Ug99-lineage race evolution is thought to have occurred via step-wise mutations selected for by resistance gene deployed in wheat. Modified from Park et al. 2011.

The range of Ug99-lineage races have expanded substantially from Uganda since 1999. Ug99-lineage races have been found in Egypt, Eritrea, Ethiopia, Kenya, Mozambique, Rwanda, South Africa, Sudan, Tanzania, Uganda, and Zimbabwe (Hale et al. 2013; Mukoyi et al. 2011; Pretorius et al. 2000, 2012; Singh et al. 2011; Szabo et al. 2014; Wolday et al 2011). In addition to these African countries, Ug99-lineage races have been detected in Iran and Yemen (Nazari et al. 2009; Singh et al. 2011). The identification of Ug99 in Iran has created some concern that the disease will eventually spread into the major wheat producing areas of India and Asia. This prediction is based on numerous factors such as regional wind currents and spore dispersal and viability. Furthermore, there has been documentation in the past of African rust pathogen races migrating to the southern Asian continent (Singh et al. 2006, 2008, 2011). Despite the great concern for the spread of Ug99-lineage races into the major wheat production areas of India via

wind currents; no movements outside of Africa has been detected since its detection in Iran in 2012.

Prior to the emergence of Ug99-lineage races, many African countries experienced severe wheat stem rust epidemics in the late 1900's as wheat production expanded (Saari and Prescott 1985). Severe wheat stem rust epidemics were reported during 1972 and 1978 in Kenya; 1975 in Tunisia; 1976 in Zambia; 1978 in Zimbabwe; and 1979, 1993, 1994, 2003, and 2013 in Ethiopia (Admassu and Fekadu 2005; Olivera et al. 2012, 2015; Saari and Prescott 1985). These epidemics have often been attributed to ideal environmental conditions during the growing season and the emergence of races virulent to primarily plant cultivars (Admassu and Fekadu 2005; Saari and Prescott 1985). The comparison of rust races in East African countries prior to 2000 is difficult due to the multitude of differential systems used to describe isolates. Many African *Pgt* races had virulence to genes that were often not included on the standard differential set (Pretorius et al. 2007). The identification of *Pgt* races began in Kenya and South Africa in the 1920's (Park et al. 2011; Pretorius et al. 2007). In the late 1960's surveys conducted in Kenya, Tanzania, Ethiopia identified 19 races and concluded the population structure was rapidly changing from previous years (Green et al. 1970; Harder et al. 1972). Further studies of the same region over a larger period of time, including the previous survey data, concluded pathogen virulence was not changing as rapidly as previously thought (Martens 1975; Park et al. 2011). In South Africa races 29 and 34 were the first to be identified in the 1920's and seemed to remain as the predominant races throughout the 1960's. The addition of supplemental differentials using deployed R-genes in the 1960's showed a large amount of variation within the 21- and 34-race groups that was previously unknown (Pretorius et al. 2007). The deployment of *Sr5*, *Sr9e*, and *Sr9g* selected isolates virulent to these genes in the 21- and 34-race groups. Races from this

lineage are part of an asexual population and were the dominant races in South Africa until they were displaced by the introduction of the Ug99-lineage races (<http://rusttracker.cimmyt.org>; Pretorius 2007; Visser et al. 2009). In the durum producing regions of Ethiopia Ug99-lineage races have not completely displaced the previous races in the region (<http://rusttracker.cimmyt.org>; Admassu and Fekadu 2005; Olivera et al. 2012, 2015). The detected number of races has decreased since 2005 when the popular cultivar ‘Digalu’, which is thought to contain the R-gene *SrTmp*, was deployed (Admassu and Fekadu 2005; Olivera et al. 2012, 2015). *SrTmp* provides resistance most Ug99-lineage races, but not other local races (Olivera et al. 2015). As such, Digalu has selected for the virulent races JRCQC, RRTTF, TRTTF, and TKTTF which are not part of the Ug99-lineage race group (Olivera et al. 2012, 2015). It is important to continually monitor non-Ug99-lineage races in Africa lest they become the majority epidemic causing races in the future.

## **Wheat and Barley**

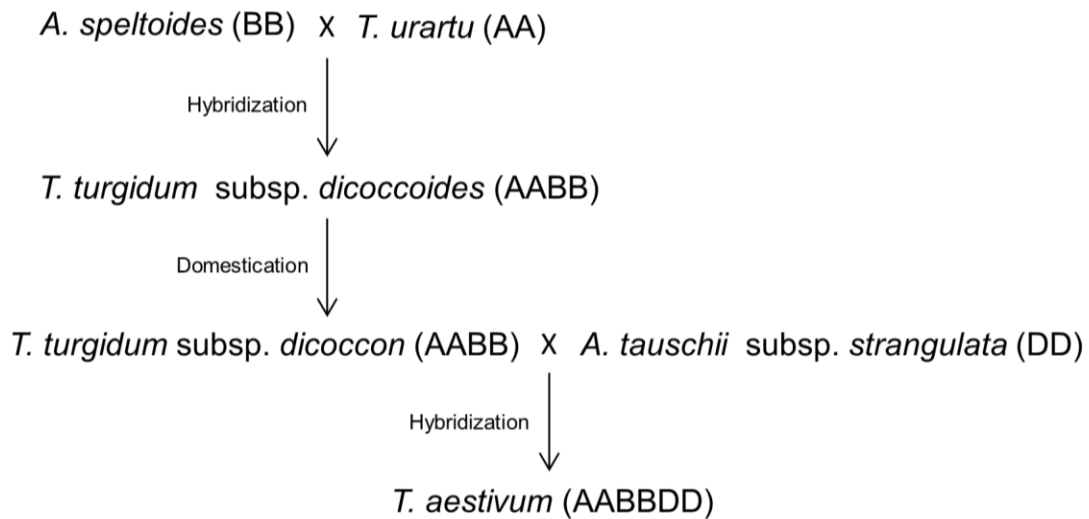
**Taxonomy of Cereal Grasses.** The taxonomy of wheat and barley has been well characterized over many years of study. The monocot plants wheat and barley are members of the Poaceae, grass, family (Bolot et al. 2009). In the Poaceae family there are three major economic subfamilies (Ehrahartoideae, Pooideae, and Panicoideae); each containing many important crops. The subfamily Panicoideae; containing the genera *Zea* (maize), *Sorghum*, *Pennisetum* (pearl millet), and *Setaria* (foxtail millet), first diverged from the other two approximately 50-70 million years ago (Bolot et al. 2009). The subfamilies Ehrahartoideae, containing the genus *Oryza* (rice), and Pooideae diverged approximately 46 million years ago (Bolot et al. 2009). Over the course of the last 46 million years the Pooideae subfamily further differentiated. The genus *Brachypodium* (brome) separated approximately 35 million years ago



from the genera *Triticum* and *Aegilops* followed by *Avena* (oats) approximately 25 million years ago, *Hordeum* (barley) approximately 13 million years ago, and finally the genus *Secale* (rye) 7 million years ago (Bolot et al. 2009; Gaut 2002; The International Brachypodium Initiative 2010; Murphy 2007).

**Wheat Evolution and Domestication.** The genus *Aegilops* is the closest related genus to the genus *Triticum*, in which wheat belongs. These two genera separated approximately 2.5 to 3.5 million years ago only to recombine, via hybridization events, to form the polyploid wheat species (Dubcovsky and Dvorak 2007; Gill and Friebe 2002; Gustafson et al. 2009; Lagudah and Appels 1992). The genus *Triticum* can be divided up among diploid ( $2n = 2x = 14$ ), allotetraploid ( $2n = 4x = 28$ ), and allohexaploid ( $2n = 6x = 42$ ) species. The evolution of *T. aestivum* can best be described as the addition of genomes through the hybridizations of various *Triticum* and *Aegilops* species (Fig. 2). Molecular characterization of *T. aestivum* suggests the diploid species *Triticum urartu* Thumanjan ex Gandilyan is the A genome donor, *Aegilops speltoides* Tausch is the putative B genome donor, and *Aegilops tauschii* Coss subsp. *strangulata* is the D genome donor (Dubcovsky and Dvorak 2007; Gill and Friebe 2002; Gustafson et al. 2009; Lagudah and Appels 1992). At some point less than 2 million years ago, *A. speltoides* and *T. urartu* interbred creating the allotetraploid wild emmer wheat (*Triticum turgidum* subsp. *dicoccoides* (Körn. Ex Asch. & Graebn.) Thell.; Dubcovsky and Dvorak 2007; Gill and Friebe 2002; Gustafson et al. 2009; Lagudah and Appels 1992). Wild emmer was domesticated in the southern Middle East resulting in the creation of cultivated emmer (*Triticum turgidum* subsp. *dicoccon* (Schrank) Thell.) and durum wheat (*T. turgidum* subsp. *durum*; Dubcovsky and Dvorak 2007; Murphy 2007). The spread of cultivated emmer into the northern Middle East approximately 7,500 years ago created a hybridization opportunity with *A. tauschii* subsp.

*strangulata* to form the allohexaploid *T. aestivum* (Dubcovsky and Dvorak 2007; Gill and Friebe 2002; Gustafson et al. 2009; Lagudah and Appels 1992).



**Figure 2.** The evolution of common wheat (*T. aestivum*).

The domestication of wild wheat and wild relatives began approximately 10,000 years ago during the Neolithic Revolution in the Middle East. The revolution is thought to have occurred due to human civilization shifting from a nomadic society toward a settled, agriculture-oriented, society (Dubcovsky and Dvorak 2007; Harlen 1992; Murphy 2007; Shewry 2009). At this time emmer and einkorn wheat (*Triticum monococcum* L.) were the most commonly grown by these early agricultural societies (Harlen 1992; Murphy 2007). The domestication of wild emmer led to the selection of individuals which had higher yields, a more even maturation rate, lacked a brittle rachis, and were free threshing (Dubcovsky and Dvorak 2007; Harlen 1992; Murphy 2007; Shewry 2009; Simons et al. 2006). Over the next thousand years, cultivated emmer and common wheat spread from the Middle East to Africa, Europe through Turkey, and China through India (Shewry 2009). Wheat was first brought to North America by Spanish missionaries through Mexico and reached what is now the United States in 1602 (Shewry 2009).

American settlers spread wheat into the North American Great Plains, with large scale production beginning in the late 1800's (Shewry 2009).

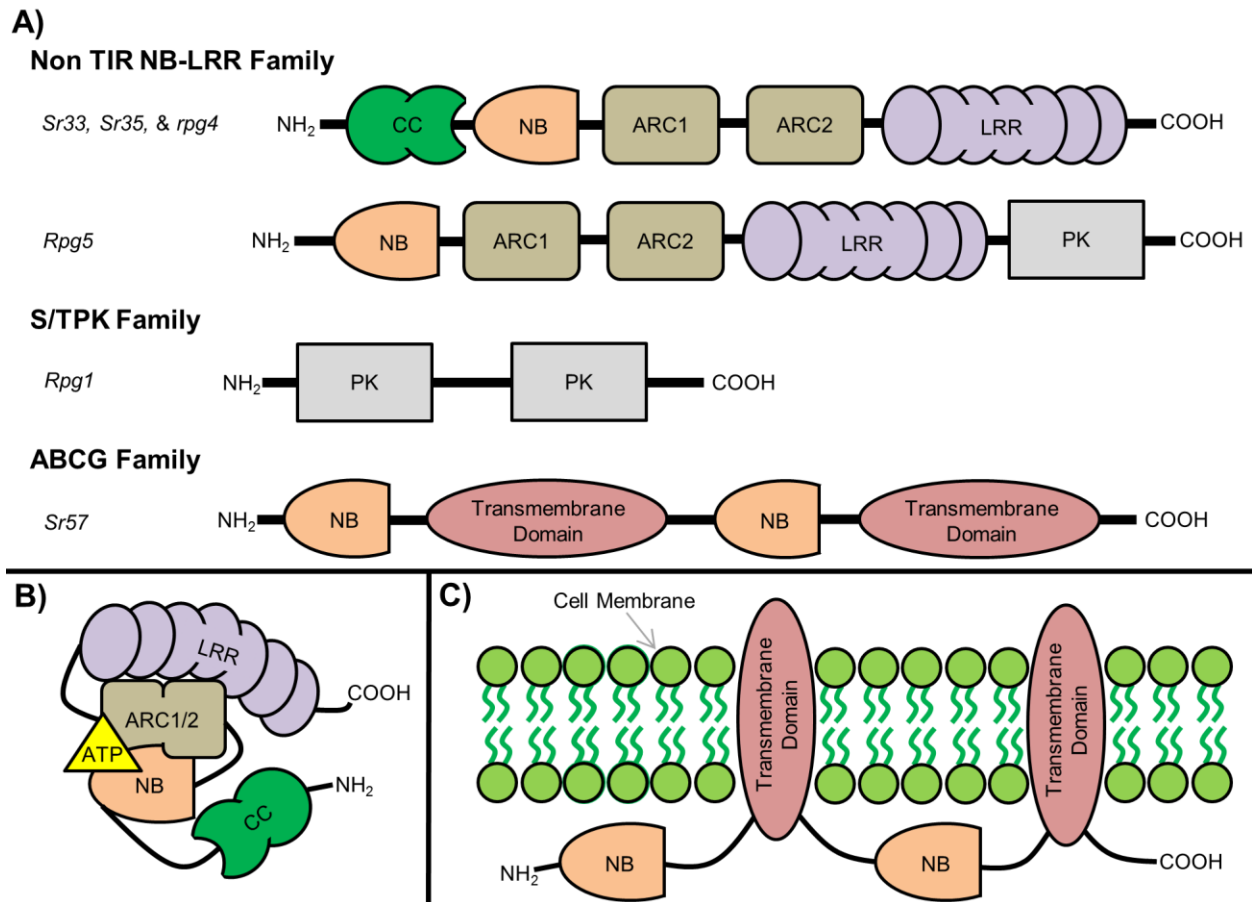
**Barley Evolution and Domestication.** The genus *Hordeum* consists of 32 species, many of which are perennial (Pourkheirandish and Komatsuda 2006; von Bothmer et al. 2003). These species are divided among different ploidy levels including diploid ( $2n = 2x = 14$ ), tetraploid ( $2n = 4x = 28$ ), and hexaploid ( $2n = 6x = 42$ ; Pourkheirandish and Komatsuda 2006; von Bothmer et al. 2003). Wild (*Hordeum vulgare* subsp. *spontaneum* K. Koch.) and cultivated barley (*H. vulgare* subsp. *vulgare* L.) are diploid annuals that do not experience any crossing barriers (Murphy 2007; Pourkheirandish and Komatsuda 2006; von Bothmer et al. 2003). Similar to wheat, agronomic traits like reduced dormancy and vernalization, a non-brittle rachis, and photo-period insensitivity were selected in wild barley during domestication (Murphy 2007; Pourkheirandish and Komatsuda 2006; von Bothmer et al. 2003). The domestication of barley is unique in that it appears to have occurred in multiple locations during approximately the same time period. Multiple genetic studies suggest barley was domesticated in the Fertile Crescent near what is now Southern Turkey and in the Himalayas near what is now Tibet (Badr et al. 2000; Dai et al. 2012; Morrell and Clegg 2007). Due to the multiple domestication sites, two routes of dissemination likely occurred. The barley domesticated in the Fertile Crescent was disseminated from Turkey into Europe and then North America, while the barley domesticated in the Himalayas was disseminated into Central and Eastern Asia (Morrell and Clegg 2007).

## Genetics of Wheat Stem Rust Resistance

**Resistance to Wheat Stem Rust in Wheat and Barley.** The incorporation of genetic resistance into deployed cultivars is one of the most effective and cost efficient disease management strategies. The ease of use and low cost make it an attractive management strategy for both developed and developing countries. In addition to economic benefits, the use of genetic resistance is environmentally friendly compared to disease management through the use of fungicides (Ellis et al. 2014). Genetic resistance to rust diseases has been well characterized in both wheat and barley. Currently there are over 60 identified *Pgt* R-genes in wheat (*Sr*) and five in barley (*Rpg*; Chelkowski et al. 2003; Singh et al. 2011). At least 31 of the R-genes found in wheat are effective to at least one race in the Ug99-lineage race group (Rouse et al. 2014a; Singh et al. 2006, 2008, 2011). Half of the effective R-genes were introgressed from wild wheat relatives. Many of these genes are not deployed due to adverse effects from linkage drag or low efficacy when deployed alone (Rouse et al. 2014a). In barley, only the *rpg4/Rpg5* complex provides resistance to Ug99-lineage races making barley vulnerable to new epidemics (Brueggeman et al. 2009; Wang et al. 2013). The identification and characterization of *Pgt* resistance genes in wheat and barley continues to be important due to the effects of linkage drag associated with current resistance and the continued addition of virulence to the Ug99-lineage race group. The molecular mechanisms underlying *Pgt* resistance is not known for most of the currently known resistance genes. The cloning and characterization of resistance genes and their proteins can provide insights as to how R-proteins interact with other host and pathogen proteins. Currently, six *P. graminis* R-genes have been cloned; *Sr33*, *Sr35*, and *Sr57* from wheat and *Rpg1*, *rpg4*, and *Rpg5* from barley.

*Sr33* and *Sr35* are both coiled-coil nucleotide-binding leucine-rich repeat (CC-NB-LRR) genes (Periyannan et al. 2013; Saintenac et al. 2013). NB-LRR domain style receptors are very common in resistance systems for many plant species and can be divided up among two categories, those with a Toll-interleukin-like receptor (TIR-NB-LRR) and those without (Gu et al. 2015; Maekawa et al. 2011; Tarr and Alexander 2009). The TIR-NB-LRR class of genes is prolific in many plants; however they are not found in monocots, like wheat and barley (Gu et al. 2015; Tarr and Alexander 2009). The domains of CC-NB-LRR proteins have been well studied functionally. The LRR domain is responsible for pathogen effector recognition and is extremely variable (Fig. 3; Takken and Goverse 2012). The nucleotide binding (NB) domain, also known as NB-ARC domain, is composed of three subunits consisting of an NB subunit and two ARC subunits (Takken and Goverse 2012). These subunits form a nucleotide binding pocket when the protein is in its resting state. The coiled coil domain is involved in initiating the signaling cascade for the pathogen defense response (Takken and Goverse 2012). Both *Sr33* and *Sr35* were introgressed from wild wheat relatives. *Sr33* was discovered in accession RL5288 of the wheat D genome progenitor *A. tauschii* and introgressed to the short arm of chromosome 1D in *T. aestivum* (Jones et al. 1991; Periyannan et al. 2013). *Sr33* encodes six exons and is an ortholog of the barley *Mla* genes, which provide resistance to barley powdery mildew caused by *Blumeria graminis* (DC) Speer f. sp. *hordei* (Periyannan et al. 2013). Despite similarity to the barley *Mla* genes, *Sr33* does not appear to interact in a similar manner. Some barley MLA proteins require chaperone proteins to function, however *Sr33* does not appear to directly interact or require chaperone proteins for *Sr33*-mediated resistance (Periyannan et al. 2013). Additionally, very little cell death was observed when viewing infection sites microscopically. The wheat relative *T. monococcum* accession PI 428170 contains *Sr35* and was used during the introgression into

*T. aestivum* on the long arm of chromosome 3A (McIntosh et al. 1984; Saintenac et al. 2013). *Sr35* encodes two exons in the expressed region and three introns in the 3' UTR. Alternatively spliced forms of *Sr35* were identified in plants that were and were not inoculated (Saintenac et al. 2013). The proportion of splice forms did not change indicating they were not involved in the regulation of pathogen defense. Alternative splicing has been shown to be involved in the regulation of disease resistance in multiple pathosystems; however it has never been demonstrated in wheat stem rust (Yang et al. 2014). Additional research is needed to further characterize *Sr33*- and *Sr35*-mediated resistance.



**Figure 3.** Cloned wheat and barley stem rust resistance gene structures. **A)** Cloned gene structures consist of coiled-coil (CC) domains; nucleotide binding domains, consisting of nucleotide binding (NB), ARC1, and ARC2 subunits; leucine-rich repeat (LRR) domains; protein kinase (PK) domains; and transmembrane domains. **B)** Protein structure of mature CC-NB-LRR genes when bound to adenosine triphosphate (ATP). **C)** Protein structure of ABCG family genes.

The adult-plant resistance gene *Sr57* was the first stem rust R-gene cloned from wheat (Krattinger et al. 2009). *Sr57* originated in *T. aestivum* and maps to the centromere of chromosome 7D (Krattinger et al. 2009, 2011). The gene is pleiotropic in nature and is associated with leaf tip necrosis (*Ltn1*), as well as, providing quantitative resistance to leaf rust (*Lr34*), stripe rust (*Yr18*), powdery mildew (*Pm38*), and spot blotch (*Sb1*; Herrera-Foessel et al. 2014). The durable multi-pathogen resistance provided by *Sr57* has made it one of the most important disease resistance genes in wheat, leading to its introgression in greater than 50 % of the cultivars worldwide (Krattinger et al. 2011). Phenotypically, *Sr57* has been shown to behave differently depending on pedigree and environment (Kerber and Aung 1999; Kolmer et al. 2011; Risk et al. 2012; Rouse et al. 2014b). Most commonly, *Sr57* provides partial resistance by inhibiting intracellular hyphal growth of the pathogens (Krattinger et al. 2009; Risk et al. 2012). The resistance conferred by *Sr57* does not elicit a hypersensitive response, altered callose deposition, or up-regulation of pathogenesis-related genes (Risk et al. 2012). In addition to hyphal inhibition, *Sr57* has been shown to enhance stem rust resistance provided by other resistance genes at adult-plant and seedling stages and act as a non-suppressor to stem rust resistance suppression genes (Kerber and Aung 1999; Kolmer et al. 2011; Risk et al. 2012; Rouse et al. 2014b). Unlike most plant disease R-genes describes thus far, *Sr57* encodes for a full ATP-binding cassette (ABC) transporter protein in the ABCG subfamily, formally the pleiotropic drug resistance family (Krattinger et al. 2009). Members of the ABCG subfamily structurally are composed of two cytosolic nucleotide binding domains and two hydrophobic transmembrane domains (Fig. 3; Krattinger et al. 2009). The transmembrane domains form a transporter for the secretion of unknown anti-microbial compounds. Two polymorphisms were observed in the resistant allele of *Sr57*. A deletion of the base pairs ‘TTC’ in exon 11 results in

the deletion of a phenylalanine at position 546, and a histidine is substituted for a tyrosine at position 634 due to a C/T SNP in exon 12 (Krattinger et al. 2009). Both of these polymorphisms are located in the first transmembrane domain of the ABCG transporter and likely affect substrate specificity (Krattinger et al. 2009). Diagnostic markers have been developed around the ‘TCC’ deletion for marker assisted selection (Lagudah et al. 2009). Multiple alleles of *Sr57* have been identified at low frequencies in the gene pool that result in susceptibility (Dakouri et al. 2010; Lagudah et al. 2009; McCallum et al. 2012). These alleles of *Sr57* are characterized as deletion events that result in a frame shift mutation or SNPs that result in pre-mature stop codons.

The *Rpg1* gene has been the main source of resistance in North America since its deployment in the 1940’s (Brueggeman et al. 2002; Zurn et al. 2015). This resistance gene is one of the most durable R-genes deployed in any pathosystem, providing resistance to many *Pgt* isolates that are not members of the QCC- or Ug99-lineage (Brueggeman et al. 2009; Steffenson 1992; Wang et al. 2013; Zurn et al. 2015). *Rpg1* was the first *Pgt* gene cloned from barley and encodes 14 exons which produce an 837 amino acid protein (Brueggeman et al. 2002). The protein produced by *Rpg1* is a receptor-like serine/threonine protein kinase (S/TPK) with two protein kinase domains arranged in tandem (Fig 3; Brueggeman et al. 2002). Receptor-like S/TPKs are a common resistance gene family and have been shown to play a role in NB-LRR-mediated resistances (Afzal et al. 2008). Unlike other receptor-like S/TPKs, RPG1 does not have a transmembrane domain suggesting it is found within the cell cytoplasm (Afzal et al. 2008; Brueggeman et al. 2002). Both of RPG1’s kinase domains are required for resistance, however only the second domain is active (Nirmala et al. 2006). The function of the first domain is thought to be involved in protein conformation and protein-protein interactions; however the



interaction involving this first domain has not been identified (Kleinhofs et al. 2009). Within five minutes of spore contact with the leaf surface, *Rpg1* is phosphorylated initiating a resistance signaling cascade (Nirmala et al. 2010). Because RPG1 is not a membrane bound protein, the phosphorylation of RPG1 may be the result of an interaction with a previously unknown receptor protein with a transmembrane domain. RPG1 present in resistant cultivars is degraded within 22 hours when inoculated with avirulent *Pgt* races; however degradation is not observed when inoculated with virulent races suggesting the degradation is necessary for the defense response (Nirmala et al. 2007). Due to the fast phosphorylation *Rpg1*-mediated resistance was thought confer pre-haustorial resistance, however microscopy observations have shown haustorial formation is not impeded during the resistance response (Zurn et al. 2015). Another putative S/TPK known as *Rpr1* has been shown to be required for *Rpg1*-mediated stem rust resistance (Zhang et al. 2006). Despite being required for *Rpg1*-mediated stem rust resistance, RPR1 has not been shown to directly interact with RPG1 suggesting RPR1 is involved downstream of RPG1 in the *Rpg1*-mediated stem rust resistance mechanism (Zhang et al. 2006; Nirmala et al. 2010).

The emergence of virulent races led to the discovery of the *rpg4/Rpg5* gene complex, which is resistant to the Pacific Northwest races and Ug99-lineage races (Brueggeman et al. 2009; Wang et al. 2013). *Rpg5* and *rpg4* have been shown to belong to the non-TIR-NB-LRR gene family (Fig3; Brueggeman et al. 2008, 2009; Wang et al. 2013). The *rpg4* gene encodes an 895 amino acid CC-NB-LRR protein and *Rpg5* is a 1,378 amino acid NB-LRR protein (Wang et al. 2013). *Rpg5* has an undefined N-terminus domain and is unique from other NB-LRR genes in that it has an additional C-terminus S/TPK domain following the LRR domain (Brueggeman et al. 2008; Wang et al. 2013). The resistance gene *Rpg5* is dominantly inherited and provides

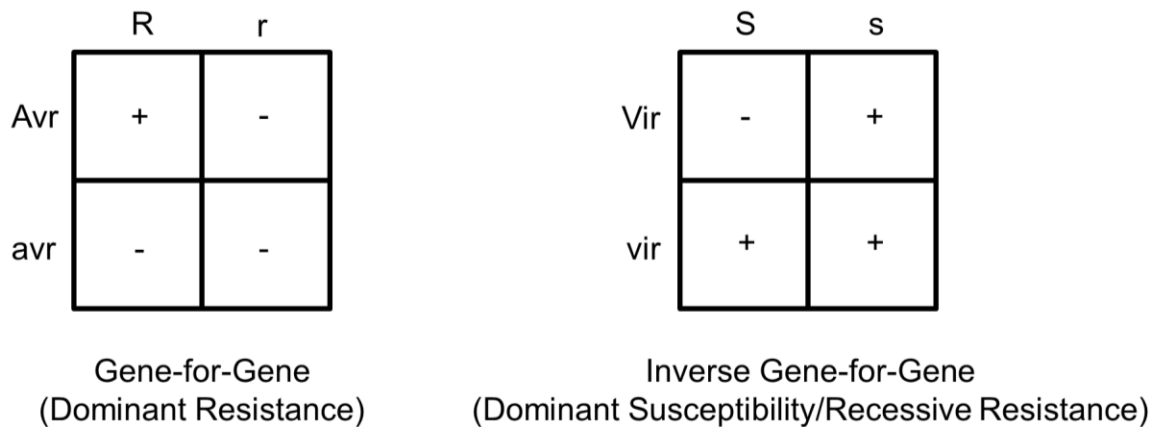
resistance the *P. graminis* f. sp. *secalis* (Wang et al. 2013) To provide resistance to *Pgt*, resistance alleles of *rpg4*, *Rpg5*, and an actin depolymerization factor (*HvAdf3*) are required (Wang et al. 2013). When one of the resistant alleles is not present the barley accession is susceptible. More work is necessary to characterize *rpg4/Rpg5* interactions with each other and pathogen effectors.

**Models of Resistance.** Multiple systems are involved in a plant's defense against biotrophic pathogens. Basal defense is the simplest of these defense systems and include physiological components such as varying plant surface topologies and secretions by the plant. This basic defense is broad and able to protect the plant from microbes and the environment in a limited capacity. Plants have also developed a series of receptors for microbial- or pathogen-associated molecular patterns (MAMPs or PAMPs). PAMPs are able to recognize common elements found in pathogens, such as chitin in fungi or flagellin in bacteria. During PAMP-triggered immunity (PTI), PAMP receptors identify a pathogen associated molecule and begin a resistance signaling cascade; which results in MAP kinase signaling, cell wall rearrangement, oxidative bursts, and hypersensitive response (Jones and Dangl 2006; Tsuda and Katagiri 2010). To overcome PTI pathogens developed proteins called effectors to hide from plant recognition. The effectors interact with host proteins to aid in infection by disrupting host resistance mechanisms. To overcome the pathogen effectors, plants evolved R-genes that produce receptors to recognize pathogen effectors and trigger resistance. The selection pressures imposed upon the pathogen population by effector-triggered immunity (ETI) lead to the modification of current effectors and creation new effectors to evade the host defense response; which in-turn imposes selection pressure on the plant populations to develop new R-genes (Jones and Dangl 2006;

Tsuda and Katagiri 2010). The alternation between resistance and susceptibility has been explained via the zig-zag model.

Multiple models have been proposed to explain host-pathogen interactions during ETI. The earliest model proposed for biotrophic pathogen-host interactions is the gene-for-gene model (Flor 1955). In the gene-for-gene model, R-proteins interact with avirulence proteins produced by the pathogen to induce a resistance response (Fig. 4). When the resistant allele is not present in the host or the avirulence allele is not present in the pathogen, the host is unable to recognize the presence of the pathogen allowing for disease. Most of the wheat stem rust R-genes, including *Sr33* and *Sr35*, are dominantly inherited and can be explained using the gene-for-gene model. Functionally, the gene-for-gene model has been described as a ligand-receptor model where the R-proteins directly interact to induce a resistance response (Keen 1990). A modification of the gene-for-gene model is the inverse gene-for-gene model (Friesen et al. 2007; Lamari et al. 2003). The inverse gene-for-gene model is most commonly used to explain the interaction between a host and necrotrophic pathogens, however the inverse gene-for-gene model can be extended to explain recessively inherited resistance to biotrophic pathogens. In the inverse gene-for-gene model as explained using necrotrophic pathogens, effectors from the pathogen, coded by virulence genes, interact with a host protein to induce cell death and cause disease (Fig. 4). Recessively inherited R-genes often code for altered or non-functional proteins. As such, the direct interaction between host proteins and the pathogen effectors are unable to occur. In the case biotrophic pathogens, a recessively inherited R-gene would be involved in part of the plants physiology that the pathogen would use to cause disease, a susceptibility factor. If the pathogen fails to interact with the host protein due to altered function or non-function disease would not occur (Fig. 4). The powdery mildew R-genes *pmr4*, *prm5*, and, *pmr6* in Arabidopsis are

examples of a recessively inherited R-gene to a biotrophic fungus. PMR6, a pectolase lyase-like protein, and PMR5, a plasma membrane associated protein, are both involved in cell-wall modeling (Vogel et al. 2002, 2004). Because the cell wall topology has changed, the *Arabidopsis* powdery mildew pathogen is unable to successfully colonize the host. The interaction between host and pathogen for *pmr4* is more direct. The gene *pmr4* is associated with callose deposition and appears to down-regulate salicylic acid-dependent pathogen defense (Frye and Innes 1998; Nishimura et al. 2003). It is thought that certain *Arabidopsis* powdery mildew races evolved an effector to utilize PMR4 to suppress host defense signaling. There are very few recessively inherited stem rust R-genes in wheat, none of which have been cloned. Cloning and characterizing recessively inherited wheat stem rust R-genes, such as *Sr12*, and pathogen effectors is needed to further explore the inverse gene-for-gene model in relation to biotrophic pathogens.



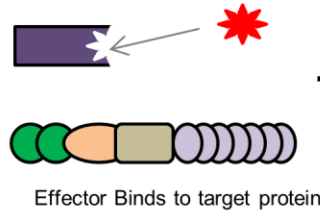
**Figure 4.** Gene-for-gene and inverse gene-for-gene models. The results of interactions between host resistance (R) and susceptibility (S) genes and pathogen avirulence (Avr) and virulence (Vir) genes are shown. Resistance to disease is indicated with ‘+’ and susceptibility is indicated with ‘-’.

The gene-for-gene and inverse gene-for-gene model are the simplest models proposed. These models rely on the assumption that a pathogen effector directly interacts with the R-protein. Physical interaction has not been shown to occur for many resistance-avirulence protein

interactions (Dangl and Jones 2001; van der Hoorn and Kamoun 2008). The guard model was proposed to explain the lack of interaction between resistance and avirulence proteins for multiple pathosystems (Dangl and Jones 2001). In the guard model R-proteins, which often belong to the NB-LRR family, monitor the host targets of pathogen effectors. When the effector and host target protein interact, the R-protein begins a signaling cascade resulting in disease resistance (Fig. 5). The manner in which the guard and target proteins interact is currently unknown. One hypothesis is the R-protein is constitutively bound to the target protein and disengages upon effector-target interaction (Dangl and Jones 2001; van der Hoorn and Kamoun 2008). Upon disengaging the guard protein initiates a signaling cascade that results in pathogen resistance. This hypothesis suggests the target protein negatively regulates the R-protein-mediated defense response. In a second hypothesis, the effector-target protein interaction creates a conformational change that increases binding affinity of the R-protein (Dangl and Jones 2001; van der Hoorn and Kamoun 2008). The binding of the R-protein to the effector-target complex would initiate signaling for the defense response. Regardless of the functional mechanism, the guard model may be evolutionary unstable due to antagonistic selection pressures posed upon host effector targets (van der Hoorn and Kamoun 2008). Selection pressure drives host effector targets to change to avoid interactions with pathogen effectors. At the same time, host effector targets are driven to improve recognition of pathogen effectors to allow for R-proteins to detect effector-target interactions. Antagonistic selection pressures are most likely not observed for situations where the host effector target is involved in critical physiological functions, due to selection against functional changes in the host protein.

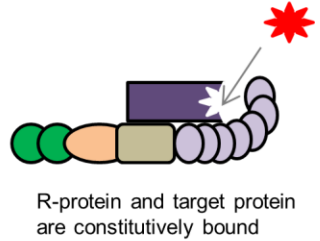
## Guard Model

Signaling hypothesis 1



R-protein binds to effector-target complex initiating resistance signaling

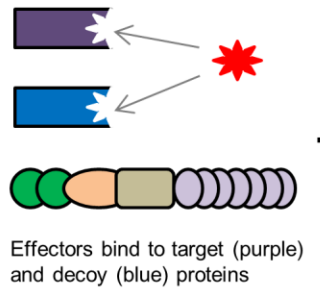
Signaling hypothesis 2



Effector binding to target protein disassociates R-protein from target protein to initiate resistance signaling

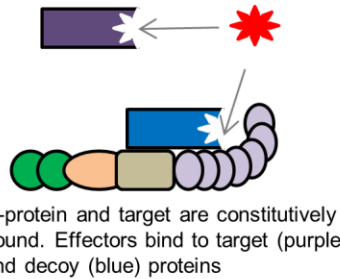
## Decoy Model

Signaling hypothesis 1



R-protein binds to effector-decoy complex initiating resistance signaling

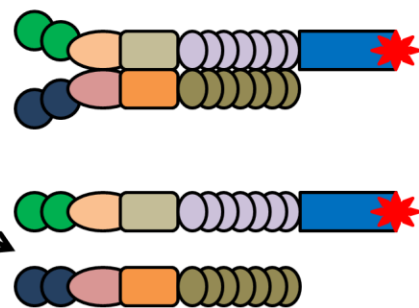
Signaling hypothesis 2



Effector binding to decoy disassociates R-protein from decoy protein to initiate resistance signaling

## Integrated Decoy Model

Effector binds to decoy domain attached to one of the constitutively bound R-proteins



**Figure 5.** Resistance signaling in the guard, decoy, and integrated decoy models. Pathogen effectors (red) interact with host target proteins (purple) or decoy proteins (blue) and R-proteins (multi-colored) interact in different ways to signal for resistance.

The decoy model was proposed to address the evolutionary instability of the guard hypothesis (van der Hoorn and Kamoun 2008). In the decoy model, the host produces decoy proteins with domains that mimic domains targeted by effectors to aid in pathogen recognition (Fig. 5). These decoy proteins may have originated evolutionarily through gene duplication events. Because of the proposed evolutionary origin, there is speculation as to whether the decoy domains and proteins retain functionality from their paralogs (Wu et al. 2015). The decoy proteins are monitored by R-proteins as in the guard model. Because the R-proteins monitor the decoy proteins, host effector targets are able to change in an attempt to avoid pathogen effectors without compromising R-protein-mediated resistance (van der Hoorn and Kamoun 2008). In addition to the gene-for-gene model, *Sr33* and *Sr35* may also be explained using the guard or decoy model. In these models the R-genes are producing proteins that recognize effector interactions with target or decoy proteins. A modified version of the decoy model, known as the integrated decoy model, has been recently proposed (Cesari et al. 2014). In the integrated decoy model, a guard NB-LRR protein is constitutively bound to a second NB-LRR with an extraneous decoy domain (Fig. 5). The effector-decoy interaction is thought to either cause a conformational change in the heterodimer or a disassociation of the heterodimer to initiate a resistance signaling cascade (Cesari et al. 2014). Wheat stem rust resistance conferred by the *rpg4/Rpg5* complex has been proposed to follow the integrated decoy model (Cesari et al. 2014). The *rpg4/Rpg5* complex fits the model because both NB-LRR proteins are required for wheat stem rust resistance and the presence of an attached serine/threonine protein kinase domain on RPG5 (Cesari et al. 2014; Wang et al. 2013). Currently, the decoy and integrated decoy model have not been experimentally demonstrated in the wheat stem rust pathosystems, however future research may provide new insights as R-genes and pathogen effectors are cloned.

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## HIGH-DENSITY MAPPING OF A RESISTANCE GENE TO UG99 FROM THE IRANIAN LANDRACE PI 626573 <sup>1</sup>

### Abstract

Managing wheat stem rust, caused by *Puccinia graminis* f. sp. *tritici* (*Pgt*), is imperative for the preservation of global food security. The most effective strategy is pyramiding several resistance genes into adapted wheat cultivars. A search for new resistance sources to *Pgt* race TTKSK resistance identified a spring wheat landrace, accession PI 626573, as a potentially novel source of resistance. A cross was made between LMPG-6, a susceptible spring wheat line, and PI 626573 and used to develop a recombinant inbred population to map the resistance. Bulk segregant analysis (BSA) of LMPG-6/PI 626573 F<sub>2</sub> progeny determined resistance was conferred by a single dominant gene given the provisional designation *SrWLR*. The BSA identified nine microsatellite (SSR) markers on the long arm of chromosome 2B associated with the resistant phenotype. Fifteen polymorphic SSRs, including the nine identified in the BSA, were used to produce a linkage map of chromosome 2B; positioning *SrWLR* in an 8.8 cM region between the SSRs GWM47 and WMC332. This region has been reported to contain the wheat stem rust resistance genes *Sr9* and *SrWeb*, the latter conferring resistance to *Pgt* race TTKSK. The 9,000 marker Illumina Infinium iSelect SNP assay was used to further saturate the *SrWLR* region. The cosegregating SNP markers IWA6121, IWA6122, IWA7620, IWA8295, and IWA8362 further delimited the *SrWLR* region distally to a 1.9 cM region. The present study

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demonstrates the iSelect assay to be an efficient tool to delimit the region of a mapping population and establish syntenic relationships between closely related species.

## **Introduction**

Wheat stem rust has historically been a major disease affecting multiple cereal crops resulting in severe yield losses (Leonard and Szabo 2005; Roelfs 1985; Singh et al. 2008, 2011). The causal organism of wheat stem rust, *Puccinia graminis* f. sp. *tritici* (*Pgt*), is a heteroecious macrocyclic fungus that can persist in many parts of the world in the uredinial stage of its life cycle (Roelfs, 1982; Singh et al. 2008, 2011). In the United States *Pgt* overwinters as uredinia on susceptible winter habit wheat varieties in southern states and Mexico and is blown north to wheat and barley fields along the “*Puccinia* pathway” in the summer (Kolmer 2001; Kolmer et al. 2007). In Africa, fields of different maturity exist due to the long growing season and elevation variability allowing *Pgt* to persist in the uredinial stage (Singh et al. 2008, 2011).

The use of resistance genes in common wheat, *Triticum aestivum*, has been shown to be an effective disease management strategy in North America since the 1950's (Roelfs 1982). The long term effectiveness of resistance genes in controlling the North American *Pgt* population is partially due to the removal of the sexual cycle of the pathogen through the eradication of the common barberry; resulting in the stabilization of the Midwestern United States rust population from year to year (Jin 2005; Roelfs 1982). The durability of this management strategy has caused the use of resistance genes to be the primary means for the control of *Pgt* (Kolmer 2001; Kolmer et al 2007; Singh et al. 2008, 2011) The emergence of the highly virulent *Pgt* race TTKSK (Ug99) and its variants have stimulated the need to identify new resistance genes (Pretorius et al. 2000; Singh et al. 2011). Ug99 was first observed in Uganda in 1998, when susceptible infection types were observed on cultivars containing *Sr31* (Singh et al. 2011). Since then, Ug99 has

migrated out of Uganda to countries along the Eastern African coast, Yemen, and Iran (Hale et al. 2013, Nazari et al. 2009; Pretorius et al. 2000; Singh et al. 2011). Currently, 23 named resistance genes are effective against the Ug99 lineage; however, many of the genes are not in adapted germplasm or are ineffective against other common races (Rouse et al. 2011; Singh et al. 2011). Many Ug99 resistance genes originated from *T. aestivum*, including *Sr28*, *Sr29*, *Sr48*, *SrTmp*, *SrCad*, *SrSha*, *SrHuw234*, *SrND643*, and *SrWeb* (Hiebert et al. 2010, 2011; Rouse et al. 2012; Singh et al. 2011). Only two resistance genes effective against Ug99, *Sr33* and *Sr35*, have been cloned. However, neither of these genes are naturally found in *T. aestivum*. *Sr33* and *Sr35* are both members of the NBS-LRR gene family commonly associated with disease resistance (Dubcovsky et al. 2012; Periyannan et al. 2013a, 2013b; Saintenac et al. 2013).

The high selection pressure imposed upon many crop species through modern breeding practices has created diversity bottlenecks, leaving current varieties with limited resistance sources and vulnerable to diseases that have long been under control (Tanksley et al. 1997). Landraces are a useful tool for many wheat breeding programs due to their association with traditional farming systems (Dreisigacker et al. 2005; Reif et al. 2005; Villa et al. 2005; Warburton et al. 2006). Landraces allow for easier incorporation of new and under-utilized sources of resistance into adapted material through traditional crossing techniques compared to using resistance from wild wheat relatives (Reif et al. 2005). The screening of landraces to identify new sources of disease resistance and the subsequent mapping of these genes has become a common practice in a number of crops, including wheat (Bonman et al. 2007, Fu et al. 2013, Gurung et al. 2011, Xiao et al. 2013).

During a recent disease resistance screening of the USDA National Small Grains Collection (NSGC), Newcomb et al. (2013) identified 278 spring habit common wheat

accessions resistant to Ug99 including the Iranian accession PI 626573. PI 626573 displayed resistance to *Pgt* race TTKSK during seedling tests at the USDA-ARS Cereal Disease Laboratory and *Pgt* race TTKST during adult tests at the Kenyan Agricultural Research Institute. PI 626573 often presents an infection type of 2 to 22+ during seedling tests and a severity of trace to 30% severity and infection responses of MR to MR-MS during adult stage field tests (Newcomb et al. 2013; Roelfs et al. 1992; Stakman et al. 1962). Single plant selections of PI 626573 were used as males and crossed with the susceptible Canadian line LMPG-6 (Little Club//Prelude/8\*Marquis/3/Gabo) to evaluate the mode of inheritance (Acevedo et al. 2011; Knott 1990). Chi-square analysis of seedling tests at the F<sub>3</sub> generation fit a 3:1 segregation ratio indicating resistance was conferred by a single dominant nuclear gene (Acevedo et al. 2011). Due to the results of the Chi-square analysis, the population was advanced via single seed decent and the genetic region was identified using bulk segregant analysis (BSA) and fine mapped using microsatellite markers (SSRs) and the 9K Illumina Infinium iSelect wheat assay (Cavanagh et al. 2013). The current study provides information for the mapping of previously unmapped iSelect SNP markers and the fine mapping of the Ug99 resistance, gene, *SrWLR*, from the landrace PI 626573.

## Materials and Methods

**Population Development and Phenotypic Evaluation.** The previously developed population was created by crossing single plant selections of PI 626573, PI 626573-2 and PI 626573-3, to the female parent LMPG-6 (Acevedo et al. 2011; Knott 1990). The LMPG-6/PI 626573 population was advanced via single seed descent to the F<sub>6</sub> generation. Families with greater than 20 seeds were evaluated at the F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub> generation. The number of families evaluated for the F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub> generations were 166, 245, 240, and 240 individuals, respectively.

The population was phenotyped at seedling stages during the F<sub>3</sub> and F<sub>4</sub> generation in the biosafety level three facility at the University of Minnesota in St. Paul, MN. Seedling infection types were determined using the 0-to-4 scale developed by Stakman et al (1962). Twenty seedlings of each F<sub>3</sub> family and 2 replicates of 10 seedlings for each F<sub>4</sub> family were inoculated 7 to 10 days after planting with *Pgt* race TTKSK isolate 04KEN156/04 urediniospores retrieved from -80°C storage. The spores were revitalized via a 45°C heat shock for 15 min and a 2 to 4 h rehydration under 80% relative humidity created with a KOH solution (Rowell 1984). The spores were suspended in a light-weight mineral oil (Sotrol 170, Phillips Petroleum, Borger, TX, USA) and disseminated onto the primary leaves of the plants using a spray inoculator. The newly inoculated plants were placed in a fume hood for 30 min to facilitate oil evaporation and then placed in a dark dew chamber for 14 h at 18°C followed by a 3 to 4 h period under florescent light to allow for spore germination (Rouse et al. 2012). Plants were then grown for 14 days at 18±2 °C in a greenhouse with a 16 h photo period prior to evaluating the disease. Individuals exhibiting an infection type of 2 or lower were considered resistant and those with infection types of 3 or higher were considered susceptible.

The population was also phenotyped in the field during the F<sub>5</sub> and F<sub>6</sub> generation at the International Stem Rust Nursery at the Kenyan Agricultural Research Institute in Njoro, Kenya. Field trials were planted in hill plots with 10 to 15 seeds per family and replicated two times. The parental lines were planted every 20 entries as checks to validate the distribution of disease pressure in the field. The hill plots were bordered by spreader rows consisting of a mixture of susceptible Kenyan cultivars containing *Sr31* and *Sr24* to select for *Pgt* race TTKST. The spreader rows were inoculated using a mixture of talc powder and urediniospores. Phenotyping was conducted by estimating the area of infection on the stem ranging from 0 to 100 percent, following a modified Cobb Scale, and using categorical scores to evaluate the infection response (Peterson et al. 1948; Roelfs et al. 1992). The infection response categories included resistant (R), moderately resistant (MR), intermediate (M), moderately susceptible (MS), and susceptible (S) and could be used individually or in combination to describe cases where a mixed response was observed (Roelfs et al. 1992). Individuals with an infection response of M or lower were considered to be resistant; whereas, individuals with infection types of MSS or higher were considered susceptible.

**Bulk Segregant Analysis.** A BSA was performed to identify the genetic region of interest. Before advancing to the F<sub>3</sub> generation, DNA was extracted from the F<sub>2</sub> individuals using a CTAB extraction method as described by Stewart and Via (1993). Homozygous resistant and homozygous susceptible F<sub>2:3</sub> families were identified by phenotyping the F<sub>2</sub> derived F<sub>3</sub> seedlings. The DNA from the F<sub>2</sub> generation of ten homozygous resistant and ten homozygous susceptible plants were combined in equal amounts to create resistant and susceptible bulks. The homozygous resistant and susceptible F<sub>2</sub> bulks and parents were genotyped with 1,037 SSRs previously used in the wheat consensus map to confirm the inheritance of the trait and identify

genetic regions responsible for the resistance (Somers et al. 2004). The polymerase chain reactions (PCRs) were accomplished in 10  $\mu$ L volumes containing 0.4 pmol of forward primer, 0.3 pmol of the reverse primer, 0.3 pmol of a M13 primer, 0.125 mM dNTPs, 0.05 units/ $\mu$ L *Taq* DNA polymerase (New England Biolabs, Inc. Beverly, MA, USA), 1X PCR buffer, and 30 ng of DNA. The M13 primers were each labeled with a 6-FAM, NEC, PET, or VIC fluorescent dye to allow for multiplexing during fragment analysis. The PCRs were performed in Applied Biosystems (Foster City, CA, USA) GeneAmp<sup>®</sup> 9700 thermal cyclers programmed to denature the DNA at 94 °C for 10 min, followed by 40 cycles of a 1 min 94 °C denaturation step, a 1 min 50 °C annealing step, and a 1 min 72 °C extension step; the program was then concluded with a final 5 min 72 °C extension step and a 4 °C permanent hold. A 3  $\mu$ L aliquot of each reaction was combined with 0.14  $\mu$ L of GeneScan<sup>™</sup> -500 LIZ<sup>®</sup> size standard (Applied Biosystems) and 6.86  $\mu$ L of formamide; and then denatured for 5 min at 94 °C and placed on ice. The PCR amplicon sizes were evaluated using an ABI 3130xL genetic analyzer and GeneMapper<sup>®</sup> v3.7 software (Applied Biosystems).

**Molecular Marker Analysis and Linkage Mapping.** Linkage mapping was done using SSRs at the F<sub>4</sub> generation and using SSRs and SNPs at the F<sub>5</sub> generation. The DNA from the F<sub>4</sub> and F<sub>5</sub> generations was extracted using the protocol described by Riede and Anderson (1996) with modifications by Liu et al. (2006) and the additional modification of lyophilizing the tissue and grinding it using a Retsch mm301 mixer mill (Retsch GmbH, Haan, Germany) as described in Rouse et al. (2012). Microsatellite markers that were identified from the bulk segregant analysis were used as a foundation for the mapping of the resistance gene at the F<sub>4</sub> generation. Additional microsatellite markers from the region were identified from the consensus map and



used to create a skeletal map of the genetic region (Somers et al. 2004). PCR for the SSRs was performed as described previously.

The large number of SNP markers on the Infinium assay allowed for the development of a genetic map for the population. For the creation of this map polymorphic SSRs from each chromosome were selected from markers identified during the bulk segregant analysis for use as chromosomal anchoring points. PCR was performed as previously described for the chromosome 2B SSRs and additional polymorphic SSRs on the F<sub>5</sub> generation. The F<sub>5</sub> generation was genotyped on the Illumina BeadStation and iScan instruments according to the manufacturer's protocol (Illumina, Inc. San Diego, CA, USA). The proprietary Infinium assay involves whole genome amplification, targeted SNP region capture on a custom iSelect bead chip array as described by Cavanagh et al. (2013), array primer extension, and then a signal amplification that is read by the iScan platform (Steemers and Gunderson 2005). The markers were scored using the Illumina GenomeStudio<sup>®</sup> software. The markers used for mapping were polymorphic and had less than five percent missing data. The linkage maps were constructed using JMP Genomics 6.0 (SAS Institute, Cary, NC, USA) using the interactive hierarchical clustering algorithm to establish linkage groups and the map order optimization algorithm to establish markers positions within a linkage group. The Kosambi mapping function was used to calculate genetic distance between markers (Kosambi 1944). Due to the SSR mapping position of *SrWLR*, the *Sr9* differential lines and cultivar 'Webster' containing *SrWeb* was also included in the Infinium iSelect assay in order to evaluate their similarity to PI 626573 in the genetic region of interest.

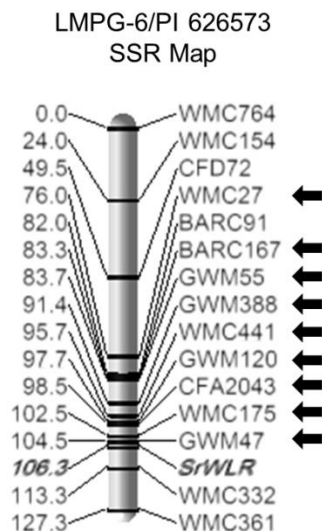
## Results

**Phenotypic Evaluation.** During seedling tests at the F<sub>3</sub> and F<sub>4</sub> generation the lowest infection type observed was a 2- and the highest infection type observed was a 4. The line PI 626573 exhibited a resistant infection type of 2 to 2+ and LMPG-6 exhibited a susceptible infection type of 3 to 34. The lowest observed infection response for the population during the F<sub>5</sub> field trial was 10M and the highest was 40S. The median observed infection responses for the resistant parent PI 626573 and susceptible parent LMPG-6 were 20MRMS and 20S, respectively. The lowest observed infection response for the population during the F<sub>6</sub> field trial was 10MR and the highest infection response was 60S. The median observed infection responses for PI 626573 and LMPG-6 were 10MR and 60S, respectively. Disease reactions observed for the field and seedling trials were consistent; families that were considered susceptible at seedling were also considered susceptible in field evaluations.

**Bulk Segregant Analysis.** The BSA identified a single region of interest and was consistent with the segregation ratio observed by Acevedo et al. suggesting resistance is conferred by a single gene (2011). Of the 1037 SSRs evaluated 640 were polymorphic between the parents, LMPG-6 and PI 626573, and nine markers co-segregated with the resistance phenotype. These nine markers were located on the long arm of chromosome 2B and consisted of BARC167, CFA2043, GWM47, GWM55, GWM120, GWM388, WMC27, WMC175 and WMC441 (Röder et al. 1998; Somers et al. 2004; Song et al. 2005). These SSR markers were used for the initial mapping of the gene.

**Linkage Mapping.** Initial mapping of the gene utilized 15 SSRs selected from both the long and short arm of chromosome 2B and the phenotype from the F<sub>5</sub> generation (Fig. 6). The map produced had a total length of 127.3 cM with a marker density of 0.13 markers per cM. The

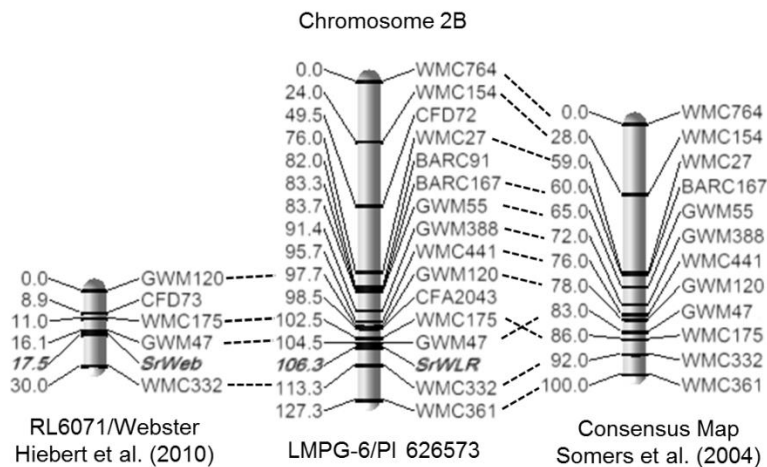
resistance gene, temporarily designated as *SrWLR*, mapped to an 8.8 cM region delimited between the markers GWM47 and WMC332. Co-linearity of this map was conserved with the wheat consensus map with the exception of a micro rearrangement of GWM47 and WMC175 (Fig. 7; Somers et al. 2004). This micro rearrangement has also been observed in the RL6071/Webster population (Hiebert et al. 2010).



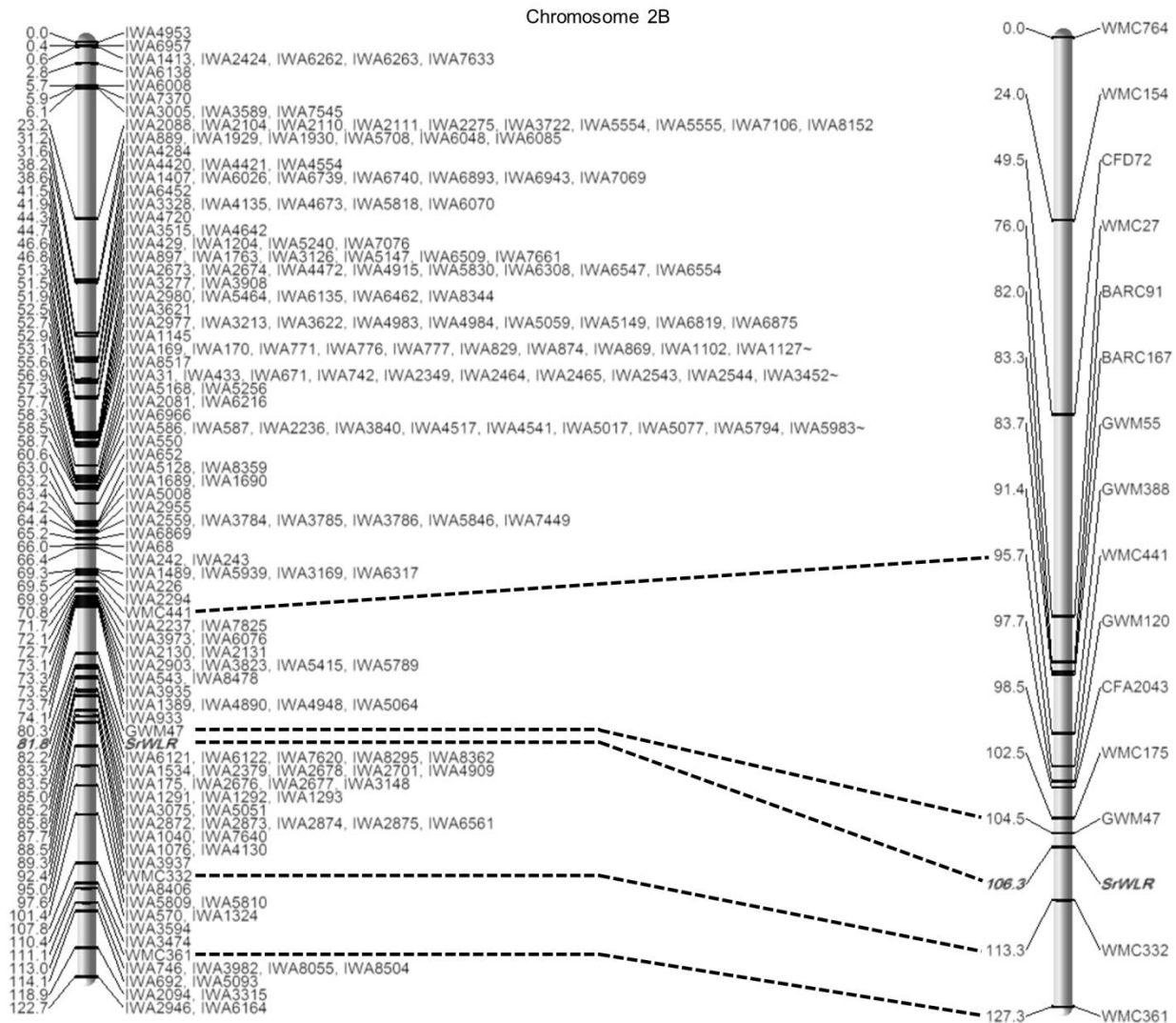
**Figure 6.** Linkage map of *SrWLR* on chromosome 2B using SSR markers. Arrows denote SSRs identified during the BSA. BARC markers are from Song et al. (2005), GWM markers are from Röder et al. (1998), and CFD and WMC markers are from Somers et al. (2004).

The Infinium assay produced 2,827 polymorphic SNP markers that had less than five percent missing data distributed across the entire wheat genome. The map produced had 25 linkage groups (Appendix A Table A1). The overall marker density across the 25 linkage groups was 1.51 markers per cM. Cosegregating loci accounted for 53.8 % of the mapped loci and ranged from two to 48 markers. The chromosome 2B linkage group was 122.7 cM and was established using four of the SSRs from the skeletal map and the phenotype of *SrWLR* from the F<sub>6</sub> generation (Fig. 8). The genetic region delimiting *SrWLR* was reduced from 8.8 cM to 1.9 cM. The *SrWLR* region was delimited 1.5 cM proximally by the SSR GWM47 and 0.4 cM distally by the cosegregating SNPs IWA6121, IWA6122, IWA7620, IWA8295, and IWA8362. Numerous

SNP marker rearrangements were observed between the consensus map and the linkage group in this study; however the markers were in agreement with the assigned chromosomal linkage groups (Cavanagh et al. 2013). Synteny analysis was performed using the Wheat Zapper application to evaluate the accuracy of the map for the *SrWLR* region (Alnemer et al. 2013). The syntenic relationships between *Triticum aestivum*, *Oryza sativa*, *Sorghum bicolor*, and *Brachypodium distachyon* were evaluated around the *SrWLR* region to evaluate the mapping order (Table 1). Synteny was conserved for the linkage map produced in the present study allowing for the conclusion that the mapping order was correct despite the observed rearrangements. The cultivar Webster did not share any alleles with PI 626573 indicating there may not be any shared lineage for the region and that *SrWeb* may be different than *SrWLR* (Table 2). Furthermore, there were not any SNPs identified that could serve as diagnostic markers for *SrWLR*, *SrWeb*, or any of the *Sr9* alleles.



**Figure 7.** Comparison of the LMPG-6/PI 626573 SSR map, wheat consensus map (Somers et al. 2004), and the RL6071/Webster chromosome 2B telocentric map (Hiebert et al. 2010). GWM markers are from Röder et al. (1998), BARC markers are from Song et al. (2005), and CFD and WMC markers are from Somers et al. (2004).



**Figure 8.** Comparison of the chromosome 2B linkage maps produced using the iSelect assay and SSRs. GWM markers are from Röder et al. (1998), BARC markers are from Song et al. (2005), CFD and WMC markers are from Somers et al. (2004), and IWA markers are from Cavanagh et al. (2013). Loci containing more than 10 cosegregating markers are denoted with a tilde (~).

**Table 1.** The syntenic relationships for SNP markers within 5 cM proximally and distally of *SrWLR* and their mapping positions on the map from the present study and the consensus map (Cavanagh et al. 2013).

Marker	Position on Chr. 2B (cM)	Consensus Map Position (cM)	<i>O. sativa</i> Gene	<i>B. distachyon</i> Gene	<i>S. bicolor</i> Gene
IWA2130	72.7	270.15	Os04g52120	Bradi1g26560	Sb06g028130
IWA2131	72.7	270.48	Os04g52120	Bradi1g26560	Sb06g028130
IWA543	73.1	269.13	Os04g51070	Bradi1g02850	Sb06g022480
IWA5415*	73.1	269.63	Os11g31410	Bradi1g32110	Sb06g027770
IWA8478*	73.3	275.11	Os11g45650	Bradi1g04160	Sb06g001175
IWA3935	73.5	262.44	Os04g50970	Bradi5g20320	Sb06g027320
IWA4948	73.7	269.13	Os01g32800	Bradi5g20220	Sb01g027860
IWA1389	73.7	269.13	Os04g50860	Bradi5g20200	Sb06g027240
IWA5064	73.7	275.11	Os04g50790	Bradi5g20150	Sb06g027200
IWA4890	73.7	303.52	Os04g50790	Bradi5g20150	Sb06g027200
IWA933*	74.1	247.93	Os04g21960	Bradi4g04250	Sb01g049840
IWA6121	82.2	300.37	Os04g53440	Bradi5g22410	Sb06g029180
IWA6122	82.2	300.37	Os04g53440	Bradi5g22410	Sb06g029180
IWA8362	82.2	300.37	Os04g53440	Bradi5g22410	Sb06g029180
IWA7620	82.2	299.03	Os04g53440	Bradi5g22410	Sb06g029180
IWA8295	82.2	299.03	Os04g53450	Bradi5g22420	Sb06g029190
IWA2379	83.3	285.21	NA	NA	NA
IWA2701	83.3	285.21	NA	NA	NA
IWA4909	83.3	285.21	Os05g28510	Bradi1g12490	Sb07g001930
IWA1534*	83.3	289.87	Os11g30700	Bradi1g12270	Sb06g003360
IWA2678	83.3	286.72	Os11g11960	Bradi1g42010	Sb06g020600
IWA2676	83.5	291.52	Os11g11960	Bradi1g42010	Sb06g020600
IWA2677	83.5	291.52	Os11g11960	Bradi1g42010	Sb06g020600
IWA3148	83.5	291.52	Os04g53720	Bradi1g45620	Sb06g029476

Markers were organized by the map presented in the current study by syntenic ordering of the three related grass species. NA reflects markers where an orthologous gene was not identified for a particular species.

\*Markers associated with transposable elements

**Table 2.** The allele present for markers in the SrWLR region for Webster and lines containing *Sr9* alleles from the differential set.

Marker	Position on Chr. 2B (cM)	Webster ( <i>SrWeb</i> )	Isr9a-Ra ( <i>Sr9a</i> )	W2691Sr9b ( <i>Sr9b</i> )	Vernstein ( <i>Sr9e</i> )	CnSSr9g ( <i>Sr9g</i> )
IWA8478	73.3	L	P	L	L	L
IWA3935	73.5	L	P	L	L	L
IWA1389	73.7	L	P	L	L	L
IWA4948	73.5	L	P	L	L	L
IWA4890	73.7	L	P	L	L	L
IWA5064	73.7	L	P	P	P	LP
IWA933	74.1	L	P	P	L	LP
IWA8362	82.2	L	P	P	L	LP
IWA7620	82.2	L	P	P	L	LP
IWA6121	82.2	L	P	P	L	LP
IWA6122	82.2	L	P	P	L	LP
IWA8295	82.2	L	P	P	L	P

The DNA genotyped consisted of a bulk of five plants. The presence of the LMPG-6 or PI 626573 allele at a locus is indicated by an L or P, respectively. Loci where both alleles were present for a line are denoted by LP.

## Discussion

The analysis of the segregation ratios at the F<sub>3</sub> generation, the BSA and subsequent genetic mapping determined that the Ug99 resistance in accession PI 626573 is conferred by a single dominant gene as previously hypothesized by Acevedo et al (2011). The ratio of observed polymorphic markers to total markers evaluated between PI 626573 and the line LMPG-6 during the BSA was higher than the typical observed ratio between two modern wheat cultivars. An increased amount of polymorphism between markers has been observed in other landrace populations (Dreisigacker et al. 2005; Reif et al. 2005). As such, the lack of selection pressure through modern breeding practices is the most likely explanation for the higher SSR polymorphism ratio observed between the landrace PI 626573 and the line LMPG-6.

The *SrWLR* locus originally mapped to an 8.8 cM region using SSRs, and was reduced to a 1.9 cM region using a combination of SSRs and SNPs. As stated previously, rearrangements were observed when comparing the map produced in the present study to the consensus map. The rearrangements are not unexpected due to the method in which MergeMap groups markers during consensus map construction (Endelman 2011; Wu et al. 2011). The MergeMap software arranges markers based on their association with nearby markers in multiple mapping populations. When two markers are grouped in at least two populations the markers will be grouped in the consensus map regardless of ordering (Endelman 2011). As such, this grouping causes a loss of physical locality when mapping the markers and may cause an incorrect non-physical ordering that is greatly affected by increased marker density (Endelman 2011). When evaluating the syntenic relationships between *T. aestivum*, *O. sativa*, *B. distachyon*, and *S. bicolor*, the markers IWA933, IWA1534, IWA5415 and IWA8478 do not belong to the syntenic region (Table 1). These markers are associated with sequences homologous to genes annotated as transposable elements in *O. sativa*, *B. distachyon*, and *S. bicolor*. As such, the substantial change in syntenic location for these loci compared to surrounding loci is not unexpected.

Numerous rust resistance genes are present on chromosome 2B including leaf rust resistance genes (*Lr13*, *Lr16*, and *Lr23*), stem rust genes (*Sr9*, *Sr16*, *Sr19*, *Sr23*, *Sr28*, *Sr36*, *Sr40*, and *SrWeb*), and stripe rust resistance genes (*Yr5* and *Yr7*) (Hiebert et al. 2010; McIntosh et al. 1995). Of these resistance genes, only *Sr9*, *Sr16*, *Sr28*, *SrWeb*, *Yr5* and *Yr7* are found on the long arm of chromosome 2B, with *Sr9*, *SrWeb*, *Yr5*, and *Yr7* being located near the SSR GWM47 (Hiebert et al 2010; McIntosh 1995). Based on the mapping data there is a strong possibility that *SrWLR* may be a *SrWeb* or a *Sr9* allele (Hiebert et al. 2010; Tsilo et al. 2007). Currently, none of the *Sr9* alleles have been shown to provide resistance to *Pgt* race TTKSK (Jin



et al. 2007). Both *SrWLR* and *SrWeb* provide similar infection types to Ug99 and do not appear to provide a broad resistance against other races. The races and number of races that *SrWeb* provides resistance to is confounded by the presence of *Sr30* in the cultivar Webster (Hiebert et al. 2010). Also the same micro rearrangement of the SSRs GWM47 and WMC175 was observed in both the LMPG-6/PI 626573 and RL6071/Webster populations (Hiebert et al. 2010). Webster was also included as an entry for the Infinium assay in order to evaluate its similarity to PI 626573 in the genetic region of interest. Evaluation of 12 SNP markers flanking *SrWLR* showed that none of the markers had the same genotype for PI 626573 and Webster, suggesting variability in the region that may indicate *SrWLR* and *SrWeb* may be distinct genes. An allelism study is currently underway to determine if *SrWLR*, *SrWeb*, and *Sr9* are allelic. However, considering that many resistance genes belong to multigene families in tandem arrays, allelism analysis may not determine if *SrWLR*, *SrWeb*, and *Sr9* are truly distinct genes. This question may be answered by cloning the genes and characterizing the surrounding regions of the wheat genome.

Further testing of *SrWLR* has shown the gene is effective against the North American *Pgt* race RKQQC isolate 99KS76A. This was accomplished by mapping the resistance phenotype to the same location on chromosome 2B (data not shown). It is unknown if *SrWeb* provides resistance to race RKQQC due to the presence of *Sr30* in the cultivar Webster (Hiebert et al. 2010). Race RKQQC occurs in very low frequencies in the United States and is not of immediate concern; however the threat of Ug99 does make *SrWLR* a useful gene for the incorporation into adapted germplasm. The iSelect markers in the *SrWLR* region are unsuitable for use as a diagnostic marker for *SrWLR* due to the presence of the PI 626573 allele being present in other cultivars (Table 2). Due to the narrow range of resistance, the pyramiding of additional effective

stem rust resistance genes will be critical to reduce any future selection pressure induced by *SrWLR* as it is incorporated into wheat breeding programs.

The use of high-throughput assays has been demonstrated to be a cost effective way to saturate a region with a large number of markers in wheat (Akhunov et al. 2009; Würschum et al. 2013). Previous assays, such as the Illumina GoldenGate assay, were limited by the number of SNPs that could be run simultaneously. This limitation was overcome with the creation of the Illumina Infinium iSelect assay (Akhunov et al. 2009; Würschum et al. 2013). In the present study, the 9K iSelect assay was able to reduce the region to a fraction of what was previously mapped using SSRs and the future advancement of this assay may provide even higher resolution. The markers IWA6121, IWA6122, IWA7620, and IWA8362 were found to be homologous to the *O. sativa* locus 04g53440, the *S. bicolor* locus 06g029180, and the *B. distachyon* locus 05g22410. There are numerous gene families that have been associated with disease resistance distally located from these loci in *O. sativa*, *S. bicolor*, and *B. distachyon*. Three of the syntenic genes of interest belong to the NBS-LRR gene family, which is commonly associated with race specific resistance (Dubcovsky et al. 2012; Periyannan et al. 2013a., 2013b; Saintenac et al. 2013). As such, future work will be focused on the positional cloning of *SrWLR*. To facilitate the positional cloning of *SrWLR* a new population consisting of 6,382 recombinant gametes has been developed and new markers based on syntenic sequences to *O. sativa*, *S. bicolor*, and *B. distachyon* are being mapped. The present study demonstrates the iSelect assay may not be appropriate for marker assisted selection in the *SrWLR* region but is capable of efficiently fine mapping genes and establishing syntenic relationships in hexaploid wheat.

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## GENETIC DISECTION OF WHEAT STEM RUST RESISTANCE FROM THE MONTENEGRIN SPRING WHEAT LANDRACE PI 362698

### Abstract

Research directed toward the identification and characterization of stem rust resistance genes in common wheat, *Triticum aestivum*, has been stimulated by the emergence of Ug99-lineage races of the wheat stem rust pathogen, *Puccinia graminis* f. sp. *tritici* (*Pgt*), in Eastern Africa. A source of *Pgt* resistance was identified in the spring wheat landrace PI 362698. PI 362698 exhibits resistance to multiple Ug99-lineage and North American races at seedling and adult-plant stages. A recombinant inbred population was developed by crossing the susceptible line LMPG-6 with a single plant selection of PI362698. QTL mapping using the Illumina iSelect 90K wheat assay was performed to identify loci associated with *Pgt* resistance. A total of 14 significant ( $P < 0.1$ ) QTLs were identified on chromosomes 1A, 2B, 3B, 5A, 5B, 6A, and 7D. The QTLs identified on chromosome 3B were identified in adult-plant trials in Kenya and seedling trials with race QFCQC. These QTLs potentially correspond to an allele of *Sr12* or a previously unknown *Pgt* resistance gene. The *Sr57/Lr34/Yr18* multi-pathogen adult-plant resistance gene located on chromosome 7D is present in PI 362698. Significant QTLs were not identified during adult-plant trials; however significant QTLs near the *Sr57/Lr34/Yr18* locus were identified during seedling trials. The QTLs on chromosomes 2B and 6A were identified during seedling trials. The chromosome 2B QTL is thought to be *Sr16* or an allele of *Sr28* and the chromosome 6A QTL is thought to be *Sr8a* based on mapping positions. No *Pgt* resistance genes are currently known to exist on the short arms of chromosomes 5A and 5B suggesting the QTLs identified on chromosomes 5A and 5B may be linked to novel sources of *Pgt* resistance.



## Introduction

The emergence of new races of the wheat stem rust pathogen, *Puccinia graminis* f. sp. *tritici* (*Pgt*), has historically been a problem in many wheat (*Triticum aestivum*) producing regions (Leonard and Szabo 2005; Roelfs 1985; Singh et al. 2008, 2011). *Pgt* is a macrocyclic rust that mainly persists in its asexual uredinial state and is primarily controlled through the use of resistance genes (Leonard and Szabo 2005; Roelfs 1985; Singh et al. 2008, 2011). The use of resistance genes has been particularly effective in the United States due to low pathogen diversity caused by the removal of the alternate host of *Pgt*, the common barberry (*Berberis vulgaris*), which is required for sexual recombination (Kolmer et al. 2007; Roelfs 1985). Despite the preclusion of *Pgt*'s sexual cycle in most of North America, new *Pgt* races occasionally emerge due to a sexual population in the Pacific Northwest and selection pressures imposed upon the *Pgt* population by deployed resistance genes (Kolmer et al. 2007). In Eastern Africa new races also emerge due to selection pressures imposed by resistance deployed resistance genes.

The emergence of Ug99-lineage races and new virulent races in the durum (*Triticum turgidum*) producing regions of Ethiopia has instilled new concerns regarding global food security (Olivera et al. 2012, 2015; Singh et al. 2008, 2011). In 1998 the *Pgt* race TTKSK (Ug99), which is virulent on *Sr31*, was identified in Uganda (Pretorius et al. 2000). Two years later a second *Pgt* race, TTKSF, was identified in South Africa with shared ancestry to Ug99 (Visser et al. 2009). Selection pressure imposed by deployed resistance genes have selected for Ug99-lineage races that are virulent on *Sr24*, *Sr36*, *Sr9h*, and *SrTmp* (Borlaug Global Rust Initiative 2015; Jin et al. 2008; Pretorius et al. 2012; Rouse et al. 2014a; Singh et al. 2011). In the durum producing regions of Ethiopia, cultivars with resistance to Ug99-lineage races were deployed (Olivera et al. 2012, 2015). These cultivars led to selection against Ug99-lineage races

leading to a predominance of the races JRCQ, TRTT, and TKTT in these regions (Olivera et al. 2012, 2015).

Over 60 wheat stem rust resistance genes are found in wheat, at least 31 of which confer resistance to at least one race in the Ug99-lineage race group (Rouse et al. 2014a; Singh et al. 2008, 2011). Approximately one third of stem rust resistance genes and half of the resistance genes effective to Ug99-lineage races were introgressed from wild wheat relatives (Rouse et al. 2014; Singe et al. 2011). Many of these genes suffer from linkage drag and low efficacy when deployed alone (Rouse et al. 2014a). Due to the continued emergence of virulent *Pgt* races it is important to identify and characterize new sources of resistance.

Landraces can serve as unexploited sources of resistance to many diseases. The deployment of previously used resistance sources in modern breeding programs has created diversity bottlenecks for many crop species, creating vulnerability to disease (Tanksley et al. 1997). As such, the increased diversity found in landraces due to their association with traditional farming systems make them useful tools for many wheat breeding programs (Dreisigacker et al. 2005; Reif et al. 2005; Villa et al. 2005; Warburton et al. 2006). Resistance genes and mechanisms identified in landraces are easier to incorporate into adapted material than those from wild relatives (Reif et al. 2005). The identification and subsequent mapping of disease resistance loci from landraces has been effectively applied to wheat (Bonman et al. 2007, Fu et al. 2013, Gurung et al. 2011, Xiao et al. 2013; Zurn et al. 2014).

During a recent study to identify *Pgt* resistance in spring habit *T. aestivum* landraces, Newcomb et al. (2013) evaluated 2,509 accessions from the USDA National Small Grains Collection (NSGC) at the International Stem Rust Nursery at the Kenyan Agricultural and Livestock Research Organization in Njoro, Kenya. A total of 278 accessions resistant to Ug99

were identified, one of which being the accession PI 362698. PI 362698 was collected from Montenegro in 1971 and displayed resistance to *Pgt* race TTKST during adult-plant field trials and race TTKSK during seedling tests at the USDA-ARS Cereal Disease Laboratory in St. Paul, MN. PI 362698 had an infection type that ranged from ;1 to 31; during seedling trials and during adult-plant trials ranged from 0 to 10% and resistant (R) to moderately susceptible (MS) for severity and infection response, respectively (Acevedo et al. 2011; Newcomb et al. 2013). PI 362698 was also shown to have the *Ppd-D1a* and *Sr57/Lr34/Yr18/Pm38/Sb1* allele via diagnostic markers (Newcomb et al. 2013). To evaluate the mode of inheritance for TTKSK resistance a single plant selection of PI 362698, PI 362698-1, was crossed to the susceptible Canadian line LMPG-6 (Little Club//Prelude/8\*Marquis/3/Gabo; Acevedo et al. 2011; Knott 1990). Mendelian ratios corresponding for one to three genes were not observed during seedling resistance evaluations at the F<sub>2</sub> generation suggesting the stem rust resistance to TTKSK found in PI 362698-1 is complexly inherited (Acevedo et al. 2011). Due to the complex nature of inheritance, the LMPG-6/PI 362698-1 population was advanced via single seed descent to identify genetic regions of interest associated with stem rust resistance via QTL analysis.

Composite interval mapping (CIM) is one of the most popular algorithms used in plant quantitative trait locus (QTL) mapping experiments; however its robustness and power is less than that of multiple interval mapping (MIM; Joehanes 2009a, 2009b; Kao et al. 1999). The increased power of MIM stems from the algorithm considering multiple chromosomal regions simultaneously allowing for the detection of multiple QTLs and improved detection of QTL by QTL interactions (Kao et al. 1999). Both of these algorithms, as well as simple interval mapping and Bayesian interval mapping, assume that trait data are normally distributed data (Johanes 2009b; Haley and Knott 1992; Kao et al. 1999; Lander and Botstein 1989; Stephens and Fisch

1998; Zeng 1994). As such, these algorithms experience reduced power when applied to non-normally distributed data which is commonly found in agricultural studies (Box 1953; Dahleen et al. 2012; Johanes 2009b). Data normality is an important factor which is often overlooked for many QTL studies which can have impacts on the ability to detect minor effect QTLs and partial disease resistance, especially in the presence of large effect QTLs (Dahleen et al. 2012; Johanes 2009b). The transformation of data is an option to meet normality assumptions; however transformation often introduces unwanted biases which skew QTL effect estimates (Johanes 2009b). Algorithms based on general linearized models (GLZ), such as CIM-GLZ and MIM-GLZ, are an excellent option to overcome normality issues in trait data which provide more power than the utilization of transformed data on traditional algorithms (Dahleen et al. 2012; Johanes 2009b). The single trait detection algorithms mentioned previously are not powerful enough to detect QTLs in environments with great variability or QTLs which are pleiotropic (Jiang and Zeng 1995; Johanes 2009a). A mixed model approach using multiple traits from multiple variable environments can be used to detect QTLs associated with the desired trait and with environmental variability (Jiang and Zeng 1995; Johanes 2009a). Moreover, different traits may be evaluated for pleiotropy using multiple trait algorithms (Jiang and Zeng 1995; Johanes 2009a). In the current study, the MIM-GLZ and MT-MIM algorithms were utilized to dissect the genetics of the stem rust resistance present in the spring wheat landrace PI 362698.

## **Materials and Methods**

**Population Development.** The susceptible Canadian line LMPG-6 was used as a female parent and crossed to a single plant selection of PI 362698, PI 362698-1 (Acevedo et al. 2011). A recombinant inbred population was created by advancing F<sub>2</sub> families via single seed decent to the

F<sub>6</sub> generation. Seeds from the 142 F<sub>7</sub> generation individuals were pooled and advanced to produce enough seeds for phenotyping.

**Phenotypic Evaluation.** The LMPG-6/PI 362698-1 population and PI 362698 were phenotyped for seedling resistance to North American and African *Pgt* races. PI 362698 was phenotyped with the North American (NA) *Pgt* races MCCF, QFCS, QTHJ, RCRS, RKQQ, TPMK, and TTTT and the African *Pgt* races TRTT, TTKSK, and TTKST to determine the spectrum of seedling resistance present in PI 362698. PI 362698-1 was phenotyped with the NA *Pgt* race QFCQC and the African *Pgt* races TTKSF and TTKSF+. Races MCCF, QFCS, QTHJ, RCRS, RKQQ, TPMK, TTTT, TRTT, TTKSK, and TTKST were evaluated at the University of Minnesota in St. Paul, MN; races TTKSF and TTKSF+ were evaluated at the University of the Free State in Bloemfontein, South Africa and race QFCQC was evaluated at North Dakota State University in Fargo, ND. The LMPG-6/PI 362698-1 population was phenotyped with *Pgt* race TRTTF isolate 06YRM34-1 and race QFCQC. Two replicates of the population was planted in consisting of five seeds per experimental unit. Seedling evaluations at the University of Minnesota and University of the Free State were conducted by inoculating seedling 7 to 10 days after planting with urediniospores retrieved from -80°C storage. A 15 min 45°C heat shock followed by a 2 to 4 h rehydration under 80% relative humidity created with a KOH solution was used to revitalize the urediniospores (Rowell 1984). A spray inoculator was used to distribute a urediniospore and mineral oil suspension (Sotrol 170, Philips Petroleum, Borger, TX, USA). The oil was allowed to evaporate from the plants in a fume hood for 30 min and then plant were placed in a dark dew chamber for 14 h at 18°C. After 14 h, the plants were exposed to fluorescent light for 3 to 4 h and transferred to a 18±2°C greenhouse with a 16 h photo period (Pretorius et al. 2012; Rouse et al. 2012). Inoculations at North Dakota State University were

similar to those conducted at the University of Minnesota and the University of the Free State; however fresh *Pgt* urediniospores were heat shocked at 45°C for 15 min prior to creating a mineral oil suspension (Sotrol 170, Chevron Phillips Chemical Company LLC, Woodlands, TX, USA) and greenhouse temperatures ranged from 20 to 24°C. The plants were grown for 12 to 14 days prior to evaluating the disease using the 0-to-4 scale developed by Stakman et al. (1962).

The LMPG-6/PI 362698-1 population was phenotyped for adult-plant resistance to Ug99-lineage races during the 2014 main season, July to October, and 2015 off season, February to May, at the International Stem Rust Nursery at the Kenyan Agricultural Research and Livestock Organization in Njoro, Kenya. Hill plots with 10 to 15 seeds were planted between spreader rows of Kenyan cultivars containing *Sr31* and *Sr24* to select for *Pgt* race TTKST. The population was replicated two times with the parental lines planted every 20 entries to evaluate the distribution of disease pressure. A mixture of talc powder and urediniospores was used to inoculate the spreader rows. The plants were phenotyped using categorical scores to evaluate infection response and estimating the area of infection using a modified Cobb Scale ranging from 0 to 100 percent (Peterson et al. 1948; Roelfs et al. 1992). Infection response categories could be used individually or in combination to describe multiple responses on a stem. The categories included immune (I), resistant (R), moderately resistant (MR), moderately susceptible (MS), and susceptible (S) (Roelfs et al. 1992).

**Linkage Mapping.** Leaf tissue was collected from each recombinant inbred line (RIL) at the F<sub>6</sub> generation, lyophilized for 24 h, and then ground using a Retsch mm301 mixer mill (Retsch GmbH, Haan, Germany) as described in Rouse et al. (2012). DNA was extracted in 96-welled plates using a modified cetyltrimethylammonium bromide (CTAB) method (Stewart and Via 1993). The F<sub>6</sub> RILs and parental lines were genotyped using the Illumina Infinium iSelect

90K wheat SNP assay (Wang et al. 2014), an Illumina BeadStation, and an Illumina iScan according to the manufacturer's protocol (Illumina Inc., San Diego, CA, USA). The markers were scored using version 1.0 of the polyploid clustering module for Illumina GenomeStudio<sup>®</sup> version 1.9.4 (Illumina Inc.).

The diagnostic STS marker csLv34 was used to amplify and map the cloned *Sr57* resistance gene (Lagudah et al. 2006). Reactions were completed at a volume of 20 µl containing 1X PCR buffer, 2.5 mM MgCl<sub>2</sub>, 187.5 µM dNTPs, 500 nM primer, 60 ng DNA, and 1 unit of GoTaq (Promega Corporation, Madison, WI, USA). Amplification was performed under the following conditions; initial denaturation at 94°C for 5 min, followed by 40 cycles of a 30 s denaturation at 94°C, a 57°C annealing step for 30 s, and an extension step of 72°C for 45 s, followed by a final extension at 72°C for 7 min. Amplicons were visualized via 2% agarose gel electrophoresis.

Markers were used for mapping if they had less than 5 % missing data and fit a 1:1 segregation ratio as determined via  $X^2$  analysis ( $P \geq 0.05$ ). Mapping was conducted using Mapdisto version 1.7.7.0.1.1 using a LOD of 5 and maximum recombination frequency of 0.1 (Loriex 2012). The robustness of the map was evaluated using a ripple command with a window size of five markers. Linkage groups were assigned to chromosomes using the 90K wheat consensus map and combined into chromosomal linkage groups with gaps less than 35 cM (Wang et al. 2014). The genetic distance between markers was calculated using the Kosambi mapping function (Kosambi 1944).

**QTL Analysis.** To utilize the data for QTL analysis, adult-plant infection responses were converted to a numerical value modified from Yu et al. (2011). The disease responses immune (I), resistant (R), resistant-moderately resistant (RMR), moderately resistant (MR), intermediate

(MRMS), moderately susceptible (MS), moderately susceptible-susceptible (MSS), and susceptible were converted to the ordinal values 0, 0.2, 0.3, 0.4, 0.6, 0.8, 0.9, and 1, respectively. Infection coefficients were calculated by multiplying the numerical disease response by the severity percentage (Yu et al. 2011). Seedling infection types were converted from the 0-to-4 Stakman scale to a 0-to-9 linear scale as described by Zhang et al. (2014). Median values were calculated for replicates and used for QTL analysis. The Shapiro-Wilk test was used to determine the normality of continuous population data. Kendall's rank correlation coefficient was calculated for traits during the same growth stage to determine whether to analyze data for pleiotropic or joint effects. All statistical tests were performed using JMP 10.0 (SAS Institute Inc., Cary, NC, USA). QTL analysis was conducted using QGene version 4.3.10 (Joehanes and Nelson 2008). MIM was used to detect QTLs using a scan interval of 2 cM (Kao et al. 1999). Data which did not meet normality assumptions were analyzed using MIM-GLZ (Joehanes 2009b). Data collected during the same growth stage was analyzed using multiple-trait multiple interval mapping (MT-MIM; Johanes 2009a). MT-MIM analysis methods included pleiotropic analysis for data which were not significantly correlated ( $P \geq 0.05$ ) and joint effect and QTL by environment (QTL x E) analysis for data which were significantly correlated ( $P < 0.05$ ). Significant QTLs ( $P < 0.10$ ) were identified using a resampling analysis of 1,000 permutations (Churchill and Doerge 1994). The Kruskal-Wallis one-way analysis of variance test was used to test for QTL by QTL interactions (Q x Q) and post-hoc analysis was conducted using the Steel-Dwass test for multiple comparisons.

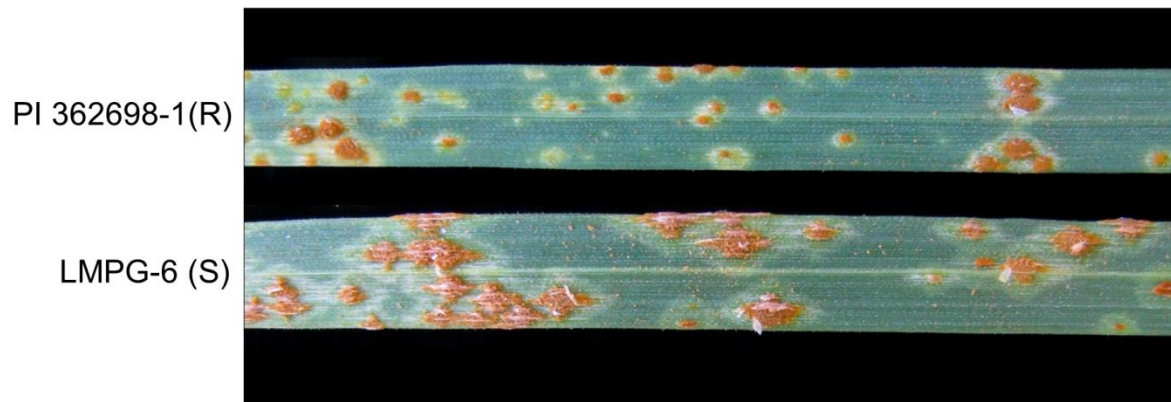


## Results

**Phenotypic Evaluation.** PI 362698 was resistant to the races tested at seedling stages (Table 3). PI 362698 was immune to many of the NA *Pgt* races evaluated at seedling stages. The races TPMK, TTKSK, TTKSF, and TTKSF+ exhibited mesothetic reactions at seedling stages (Fig. 9). When evaluating the LMPG-6/PI 362698-1 population for resistance to NA race QFCQC at seedling stages, the infection types ranged from 1 to 3+4. The QFCQC infection types of the parents ranged from 2-1 to 2 and 3 to 34 for PI 362698-1 and LMPG-6, respectively. The infection types of the LMPG-6/PI 362698-1 population ranged from ;12- to 3+ when inoculated with the African *Pgt* race TRTT. The TRTT infection types of PI 362698-1 ranged from 12- to 2-. The TRTT infection type for LMPG-6 was 3+ for all replications during population phenotyping. Infection response and severity variation was observed for LMPG-6, PI 362698-1, and the LMPG-6/PI 362698-1 population during the 2014 and 2015 adult-plant trials in Kenya (Table 4). The median disease responses during the 2014 adult-plant trial were trace R and 40S for PI 362698-1 and LMPG-6, respectively. During the 2015 adult-plant, the median disease responses were 1RMR for PI 362698-1 and 70S for LMPG-6.

**Table 3.** Median seedling infection types (IT) of PI 362698 when inoculated with North American and African *Pgt* races.

<b>Race</b>	<b>Origin</b>	<b>Median IT</b>
MCCF	N. America	0/;
QFCQC	N. America	22-/2
QFCS	N. America	0
QTHJ	N. America	0
RCRS	N. America	0
RKQQ	N. America	0/1
TPMK	N. America	;3
TTTT	N. America	0
TRTT	Africa	2-
TTKSK	Africa	;3
TTKSF	Africa	;3
TTKSF+	Africa	;3
TTKST	Africa	0



**Figure 9.** Typical mesothetic seedling resistance displayed by PI 362698-1 compared to the susceptible line LMPG-6. Infection types from the African *Pgt* race TTKSF are shown.

**Table 4.** The ranges of disease infection responses (IR) and severities for PI 362698-1, LMPG-6, and the LMPG-6/PI 362698-1 population during the 2014 and 2015 Kenyan adult-plant trials.

Trial	PI 362698-1		LMPG-6		LMPG-6/PI 362698-1	
	IR	Severity	IR	Severity	IR	Severity
Kenya 2014	I to R	0% to Trace	MS to S	20 to 60%	R to S	Trace to 60%
Kenya 2015	R to MR	0% to Trace	MSS to S	40 to 70%	R to S	Trace to 70%

**Linkage Mapping.** The STS marker csLv34 and 6,794 SNP markers from the 90K Infinium iSelect wheat assay met the mapping criteria. A genomic map consisting of 2,138 unique loci (bins) distributed across 30 linkage groups was produced with csLv34 and 6,766 of the SNP markers (Appendix C Table C1). Co-segregating markers were found at 42.9% of the bins, ranging from 2 to 90 co-segregating markers per bin. The genomic map had densities of 0.71 bins per cM and 2.26 markers per cM.

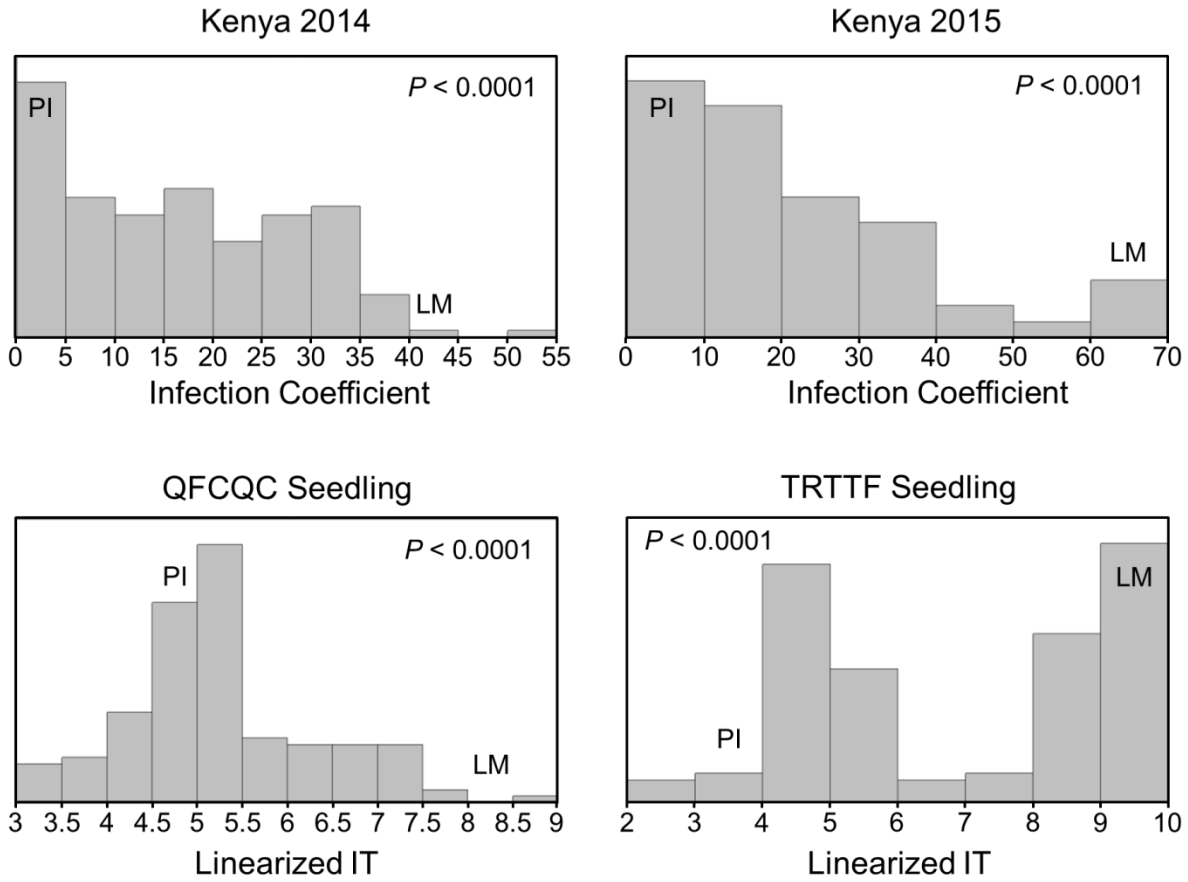
**QTL Analysis.** Evaluation of normality using the Shapiro Wilk test revealed that all data from the adult and seedling trials were not normally distributed (Fig. 10). As such, the MIM-GLZ algorithm was utilized to evaluate the traits. A total of 13 significant QTLs were identified using MIM-GLZ, 10 during seedling trials and 4 during adult plant trials (Table 5).

During the QFCQC seedling trial, 3 significant QTLs were identified located on the long arm of chromosome 2B and centromeres of chromosomes 4A and 7D. Significant Q x Q

interactions ( $P < 0.0001$ ) were detected between *Qsr.ace-2B* and *Qsr.ace-4A* and *Qsr.ace-7D2* and *Qsr.ace-4A* during the QFCQC seedling trial (Fig. 12). A total of 7 significant QTLs were identified during the TRTTF seedling trial; three on the short arms of chromosomes 5A, 5B, and 6A; three near the centromeres of chromosomes 3B and 7D; and one on the long arms of chromosomes 2B. The QTL located on the short arm of chromosome 6A, *Qsr.ace-6A*, explains 96% of the phenotypic variation. The two QTLs identified during the TRTTF trial on the chromosome 7D linkage groups, *Qsr.ace-7D1* and *Qsr.ace-7D2*, are both located near the centromere. The Kendall's rank correlation coefficient determined there was not a significant correlation ( $P = 0.551$ ) between the QFCQC and TRTTF seedling trials. As such, pleiotropic analysis was performed using the MT-MIM algorithm to identify minor effect QTLs associated with resistance. Significant QTLs were not identified during the pleiotropic analysis of the seedling data.

QTLs identified during adult plant trials were found on the long arm of chromosome 1A and near the centromere of chromosome 3B. *Qsr.ace-3B* was identified was identified in both field trials; however *Qsr.ace-1A* was only identified during the 2014 adult-plant trial. A peak at the *Qsr.ace-1A* locus was present but not significant during the 2015 adult-plant trial. Significant Q x Q interactions ( $P < 0.0001$ ) were detected at the *Qsr.ace-3B* and *Qsr.ace-1A* loci (Fig. 11). An additive effect was observed between the PI 362698-1 allele at *Qsr.ace-3B* and the LMPG-6 allele at *Qsr.ace-1A*. No significant QTLs at the *Sr57* adult-plant resistance locus were identified during adult trials. A significant correlation ( $P < 0.0001$ ) was identified between the 2014 and 2015 adult-plant trials using Kendall's rank correlation coefficient. As such, MT-MIM analysis performed for joint effects and QTL x E interactions. One significant QTL, *Qsr.ace-3B*, was

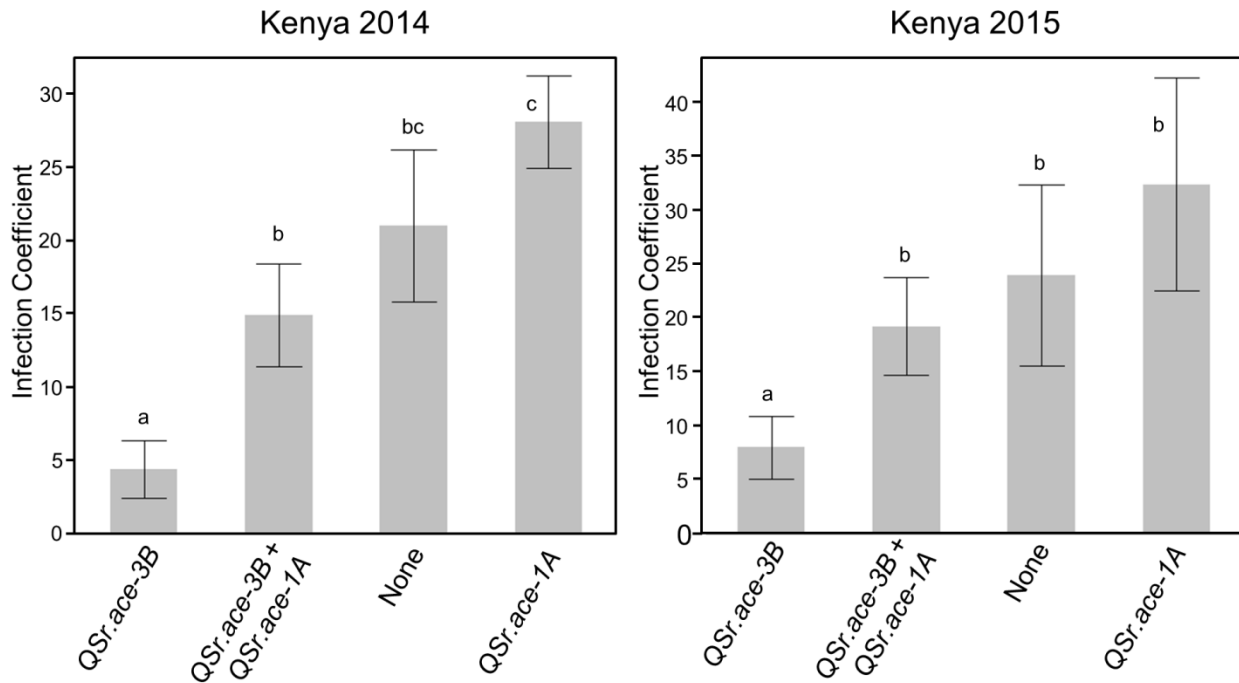
detected near the centromere of chromosome 3B (Table 4). Significant QTLs were not identified when performing QTL x E analysis.



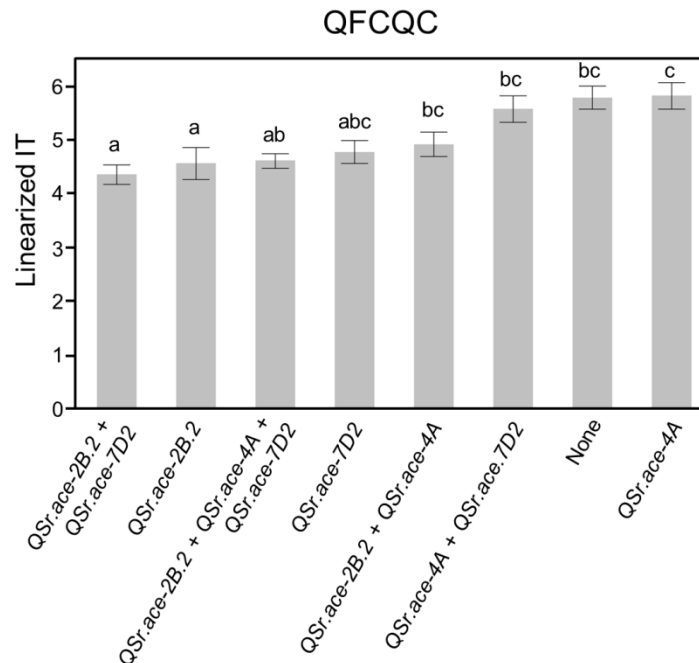
**Figure 10.** Distributions of the seedling and adult-plant data for the LMPG-6/PI 362698-1 population. Median values for PI 362698-1 and LMPG-6 are designated with PI and LM, respectively.  $P$ -values in corners of each graph correspond to the Shapiro Wilk test of normality where  $P$ -values of less than 0.05 indicate non-normality.

**Table 5.** Significant QTLs identified for the LMPG-6/PI 362698-1 population.

Trait/QTL	Algorithm	Flanking Markers (Position cM)	LOD	R <sup>2</sup>	Additive
Kenya 2014					
<i>QSr.ace-1A</i>	MIM-GLZ	IWA3783 (174.0)-IWA7757 (176.0)	4.45	0.15	9.36
<i>QSr.ace-3B</i>	MIM-GLZ	IWA210 (89.5)-IWA7388 (95.6)	11.15	0.34	-6.58
Kenya 2015					
<i>QSr.ace-3B</i>	MIM-GLZ	IWB69999 (75.3)-IWB3668 (83.0)	8.11	0.30	-7.84
Kenya 2014 & 2015					
<i>QSr.ace-3B</i>	MT-MIM Joint Effect	IWA210 (89.5)-IWA7388 (95.6)	10.41	0.27	-5.94
QFCQC					
<i>QSr.ace-2B.2</i>	MIM-GLZ	IWB59226 (174.9)-IWB46446 (177.9)	14.26	0.38	-0.54
<i>QSr.ace-4A</i>	MIM-GLZ	IWA3877 (71.1)-IWA4254 (72.8)	6.91	0.21	0.40
<i>QSr.ace-7D2</i>	MIM-GLZ	IWA1247 (0.0)-IWA23802 (7.4)	6.78	0.20	-0.36
TRTTF					
<i>QSr.ace-2B.1</i>	MIM-GLZ	IWB20453 (120.8)-IWB72408 (123.2)	11.12	0.33	-0.26
<i>QSr.ace-3B</i>	MIM-GLZ	IWB69999 (75.3)-IWB3668 (83.0)	19.48	0.50	1.44
<i>QSr.ace-5A1</i>	MIM-GLZ	IWB26906 (5.3)-IWB30060 (8.2)	12.28	0.36	0.50
<i>QSr.ace-5B</i>	MIM-GLZ	IWB22465 (3.2)-IWB35827 (6.4)	12.76	0.37	-0.92
<i>QSr.ace-6A</i>	MIM-GLZ	IWB882 (5.2)-IWB2598 (7.2)	91.55	0.96	-1.95
<i>QSr.ace-7D1</i>	MIM-GLZ	IWB74313 (7.6)-csLv34 (43.1)	15.70	0.43	-0.50
<i>QSr.ace-7D2</i>	MIM-GLZ	IWA1247 (0.0)-IWA23802 (7.4)	14.06	0.40	0.47



**Figure 11.** The effects of the PI 362698-1 allele at the *QSr.ace-3B.2* and *QSr.ace-1A* loci on adult-plant resistance during the 2014 and 2015 trials in Kenya. Genotypes with the same letter (a-c) are not significantly different and were arranged in a manner where ‘a’ is the most resistant and ‘c’ is the most susceptible.



**Figure 12.** Effects of the PI 362698-1 allele at significant QFCQC QTLs on the phenotype. QTL combinations with the same letter (a-c) are not significantly different. The lower the linearized infection type (IT) the more resistant the QTL combination.

## Discussion

PI 362698-1 is a highly resistant wheat landrace which contains multiple resistance genes. Significant QTLs were identified on chromosomes 1A, 2B, 3B, 4A, 5A, 5B, 6A, and 7D. QTLs identified on chromosomes 3B and 7D were identified in multiple trials. Significant QTLs were identified on chromosome 1A and 3B during adult-plant trials and 2B, 3B, 4A, 5A, 5B, 6A, and 7D during the seedling trials. Resistance to Ug99-lineage races found in Kenya are conferred by QTLs found on chromosome 1A and 3B. QTLs mapping to chromosome 2B, 4A, and 7D contribute to seedling resistance to *Pgt* race QFCQC. TRTTF resistance is associated with QTLs identified on chromosomes 2B, 3B, 5A, 5B, 6A, and 7D.

The *Q<sub>Sr.ace-3B</sub>* QTL was identified during the 2014 and 2015 Kenyan adult plant trials using the MIM-GLZ and MT-MIM algorithms and during the TRTTF seedling trials using the MIM-GLZ algorithm. *Q<sub>Sr.ace-3B</sub>* maps near the centromere of chromosome 3B and its mapping position varies by 6 cM between trials. This mapping discrepancy is likely due to environmental variation and the effects of other QTL in the genome. The resistance gene *Sr12* maps near the centromere of chromosome 3B, however it is ineffective against Ug99-lineage races (Rouse et al. 2014b; Singh et al. 2008, 2011). As such, *Q<sub>Sr.ace-3B</sub>* may be associated with a new gene or a previously unknown allele of *Sr12*.

QTLs were detected on the long arm of chromosome 1A during the 2014 and 2015 adult-plant trials in Kenya however the QTL, *Q<sub>Sr.ace-1A</sub>*, was only significant during the 2014 trial. When the PI 362698-1 allele is present at the *Q<sub>Sr.ace-1A</sub>* locus, increased susceptibility was observed for both the 2014 and 2015 Kenyan adult-plant trials (Fig. 11). QTLs have been described in multiple studies on the long arm of chromosome 1A that interact with *Sr12* to increase susceptibility to *Pgt* (Rouse et al. 2014b; Singh et al. 2013). The QTLs described by

Rouse et al. (2014b) and Singh et al. (2013) were identified using DArT markers making comparisons between maps difficult.

The significant QTLs identified on linkage groups 7D1 and 7D2, *Q<sub>Sr.ace-7D1</sub>* and *Q<sub>Sr.ace-7D2</sub>*, map near the centromere of chromosome 7D. Linkage groups 7D1 and 7D2 consist of the short and long arms of chromosome 7D, respectively. Marker density near the centromere of 7D is low resulting in two linkage groups. The pleiotropic adult-plant resistance gene *Sr57/Lr34/Yr18/Pm38/Sb1* mapped to the centromeric end of the 7D1 linkage group. However, no significant QTLs near the *Sr57* locus were observed during the 2014 or 2015 Kenyan trials when using the MIM-GLZ or MT-MIM algorithms. *Sr57* has been shown to be greatly influenced by environmental variation which can explain why no effects were detected during the adult-plant trials (Rouse et al. 2014b; Rutkoski et al. 2014; Yu et al. 2011). Interestingly, *Q<sub>Sr.ace-7D1</sub>* and *Q<sub>Sr.ace-7D2</sub>* were detected during seedling trials. Risk et al. (2012) observed effects from the *Sr57* locus in cooler temperatures and in specific genetic backgrounds during wheat leaf rust seedling trials. Despite *Sr57* being considered an adult-plant resistance gene, it has been shown to provide enhancing effects to other stem rust resistance genes at seedling stages (Kerber and Aung 1999). *Q<sub>Sr.ace-7D1</sub>* was detected only during the TRTTF trial and *Q<sub>Sr.ace-7D2</sub>* was detected for both the QFCQC and TRTTF seedling trials. *Q<sub>Sr.ace-7D2</sub>* provided resistance during the QFCQC trial however no additive effects were detected with other resistance QTLs (Fig. 12). Due to the low mapping resolution near the centromere, it is difficult to determine if the significant QTLs detected on chromosome 7D in the present study may be from *Sr57* or an additional unknown gene.

A major QTL was detected on the short arm of chromosome 6A during the TRTTF seedling trial. The genes *Sr8a*, *Sr22*, *Sr24*, *Sr26*, *Sr27*, *Sr31*, *Sr33*, *Sr35*, *Sr39*, *Sr40*, *Sr46*, *Sr47*,



*Sr50*, and *SrSatu* are all effective against TRTTF (Olivera et al. 2012). Of the effective genes, only *Sr8a* originates in *T. aestivum* and maps to the short arm of chromosome 6A (Guerrero-Chavez et al. 2015; Singh et al. 2011). Comparative mapping suggests *Q<sub>Sr.ace-6A</sub>* is *Sr8a*. The population distribution of the TRTTF seedling data was bimodal, suggesting resistance is strongly influenced by a single gene (Fig. 10). The results are in line with the bimodal distribution, as *Q<sub>Sr.ace-6A</sub>* explained 96% of the phenotypic variation. Multiple QTLs were identified during the TRTTF seedling trial, however the manner in which they interact is unknown due to the overwhelming effect of *Q<sub>Sr.ace-6A</sub>*.

Two QTLs were identified on the long arm of chromosome 2B during seedling trials. *Q<sub>Sr.ace-2B.1</sub>* and *Q<sub>Sr.ace-2B.2</sub>* were detected during the TRTTF and QFCQC seedling trials, respectively. The stem rust resistance genes *Sr9*, *Sr16*, *Sr28*, and *SrWLR* are present on the long arm of chromosome 2B (Rouse et al. 2012, 2014a; Zurn et al. 2014). *Q<sub>Sr.ace-2B.1</sub>* maps near the *Sr9* alleles and *SrWLR*, which are not effective against *Pgt* race TRTTF (Olivera et al. 2012; Rouse et al. 2014a; Zurn et al. 2014). The effects of *Q<sub>Sr.ace-2B.1</sub>* in the present study are not known due to the large effect of *Q<sub>Sr.ace-6A</sub>*. Comparative mapping results from McIntosh (1978), Rouse et al. (2012), and Zurn et al. (2014) suggests *Q<sub>Sr.ace-2B.2</sub>* could be *Sr16*, *Sr28*, an allele of *Sr16* or *Sr28*, or a new gene. *Sr16* is considered as a seedling resistance gene and often does not contribute to adult-plant resistance (Garvin Vangas et al. 2008; Kolmer et al. 2011) *Sr16* is thought to be in the background of many wheat accessions and virulence to *Sr16* is relatively common (Kolmer et al. 2011). *Sr28* provides moderate resistance to TTKSK and TTKST at adult-plant stages and exhibits mesothetic infection types to each race at seedling stages; however *Sr28* does not provide resistance to the NA races MCCF, RCRS, RKQQ, and QFCS (Rouse et al. 2011). *Q<sub>Sr.ace-2B.2</sub>* may be associated with *Sr16* as it is commonly

observed during seedling trials or a new allele of *Sr28* which is effective to NA races at seedling stages and not effective against Ug99-lineage races.

The significant QTL identified near the centromere of chromosome 4A, *QSr.ace-4A*, increases susceptibility to *Pgt* race QFCQC (Fig. 12). This increase in susceptibility is observed in the presence of *QSr.ace-2B.2* and *QSr.ace-7D2*. Crossa et al. (2007) reported a stem rust resistance QTL near the centromere of chromosome 4A during adult-plant evaluations of *T. aestivum*. This QTL's effect on resistance is unknown because it was identified during an association mapping study.

*QSr.ace-5A* maps near the telomere of the short arm of chromosome 5A and *QSr.ace-5B* maps to the short arm of chromosome 5B. No previously identified stem rust resistance genes are located on the short arms of chromosomes 5A and 5B; however QTLs on the short arms have been identified during *Pgt* association mapping studies of durum and common wheat. Letta et al. (2014) reported QTLs near the telomere of the short arm of 5A and the short arm of 5B during seedling TTKSK and JRCQC trials of durum wheat. Similarly, an adult-plant Ug99 stem rust resistance QTL was reported on the short arm of chromosome 5B of common wheat; however the QTL was inconsistent between replicates (Yu et al. 2011).

The identification of stem rust resistance QTLs at genomic locations harboring known resistance genes and the identification of novel loci makes PI 362698 a useful accession for future breeding efforts. Additional work is needed to validate the detected QTLs. Future work will focus on the replication of greenhouse studies and the evaluation of new *Pgt* races to further dissect the resistance found in PI 362698-1. Additionally, lines from the LMPG-6/PI 362698-1 population without the PI 362698 alleles at major QTLs are being selected to create new

populations to validate and potentially identify additional minor effect QTLs associated with *Pgt* resistance.

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## UNRAVELING THE WHEAT STEM RUST INFECTION PROCESS ON BARLEY GENOTYPES THROUGH RELATIVE QPCR AND FLUORESCENCE MICROSCOPY <sup>2</sup>

### Abstract

The infection process of wheat stem rust (*Puccinia graminis* f. sp. *tritici*) on barley (*Hordeum vulgare*) is often observed as a mesothetic infection type at the seedling stages and cultivars containing the same major resistance genes often show variation in the level of resistance provided against the same pathogen race or isolate. Thus, robust phenotyping data based on quantification of fungal DNA can improve the ability to elucidate host-pathogen interaction, especially at early time points of infection when disease symptoms are not yet evident. The use of quantitative real time polymerase chain reaction (qPCR) was used to determine the amount of fungal DNA relative to host DNA in infected tissue providing new insights about fungal development and host resistance during the infection process in this pathosystem. The stem rust susceptible cultivar ‘Steptoe’, resistant cultivars containing only *Rpg1* (‘Beacon’, ‘Morex’, and ‘Chevron’), and the resistant line Q21861 containing *Rpg1* and the *rpg4/Rpg5* complex were evaluated using the traditional 0-4 rating scale, fluorescence microscopy, and q-PCR. Statistical differences ( $P < 0.05$ ) were observed in fungal development as early as 24 hours post inoculation using the qPCR assay. Fungal development observed using fluorescence microscopy displayed the same hierarchical ordering observed using the qPCR assay. The fungal development occurring at 24 and 48 hours post inoculation was vastly different

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<sup>2</sup> The material in this chapter is reprinted with permission from the American Phytopathological Society from the article Zurn, J. D., Dugyala, S., Borowicz, P., Brueggemen, R., and Acevedo, M. 2014. Unraveling the wheat stem rust infection process on barley genotypes through relative qPCR and fluorescence microscopy. *Phytopathology* 105:707-712. Jason Zurn’s role in this manuscript was the conduction of the qPCR experiment and analysis and interpretation of the qPCR and microscopy data. Additionally, Jason Zurn wrote the manuscript and performed corrections suggested by the co-authors and the journal’s reviewers.

than what was expected using the traditional disease phenotyping methodology; with Steptoe appearing more resistant than the barley lines harboring the known *Rpg1* and *rpg4/Rpg5* resistance complex. This data indicates potential early pre-haustorial resistance contributions in a cultivar considered susceptible based on infection type. Moreover, the temporal differences in resistance suggests pre- and post-haustorial resistance mechanisms in the barley-wheat stem rust infection process, indicating potential host genotype contributions related to basal defense during the wheat stem rust infection process.

## **Introduction**

In the early 20th century many epidemics of wheat stem rust, caused by *Puccinia graminis* f. sp. *tritici* Erikss. & E. Henning, caused large yield losses for common wheat (*Triticum aestivum* L.), durum wheat (*T. turgidum* subsp. *durum* (Desf.) Husn.), and barley (*Hordeum vulgare* L.). Since then, *P. graminis* has been primarily managed through the removal of its alternate host the common barberry (*Berberis vulgaris* L.), and the introduction of resistant wheat and barley cultivars (Leonard and Szabo 2005). The barberry eradication program in the United States was particularly effective by eliminating the sexual stage of *P. graminis* (Leonard and Szabo 2005). The removal of the pathogen's sexual stage precludes genetic recombination; dramatically slowing the emergence of new races and allowing for the prediction of race prevalence on a yearly basis (Roelfs 1982).

The distribution of resistant barley varieties to farmers has mitigated damage caused by *P. graminis* f. sp. *tritici* since the 1940's (Steffenson 1992). This is mainly due to the incorporation of the gene *Rpg1*, which was acquired from the cultivar 'Kindred' in the United States and the cultivar 'Peatland' in Canada, and is now fixed in all Midwestern barley cultivars (Brueggeman et al. 2002). *Rpg1* provides the majority of resistance to endemic races of the stem

rust pathogen in the Midwestern United States and Prairie Provinces of Canada (Brueggeman et al. 2002; Chelkowski et al. 2003). Furthermore, significant effort has been devoted towards the characterization of *Rpg1* due to its long standing success as a durable resistance gene. The emergence of highly virulent Ug99 lineage in Eastern Africa in 1999 and races virulent on *Rpg1* from the Pacific Northwest in 1989 and the ensuing identification of the *rpg4/Rpg5* resistance complex effective against these races have warranted a need to better understand the barley-wheat stem rust pathosystem (Pretorius et al. 2000; Steffenson 1992; Steffenson et al. 2012).

*Rpg1*-containing cultivars often exhibit varying resistant infection types due to their unique genetic backgrounds (Nirmala et al 2007; Steffenson 1992; Sun and Steffenson 2005; Zhang et al. 2006). The quantitative interactions of genes influencing this phenomenon are not currently fully understood. The use of a traditional 0-to-4 scoring scale on barley seedling is often complicated by a mesothetic reaction to many pathotypes of *P. graminis* (Derevnina et al. 2014; Steffenson 1992; Steffenson and Wilcoxson 1985). Quantification of fungal DNA by quantitative real-time polymerase chain reaction (qPCR) is an effective way to overcome the limitations of evaluating host-pathogen interaction solely based on categorical data collected using the 0 to 4 scale. This method also allows for a more robust assessment of temporal interactions occurring during the infection process because of the ability to assess early stages of the infection process.

The use of absolute qPCR for resistance phenotyping has been used successfully for other cereal pathosystems, such as crown rust (caused by *Puccinia coronata* f. sp. *avenae* P. Syd. & Syd.) in *Avena sativa* L. (Jackson et al. 2006). The process described by Jackson et. al. (2006), involved a series of laborious measurements which lead to the development of a relative assay; which overcame the measurement issues by using specific primer and probe combinations for a

reference gene instead of relying on dry weight measurements (Acevedo et al. 2010b). The use of relative qPCR assays has been shown to provide an accurate way to characterize a cultivar's phenotype; as well as provide information about cultivar resistance prior to the appearance of symptoms in numerous pathosystems (Acevedo et al. 2010b; Atallah et al. 2007; Atallah and Stevenson 2006; Hu et al. 2013; Pasche et al. 2013; Rashed et al. 2013). Additionally, relative qPCR has been successfully utilized to map quantitative trait loci associated with adult partial resistance (Acevedo et al. 2010a).

Because disease symptoms are not visible until 8 or 9 days after inoculation, it is difficult to determine how the wheat stem rust infection progresses during early stages of development. Currently, the best methodology for assessing the infection process at early stages is through the use of fluorescence microscopy. Fluorescence microscopy has been used to evaluate the infection process of wheat rusts; however the methodology surrounding sample preparation is laborious for large sample sizes (Kuck et al. 1981; Moldenhauer et al. 2006; Rohringer et al. 1979; Rohringer et al. 1977; Wang et al. 2013). Thus, the objective of this project was to develop a qPCR assay to assess the infection process at multiple time points, determine the accuracy of the qPCR assay at early stages using fluorescence microscopy and late stages using traditional phenotyping, and evaluate cellular and physical differences in host resistance at the early stages of the infection process.

## **Materials and Methods**

**Host and Inoculum.** Four barley cultivars ('Steptoe', 'Beacon', 'Morex', and 'Chevron') and the line Q21861 were grown in a completely randomized design with an experimental unit consisting of two plants. The experimental units were replicated four times for each time point to be evaluated for the qPCR assay. The experiment was performed twice to account for biological

and experimental variation. An independent set of the same varieties consisting of 12 replications of one plant per genotype per time point was also planted for evaluation using fluorescence microscopy. The cultivar Steptoe does not contain any previously characterized resistance genes to *P. graminis*, the cultivars Beacon, Morex, and Chevron have the major resistance gene *Rpg1*, which is effective against *P. graminis* f. sp. *tritici* race MCCFC used in this study, and the line Q21861 contains both *Rpg1* and the *rpg4/Rpg5* resistance complex, which is also effective against *P. graminis* f. sp. *tritici* race MCCFC (Brueggeman et al. 2009; Nirmala et al. 2007; Nirmala et al. 2010). Plants were grown in a growth chamber with a day-and-night cycle of 14 and 10 h and a temperature of 22 and 18°C. Seven days after planting the seedlings were inoculated via a spray inoculation with *P. graminis* f. sp. *tritici* race MCCFC at a concentration of  $7 \times 10^6$  urediniospores/mL of Soltrol 170 (Chevron Phillips Chemical Company LLC, Woodlands, TX).

#### **Sample Handling, Phenotypic Evaluation, and Standard Development for qPCR.**

Four tissue samples were collected for the qPCR assays at five time points for each barley genotype reflecting a natural progression of the infection process. The temporal points for the first experiment included prior to inoculation, immediately after inoculation, 48 h post inoculation (HPI), 6 days post inoculation (DPI), and 14 DPI. The temporal points for the second experiment included prior to inoculation, immediately after inoculation, 24 and 48 HPI and 6 DPI. At each time point, 5 cm of tissue was collected from the center of the leaves and stored in a 2-ml micro tube and stored at -80°C until all samples were collected. At 12 DPI, all plants were scored prior to tissue collection using a 0-to-4 scale and the median infection type observed was used to establish resistance levels to *P. graminis* f. sp. *tritici* race MCCFC for each cultivar. The 0-to-4 scale used was modified from the scale used to evaluate *P. graminis* f. sp. *tritici* infection

in wheat (Stakman et al. 1962). In the scale an infection type of 0 indicates the absence of symptoms, a fleck (;) infection type indicate necrosis in the absence of visual uredinial pustules, an infection type of 1 indicates a pustule surrounded by necrosis, an infection type of 2 indicates a pustule surrounded by chlorosis, and infection type of 3 is defined as a round pustule without chlorosis, and an infection type of 4 is defined as a large and often diamond shaped pustule. Additionally, a plus (+) or minus (-) sign was used to indicate increased or decreased sporulation that deviate from what is typically observed for an infection type, and a mesothetic reaction was denoted with a X. In cases where multiple infection types are observed on a leaf, each infection type was recorded in order of frequency observed on the leaf. Infection types of 0, fleck (;), 1, 2, and X are considered resistant and infection type of 3 and 4 are susceptible.

DNA for the standards and samples was extracted using a modified cetyltrimethylammonium bromide method (Stewart and Via 1993). Host and pathogen standards for this experiment consisted of DNA extracted from the barley variety Steptoe and *P. graminis* f. sp. *tritici* race MCCFC urediniospores, respectively. Five-point serial host and pathogen standards were developed by diluting genomic DNA to concentrations ranging from 200 ng/μl to 2.47 ng/μl along a three-fold serial dilution in accordance with the MIQE guidelines (Bustin et al. 2009).

**Evaluation of Stem Rust Infection Progression via qPCR.** Fungal DNA was amplified utilizing a previously developed hydrolysis probe and species specific markers (Barnes and Szabo 2007). Primers and hydrolysis probes for the reference gene (Table 6) were developed based on a barley ubiquitin gene (Genbank accession M60175) identified by Rostoks et al. (2003). Primers were obtained from Sigma Aldrich (St. Louis, MO) and hydrolysis probes were obtained from Life Technologies (Carlsbad, CA). The expected amplicon size is 242 and 270 bp

for the barley (Hvubi-F1 and Hvubi-R1) and rust primers (ITS1rustF10d and ITS1rustR3c), respectively. Amplicon size was confirmed through conventional PCR and agarose gel electrophoresis. Reactions were completed at a volume of 20 µl containing 1X PCR buffer, 2.5 mM MgCl<sub>2</sub>, 187.5 µM dNTPs, 500 nM primer, 60 ng DNA, and 1 unit of GoTaq (Promega Corporation, Madison, WI). Amplification was performed under the following conditions; initial denaturation at 94°C for 5 min, followed by 40 cycles of a 30 s denaturation at 94°C, a 60°C annealing step for 30 s, and an extension step of 72°C for 45 s, followed by a final extension at 72°C for 7 min. The specificity of the fungal and barley primers and probes was confirmed on the standards through qPCR. This was accomplished by running the markers with their corresponding template DNA, with the opposite DNA, and as a multiplex reaction with both barley and fungal DNA present; to insure no reaction inhibition or nonspecific amplification occurs. All qPCR reactions were performed in a Bio-Rad Laboratories C1000 thermocycler with an attached CFX96 real-time PCR detection system (Bio-Rad Laboratories, Hercules, CA) utilizing the following protocol; denaturation of 95°C for 3 min followed by 40 cycles of a 15 s denaturation at 95°C and a 1 min annealing step at 60°C. The reactions were optimized to a volume of 25 µl in clear 96 well PCR plates (Bio-Rad Laboratories) using iQ multiplex powermix (Bio-Rad Laboratories) with each reaction containing 8.75 pmol of each ubiquitin primer and probe and 5 pmol of each fungal primer and probe. The efficiency ( $\text{efficiency} = 10^{(1/\text{slope}) - 1}$ ) of the experiment was then calculated to determine multiplex suitability and repeatability (Bustin et al. 2009).

**Table 6.** Barley ubiquitin and *P. graminis* f. sp. *tritici* ITS primer and probe sequences.

Primer/Probe	Sequence (5'-3')
Hvubi-F1	ACTACAACATCCAGAAGGAGTCCAC
Hvubi-R1	GTCGAAGTGGTTGGCGGCCATGAAGGTC
Hvubi VIC	VIC-CGCCAAGAAGCGCAAGAAGAAGACGTACACC-MGBNFQ
ITS1rustF10d	TGAACCTGCAGAAGGATCATT
ITS1rustR3c	TGAGAGCCTAGAGATCCATTGTTA
Pg FAM 1	6FAM-TTGTGGCTCGACTCTCTTATAAACCAAACC-MGBNFQ

The samples for each time point were run in replicate using the previously mentioned conditions and the assay was repeated twice. Each assay consisted of the samples from one time point and the standards. Samples where quantification cycle (Cq) values were greater than 37 or where Cq values for a primer set differed by more than one cycle between replicates within an assay were removed from analysis. The varieties were evaluated by subtracting the Cq value of the barley hydrolysis probe from the Cq value of the fungal hydrolysis probe for each sample to normalize for the amount of barley tissue present. A Shapiro-Wilk test was used to establish population normality at each time point followed by an analysis of variance (ANOVA) for the cultivars and line to determine if statistical differences were observed. Tukey's honest significant difference test was performed to establish statistical differences between cultivars and provide a ranking from most to least amount of fungal DNA present. All statistical analysis was performed using JMP 10.0 (SAS Institute Inc., Cary, NC).

**Evaluation of Stem Rust Infection Progression via Fluorescence Microscopy.** Twelve 2-cm tissue segments from the center of the primary leaf were collected for each barley genotype at each time point. The time points, 24 and 48 HPI, were evaluated using a modified Uvitex 2B fluorescence microscopy protocol developed by S. Dugyala, P. Borowicz, R. Brueggeman, and M. Acevedo (*unpublished data*; Kuck et al. 1981; Moldenhauer et al. 2006; Rohringer et al. 1977). The samples were cleared in chloroform-methanol (2:1 vol/vol) for 3 h at 22°C. The chloroform-methanol solution was replaced with a lactophenol-ethanol (1:2 vol/vol) solution and

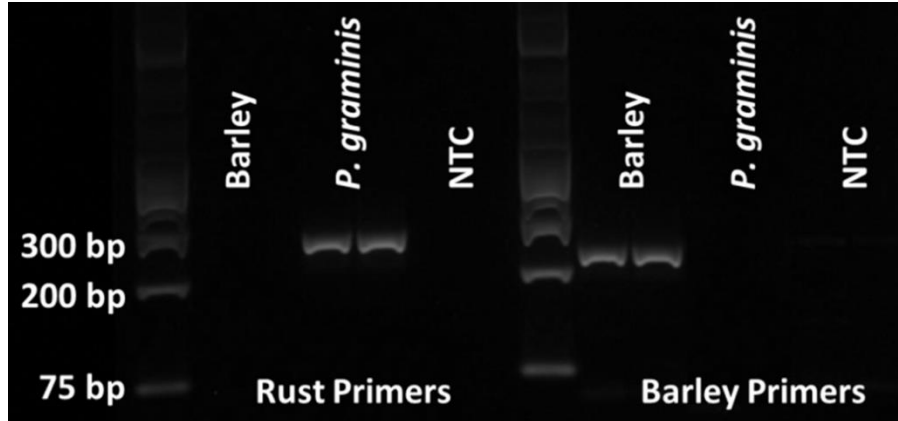


incubated at 70°C for 2 min and then stored overnight at 22°C. After washing in 50% ethanol twice for 15 min, twice in 0.5M NaOH for 15 min, and twice in distilled water for 15 min, samples were incubated in 0.1 M Tris/HCl buffer for 30 min at 22°C, 0.3% Uvitex 2B for 5 min at 22°C, and then washed four times in distilled water for 10 min. The multiple wash steps were followed by incubating the samples in 25% glycerol for 20 min at 22°C and then storing them in 50% glycerol at 4 °C in the dark until they were mounted between a glass slide and a coverslip in a lactophenol and glycerol (1:200 vol:vol) solution. All mounted tissue samples were viewed using a structured illumination technique using a Zeiss ApoTome 2 module on a Zeiss Axio Imager M2 fluorescence microscope with the BP379-401 excitation filter and FT420 beam splitter (Carl Zeiss AG, Oberkochen, Germany).

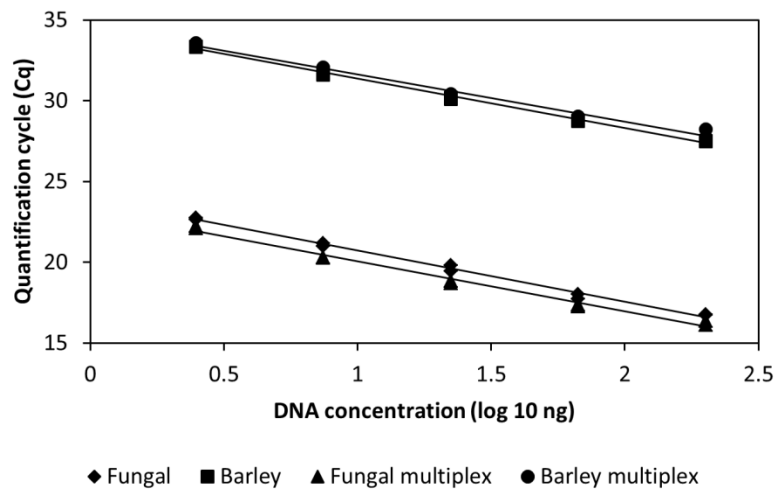
## Results

**Evaluation of the Stem Rust Infection Process via qPCR Assay.** The primers utilized for qPCR were found to be specific and only produced amplicons from the expected DNA sources (Fig. 13). Additionally, the fungal and barley primers and probes did not perform significantly different ( $P = 0.65$ ) under single or multiplex conditions (Fig. 14). Cross amplification was not observed between the barley DNA and fungal primers and probes or the fungal DNA and barley primers and probes during the qPCR assay. The C<sub>q</sub> values for the fungal standards ranged from  $19.5 \pm 0.3$  for the 200 ng/μl standard to  $25.7 \pm 0.4$  for the 2.47 ng/μl standard in the first experiment and from  $21.1 \pm 0.3$  for the 200 ng/μl standard to  $25.8 \pm 0.2$  for the 2.47 ng/μl standard in the second experiment. The C<sub>q</sub> values for the barley standards ranged from  $27.0 \pm 0.3$  for the 200 ng/μl standard to  $32.9 \pm 0.4$  for the 2.47 ng/μl standard in the first experiment and from  $21.1 \pm 0.3$  for the 200 ng/μl standard to  $31.6 \pm 0.2$  for the 2.47 ng/μl standard in the second experiment. The average reaction efficiencies for the first experiment

were  $100.2 \pm 4.8$  and  $106.7 \pm 5.4\%$  for the fungal and barley primer and probe combination, respectively. The average reaction efficiencies for the second experiment were  $100.4 \pm 6.0$  and  $108.5 \pm 7.4\%$  for the fungal and barley primer and probe combination, respectively. The prior to inoculation time point produced fungal Cq values greater than 37 in all samples for both the first and second experiment. As such, 37 cycles was utilized as a cutting off point for the presence of the pathogen and the prior to inoculation time points were excluded from further analysis. In addition to the control time point, 20 data points (6.25%) from the first experiment and 51 data points (15.94%) from the second experiment were removed due to Cq values differing by more than one for intra-assay replicates or for Cq values of one of the primers being greater than 37. The Shapiro-Wilk test established a normal distribution was present for each population at each time point. The ANOVA analysis showed significant differences ( $P < 0.05$ ) for the barley varieties at each time point for both the first and second experiment (Table 7). During the first experiment, at the 48 HPI time point, the least amount of fungal DNA was present on the resistant line Beacon followed by the traditionally susceptible line Steptoe and the largest amount of fungal DNA was present on the highly resistant cultivar Q21861. This hierarchical order changed by the 12 DPI time point and the susceptible cultivar Steptoe had the most fungal DNA and the resistant lines Morex and Q21861 had the least fungal DNA. A similar pattern was observed for the second experiment. At the 48 HPI time point, the least amount of fungal DNA was detected on the susceptible cultivar Steptoe and the most was detected on the resistant cultivars Chevron and Q21861. The hierarchical ordering change observed in the first experiment was also observed in the second experiment by the 6 DPI time point. The most fungal DNA was detected on the susceptible cultivar Steptoe and the least amount of fungal DNA was found on the resistant cultivars Morex, Chevron, and Q21861.



**Figure 13.** Results of the specificity test of the rust primers (ITS1rustF10d and ITS1rustR3c) and the barley primers (Hvubi-F1 and Hvubi-R1). NTC = non-template control where water was used in place of DNA.



**Figure 14.** Efficiency curves for the fungal and barley DNA standards under single and multiplex conditions. Fungal,  $y = -3.173x + 23.907$   $R^2 = 0.993$  Efficiency = 106.6 %; Fungal multiplex,  $y = -3.101x + 23.164$   $R^2 = 0.989$  Efficiency = 110.1 %; Barley,  $y = -3.060x + 34.424$   $R^2 = 0.997$  Efficiency = 112.2 %; Barley multiplex,  $y = -2.929x + 34.549$   $R^2 = 0.991$  Efficiency = 119.5 %.

**Table 7.** Comparison of mean relative fungal DNA in planta for each time point and the observed median infection type (IT) for each barley genotype during the two experiments <sup>z</sup>

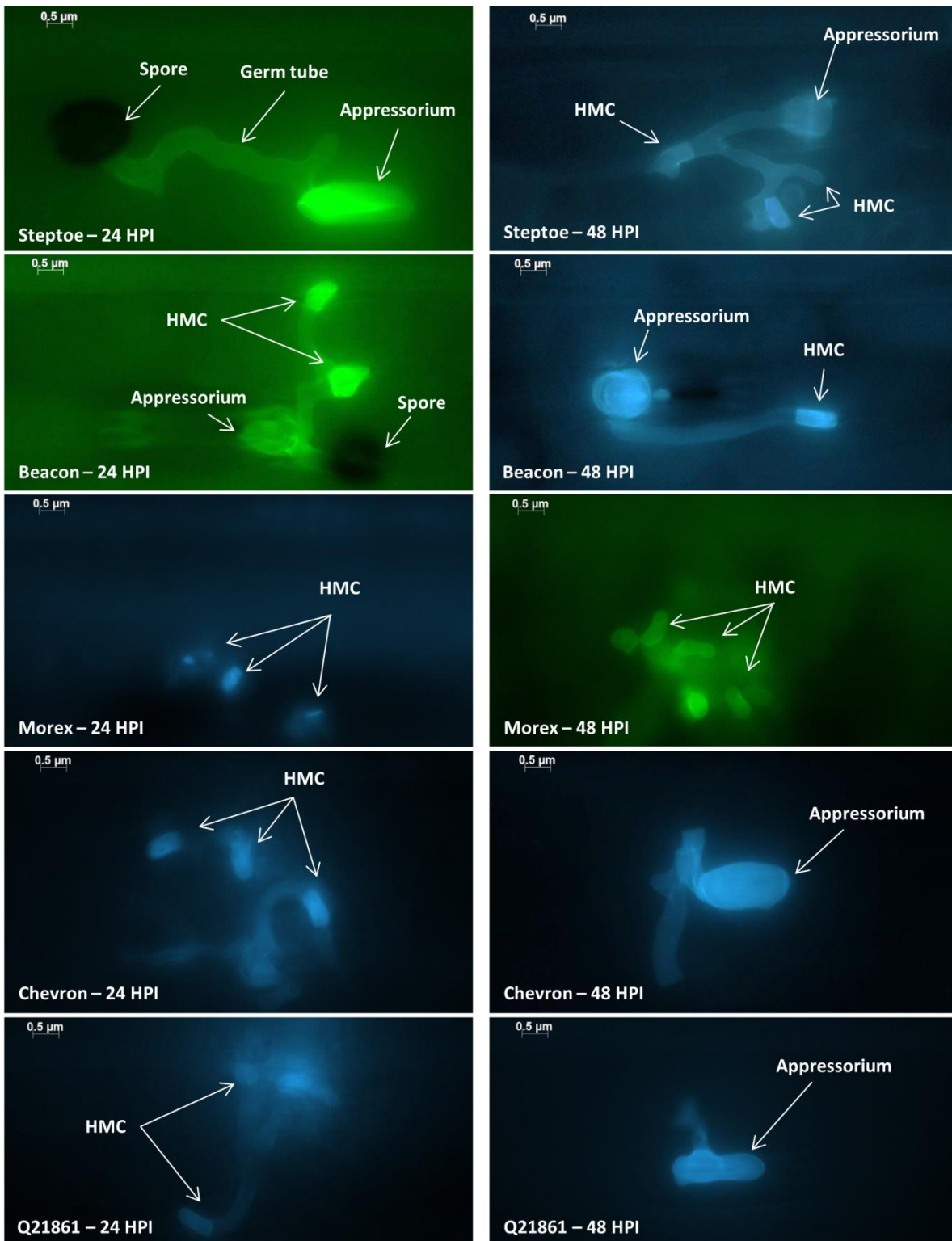
Cultivar/Line	Experiment 1					Experiment 2				
	0 HPI <sup>z</sup>	48 HPI <sup>z</sup>	6 DPI <sup>z</sup>	12 DPI <sup>z</sup>	IT	0 HPI <sup>z</sup>	24 HPI <sup>z</sup>	48 HPI <sup>z</sup>	6 DPI <sup>z</sup>	IT
Steptoe	2.64 a	2.23 b	0.93 a	-7.13 c	3	2.51 a	1.70 ab	1.16 a	-6.02 c	3
Beacon	3.29 a	4.96 a	-2.22 b	-4.44 b	12	1.84 ab	2.15 a	1.04 ab	-4.55 b	21
Morex	0.76 b	1.59 bc	1.37 a	-0.54 a	21	0.94 c	0.59 c	0.24 bc	-1.98 a	12
Chevron	1.5 ab	1.31 bc	-4.24 c	-3.56 b	X (0;21)	1.29 bc	0.86 bc	-0.45 c	-1.15 a	X (0;12)
Q21861	0.61 b	0.81 c	-1.46 b	-1.34 a	0;	2.37 ab	0.97 bc	-0.31 c	-3.05 a	0;

<sup>z</sup> Barley genotypes with the same letter in a column are not statistically different. The letters of the statistical group from “a” to “d” describes the relation from low to high amounts of fungal DNA relative to host DNA. The time point 0 HPI consists of tissue collected immediately after inoculation. Mean of relative fungal DNA was calculated by subtracting the barley Cq from the fungal Cq.

### **Evaluation of the Stem Rust Infection Process via Fluorescence Microscopy.**

Phenotypic differences at the microscopic level including timing of pathogen structure development, number of established infection points, and host resistance responses were observed among cultivars. For each sample, 100 infection sites were observed at the 24 and 48 HPI time points. At 24 HPI appressoria were observed on the cultivar Steptoe while both appressoria and haustorial mother cells (HMC) were observed on Morex, Beacon, Chevron, and Q21861 (Fig. 15). By 24 HPI 100% of the observed *P. graminis* spores had formed appressoria and 20% formed sub-stomatal vesicles for the cultivar Steptoe. The *P. graminis* growth had progressed further in the infection process by 24 HPI in all *Rpg1* containing varieties. HMC were observed for 80, 100, 90, and 70% of the *P. graminis* spores inoculated on Beacon, Morex, Chevron, and Q21861, respectively. Necrosis associated with a hypersensitive response was observed for Chevron and Q21861 at 48 HPI. At 48 HPI HMC were formed for 30% of the *P. graminis* infection sites inoculated on Steptoe, 80% for Beacon, and 100% for Morex, Chevron, and Q21861.

**Phenotypic Evaluation.** During the phenotypic evaluation of experiment 1 the lowest infection type observed was a 0; and the highest was a 3+ (Table 7). The susceptible cultivar Steptoe's infection type ranged from 3 to 3+. The infection types of the resistant varieties Beacon, Morex, and Q21861 ranged from 12 to 2, 12 to 2, and from 0; to ;1-, respectively. During the evaluation of experiment 2 the lowest infection type observed was a 0; and the highest was a 3+ (Table 6). Steptoe ranged from 3- to 3+, Beacon from 12 to 2, Morex from 12 to 21, and Q21861 from 0; to ;1-. All Chevron individuals presented with a mesothetic reaction (X) that included the infection types 0;, 1, and 2 in both experiments 1 and 2.



**Figure 15.** Fluorescence microscopy images showing infection structure development for *P. graminis* f. sp. *tritici* race MCCFC on barley. All images were taken at 63 X magnification. The color of some images was adjusted to green to provide better contrast. Haustorial mother cell (HMC) development was difficult to observe for Chevron and Q21861 at 48 HPI due to a masking effect resulting from host necrosis.

## Discussion

The qPCR assay reported in the current study was shown to effectively separate cultivars by the relative amounts of fungal DNA at early stages of the infection process. The hierarchical order produced by the analysis method at 24 and 48 HPI was not the same as the order by the level of resistance determined using the traditional phenotyping methodology at 12 DPI. However, the qPCR assay demonstrated similarity to qualitative microscopic observations at 48 HPI, allowing for early phenotyping and the ability to separate temporal differences in resistance responses.

The phenotyping at 12 DPI was consistent with what has been previously reported for all of the lines except Chevron (Nirmala et al. 2010; Steffenson 1992). Chevron has been previously reported to have an infection type that ranges between 0; to 1; when inoculated with race MCC. It is unknown why Chevron displayed a mesothetic reaction; however, the infection types observed were consistent between experiments 1 and 2 in the present study. It is possible that there are virulence differences between the MCCFC isolate used in the current study and the MCC isolates used in previous studies which affect Chevron's infection type. The 12 DPI time point the qPCR assay was able to distinguish the susceptible cultivar Steptoe from the resistant cultivars and lines; however the hierarchical ordering of resistant cultivars for the qPCR assay and the order based solely on infection types was not the same. This lack of similarity may be due to the qPCR assay being able to account for additional components of resistance and the nature of the stem rust infection process; such as disease severity, infection efficiency (receptivity), mycelial growth, latent period, and aggressiveness of the pathogen (Díaz-Lago et al. 2003; Parlevliet 1985; Steffenson and Wilcoxson 1985; Tiburzy et al. 1990). The ability to

differentiate these components may lead to the identification and incorporation of underutilized and underappreciated resistance mechanisms.

The ability to phenotype barley at early time points can provide new and useful information toward understanding the mechanisms involved in stem rust resistance. Upon completion of the first experiment, the time point of 24 HPI was added to determine if statistical differences could be detected earlier than 48 HPI. It was found that the hierarchical order of the 24 HPI time point was similar to that of the 0 HPI time point in the second experiment as statistical differences were observed between the cultivars at 0 HPI (Table 7). Furthermore, this ordering did not correlate with the microscopic observations at 24 HPI. These variations may be due to the number of spores on the leaf surface or the amount of leaf tissue present; and suggests the qPCR assay may not be sensitive or accurate enough at very low levels of fungal DNA in planta.

In barley, the most well characterized resistance gene to wheat stem rust is *Rpg1* (Brueggeman et al. 2009; Nirmala et al. 2007; Nirmala et al. 2010; Nirmala et al. 2011). The phosphorylation of *Rpg1* has been shown to occur within 5 min of spore contact with the leaf when inoculated with *P. graminis* f. sp. *tritici* race MCC (Nirmala et al. 2010; Nirmala et al. 2011). The early phosphorylation in response to spore contact suggests the *Rpg1*-mediated resistance response would be a pre-haustorial resistance response (Niks and Dekens 1991; Vaz Patto et al. 2009). Microscopic observations in the present study, however, show necrosis occurs between 24 and 48 HPI in *Rpg1*-containing varieties after the formation of HMC within the first 24 HPI. As such, the *Rpg1*-mediated resistance pathway does not appear to impede the formation of haustoria. Furthermore, the evidence presented by Nirmala et al. (2007) supporting *Rpg1* phosphorylation and subsequent degradation prior to the 24 HPI time point suggests the early



spore detection may prime the later post-haustorial formation defense response. Thus, *Rpg1*-mediated resistance may involve both pre- and post-haustorial components.

Interestingly, in the current study the susceptible cultivar Steptoe displayed greater resistance to *P. graminis* race MCCFC at both 24 and 48 HPI compared to the varieties containing known stem rust resistance genes. As a susceptible cultivar, it would be expected that fungal growth and structural development would occur at a greater rate than resistant cultivars. However, at 24 and 48 HPI the fungal development in Steptoe was delayed indicating there may be a minor gene or genes providing a stronger initial resistance than the barley varieties containing *Rpg1* and *rpg4/Rpg5*. This basal resistance could be provided via physiological differences in the leaf epidermal chemistry of Steptoe. Variations of cuticle surface chemistry between cultivars have been shown to have an effect on the infection process of *Blumeria graminis* (DC) Speer f. sp. *hordei* on barley and *B. graminis* (DC) Speer f. sp. *tritici* on wheat (Yang and Ellingboe 1972). Surface topology and chemistry have also been shown to play important roles in inducing the formation of appressoria for *P. graminis* f. sp. *tritici* (Collins et al. 2001; Read et al. 1997). Conversely, the resistance may be provided by a minor-effect resistance gene or a minor-effect gene that provides an additive effect to other resistance genes. Two minor additive effect stem rust resistance QTL have been previously identified in barley. Both of these QTL were located on chromosome 2H; one was identified in Morex by Druka et al. (2008) and the other identified in SM89010 by Moscou et al. (2011). Both QTL were identified via expression (e)QTL methodology and do not appear to provide resistance while unaccompanied by a major effect resistance gene, such as *Rpg1* or *rpg4/Rpg5*. The eQTL identified by Druka et al. (2008) was mapped using the Steptoe/Morex double haploid population and found to be conferred by Morex. The eQTL in Morex was identified using mRNA from non-

inoculated plants which would only allow for identification of genes that are constitutively expressed. Furthermore, the eQTL was detected using the infection type 12 to 14 DPI, which may not allow for detection of the defense response in Steptoe observed at 24 and 48 HPI in this study. Despite the presumed presence of this resistance component gene in Steptoe, the effect is not enough to provide resistance during later stages of the infection resulting in susceptibility at 12 DPI. Future mapping experiments will be needed to identify the gene or genes involved. The observations in the present study demonstrate the variability of resistance at different stages and the need for additional methods of evaluation to unravel the complexities of disease resistance.

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## SUMMARY OF THE WORK CONDUCTED

Resistance to wheat stem rust caused by *Puccinia graminis* f. sp. *tritici* (*Pgt*) has historically been a problem both locally and globally. North Dakota experienced great epidemics during the 1900's and Eastern Africa has had multiple recent epidemics that have decimated wheat and barley production. Due to the emergence of highly virulent *Pgt* races in foreign locations and the ease of the pathogen to spread, continued research is imperative to best prepare the wheat and barley breeders and producers for future epidemics. A multi-faceted research approach directed toward both the host and pathogen is necessary to efficiently manage rust diseases in cereals. In this dissertation, two spring wheat landraces were evaluated for resistance to *Pgt* and a new phenotyping methodology was developed to evaluate the infection process of *Pgt* on barley.

The gene *SrWLR* was identified as a potentially new source of resistance from the Iranian landrace PI 626573. *SrWLR* provides resistance to some Ug99-lineage races and the North American race RKQQ. The gene maps to the long arm of chromosome 2B and may be allelic with *Sr9*. Currently only one allele of *Sr9*, *Sr9h*, provides resistance to Ug99. *Sr9h*, formally known as *SrWeb*, does not provide resistance to race RKQQ suggesting *SrWLR* may be a different allele of or gene from *Sr9h*. Work is currently underway to clone *SrWLR* via positional cloning (Appendix B). The positional cloning of *SrWLR* can provide new insights toward molecular mechanisms associated with *Pgt* resistance as well as determine if *SrWLR* is an allele of *Sr9*. Additionally the cloning of *SrWLR* will streamline breeding efforts by allowing for the development of a perfect marker for marker assisted selection. Finally, cloning *SrWLR* can assist in the identification of virulence genes in *Pgt* that interact with *SrWLR*-mediated resistance.

The Montenegrin spring wheat landrace PI 362698 contains resistance to multiple North American and African *Pgt* races. A QTL analysis of the LMPG-6/PI 362698-1 population identified 14 significant QTLs associated with *Pgt* resistance. Many of the QTLs mapped to regions near known resistance genes. The QTL *QSr.ace-3B* provides resistance to Ug99 and QFCQC and maps near the *Sr12* locus. *Sr12* does not provide resistance to Ug99 suggesting that *QSr.ace-3B* is associated with a new allele of *Sr12* or a new gene. The QTLs *QSr.ace-7D1* and *QSr.ace-7D2* were identified during the TRTTF and QFCQC seedling trials and map near the *Sr57/Lr34/Yr18* multi-pathogen resistance locus. *QSr.ace-2B.2*, identified during the QFCQC trial, and *QSr.ace-6A*, identified during the TRTTF trial, map to similar locations as *Sr16* and *Sr8a*, respectively. Finally, *QSr.ace-2B.1* maps to a location near *Sr9*. In addition to the QTLs associated with known resistance genes, additional QTLs were identified which may be associated with previously unknown resistance genes. Additional work will be necessary to fully dissect the complexities of the resistance present in PI 362698.

PI 362698, PI 626573, and individuals from the LMPG-6/PI 626573 population are currently being utilized to introgress their resistances into adapted North Dakota germplasm. Because PI 362698 and PI 626573 are landraces, there is likely to be less linkage drag associated with the resistance compared to wild relatives. A diagnostic marker has been developed for *SrWLR* based around high-resolution meltcurve analysis. Additionally, the diagnostic marker for *Sr57/Lr34/Yr18* is being used to incorporate *Sr57* in the PI 362698 crosses. The LMPG-6/PI 626573 population has been evaluated for resistance to leaf rust, caused by *Puccinia triticina*, and tan spot, caused by *Pyrenophora tritici-repentis*. Resistance has been identified to leaf rust, ToxA, and ToxC in some of the recombinant lines, making them ideal candidates for pre-breeding efforts.



The early stages of *Pgt* infection on barley are not well understood. To gain new insights about the infection process a qPCR assay was developed and validated using traditional phenotyping and fluorescence microscopy. Barley accessions containing varying levels of resistance were evaluated with *Pgt* race MCCF. Interestingly, the susceptible cultivar ‘Step toe’ was more resistant than accessions containing resistance conferred by *Rpg1* and the *rpg4/Rpg5* complex at early time points. At some point after 48 hours after inoculation Step toe becomes more susceptible than the resistant cultivars. *Rpg1*-mediated resistance was found to provide post-haustorial resistance despite previous reports of *Rpg1* being phosphorylated within 5 min of spore contact with the leaf surface. Moreover, necrosis caused by *Rpg1* was shown to occur between 24 and 48 hours post inoculation. The information from this experiment can be used to better characterize barley resistance mechanisms and provide micro-phenotypes for future barley lines at early infection stages. The assay can also be used to identify genes associated with virulence and pathogen growth in *Pgt*.

The work presented in this dissertation is not an end, but a beginning to a large body of work to support both breeders and growers. This support will be delivered through the deployment of new resistances in adapted cultivars and preparedness for future epidemics through an increased understanding of the *Pgt* pathosystems.

## APPENDIX A. GENETIC MAP OF THE LMPG-6/PI 626573 POPULATION

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups.

Grain Genes Marker Name	Marker	Linkage Group	Position (cM)
IWA1376	wsnp_Ex_c10657_17376448	1A	0.0
IWA8622	wsnp_RFL_Contig4735_5673999	1A	5.7
IWA4351	wsnp_Ex_c57982_59470152	1A	6.7
IWA6649	wsnp_Ku_c183_358844	1A	6.7
IWA4034	wsnp_Ex_c4876_8692849	1A	8.0
IWA6172	wsnp_JD_c7522_8606553	1A	8.0
IWA4754	wsnp_Ex_c7965_13520238	1A	8.2
IWA7796	wsnp_Ra_c26191_35761997	1A	28.5
IWA5866	wsnp_JD_c15748_15112101	1A	34.9
IWA6431	wsnp_Ku_c11769_19153951	1A	34.9
IWA1142	wsnp_CAP8_c1141_707721	1A	38.0
IWA164	wsnp_BE445121A_Ta_1_8	1A	38.0
IWA5339	wsnp_Ex_rep_c66980_65419811	1A	38.0
IWA3398	wsnp_Ex_c3253_5994376	1A	39.7
IWA3399	wsnp_Ex_c3253_5995011	1A	39.7
IWA1450	wsnp_Ex_c111741_93530669	1A	40.5
IWA1580	wsnp_Ex_c12101_19360213	1A	40.5
IWA2655	wsnp_Ex_c2181_4089639	1A	40.5
IWA2656	wsnp_Ex_c2181_4089788	1A	40.5
IWA2921	wsnp_Ex_c24686_33941368	1A	40.5
IWA2922	wsnp_Ex_c24686_33942264	1A	40.5
IWA3115	wsnp_Ex_c2749_5091813	1A	40.5
IWA5080	wsnp_Ex_rep_c103028_88077819	1A	40.5
IWA710	wsnp_CAP11_c23_61357	1A	40.5
IWA7421	wsnp_Ku_rep_c107796_93118214	1A	40.5
IWA8307	wsnp_RFL_Contig2185_1520256	1A	40.5
IWA3346	wsnp_Ex_c31525_40302140	1A	40.9
IWA3347	wsnp_Ex_c31525_40302747	1A	40.9
IWA8615	wsnp_RFL_Contig4704_5607996	1A	40.9
IWA492	wsnp_BF478737A_Ta_2_1	1A	41.2
IWA1933	wsnp_Ex_c14733_22819350	1A	41.8
IWA1934	wsnp_Ex_c14733_22819625	1A	41.8
IWA2337	wsnp_Ex_c18662_27538313	1A	41.8
IWA3020	wsnp_Ex_c26098_35349905	1A	41.8
IWA3898	wsnp_Ex_c44498_50537128	1A	41.8
IWA4020	wsnp_Ex_c48375_53299028	1A	41.8
IWA4061	wsnp_Ex_c49829_54319220	1A	41.8
IWA4071	wsnp_Ex_c50235_54588957	1A	41.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4555	wsnp_Ex_c66106_64268316	1A	41.8
IWA4646	wsnp_Ex_c7258_12461939	1A	41.8
IWA4974	wsnp_Ex_c9872_16271161	1A	41.8
IWA8255	wsnp_RFL_Contig1736_858448	1A	41.8
IWA3952	wsnp_Ex_c45880_51550172	1A	42.0
IWA4286	wsnp_Ex_c5603_9860447	1A	42.0
IWA5300	wsnp_Ex_rep_c66767_65124989	1A	42.0
IWA7439	wsnp_Ku_rep_c68419_67400635	1A	42.0
IWA1482	wsnp_Ex_c11374_18361760	1A	42.2
IWA2871	wsnp_Ex_c24117_33363865	1A	42.2
IWA3147	wsnp_Ex_c28165_37310070	1A	42.2
IWA3689	wsnp_Ex_c39661_46902650	1A	42.2
IWA3690	wsnp_Ex_c39661_46902689	1A	42.2
IWA4775	wsnp_Ex_c8162_13799067	1A	42.2
IWA5194	wsnp_Ex_rep_c66282_64438053	1A	42.2
IWA5509	wsnp_Ex_rep_c68183_66958099	1A	42.2
IWA6942	wsnp_Ku_c3468_6420199	1A	42.2
IWA8238	wsnp_RFL_Contig1313_407433	1A	42.2
IWA8294	wsnp_RFL_Contig2121_1395405	1A	42.2
GWM164	GWM164	1A	43.1
IWA3016	wsnp_Ex_c2603_4841355	1A	43.9
IWA1785	wsnp_Ex_c13564_21327699	1A	45.2
IWA1807	wsnp_Ex_c1374_2630879	1A	45.2
IWA2630	wsnp_Ex_c21592_30743815	1A	45.2
IWA3451	wsnp_Ex_c33831_42253707	1A	45.2
IWA3472	wsnp_Ex_c34260_42602649	1A	45.2
IWA3473	wsnp_Ex_c34260_42602746	1A	45.2
IWA3536	wsnp_Ex_c3572_6531810	1A	45.2
IWA3867	wsnp_Ex_c43454_49770425	1A	45.2
IWA4649	wsnp_Ex_c7271_12483592	1A	45.2
IWA5952	wsnp_JD_c24506_20670773	1A	45.2
IWA6044	wsnp_JD_c40990_29127031	1A	45.2
IWA6985	wsnp_Ku_c3844_7053669	1A	45.2
IWA7241	wsnp_Ku_c67495_66513940	1A	45.2
IWA7677	wsnp_Ra_c18045_27024765	1A	45.2
IWA2744	wsnp_Ex_c2273_4259708	1A	45.4
IWA6657	wsnp_Ku_c18611_27943266	1A	45.4
IWA3144	wsnp_Ex_c2814_5203467	1A	45.6
IWA3666	wsnp_Ex_c3906_7086294	1A	45.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4661	wsnp_Ex_c7360_12617987	1A	45.8
IWA5083	wsnp_Ex_rep_c103087_88123733	1A	45.8
IWA5084	wsnp_Ex_rep_c103087_88124573	1A	45.8
IWA7557	wsnp_Ra_c11023_17980284	1A	45.8
IWA5310	wsnp_Ex_rep_c66846_65240088	1A	47.3
IWA4327	wsnp_Ex_c572_1138503	1A	49.3
IWA2328	wsnp_Ex_c18616_27481826	1A	49.7
IWA3857	wsnp_Ex_c4310_7770452	1A	49.7
IWA7862	wsnp_Ra_c32175_41221223	1A	49.7
IWA2995	wsnp_Ex_c25734_34995416	1A	49.9
IWA5740	wsnp_Ex_rep_c73818_71733737	1A	49.9
IWA7173	wsnp_Ku_c557_1166684	1A	49.9
IWA4179	wsnp_Ex_c534_1058778	1A	50.5
IWA459	wsnp_BF428726A_Ta_2_5	1A	50.5
IWA5839	wsnp_JD_c13903_13781269	1A	50.5
IWA1593	wsnp_Ex_c1216_2336458	1A	50.7
IWA1608	wsnp_Ex_c12336_19686808	1A	50.7
IWA1609	wsnp_Ex_c12336_19687074	1A	50.7
IWA3475	wsnp_Ex_c34344_42676379	1A	50.7
IWA3820	wsnp_Ex_c42282_48900922	1A	50.7
IWA3821	wsnp_Ex_c42282_48901252	1A	50.7
IWA3822	wsnp_Ex_c42282_48901677	1A	50.7
IWA3934	wsnp_Ex_c4539_8148835	1A	50.7
IWA4116	wsnp_Ex_c5192_9203100	1A	50.7
IWA4117	wsnp_Ex_c5192_9203682	1A	50.7
IWA5277	wsnp_Ex_rep_c66628_64934660	1A	50.7
IWA6709	wsnp_Ku_c21356_31093507	1A	50.7
IWA6756	wsnp_Ku_c24239_34199356	1A	50.7
IWA7018	wsnp_Ku_c39878_48218985	1A	50.7
IWA7644	wsnp_Ra_c16080_24638622	1A	50.7
IWA2584	wsnp_Ex_c21193_30320134	1A	51.0
IWA162	wsnp_BE445113A_Ta_2_1	1A	56.0
IWA7868	wsnp_Ra_c3270_6136110	1A	56.0
IWA7869	wsnp_Ra_c3270_6136601	1A	56.0
IWA5169	wsnp_Ex_rep_c108951_91954190	1A	56.4
IWA6553	wsnp_Ku_c15214_23756800	1A	56.4
IWA7573	wsnp_Ra_c11877_19161832	1A	56.4
IWA8101	wsnp_Ra_c9209_15425473	1A	56.4
IWA931	wsnp_CAP12_c1960_972031	1A	56.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA605	wsnp_BM140362A_Ta_2_2	1A	57.1
IWA2540	wsnp_Ex_c20489_29564938	1A	57.3
IWA4511	wsnp_Ex_c6452_11213329	1A	57.3
IWA3406	wsnp_Ex_c32590_41222878	1A	57.7
IWA2703	wsnp_Ex_c22284_31478675	1A	58.3
IWA1979	wsnp_Ex_c15088_23268345	1A	59.4
IWA2483	wsnp_Ex_c1997_3755720	1A	59.4
IWA2485	wsnp_Ex_c1997_3756118	1A	59.4
IWA2489	wsnp_Ex_c1997_3757496	1A	59.4
IWA2491	wsnp_Ex_c1997_3757721	1A	59.4
IWA6144	wsnp_JD_c6544_7697235	1A	59.4
IWA6145	wsnp_JD_c6544_7697412	1A	59.4
IWA6146	wsnp_JD_c6544_7697578	1A	59.4
IWA601	wsnp_BM137879A_Ta_2_1	1A	59.6
IWA2314	wsnp_Ex_c1845_3472790	1A	59.8
IWA6341	wsnp_JG_c3720_1558699	1A	59.8
IWA2541	wsnp_Ex_c20495_29571203	1A	61.5
IWA3340	wsnp_Ex_c3145_5812670	1A	61.5
IWA3614	wsnp_Ex_c3749_6828492	1A	61.5
IWA6624	wsnp_Ku_c17322_26392311	1A	61.5
IWA7144	wsnp_Ku_c5210_9289260	1A	61.5
IWA7145	wsnp_Ku_c5210_9290700	1A	61.5
IWA3405	wsnp_Ex_c3258_6004611	1A	61.7
IWA5534	wsnp_Ex_rep_c68493_67320068	1A	61.7
IWA7570	wsnp_Ra_c11594_18777085	1A	61.7
IWA5125	wsnp_Ex_rep_c104894_89466993	1A	62.1
IWA4080	wsnp_Ex_c5060_8985678	1A	63.4
IWA3980	wsnp_Ex_c4685_8377545	1A	63.8
IWA6176	wsnp_JD_c7581_8666052	1A	63.8
IWA6933	wsnp_Ku_c33917_43336035	1A	65.3
IWA6934	wsnp_Ku_c33917_43336069	1A	65.3
IWA4538	wsnp_Ex_c6563_11378915	1A	65.5
IWA1081	wsnp_CAP7_c3472_1623955	1A	65.8
IWA577	wsnp_BG606986A_Ta_2_1	1A	66.4
IWA578	wsnp_BG606986A_Ta_2_4	1A	66.4
IWA5832	wsnp_JD_c13384_13393159	1A	66.4
IWA3434	wsnp_Ex_c33452_41938013	1A	68.1
IWA3435	wsnp_Ex_c33452_41938159	1A	68.1
IWA5046	wsnp_Ex_rep_c102067_87313597	1A	69.6

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5047	wsnp_Ex_rep_c102067_87314043	1A	69.6
IWA1195	wsnp_CAP8_c4785_2322876	1A	70.0
IWA135	wsnp_BE443588A_Ta_2_1	1A	70.0
IWA136	wsnp_BE443588A_Ta_2_2	1A	70.0
IWA3060	wsnp_Ex_c26688_35918122	1A	70.0
IWA3195	wsnp_Ex_c28900_37982485	1A	70.0
IWA3962	wsnp_Ex_c4612_8254533	1A	70.0
IWA6091	wsnp_JD_c5144_6266384	1A	70.0
IWA8334	wsnp_RFL_Contig2409_1937215	1A	70.0
IWA1790	wsnp_Ex_c1359_2604298	1A	71.5
IWA254	wsnp_BE494527A_Ta_2_1	1A	71.5
IWA6975	wsnp_Ku_c3804_6986527	1A	71.5
IWA3145	wsnp_Ex_c28149_37293117	1A	72.4
IWA3146	wsnp_Ex_c28149_37293173	1A	72.4
IWA735	wsnp_CAP11_c29_68486	1A	73.4
IWA4931	wsnp_Ex_c9534_15793556	1A	74.0
IWA4523	wsnp_Ex_c6488_11266589	1A	75.8
IWA5911	wsnp_JD_c20553_18260731	1A	77.3
IWA2404	wsnp_Ex_c19353_28290393	1A	77.7
IWA2405	wsnp_Ex_c19353_28290651	1A	77.7
IWA7924	wsnp_Ra_c4184_7637695	1A	85.1
IWA1015	wsnp_CAP12_rep_c8598_3608465	1A	85.3
IWA1118	wsnp_CAP7_rep_c5385_2417464	1A	85.3
IWA1119	wsnp_CAP7_rep_c5385_2417467	1A	85.3
IWA1618	wsnp_Ex_c12399_19776420	1A	85.7
IWA1619	wsnp_Ex_c12399_19776543	1A	85.7
IWA3485	wsnp_Ex_c34594_42877119	1A	85.7
IWA3486	wsnp_Ex_c34594_42877243	1A	85.7
IWA8135	wsnp_Ra_rep_c108284_91604017	1A	85.7
IWA1587	wsnp_Ex_c12123_19388313	1A	94.0
IWA7428	wsnp_Ku_rep_c109724_94227136	1A	94.0
IWA7591	wsnp_Ra_c12759_20345987	1A	94.0
IWA2819	wsnp_Ex_c23598_32827681	1A	98.1
IWA6252	wsnp_JD_rep_c49006_33254837	1A	98.3
IWA6253	wsnp_JD_rep_c49006_33254974	1A	98.3
IWA3783	wsnp_Ex_c41553_48351921	1A	99.1
IWA7316	wsnp_Ku_c816_1684613	1A	99.1
IWA7893	wsnp_Ra_c36089_44508724	1A	100.6
IWA1368	wsnp_Ex_c10631_17340809	1A	100.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4897	wsnp_Ex_c9343_15514531	1A	104.4
IWA2994	wsnp_Ex_c25730_34991010	1A	104.6
IWA4898	wsnp_Ex_c9343_15514687	1A	104.6
IWA4978	wsnp_Ex_c9918_16332583	1A	104.6
IWA5491	wsnp_Ex_rep_c68058_66805898	1A	104.6
IWA3378	wsnp_Ex_c3201_5910659	1A	105.2
IWA1559	wsnp_Ex_c11939_19147602	1A	106.1
IWA1560	wsnp_Ex_c11939_19147790	1A	106.1
IWA2035	wsnp_Ex_c1557_2973321	1A	106.1
IWA8051	wsnp_Ra_c6891_11974621	1A	106.1
IWA8020	wsnp_Ra_c59303_60669172	1A	108.0
IWA4943	wsnp_Ex_c9600_15889471	1A	109.3
IWA4518	wsnp_Ex_c6476_11246531	1A	109.5
IWA8523	wsnp_RFL_Contig3850_4199825	1A	109.7
IWA2278	wsnp_Ex_c17990_26770146	1A	111.2
IWA3799	wsnp_Ex_c4186_7560575	1A	111.2
IWA4120	wsnp_Ex_c52086_55808126	1A	111.2
IWA4121	wsnp_Ex_c52086_55808193	1A	111.2
IWA4122	wsnp_Ex_c52086_55808363	1A	111.2
IWA4123	wsnp_Ex_c52086_55808824	1A	111.2
IWA5734	wsnp_Ex_rep_c72011_70562321	1A	111.2
IWA5806	wsnp_JD_c12333_12595897	1A	111.2
IWA3182	wsnp_Ex_c2868_5293485	1B	0.0
IWA6489	wsnp_Ku_c13229_21142792	1B	2.2
IWA1396	wsnp_Ex_c1085_2078686	1B	3.0
IWA406	wsnp_BE637971B_Ta_1_20	1B	3.0
IWA4242	wsnp_Ex_c5469_9655534	1B	3.0
IWA4073	wsnp_Ex_c50340_54659660	1B	3.2
IWA1883	wsnp_Ex_c14273_22230844	1B	19.3
IWA2282	wsnp_Ex_c18107_26909127	1B	21.7
IWA8557	wsnp_RFL_Contig4080_4587633	1B	22.8
IWA361	wsnp_BE586140B_Ta_2_1	1B	23.9
IWA1947	wsnp_Ex_c14832_22953512	1B	24.7
IWA1948	wsnp_Ex_c14832_22953585	1B	24.7
IWA7480	wsnp_Ku_rep_c70742_70379526	1B	24.9
IWA2577	wsnp_Ex_c2111_3963161	1B	25.1
IWA2578	wsnp_Ex_c2111_3963339	1B	25.1
IWA3169	wsnp_Ex_c28495_37622019	1B	25.1
IWA7117	wsnp_Ku_c4911_8795151	1B	25.1

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
GWM413	GWM413	1B	25.5
IWA6886	wsnp_Ku_c30910_40695864	1B	31.6
IWA7934	wsnp_Ra_c4296_7819139	1B	31.6
IWA1399	wsnp_Ex_c10869_17671164	1B	32.1
IWA1451	wsnp_Ex_c11177_18096010	1B	32.1
IWA1841	wsnp_Ex_c14_27570	1B	32.1
IWA1885	wsnp_Ex_c1429_2745237	1B	32.1
IWA2197	wsnp_Ex_c17238_25895129	1B	32.1
IWA284	wsnp_BE497109B_Ta_2_5	1B	32.1
IWA3837	wsnp_Ex_c42700_49214730	1B	32.1
IWA5592	wsnp_Ex_rep_c69266_68192766	1B	32.1
IWA5681	wsnp_Ex_rep_c70284_69228305	1B	32.1
IWA5987	wsnp_JD_c2964_3940341	1B	32.1
IWA7219	wsnp_Ku_c62848_63784645	1B	32.1
IWA8338	wsnp_RFL_Contig2449_2013497	1B	32.1
IWA8392	wsnp_RFL_Contig2794_2564017	1B	32.1
IWA8506	wsnp_RFL_Contig373_3974834	1B	32.1
IWA4389	wsnp_Ex_c5947_10431109	1B	32.7
IWA8619	wsnp_RFL_Contig4726_5654774	1B	33.5
IWA3620	wsnp_Ex_c37635_45347415	1B	33.7
IWA4975	wsnp_Ex_c9902_16309166	1B	33.7
IWA7737	wsnp_Ra_c21132_30487331	1B	33.7
IWA3631	wsnp_Ex_c38116_45719983	1B	34.2
IWA6259	wsnp_JD_rep_c49357_33576509	1B	34.2
IWA6890	wsnp_Ku_c30982_40765254	1B	34.2
IWA6891	wsnp_Ku_c30982_40765341	1B	34.2
IWA7977	wsnp_Ra_c49942_54740532	1B	34.2
IWA1302	wsnp_Ex_c10233_16784994	1B	35.0
IWA7234	wsnp_Ku_c66585_65967792	1B	35.0
IWA7343	wsnp_Ku_c9014_15193623	1B	35.0
IWA3048	wsnp_Ex_c26419_35667216	1B	35.2
IWA6581	wsnp_Ku_c16117_24917524	1B	35.2
IWA5304	wsnp_Ex_rep_c66802_65172754	1B	35.4
IWA139	wsnp_be443797B_Ta_2_1	1B	35.8
IWA2073	wsnp_Ex_c15934_24341135	1B	35.8
IWA3295	wsnp_Ex_c30805_39678077	1B	35.8
IWA4402	wsnp_Ex_c6022_10552811	1B	35.8
IWA5546	wsnp_Ex_rep_c68573_67416138	1B	35.8
IWA8148	wsnp_Ra_rep_c111777_93910754	1B	35.8



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA43	wsnp_BE403956B_Ta_2_1	1B	36.9
IWA378	wsnp_BE591501B_Ta_2_1	1B	37.3
IWA213	wsnp_BE489692B_Ta_2_2	1B	37.9
IWA2222	wsnp_Ex_c17452_26163496	1B	39.2
IWA2667	wsnp_Ex_c22006_31180883	1B	39.2
IWA2668	wsnp_Ex_c22006_31181239	1B	39.2
IWA4141	wsnp_Ex_c52474_56060204	1B	39.2
IWA8047	wsnp_Ra_c6724_11703420	1B	39.2
IWA805	wsnp_CAP11_c76_113375	1B	39.2
IWA2504	wsnp_Ex_c2004_3770146	1B	39.7
IWA1680	wsnp_Ex_c12774_20272038	1B	40.1
IWA2554	wsnp_Ex_c2077_3894016	1B	40.1
IWA3057	wsnp_Ex_c26620_35859364	1B	40.1
IWA4197	wsnp_Ex_c5388_9526777	1B	40.1
IWA4198	wsnp_Ex_c5388_9527189	1B	40.1
IWA4987	wsnp_Ex_c9960_16397347	1B	40.1
IWA5278	wsnp_Ex_rep_c66643_64952627	1B	40.1
IWA6073	wsnp_JD_c4641_5774711	1B	40.1
IWA6674	wsnp_Ku_c19618_29134473	1B	40.1
IWA6684	wsnp_Ku_c20139_29729256	1B	40.1
IWA6758	wsnp_Ku_c24323_34285350	1B	40.1
IWA7594	wsnp_Ra_c12888_20519578	1B	40.1
IWA890	wsnp_CAP11_rep_c8576_3700031	1B	40.1
IWA7017	wsnp_Ku_c39862_48205590	1B	40.5
IWA3945	wsnp_Ex_c4561_8184576	1B	41.6
IWA491	wsnp_BF478690B_Ta_2_1	1B	41.6
IWA2254	wsnp_Ex_c17707_26454940	1B	42.0
IWA269	wsnp_BE495786B_Ta_2_1	1B	42.0
IWA270	wsnp_BE495786B_Ta_2_2	1B	42.0
IWA4316	wsnp_Ex_c5679_9976893	1B	42.0
IWA460	wsnp_BF428726B_Ta_2_2	1B	42.0
IWA554	wsnp_BG313767B_Ta_2_1	1B	42.0
IWA6107	wsnp_JD_c5659_6814240	1B	42.0
IWA7700	wsnp_Ra_c19148_28288923	1B	42.0
IWA7836	wsnp_Ra_c29782_39115548	1B	42.0
IWA1953	wsnp_Ex_c14871_23001630	1B	42.2
IWA4680	wsnp_Ex_c7447_12751589	1B	44.8
IWA4681	wsnp_Ex_c7447_12752449	1B	44.8
IWA2709	wsnp_Ex_c22377_31571527	1B	45.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3713	wsnp_Ex_c402_791233	1B	45.0
IWA2626	wsnp_Ex_c21559_30710510	1B	47.4
IWA4819	wsnp_Ex_c8625_14468525	1B	47.4
IWA4999	wsnp_Ex_rep_c101231_86636951	1B	47.4
IWA4361	wsnp_Ex_c58292_59652859	1B	47.6
IWA2717	wsnp_Ex_c22439_31632880	1B	47.8
IWA5227	wsnp_Ex_rep_c66389_64588691	1B	47.8
IWA5962	wsnp_JD_c2636_3554874	1B	47.8
IWA3076	wsnp_Ex_c26860_36084209	1B	48.0
IWA3189	wsnp_Ex_c28733_37836638	1B	50.4
IWA3384	wsnp_Ex_c32284_40970312	1B	51.3
IWA4488	wsnp_Ex_c6378_11086366	1B	51.3
IWA6294	wsnp_JD_rep_c63201_40318622	1B	56.1
IWA3341	wsnp_Ex_c3147_5816957	1B	56.9
IWA367	wsnp_BE590634B_Ta_2_1	1B	56.9
IWA368	wsnp_BE590634B_Ta_2_5	1B	56.9
IWA7178	wsnp_Ku_c56140_59771186	1B	56.9
IWA7179	wsnp_Ku_c56140_59771244	1B	56.9
IWA8379	wsnp_RFL_Contig2736_2456215	1B	56.9
IWA4875	wsnp_Ex_c9091_15135511	1B	57.8
IWA8398	wsnp_RFL_Contig2818_2601481	1B	57.8
IWA5769	wsnp_JD_c100_159424	1B	58.8
IWA5861	wsnp_JD_c1544_2179305	1B	59.0
IWA5862	wsnp_JD_c1544_2180289	1B	59.0
IWA8246	wsnp_RFL_Contig1493_681815	1B	59.0
IWA3017	wsnp_Ex_c26083_35336771	1B	59.5
IWA7619	wsnp_Ra_c13959_21943006	1B	66.5
IWA3097	wsnp_Ex_c27176_36393952	1B	66.7
IWA5446	wsnp_Ex_rep_c67747_66422495	1B	66.7
IWA5447	wsnp_Ex_rep_c67747_66422869	1B	66.7
IWA7422	wsnp_Ku_rep_c107952_93214466	1B	67.3
IWA1069	wsnp_CAP7_c266_144809	1B	73.4
IWA5847	wsnp_JD_c14411_14148961	1B	74.1
IWA1092	wsnp_CAP7_c4778_2155754	1B	76.7
IWA374	wsnp_BE591290B_Ta_2_7	1B	80.8
IWA977	wsnp_CAP12_c590_319407	1B	80.8
IWA8461	wsnp_RFL_Contig3352_3456277	1B	81.2
IWA919	wsnp_CAP12_c1337_682282	1B	82.0
IWA920	wsnp_CAP12_c1337_682349	1B	82.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5758	wsnp_Ex_rep_c88749_79992654	1B	91.5
IWA1504	wsnp_Ex_c11461_18489681	1B	93.5
IWA4694	wsnp_Ex_c750_1474351	1B	93.5
IWA4935	wsnp_Ex_c955_1827567	1B	93.5
IWA545	wsnp_BG274687B_Ta_2_1	1B	93.5
IWA2077	wsnp_Ex_c1597_3045682	1B	94.5
IWA6647	wsnp_Ku_c1827_3575162	1B	94.5
IWA3124	wsnp_Ex_c278_538158	1D	0.0
IWA3125	wsnp_Ex_c278_538285	1D	0.0
IWA3753	wsnp_Ex_c41048_47969948	1D	0.2
IWA5996	wsnp_JD_c3091_4079762	1D	0.2
IWA7797	wsnp_Ra_c2633_5017265	1D	14.0
IWA5371	wsnp_Ex_rep_c67198_65703538	1D	15.7
IWA5372	wsnp_Ex_rep_c67198_65703657	1D	15.7
IWA6500	wsnp_Ku_c13622_21660346	1D	15.7
IWA6621	wsnp_Ku_c17177_26216230	1D	15.7
IWA817	wsnp_CAP11_c8597_3709328	1D	15.7
IWA4716	wsnp_Ex_c7705_13141187	1D	17.0
IWA713	wsnp_CAP11_c2307_1200406	1D	17.0
IWA7533	wsnp_Ra_c1020_2062200	1D	17.0
IWA4645	wsnp_Ex_c7252_12454704	1D	17.6
IWA8551	wsnp_RFL_Contig4025_4499792	1D	19.3
IWA362	wsnp_BE586140D_Ta_2_2	1D	37.8
IWA4598	wsnp_Ex_c6974_12025571	1D	37.8
IWA5018	wsnp_Ex_rep_c101500_86856089	1D	37.8
IWA5019	wsnp_Ex_rep_c101500_86856438	1D	37.8
IWA5020	wsnp_Ex_rep_c101500_86856679	1D	37.8
IWA57	wsnp_BE405518D_Ta_2_3	1D	37.8
IWA165	wsnp_BE445121D_Ta_2_2	1D	40.2
IWA5698	wsnp_Ex_rep_c70574_69491038	1D	44.0
IWA3058	wsnp_Ex_c26626_35864468	1D	63.6
IWA1734	wsnp_Ex_c13164_20793506	1D	64.0
IWA1736	wsnp_Ex_c1318_2519998	1D	64.0
IWA1737	wsnp_Ex_c1318_2520706	1D	64.0
IWA1738	wsnp_Ex_c1318_2520916	1D	64.0
IWA2097	wsnp_Ex_c1609_3069103	1D	64.0
IWA3013	wsnp_Ex_c25974_35235456	1D	64.0
IWA3014	wsnp_Ex_c25974_35235503	1D	64.0
IWA3107	wsnp_Ex_c27290_36498462	1D	64.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3108	wsnp_Ex_c27290_36498531	1D	64.0
IWA4342	wsnp_Ex_c57601_59245380	1D	64.0
IWA4343	wsnp_Ex_c57601_59245549	1D	64.0
IWA4344	wsnp_Ex_c57601_59245965	1D	64.0
IWA4585	wsnp_Ex_c6920_11928994	1D	64.0
IWA4586	wsnp_Ex_c6920_11929171	1D	64.0
IWA4587	wsnp_Ex_c6920_11929748	1D	64.0
IWA4588	wsnp_Ex_c6920_11929922	1D	64.0
IWA6186	wsnp_JD_c8173_9207415	1D	64.0
IWA6791	wsnp_Ku_c2624_4986980	1D	64.0
IWA6792	wsnp_Ku_c2624_4987257	1D	64.0
IWA7170	wsnp_Ku_c5560_9851459	1D	64.0
IWA7171	wsnp_Ku_c5560_9853214	1D	64.0
IWA7276	wsnp_Ku_c7266_12551048	1D	64.0
IWA7277	wsnp_Ku_c7266_12551309	1D	64.0
IWA3638	wsnp_Ex_c3831_6966926	1D	64.4
IWA4777	wsnp_Ex_c8188_13842273	1D	64.4
IWA7921	wsnp_Ra_c4135_7565040	1D	64.4
IWA2021	wsnp_Ex_c15396_23659859	1D	64.6
IWA4006	wsnp_Ex_c4808_8584315	1D	64.6
IWA5577	wsnp_Ex_rep_c69024_67924125	1D	64.6
IWA1631	wsnp_Ex_c12447_19847242	1D	64.8
IWA2340	wsnp_Ex_c18665_27541568	1D	64.8
IWA2341	wsnp_Ex_c18665_27541726	1D	64.8
IWA5232	wsnp_Ex_rep_c66423_64640941	1D	64.8
IWA5233	wsnp_Ex_rep_c66423_64640965	1D	64.8
IWA5234	wsnp_Ex_rep_c66423_64641115	1D	64.8
IWA5235	wsnp_Ex_rep_c66423_64641680	1D	64.8
IWA3122	wsnp_Ex_c2772_5130007	2A	0.0
IWA3556	wsnp_Ex_c36049_44083089	2A	0.8
IWA1562	wsnp_Ex_c11950_19164041	2A	1.1
IWA1563	wsnp_Ex_c11950_19164191	2A	1.1
IWA4989	wsnp_Ex_c997_1906900	2A	1.1
IWA6745	wsnp_Ku_c23598_33524490	2A	1.1
IWA6922	wsnp_Ku_c33374_42877546	2A	1.1
IWA3382	wsnp_Ex_c322_624793	2A	2.1
IWA3468	wsnp_Ex_c342_670243	2A	2.1
IWA3469	wsnp_Ex_c342_670415	2A	2.1
WMC407	WMC407	2A	2.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA8513	wsnp_RFL_Contig3790_4082085	2A	6.1
IWA4212	wsnp_Ex_c5412_9564046	2A	28.3
IWA4213	wsnp_Ex_c5412_9564346	2A	28.3
IWA4214	wsnp_Ex_c5412_9564478	2A	28.3
IWA4215	wsnp_Ex_c5412_9564550	2A	28.3
IWA4216	wsnp_Ex_c5412_9565527	2A	28.3
IWA4217	wsnp_Ex_c5412_9565733	2A	28.3
IWA3280	wsnp_Ex_c30481_39394826	2A	32.9
IWA6477	wsnp_Ku_c1292_2572053	2A	33.3
IWA6478	wsnp_Ku_c1292_2572110	2A	33.3
IWA4385	wsnp_Ex_c59373_60260876	2A	34.8
IWA6384	wsnp_Ku_c10302_17079851	2A	34.8
IWA4830	wsnp_Ex_c866_1684236	2A	35.2
IWA630	wsnp_BQ168780B_Ta_2_1	2A	41.8
IWA3194	wsnp_Ex_c2887_5330787	2A	44.7
IWA5022	wsnp_Ex_rep_c101526_86881496	2A	44.7
IWA5023	wsnp_Ex_rep_c101526_86881619	2A	44.7
IWA5893	wsnp_JD_c18695_17091254	2A	44.7
IWA5495	wsnp_Ex_rep_c68113_66877517	2A	44.9
IWA562	wsnp_BG314532A_Ta_2_1	2A	44.9
IWA5823	wsnp_JD_c13086_13174336	2A	44.9
IWA5824	wsnp_JD_c13086_13174510	2A	44.9
IWA2005	wsnp_Ex_c15325_23564654	2A	45.1
IWA2006	wsnp_Ex_c15325_23565794	2A	45.1
IWA2007	wsnp_Ex_c15325_23565935	2A	45.1
IWA5793	wsnp_JD_c12088_12411845	2A	45.1
IWA901	wsnp_CAP11_rep_c8768_3788007	2A	45.1
IWA991	wsnp_CAP12_c901_472535	2A	45.1
IWA2531	wsnp_Ex_c20370_29434410	2A	46.1
IWA3569	wsnp_Ex_c36242_44232305	2A	46.1
IWA3570	wsnp_Ex_c36242_44232473	2A	46.1
IWA3802	wsnp_Ex_c41913_48628356	2A	46.1
IWA3803	wsnp_Ex_c41913_48628389	2A	46.1
IWA4026	wsnp_Ex_c4847_8646583	2A	46.1
IWA4027	wsnp_Ex_c4847_8646784	2A	46.1
IWA2159	wsnp_Ex_c16677_25220222	2A	47.2
IWA2259	wsnp_Ex_c1782_3365844	2A	47.2
IWA4410	wsnp_Ex_c60588_60977198	2A	47.2
IWA5037	wsnp_Ex_rep_c101866_87158671	2A	47.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5585	wsnp_Ex_rep_c69124_68035485	2A	47.2
IWA5586	wsnp_Ex_rep_c69124_68035904	2A	47.2
IWA6139	wsnp_JD_c6436_7600132	2A	47.2
IWA6369	wsnp_JG_c926_520103	2A	47.2
IWA6514	wsnp_Ku_c14099_22301373	2A	47.2
IWA7248	wsnp_Ku_c6826_11860405	2A	47.2
IWA7389	wsnp_Ku_rep_c102140_89178676	2A	47.2
IWA7705	wsnp_Ra_c19526_28719561	2A	47.2
IWA581	wsnp_BG607088A_Ta_1_1	2A	47.6
IWA690	wsnp_CAP11_c1787_968410	2A	47.6
IWA8328	wsnp_RFL_Contig2370_1864666	2A	47.6
IWA2758	wsnp_Ex_c22862_32074455	2A	48.0
IWA533	wsnp_BG263521A_Ta_2_1	2A	48.0
IWA534	wsnp_BG263521A_Ta_2_2	2A	48.0
IWA5378	wsnp_Ex_rep_c67264_65795361	2A	48.7
IWA1274	wsnp_Ex_c10083_16570816	2A	48.9
IWA1968	wsnp_Ex_c1499_2868716	2A	48.9
IWA2962	wsnp_Ex_c2536_4728768	2A	48.9
IWA2971	wsnp_Ex_c25409_34677674	2A	48.9
IWA3007	wsnp_Ex_c2592_4822528	2A	48.9
IWA3380	wsnp_Ex_c32079_40793255	2A	48.9
IWA4623	wsnp_Ex_c7091_12199032	2A	48.9
IWA5569	wsnp_Ex_rep_c68871_67756221	2A	48.9
IWA5870	wsnp_JD_c16067_15341994	2A	48.9
IWA8130	wsnp_Ra_rep_c106961_90622638	2A	48.9
IWA845	wsnp_CAP11_rep_c4135_1956064	2A	48.9
IWA3431	wsnp_Ex_c33420_41911147	2A	49.1
IWA5425	wsnp_Ex_rep_c67621_66275106	2A	49.1
IWA1009	wsnp_CAP12_rep_c4584_2092741	2A	49.3
IWA1013	wsnp_CAP12_rep_c5840_2647196	2A	49.3
IWA1103	wsnp_CAP7_c7742_3467376	2A	49.3
IWA1122	wsnp_CAP7_rep_c5524_2482342	2A	49.3
IWA1133	wsnp_CAP7_rep_c9097_4074450	2A	49.3
IWA1134	wsnp_CAP7_rep_c9455_4223473	2A	49.3
IWA1230	wsnp_CAP8_rep_c4276_2091752	2A	49.3
IWA1234	wsnp_CAP8_rep_c4792_2326084	2A	49.3
IWA1369	wsnp_Ex_c1064_2034431	2A	49.3
IWA1370	wsnp_Ex_c1064_2034518	2A	49.3
IWA1371	wsnp_Ex_c1064_2034730	2A	49.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1496	wsnp_Ex_c11437_18454413	2A	49.3
IWA1936	wsnp_Ex_c14760_22866280	2A	49.3
IWA1937	wsnp_Ex_c14760_22866930	2A	49.3
IWA1966	wsnp_Ex_c14980_23134376	2A	49.3
IWA2296	wsnp_Ex_c18271_27089779	2A	49.3
IWA2648	wsnp_Ex_c21721_30882221	2A	49.3
IWA2654	wsnp_Ex_c21786_30948397	2A	49.3
IWA2831	wsnp_Ex_c23720_32957892	2A	49.3
IWA3255	wsnp_Ex_c29940_38921491	2A	49.3
IWA3388	wsnp_Ex_c3232_5960344	2A	49.3
IWA3427	wsnp_Ex_c33196_41722217	2A	49.3
IWA3819	wsnp_Ex_c42230_48866587	2A	49.3
IWA3946	wsnp_Ex_c45617_51361414	2A	49.3
IWA4322	wsnp_Ex_c56928_58852277	2A	49.3
IWA4627	wsnp_Ex_c7154_12289504	2A	49.3
IWA4628	wsnp_Ex_c7154_12290649	2A	49.3
IWA5362	wsnp_Ex_rep_c67143_65626838	2A	49.3
IWA5406	wsnp_Ex_rep_c67481_66083943	2A	49.3
IWA5715	wsnp_Ex_rep_c70891_69758513	2A	49.3
IWA6264	wsnp_JD_rep_c49684_33856127	2A	49.3
IWA6874	wsnp_Ku_c30418_40245121	2A	49.3
IWA6991	wsnp_Ku_c38662_47257696	2A	49.3
IWA7001	wsnp_Ku_c3907_7157334	2A	49.3
IWA7041	wsnp_Ku_c4213_7674814	2A	49.3
IWA7075	wsnp_Ku_c44873_52048221	2A	49.3
IWA7548	wsnp_Ra_c10861_17763060	2A	49.3
IWA7683	wsnp_Ra_c18391_27447178	2A	49.3
IWA8015	wsnp_Ra_c58188_60004916	2A	49.3
IWA8016	wsnp_Ra_c58188_60005934	2A	49.3
IWA8210	wsnp_Ra_rep_c88200_80168527	2A	49.3
IWA864	wsnp_CAP11_rep_c4303_2031651	2A	49.3
IWA872	wsnp_CAP11_rep_c5024_2352900	2A	49.3
IWA873	wsnp_CAP11_rep_c5124_2393868	2A	49.3
IWA877	wsnp_CAP11_rep_c6137_2841945	2A	49.3
IWA878	wsnp_CAP11_rep_c6376_2943437	2A	49.3
IWA895	wsnp_CAP11_rep_c8681_3747503	2A	49.3
IWA1008	wsnp_CAP12_rep_c4379_1995966	2A	49.5
IWA1932	wsnp_Ex_c14717_22800771	2A	49.5
IWA3808	wsnp_Ex_c4203_7590741	2A	49.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7837	wsnp_Ra_c30244_39523512	2A	49.5
IWA972	wsnp_CAP12_c5344_2430233	2A	49.5
IWA1252	wsnp_CD452951A_Ta_2_1	2A	49.7
IWA1579	wsnp_Ex_c12068_19316125	2A	49.7
IWA2520	wsnp_Ex_c2030_3807284	2A	49.7
IWA2549	wsnp_Ex_c20649_29731279	2A	49.7
IWA336	wsnp_BE517627A_Ta_2_1	2A	49.7
IWA5540	wsnp_Ex_rep_c68516_67350929	2A	49.7
IWA673	wsnp_CAP11_c1488_833183	2A	49.7
IWA6734	wsnp_Ku_c2325_4468237	2A	49.7
IWA5293	wsnp_Ex_rep_c66709_65042923	2A	49.9
IWA1202	wsnp_CAP8_c607_445315	2A	50.1
IWA2001	wsnp_Ex_c15301_23528979	2A	50.1
IWA2002	wsnp_Ex_c15301_23529079	2A	50.1
IWA2537	wsnp_Ex_c20445_29515644	2A	50.1
IWA2604	wsnp_Ex_c2138_4015101	2A	50.1
IWA2605	wsnp_Ex_c2138_4015881	2A	50.1
IWA2948	wsnp_Ex_c25057_34318425	2A	50.1
IWA309	wsnp_be498599A_Ta_2_2	2A	50.1
IWA4815	wsnp_Ex_c8587_14418021	2A	50.1
IWA5188	wsnp_Ex_rep_c66270_64420584	2A	50.1
IWA5219	wsnp_Ex_rep_c66377_64570189	2A	50.1
IWA5272	wsnp_Ex_rep_c66615_64916114	2A	50.1
IWA5273	wsnp_Ex_rep_c66615_64916512	2A	50.1
IWA5305	wsnp_Ex_rep_c66809_65184970	2A	50.1
IWA5307	wsnp_Ex_rep_c66809_65185323	2A	50.1
IWA5549	wsnp_Ex_rep_c68599_67447880	2A	50.1
IWA5550	wsnp_Ex_rep_c68599_67447926	2A	50.1
IWA574	wsnp_bg606625A_Ta_2_1	2A	50.1
IWA5744	wsnp_Ex_rep_c75827_73041653	2A	50.1
IWA588	wsnp_BG608354A_Ta_2_1	2A	50.1
IWA5993	wsnp_JD_c3032_4015340	2A	50.1
IWA6593	wsnp_Ku_c16371_25240695	2A	50.1
IWA7531	wsnp_Ra_c10091_16694335	2A	50.1
IWA7569	wsnp_Ra_c11564_18736249	2A	50.1
IWA7969	wsnp_Ra_c4850_8698731	2A	50.1
IWA3086	wsnp_Ex_c27023_36242252	2A	50.3
IWA3653	wsnp_Ex_c3869_7028759	2A	50.3
IWA5302	wsnp_Ex_rep_c66800_65171198	2A	50.3



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5303	wsnp_Ex_rep_c66800_65171259	2A	50.3
IWA7464	wsnp_Ku_rep_c69876_69364477	2A	50.3
IWA528	wsnp_BG263263A_Ta_2_1	2A	50.8
IWA111	wsnp_BE442788A_Ta_2_1	2A	51.6
IWA411	wsnp_BF145580A_Ta_2_1	2A	51.6
IWA412	wsnp_BF145580A_Ta_2_2	2A	51.6
IWA887	wsnp_CAP11_rep_c8469_3658252	2A	51.6
IWA812	wsnp_CAP11_c838_518859	2A	52.9
IWA7947	wsnp_Ra_c4503_8155485	2A	55.3
IWA5130	wsnp_Ex_rep_c105158_89662129	2A	70.2
IWA5855	wsnp_JD_c15127_14676522	2A	78.5
IWA5856	wsnp_JD_c15127_14676999	2A	78.5
IWA2884	wsnp_Ex_c2426_4542393	2A	80.0
IWA4294	wsnp_Ex_c5619_9884202	2A	80.0
IWA5462	wsnp_Ex_rep_c67848_66550913	2A	80.0
IWA5463	wsnp_Ex_rep_c67848_66550974	2A	80.0
IWA572	wsnp_BG605368A_Ta_2_4	2A	80.0
IWA5733	wsnp_Ex_rep_c71983_70544041	2A	80.0
IWA6286	wsnp_JD_rep_c61500_39461849	2A	80.0
IWA6503	wsnp_Ku_c13700_21770090	2A	80.0
IWA6844	wsnp_Ku_c28467_38394887	2A	80.0
IWA6845	wsnp_Ku_c28467_38394907	2A	80.0
IWA7149	wsnp_Ku_c52392_57380726	2A	80.0
IWA7166	wsnp_Ku_c54793_58953037	2A	80.0
IWA7540	wsnp_Ra_c10658_17500498	2A	80.0
IWA7583	wsnp_Ra_c12275_19707323	2A	80.0
IWA7593	wsnp_Ra_c12874_20497763	2A	80.2
IWA6307	wsnp_JD_rep_c64440_41093162	2A	80.4
IWA4365	wsnp_Ex_c5856_10275776	2A	80.6
IWA4366	wsnp_Ex_c5856_10275959	2A	80.6
IWA4367	wsnp_Ex_c5856_10276064	2A	80.6
IWA3940	wsnp_Ex_c45487_51267140	2A	85.9
IWA7876	wsnp_Ra_c3378_6318431	2A	87.2
IWA1960	wsnp_Ex_c14953_23104041	2A	92.5
IWA8385	wsnp_RFL_Contig2763_2509104	2A	92.5
IWA3752	wsnp_Ex_c41007_47932833	2A	96.0
IWA684	wsnp_CAP11_c1711_934478	2A	96.0
IWA5066	wsnp_Ex_rep_c102390_87572532	2A	96.2
IWA6931	wsnp_Ku_c33884_43306422	2A	96.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5685	wsnp_Ex_rep_c70299_69243401	2A	101.5
IWA5686	wsnp_Ex_rep_c70299_69243835	2A	101.5
IWA6548	wsnp_Ku_c15077_23576078	2A	101.5
IWA6549	wsnp_Ku_c15077_23576192	2A	101.5
IWA8040	wsnp_Ra_c66636_64922359	2A	101.5
IWA8041	wsnp_Ra_c66636_64923321	2A	101.5
IWA227	wsnp_BE490384A_Ta_2_1	2A	109.8
IWA5840	wsnp_JD_c13946_13810300	2A	110.6
IWA7761	wsnp_Ra_c22610_32088836	2A	110.6
IWA5271	wsnp_Ex_rep_c66606_64905694	2A	110.9
IWA6797	wsnp_Ku_c26323_36285601	2A	113.7
IWA6798	wsnp_Ku_c26323_36285697	2A	113.7
IWA7671	wsnp_Ra_c17622_26522072	2A	117.1
IWA5759	wsnp_Ex_rep_c90786_81061397	2A	121.1
IWA4658	wsnp_Ex_c73454_71499715	2A	121.3
IWA5978	wsnp_JD_c289_450995	2A	121.3
IWA2983	wsnp_Ex_c25636_34897348	2A	121.9
IWA3809	wsnp_Ex_c4204_7594348	2A	121.9
IWA5082	wsnp_Ex_rep_c103072_88111184	2A	121.9
IWA2777	wsnp_Ex_c2311_4327441	2A	124.6
IWA4963	wsnp_Ex_c979_1874338	2A	125.2
IWA5989	wsnp_JD_c30_49073	2A	125.2
IWA5990	wsnp_JD_c30_49149	2A	125.2
IWA5991	wsnp_JD_c30_49876	2A	125.2
IWA5992	wsnp_JD_c30_50478	2A	125.2
IWA7122	wsnp_Ku_c498_1036380	2A	125.2
IWA7638	wsnp_Ra_c15518_23944753	2A	125.2
IWA8325	wsnp_RFL_Contig2324_1803878	2A	125.2
IWA4459	wsnp_Ex_c62466_62093712	2A	125.4
IWA4870	wsnp_Ex_c905_1748920	2A	144.8
IWA4445	wsnp_Ex_c6209_10838456	2A	156.0
IWA4953	wsnp_Ex_c9706_16040258	2B	0.0
IWA6957	wsnp_Ku_c3663_6748611	2B	0.4
IWA1413	wsnp_Ex_c10961_17803258	2B	0.6
IWA2424	wsnp_Ex_c19516_28480964	2B	0.6
IWA6262	wsnp_JD_rep_c49438_33652645	2B	0.6
IWA6263	wsnp_JD_rep_c49438_33652663	2B	0.6
IWA7633	wsnp_Ra_c1501_2991585	2B	0.6
IWA6138	wsnp_JD_c640_960796	2B	2.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6008	wsnp_JD_c3288_4296662	2B	5.7
IWA7370	wsnp_Ku_c9883_16462146	2B	5.9
IWA3005	wsnp_Ex_c259_497455	2B	6.1
IWA3589	wsnp_Ex_c3685_6723631	2B	6.1
IWA7545	wsnp_Ra_c10712_17572884	2B	6.1
IWA2088	wsnp_Ex_c1602_3055066	2B	23.2
IWA2104	wsnp_Ex_c16144_24583060	2B	23.2
IWA2110	wsnp_Ex_c1629_3103725	2B	23.2
IWA2111	wsnp_Ex_c1629_3103807	2B	23.2
IWA2275	wsnp_Ex_c1792_3381544	2B	23.2
IWA3722	wsnp_Ex_c40567_47598887	2B	23.2
IWA5554	wsnp_Ex_rep_c68623_67474885	2B	23.2
IWA5555	wsnp_Ex_rep_c68623_67474935	2B	23.2
IWA7106	wsnp_Ku_c48_103915	2B	23.2
IWA8152	wsnp_Ra_rep_c117300_96881829	2B	23.2
IWA1929	wsnp_Ex_c14711_22788263	2B	31.2
IWA1930	wsnp_Ex_c14711_22788586	2B	31.2
IWA5708	wsnp_Ex_rep_c70756_69644826	2B	31.2
IWA6048	wsnp_JD_c42879_30043973	2B	31.2
IWA6085	wsnp_JD_c5064_6183978	2B	31.2
IWA889	wsnp_CAP11_rep_c8489_3665230	2B	31.2
IWA4284	wsnp_Ex_c56027_58306755	2B	31.6
IWA4420	wsnp_Ex_c6099_10674406	2B	38.2
IWA4421	wsnp_Ex_c6099_10674508	2B	38.2
IWA4554	wsnp_Ex_c66052_64232430	2B	38.2
IWA1407	wsnp_Ex_c10941_17776989	2B	38.6
IWA6026	wsnp_JD_c3732_4781170	2B	38.6
IWA6739	wsnp_Ku_c23305_33210628	2B	38.6
IWA6740	wsnp_Ku_c23305_33210841	2B	38.6
IWA6893	wsnp_Ku_c31_62657	2B	38.6
IWA6943	wsnp_Ku_c34759_44069854	2B	38.6
IWA7069	wsnp_Ku_c44441_51721669	2B	38.6
IWA6452	wsnp_Ku_c12022_19520410	2B	41.5
IWA3328	wsnp_Ex_c31262_40077397	2B	41.9
IWA4135	wsnp_Ex_c5239_9272511	2B	41.9
IWA4673	wsnp_Ex_c741_1456698	2B	41.9
IWA5818	wsnp_JD_c12687_12877994	2B	41.9
IWA6070	wsnp_JD_c4621_5757201	2B	41.9
IWA4720	wsnp_Ex_c7738_13195349	2B	44.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3515	wsnp_Ex_c35195_43389213	2B	44.7
IWA4642	wsnp_Ex_c7246_12443506	2B	44.7
IWA1204	wsnp_CAP8_c630_456418	2B	46.6
IWA429	wsnp_BF202681B_Ta_2_2	2B	46.6
IWA5240	wsnp_Ex_rep_c66448_64683704	2B	46.6
IWA7076	wsnp_Ku_c4507_8157580	2B	46.6
IWA1763	wsnp_Ex_c13351_21042379	2B	46.8
IWA3126	wsnp_Ex_c27867_37030045	2B	46.8
IWA5147	wsnp_Ex_rep_c106004_90240692	2B	46.8
IWA6509	wsnp_Ku_c13905_22034406	2B	46.8
IWA7661	wsnp_Ra_c16822_25566950	2B	46.8
IWA897	wsnp_CAP11_rep_c8700_3756682	2B	46.8
IWA2673	wsnp_Ex_c22018_31192778	2B	51.3
IWA2674	wsnp_Ex_c22018_31193171	2B	51.3
IWA4472	wsnp_Ex_c62844_62315607	2B	51.3
IWA4915	wsnp_Ex_c944_1810245	2B	51.3
IWA5830	wsnp_JD_c13359_13373795	2B	51.3
IWA6308	wsnp_JD_rep_c64505_41132927	2B	51.3
IWA6547	wsnp_Ku_c15057_23554067	2B	51.3
IWA6554	wsnp_Ku_c15336_23908130	2B	51.3
IWA3277	wsnp_Ex_c3044_5620102	2B	51.5
IWA3908	wsnp_Ex_c44761_50731830	2B	51.5
IWA2980	wsnp_Ex_c2560_4764402	2B	51.9
IWA5464	wsnp_Ex_rep_c67865_66570323	2B	51.9
IWA6135	wsnp_JD_c6350_7516597	2B	51.9
IWA6462	wsnp_Ku_c12517_20191465	2B	51.9
IWA8344	wsnp_RFL_Contig2506_2098552	2B	51.9
IWA3621	wsnp_Ex_c3764_6853627	2B	52.5
IWA2977	wsnp_Ex_c2557_4761174	2B	52.7
IWA3213	wsnp_Ex_c29108_38173309	2B	52.7
IWA3622	wsnp_Ex_c3769_6861195	2B	52.7
IWA4983	wsnp_Ex_c9935_16358436	2B	52.7
IWA4984	wsnp_Ex_c9935_16358536	2B	52.7
IWA5059	wsnp_Ex_rep_c102216_87433489	2B	52.7
IWA5149	wsnp_Ex_rep_c106085_90293854	2B	52.7
IWA6819	wsnp_Ku_c2725_5163093	2B	52.7
IWA6875	wsnp_Ku_c3042_5706318	2B	52.7
IWA1145	wsnp_CAP8_c1240_753371	2B	52.9
IWA1102	wsnp_CAP7_c7341_3280398	2B	53.1

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1127	wsnp_CAP7_rep_c6301_2835323	2B	53.1
IWA1128	wsnp_CAP7_rep_c7219_3228859	2B	53.1
IWA1129	wsnp_CAP7_rep_c7347_3283296	2B	53.1
IWA1130	wsnp_CAP7_rep_c7349_3284058	2B	53.1
IWA1131	wsnp_CAP7_rep_c8024_3598111	2B	53.1
IWA1177	wsnp_CAP8_c2869_1478615	2B	53.1
IWA1188	wsnp_CAP8_c4328_2115116	2B	53.1
IWA1229	wsnp_CAP8_rep_c4147_2032009	2B	53.1
IWA1237	wsnp_CAP8_rep_c5599_2654989	2B	53.1
IWA169	wsnp_BE445278B_Ta_2_1	2B	53.1
IWA170	wsnp_BE445278B_Ta_2_3	2B	53.1
IWA4604	wsnp_Ex_c7003_12065567	2B	53.1
IWA4606	wsnp_Ex_c7003_12065828	2B	53.1
IWA771	wsnp_CAP11_c5240_2436441	2B	53.1
IWA776	wsnp_CAP11_c5474_2542512	2B	53.1
IWA777	wsnp_CAP11_c5474_2542616	2B	53.1
IWA829	wsnp_CAP11_rep_c4012_1894511	2B	53.1
IWA869	wsnp_CAP11_rep_c4487_2113015	2B	53.1
IWA874	wsnp_CAP11_rep_c5367_2492424	2B	53.1
IWA8517	wsnp_RFL_Contig3802_4108582	2B	55.6
IWA2349	wsnp_Ex_c18750_27627600	2B	56.9
IWA2464	wsnp_Ex_c19819_28826877	2B	56.9
IWA2465	wsnp_Ex_c19819_28827344	2B	56.9
IWA2543	wsnp_Ex_c20529_29608872	2B	56.9
IWA2544	wsnp_Ex_c20529_29609310	2B	56.9
IWA31	wsnp_BE403506B_Ta_1_2	2B	56.9
IWA3452	wsnp_Ex_c3386_6217645	2B	56.9
IWA3453	wsnp_Ex_c3386_6217891	2B	56.9
IWA3889	wsnp_Ex_c4423_7960221	2B	56.9
IWA3942	wsnp_Ex_c45595_51343969	2B	56.9
IWA4106	wsnp_Ex_c51661_55531646	2B	56.9
IWA4107	wsnp_Ex_c51661_55533018	2B	56.9
IWA4134	wsnp_Ex_c5238_9271937	2B	56.9
IWA4136	wsnp_Ex_c52405_56014689	2B	56.9
IWA433	wsnp_BF202975B_Ta_2_1	2B	56.9
IWA4822	wsnp_Ex_c8641_14485630	2B	56.9
IWA4982	wsnp_Ex_c9932_16354389	2B	56.9
IWA5090	wsnp_Ex_rep_c103248_88252209	2B	56.9
IWA5091	wsnp_Ex_rep_c103248_88252281	2B	56.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5600	wsnp_Ex_rep_c69340_68274022	2B	56.9
IWA5653	wsnp_Ex_rep_c69895_68855724	2B	56.9
IWA5654	wsnp_Ex_rep_c69895_68856078	2B	56.9
IWA5659	wsnp_Ex_rep_c69928_68889568	2B	56.9
IWA5926	wsnp_JD_c21530_18862386	2B	56.9
IWA5927	wsnp_JD_c21530_18862705	2B	56.9
IWA6000	wsnp_JD_c3166_4159751	2B	56.9
IWA6265	wsnp_JD_rep_c49813_33962513	2B	56.9
IWA671	wsnp_CAP11_c1436_808089	2B	56.9
IWA7146	wsnp_Ku_c52199_57246606	2B	56.9
IWA7215	wsnp_Ku_c6183_10867720	2B	56.9
IWA742	wsnp_CAP11_c307_255609	2B	56.9
IWA7420	wsnp_Ku_rep_c107413_92888678	2B	56.9
IWA7499	wsnp_Ku_rep_c71678_71421327	2B	56.9
IWA7524	wsnp_Ku_rep_c83117_78896856	2B	56.9
IWA8112	wsnp_Ra_rep_c103071_87770006	2B	56.9
IWA8227	wsnp_RFL_Contig1150_196572	2B	56.9
IWA8454	wsnp_RFL_Contig3304_3372802	2B	56.9
IWA5168	wsnp_Ex_rep_c108679_91802578	2B	57.3
IWA5256	wsnp_Ex_rep_c66524_64799410	2B	57.3
IWA2081	wsnp_Ex_c15985_24399118	2B	57.7
IWA6216	wsnp_JD_c9251_10121369	2B	57.7
IWA6966	wsnp_Ku_c37269_46153087	2B	58.3
IWA2236	wsnp_Ex_c17576_26303707	2B	58.5
IWA3840	wsnp_Ex_c4273_7712252	2B	58.5
IWA4517	wsnp_Ex_c6471_11241582	2B	58.5
IWA4541	wsnp_Ex_c65790_64067038	2B	58.5
IWA5017	wsnp_Ex_rep_c101477_86838533	2B	58.5
IWA5077	wsnp_Ex_rep_c103017_88070251	2B	58.5
IWA5794	wsnp_JD_c12127_12442581	2B	58.5
IWA586	wsnp_BG608232B_Ta_2_1	2B	58.5
IWA587	wsnp_BG608232B_Ta_2_2	2B	58.5
IWA5983	wsnp_JD_c29301_23358365	2B	58.5
IWA6607	wsnp_Ku_c16865_25822301	2B	58.5
IWA6921	wsnp_Ku_c33341_42849025	2B	58.5
IWA6948	wsnp_Ku_c35215_44455846	2B	58.5
IWA7015	wsnp_Ku_c39797_48152615	2B	58.5
IWA7195	wsnp_Ku_c58640_61287250	2B	58.5
IWA7684	wsnp_Ra_c18396_27453775	2B	58.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA550	wsnp_BG313179B_Ta_2_1	2B	58.7
IWA652	wsnp_CAP11_c114_140053	2B	60.6
IWA5128	wsnp_Ex_rep_c105129_89641882	2B	63.0
IWA8359	wsnp_RFL_Contig2598_2253005	2B	63.0
IWA1689	wsnp_Ex_c128_254788	2B	63.2
IWA1690	wsnp_Ex_c128_255285	2B	63.2
IWA5008	wsnp_Ex_rep_c101349_86725007	2B	63.4
IWA2955	wsnp_Ex_c25217_34481787	2B	64.2
IWA2559	wsnp_Ex_c2097_3932976	2B	64.4
IWA3784	wsnp_Ex_c41558_48355943	2B	64.4
IWA3785	wsnp_Ex_c41558_48356814	2B	64.4
IWA3786	wsnp_Ex_c41558_48356869	2B	64.4
IWA5846	wsnp_JD_c14405_14144807	2B	64.4
IWA7449	wsnp_Ku_rep_c68888_68067293	2B	64.4
IWA6869	wsnp_Ku_c3000_5638635	2B	65.2
IWA68	wsnp_BE406277B_Ta_1_2	2B	66.0
IWA242	wsnp_BE490763B_Ta_2_1	2B	66.4
IWA243	wsnp_BE490763B_Ta_2_2	2B	66.4
IWA1489	wsnp_Ex_c114_230248	2B	69.3
IWA5939	wsnp_JD_c2273_3105037	2B	69.3
IWA6169	wsnp_JD_c744_1111659	2B	69.3
IWA6317	wsnp_JD_rep_c67103_42432235	2B	69.3
IWA226	wsnp_BE490267A_Ta_2_1	2B	69.5
IWA2294	wsnp_Ex_c18261_27078080	2B	69.9
WMC441	WMC441	2B	70.8
IWA2237	wsnp_Ex_c1758_3326792	2B	71.7
IWA7825	wsnp_Ra_c28955_38371323	2B	71.7
IWA3973	wsnp_Ex_c46576_52042185	2B	72.1
IWA6076	wsnp_JD_c47318_32176833	2B	72.1
IWA2130	wsnp_Ex_c16425_24923685	2B	72.7
IWA2131	wsnp_Ex_c16425_24923837	2B	72.7
IWA2903	wsnp_Ex_c2445_4573233	2B	73.1
IWA3823	wsnp_Ex_c4230_7639858	2B	73.1
IWA5415	wsnp_Ex_rep_c67561_66189356	2B	73.1
IWA5789	wsnp_JD_c11975_12326445	2B	73.1
IWA543	wsnp_BG274584B_Ta_2_1	2B	73.3
IWA8478	wsnp_RFL_Contig3522_3685860	2B	73.3
IWA3935	wsnp_Ex_c4542_8154800	2B	73.5
IWA1389	wsnp_Ex_c10796_17575074	2B	73.7

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4890	wsnp_Ex_c922_1775246	2B	73.7
IWA4948	wsnp_Ex_c9628_15927045	2B	73.7
IWA5064	wsnp_Ex_rep_c102385_87568304	2B	73.7
IWA933	wsnp_CAP12_c197_110707	2B	74.1
GWM47	GWM47	2B	80.3
<i>SrWLR</i>	<i>SrWLR</i>	2B	81.8
IWA6121	wsnp_JD_c6010_7167084	2B	82.2
IWA6122	wsnp_JD_c6010_7167159	2B	82.2
IWA7620	wsnp_Ra_c13963_21949302	2B	82.2
IWA8295	wsnp_RFL_Contig2123_1397739	2B	82.2
IWA8362	wsnp_RFL_Contig2612_2274356	2B	82.2
IWA1534	wsnp_Ex_c11748_18884081	2B	83.3
IWA2379	wsnp_Ex_c1915_3618286	2B	83.3
IWA2678	wsnp_Ex_c2203_4130096	2B	83.3
IWA2701	wsnp_Ex_c22271_31463382	2B	83.3
IWA4909	wsnp_Ex_c942_1806632	2B	83.3
IWA175	wsnp_BE445431B_Ta_1_1	2B	83.5
IWA2676	wsnp_Ex_c2203_4129271	2B	83.5
IWA2677	wsnp_Ex_c2203_4129457	2B	83.5
IWA3148	wsnp_Ex_c2819_5213149	2B	83.5
IWA1291	wsnp_Ex_c1016_1943126	2B	85.0
IWA1292	wsnp_Ex_c1016_1943573	2B	85.0
IWA1293	wsnp_Ex_c1016_1943827	2B	85.0
IWA3075	wsnp_Ex_c26818_36041748	2B	85.2
IWA5051	wsnp_Ex_rep_c102127_87360034	2B	85.2
IWA2872	wsnp_Ex_c24135_33382318	2B	85.8
IWA2873	wsnp_Ex_c24135_33382521	2B	85.8
IWA2874	wsnp_Ex_c24135_33382700	2B	85.8
IWA2875	wsnp_Ex_c24135_33382813	2B	85.8
IWA6561	wsnp_Ku_c15498_24122936	2B	85.8
IWA1040	wsnp_CAP7_c1592_791887	2B	87.7
IWA7640	wsnp_Ra_c15621_24073604	2B	87.7
IWA1076	wsnp_CAP7_c317_172502	2B	88.5
IWA4130	wsnp_Ex_c52268_55928053	2B	88.5
IWA3937	wsnp_Ex_c45468_51254832	2B	89.3
WMC332	WMC332	2B	92.4
IWA8406	wsnp_RFL_Contig2914_2757372	2B	95.0
IWA5809	wsnp_JD_c12346_12606967	2B	97.6
IWA5810	wsnp_JD_c12346_12607102	2B	97.6



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1324	wsnp_Ex_c10441_17078853	2B	101.4
IWA570	wsnp_BG605258B_Ta_2_1	2B	101.4
IWA3594	wsnp_Ex_c3695_6740063	2B	107.8
IWA3474	wsnp_Ex_c34303_42642389	2B	110.4
WMC361	WMC361	2B	111.1
IWA3982	wsnp_Ex_c4690_8386386	2B	113.0
IWA746	wsnp_CAP11_c3226_1588070	2B	113.0
IWA8055	wsnp_Ra_c7049_12224017	2B	113.0
IWA8504	wsnp_RFL_Contig3712_3953814	2B	113.0
IWA5093	wsnp_Ex_rep_c103381_88353000	2B	114.1
IWA692	wsnp_CAP11_c1820_985143	2B	114.1
IWA2094	wsnp_Ex_c16074_24502385	2B	118.9
IWA3315	wsnp_Ex_c31064_39902843	2B	118.9
IWA2946	wsnp_Ex_c25043_34305764	2B	122.7
IWA6164	wsnp_JD_c7305_8404286	2B	122.7
IWA5752	wsnp_Ex_rep_c80588_75758453	2D	0.0
IWA1107	wsnp_CAP7_c888_455397	2D	5.8
IWA1290	wsnp_Ex_c101374_86744680	2D	5.8
IWA1601	wsnp_Ex_c12250_19568265	2D	5.8
IWA4711	wsnp_Ex_c7669_13090850	2D	5.8
IWA6156	wsnp_JD_c69_109951	2D	8.0
IWA989	wsnp_CAP12_c812_428290	2D	29.2
IWA760	wsnp_CAP11_c3842_1829821	2D	31.4
IWA927	wsnp_CAP12_c1503_764765	2D	32.7
BARC168	BARC168	2D	39.4
IWA8151	wsnp_Ra_rep_c116793_96612614	2D	59.6
IWA8304	wsnp_RFL_Contig2179_1504740	2D	59.6
IWA8544	wsnp_RFL_Contig3960_4401914	2D	61.1
IWA2961	wsnp_Ex_c25311_34578436	2D	62.0
IWA5637	wsnp_Ex_rep_c69782_68740893	2D	63.5
IWA1269	wsnp_Ex_c10014_16476905	3A	0.0
IWA1270	wsnp_Ex_c10014_16477392	3A	0.0
IWA1702	wsnp_Ex_c12875_20407926	3A	0.0
IWA447	wsnp_BF293133A_Ta_2_2	3A	0.0
IWA5427	wsnp_Ex_rep_c67635_66291944	3A	0.0
IWA5428	wsnp_Ex_rep_c67635_66292111	3A	0.0
IWA5429	wsnp_Ex_rep_c67635_66292308	3A	0.0
IWA5430	wsnp_Ex_rep_c67635_66292689	3A	0.0
IWA7771	wsnp_Ra_c2339_4506620	3A	0.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2993	wsnp_Ex_c2573_4788116	3A	0.2
IWA6387	wsnp_Ku_c10362_17156084	3A	0.2
IWA2737	wsnp_Ex_c22683_31887736	3A	0.4
IWA2738	wsnp_Ex_c22683_31887799	3A	0.4
IWA8280	wsnp_RFL_Contig1999_1190396	3A	0.4
IWA8587	wsnp_RFL_Contig4398_5146811	3A	0.4
IWA8127	wsnp_Ra_rep_c106523_90273922	3A	4.5
IWA851	wsnp_CAP11_rep_c4157_1965583	3A	4.5
IWA3939	wsnp_Ex_c4548_8166555	3A	8.8
IWA8105	wsnp_Ra_c9738_16173810	3A	8.8
IWA8106	wsnp_Ra_c9738_16174002	3A	8.8
IWA2047	wsnp_Ex_c15674_24004513	3A	24.8
IWA7086	wsnp_Ku_c4568_8243775	3A	24.8
IWA4675	wsnp_Ex_c742_1458033	3A	38.2
IWA4333	wsnp_Ex_c57322_59083238	3A	38.4
IWA4334	wsnp_Ex_c57322_59084809	3A	38.4
IWA4335	wsnp_Ex_c57322_59084950	3A	38.4
IWA7552	wsnp_Ra_c10911_17834481	3A	38.4
IWA4676	wsnp_Ex_c742_1458743	3A	38.6
IWA6413	wsnp_Ku_c11052_18135847	3A	38.6
IWA443	wsnp_BF292295A_Ta_2_1	3A	40.3
IWA1972	wsnp_Ex_c15036_23203474	3A	40.7
IWA7501	wsnp_Ku_rep_c71761_71496470	3A	43.1
GWM32	GWM32	3A	43.3
IWA2019	wsnp_Ex_c1538_2937905	3A	43.3
IWA5399	wsnp_Ex_rep_c67460_66057400	3A	43.3
IWA4009	wsnp_Ex_c48136_53140385	3A	43.6
IWA2095	wsnp_Ex_c16079_24507688	3A	44.0
IWA2763	wsnp_Ex_c22888_32105519	3A	44.0
IWA5387	wsnp_Ex_rep_c67349_65914945	3A	44.0
IWA7712	wsnp_Ra_c19979_29215858	3A	44.0
IWA1894	wsnp_Ex_c14420_22402673	3A	44.2
IWA2324	wsnp_Ex_c18596_27457344	3A	44.2
IWA6229	wsnp_JD_c9434_10274598	3A	45.9
IWA8215	wsnp_Ra_rep_c99053_85689574	3A	48.3
IWA4397	wsnp_Ex_c5997_10512308	3A	48.5
IWA5164	wsnp_Ex_rep_c108072_91444417	3A	48.5
IWA8388	wsnp_RFL_Contig2767_2518373	3A	48.5
IWA8405	wsnp_RFL_Contig2913_2755542	3A	48.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6483	wsnp_Ku_c1307_2606226	3A	48.7
IWA7415	wsnp_Ku_rep_c104691_91086871	3A	48.7
IWA7012	wsnp_Ku_c3956_7237707	3A	49.1
IWA3794	wsnp_Ex_c41767_48517061	3A	49.5
IWA2154	wsnp_Ex_c1660_3159173	3A	50.2
IWA1699	wsnp_Ex_c12850_20377830	3A	50.4
IWA1377	wsnp_Ex_c10667_17387885	3A	50.8
IWA1378	wsnp_Ex_c10667_17389292	3A	50.8
IWA1435	wsnp_Ex_c11085_17973016	3A	50.8
IWA7319	wsnp_Ku_c8334_14181247	3A	50.8
IWA2750	wsnp_Ex_c22766_31972755	3A	51.0
IWA2751	wsnp_Ex_c22766_31972812	3A	51.0
IWA4922	wsnp_Ex_c9468_15696542	3A	51.0
IWA73	wsnp_BE406587A_Ta_2_1	3A	51.0
IWA1019	wsnp_CAP12_rep_c8867_3720285	3A	51.2
IWA1713	wsnp_Ex_c12948_20511479	3A	51.2
IWA249	wsnp_BE494474A_Ta_2_2	3A	51.2
IWA250	wsnp_BE494474A_Ta_2_3	3A	51.2
IWA3930	wsnp_Ex_c45213_51068540	3A	51.2
IWA3931	wsnp_Ex_c45213_51068665	3A	51.2
IWA4883	wsnp_Ex_c9145_15214903	3A	51.2
IWA4917	wsnp_Ex_c9458_15679797	3A	51.2
IWA5632	wsnp_Ex_rep_c69752_68711460	3A	51.2
IWA7355	wsnp_Ku_c9433_15811664	3A	51.2
IWA7476	wsnp_Ku_rep_c70479_70079622	3A	51.2
IWA7826	wsnp_Ra_c29280_38672141	3A	51.2
IWA132	wsnp_BE443568A_Ta_2_1	3A	52.1
IWA133	wsnp_BE443568A_Ta_2_2	3A	52.1
IWA234	wsnp_BE490613A_Ta_2_1	3A	52.1
IWA5124	wsnp_Ex_rep_c104884_89459472	3A	52.1
IWA743	wsnp_CAP11_c318_261649	3A	52.1
IWA8465	wsnp_RFL_Contig3396_3515504	3A	52.1
IWA1998	wsnp_Ex_c15269_23491104	3A	52.3
IWA1999	wsnp_Ex_c15269_23492289	3A	52.3
IWA2801	wsnp_Ex_c2331_4369782	3A	52.3
IWA2986	wsnp_Ex_c25668_34932304	3A	52.3
IWA5311	wsnp_Ex_rep_c66865_65262277	3A	52.3
IWA5312	wsnp_Ex_rep_c66865_65262612	3A	52.3
IWA5313	wsnp_Ex_rep_c66865_65262892	3A	52.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5314	wsnp_Ex_rep_c66865_65263145	3A	52.3
IWA5315	wsnp_Ex_rep_c66865_65264070	3A	52.3
IWA5849	wsnp_JD_c14691_14352459	3A	52.3
IWA5994	wsnp_JD_c3034_4017676	3A	52.3
IWA7541	wsnp_Ra_c10669_17515792	3A	52.3
IWA1762	wsnp_Ex_c1335_2556442	3A	52.7
IWA4707	wsnp_Ex_c763_1503467	3A	52.7
IWA4794	wsnp_Ex_c8334_14049699	3A	52.7
IWA5578	wsnp_Ex_rep_c69034_67934852	3A	52.7
IWA5579	wsnp_Ex_rep_c69034_67935465	3A	52.7
IWA5973	wsnp_JD_c2743_3678590	3A	52.7
IWA8621	wsnp_RFL_Contig4734_5671036	3A	52.7
IWA1536	wsnp_Ex_c11807_18960045	3A	52.9
IWA1700	wsnp_Ex_c12871_20400823	3A	52.9
IWA1701	wsnp_Ex_c12871_20402160	3A	52.9
IWA3250	wsnp_Ex_c29742_38738725	3A	52.9
IWA3512	wsnp_Ex_c35073_43285821	3A	52.9
IWA3999	wsnp_Ex_c47763_52874806	3A	52.9
IWA4110	wsnp_Ex_c51776_55603135	3A	52.9
IWA7073	wsnp_Ku_c44716_51926415	3A	58.2
IWA2291	wsnp_Ex_c18223_27035083	3A	60.6
IWA7132	wsnp_Ku_c50833_56310208	3A	63.7
IWA4851	wsnp_Ex_c8884_14841846	3A	64.8
IWA1260	wsnp_CD454173A_Ta_2_8	3A	65.0
IWA4053	wsnp_Ex_c4923_8767234	3A	65.0
IWA6652	wsnp_Ku_c18497_27803432	3A	65.0
IWA925	wsnp_CAP12_c147_84461	3A	65.0
IWA1294	wsnp_Ex_c101710_87025916	3A	65.2
IWA6996	wsnp_Ku_c38911_47455674	3A	65.2
IWA6997	wsnp_Ku_c38911_47455924	3A	65.2
IWA3543	wsnp_Ex_c35861_43926307	3A	66.5
IWA3544	wsnp_Ex_c35861_43926854	3A	66.5
IWA3545	wsnp_Ex_c35861_43927741	3A	66.5
IWA3546	wsnp_Ex_c35861_43928486	3A	66.5
IWA5114	wsnp_Ex_rep_c104327_89077792	3A	66.5
IWA5601	wsnp_Ex_rep_c69342_68276235	3A	66.5
IWA5602	wsnp_Ex_rep_c69342_68276256	3A	66.5
IWA2348	wsnp_Ex_c18747_27625264	3A	66.7
IWA5657	wsnp_Ex_rep_c69919_68881108	3A	66.7

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7087	wsnp_Ku_c458_954940	3A	68.2
IWA444	wsnp_BF292596A_Ta_1_1	3A	68.4
IWA445	wsnp_BF292596A_Ta_1_3	3A	68.4
IWA4296	wsnp_Ex_c5623_9891427	3A	68.6
IWA4298	wsnp_Ex_c5623_9891584	3A	68.6
IWA7696	wsnp_Ra_c19079_28210937	3A	69.5
IWA3523	wsnp_Ex_c35457_43602680	3A	69.7
IWA4810	wsnp_Ex_c8517_14315660	3A	69.7
IWA5456	wsnp_Ex_rep_c67786_66472676	3A	69.7
IWA1877	wsnp_Ex_c14202_22144844	3A	72.5
IWA1879	wsnp_Ex_c14202_22145805	3A	72.5
IWA1891	wsnp_Ex_c14400_22381382	3A	72.5
IWA1892	wsnp_Ex_c14400_22381548	3A	72.5
IWA5419	wsnp_Ex_rep_c67588_66227926	3A	72.5
IWA5595	wsnp_Ex_rep_c69314_68244036	3A	72.5
IWA5596	wsnp_Ex_rep_c69314_68244502	3A	72.5
IWA6672	wsnp_Ku_c19456_28944589	3A	72.5
IWA7169	wsnp_Ku_c55137_59154077	3A	72.5
IWA7324	wsnp_Ku_c8400_14280021	3A	72.5
IWA8455	wsnp_RFL_Contig3308_3379765	3A	72.5
IWA1611	wsnp_Ex_c12341_19693090	3A	78.3
IWA2028	wsnp_Ex_c15475_23756906	3A	79.4
IWA2029	wsnp_Ex_c15475_23757972	3A	79.4
IWA2008	wsnp_Ex_c1533_2930233	3A	79.8
IWA2263	wsnp_Ex_c17859_26621184	3A	82.7
IWA2264	wsnp_Ex_c17859_26621688	3A	82.7
IWA2265	wsnp_Ex_c17859_26621754	3A	82.7
IWA2266	wsnp_Ex_c17859_26621898	3A	82.7
IWA2518	wsnp_Ex_c20250_29303152	3A	82.7
IWA2842	wsnp_Ex_c2381_4463608	3A	82.7
IWA3401	wsnp_Ex_c32546_41187432	3A	82.7
IWA6396	wsnp_Ku_c10468_17301216	3A	85.1
IWA2372	wsnp_Ex_c1903_3592518	3A	93.9
IWA7938	wsnp_Ra_c4373_7946257	3A	101.9
IWA1366	wsnp_Ex_c10630_17338703	3A	102.6
IWA1367	wsnp_Ex_c10630_17338753	3A	102.6
IWA7812	wsnp_Ra_c27517_37034553	3A	102.6
IWA5190	wsnp_Ex_rep_c66274_64426834	3A	115.6
IWA5191	wsnp_Ex_rep_c66274_64426901	3A	115.6

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2396	wsnp_Ex_c19309_28242774	3A	115.8
IWA6716	wsnp_Ku_c217_430915	3A	115.8
IWA7999	wsnp_Ra_c5454_9660102	3A	115.8
IWA3031	wsnp_Ex_c26213_35462685	3A	116.5
IWA4407	wsnp_Ex_c60462_60905848	3A	121.0
IWA6725	wsnp_Ku_c2249_4335279	3A	121.0
IWA194	wsnp_BE446462D_Ta_2_1	3B	0.0
IWA195	wsnp_BE446462D_Ta_2_3	3B	0.0
BARC147	BARC147	3B	9.1
IWA2691	wsnp_Ex_c22154_31342077	3B	10.0
IWA2822	wsnp_Ex_c23633_32868822	3B	10.0
IWA2908	wsnp_Ex_c24548_33795073	3B	10.0
IWA5299	wsnp_Ex_rep_c66766_65123941	3B	10.0
IWA5347	wsnp_Ex_rep_c67033_65490126	3B	10.0
IWA92	wsnp_BE426287D_Ta_1_1	3B	10.0
IWA2493	wsnp_Ex_c19993_29024127	3B	14.3
IWA7231	wsnp_Ku_c663_1368085	3B	14.3
IWA7647	wsnp_Ra_c16264_24873670	3B	14.3
IWA7678	wsnp_Ra_c18153_27161629	3B	14.3
IWA982	wsnp_CAP12_c680_363345	3B	17.1
IWA3983	wsnp_Ex_c47078_52393295	3B	32.3
IWA8522	wsnp_RFL_Contig3845_4190041	3B	32.3
IWA3426	wsnp_Ex_c33140_41677458	3B	32.8
IWA747	wsnp_CAP11_c323_263628	3B	33.6
IWA748	wsnp_CAP11_c323_263800	3B	33.6
IWA3731	wsnp_Ex_c4069_7355357	3B	36.0
IWA3732	wsnp_Ex_c4069_7355431	3B	36.0
IWA7267	wsnp_Ku_c7173_12391539	3B	36.0
IWA3896	wsnp_Ex_c44447_50496676	3B	36.4
IWA6482	wsnp_Ku_c13069_20938717	3B	36.4
IWA1458	wsnp_Ex_c11246_18191079	3B	36.8
IWA4838	wsnp_Ex_c8695_14561512	3B	36.8
IWA4843	wsnp_Ex_c8802_14726148	3B	36.8
IWA5325	wsnp_Ex_rep_c66896_65307566	3B	36.8
IWA3117	wsnp_Ex_c2756_5105594	3B	37.0
IWA347	wsnp_BE518003B_Ta_2_3	3B	37.0
IWA3974	wsnp_Ex_c4661_8344663	3B	37.0
IWA2119	wsnp_Ex_c16304_24782232	3B	37.3
IWA3716	wsnp_Ex_c40250_47352047	3B	37.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2662	wsnp_Ex_c21930_31102213	3B	37.5
IWA2663	wsnp_Ex_c21930_31102685	3B	37.5
IWA3787	wsnp_Ex_c4156_7506400	3B	37.5
IWA3788	wsnp_Ex_c4156_7507247	3B	37.5
IWA4054	wsnp_Ex_c4927_8772847	3B	37.5
IWA5396	wsnp_Ex_rep_c67404_65986980	3B	37.9
IWA6201	wsnp_JD_c8629_9593995	3B	37.9
IWA4039	wsnp_Ex_c4888_8713275	3B	38.1
IWA4040	wsnp_Ex_c4888_8714379	3B	38.1
IWA7860	wsnp_Ra_c32055_41111615	3B	38.1
IWA8326	wsnp_RFL_Contig2338_1839077	3B	38.1
IWA5977	wsnp_JD_c2863_3822253	3B	38.3
IWA5880	wsnp_JD_c17082_16025440	3B	38.7
IWA1206	wsnp_CAP8_c6899_3227098	3B	38.9
IWA210	wsnp_BE489326B_Ta_2_1	3B	38.9
IWA211	wsnp_BE489326B_Ta_2_2	3B	38.9
IWA2492	wsnp_Ex_c19982_29009504	3B	38.9
IWA2622	wsnp_Ex_c21499_30644485	3B	38.9
IWA2728	wsnp_Ex_c22630_31827919	3B	38.9
IWA292	wsnp_BE497469B_Ta_2_1	3B	38.9
IWA2990	wsnp_Ex_c257_491667	3B	38.9
IWA377	wsnp_BE591466B_Ta_2_2	3B	38.9
IWA4685	wsnp_Ex_c7478_12792943	3B	38.9
IWA5351	wsnp_Ex_rep_c67067_65534806	3B	38.9
IWA5814	wsnp_JD_c1247_1802330	3B	38.9
IWA6018	wsnp_JD_c35642_26554827	3B	38.9
IWA6279	wsnp_JD_rep_c53979_36270209	3B	38.9
IWA629	wsnp_BQ168706B_Ta_2_2	3B	38.9
IWA781	wsnp_CAP11_c558_382875	3B	38.9
IWA91	wsnp_BE426222B_Ta_2_1	3B	38.9
IWA6633	wsnp_Ku_c17718_26860963	3B	40.0
IWA2494	wsnp_Ex_c19994_29025586	3B	40.2
IWA5770	wsnp_JD_c10233_10936535	3B	40.2
IWA6422	wsnp_Ku_c11466_18716865	3B	40.4
IWA6655	wsnp_Ku_c18538_27857915	3B	40.4
IWA3021	wsnp_Ex_c26128_35374652	3B	40.8
IWA1383	wsnp_Ex_c10717_17456391	3B	41.9
IWA1449	wsnp_Ex_c1116_2138756	3B	41.9
IWA2999	wsnp_Ex_c2580_4799370	3B	41.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3001	wsnp_Ex_c2580_4800249	3B	41.9
IWA3504	wsnp_Ex_c34975_43204180	3B	41.9
IWA6213	wsnp_JD_c9042_9950637	3B	41.9
IWA2329	wsnp_Ex_c18624_27492167	3B	42.1
IWA4452	wsnp_Ex_c6223_10857649	3B	42.1
IWA6677	wsnp_Ku_c19631_29148397	3B	42.1
IWA6793	wsnp_Ku_c26257_36216869	3B	42.1
IWA6794	wsnp_Ku_c26257_36216976	3B	42.1
IWA7595	wsnp_Ra_c12935_20587578	3B	42.1
IWA1607	wsnp_Ex_c123_244117	3B	42.9
IWA1898	wsnp_Ex_c14462_22457559	3B	42.9
IWA1909	wsnp_Ex_c14551_22578987	3B	42.9
IWA2672	wsnp_Ex_c22016_31191407	3B	42.9
IWA2800	wsnp_Ex_c2330_4366134	3B	42.9
IWA3997	wsnp_Ex_c4769_8510104	3B	42.9
IWA4193	wsnp_Ex_c5378_9504586	3B	42.9
IWA4194	wsnp_Ex_c5378_9505087	3B	42.9
IWA4195	wsnp_Ex_c5378_9505533	3B	42.9
IWA4630	wsnp_Ex_c7172_12318529	3B	42.9
IWA6086	wsnp_JD_c5067_6187376	3B	42.9
IWA6300	wsnp_JD_rep_c63942_40788045	3B	42.9
IWA7247	wsnp_Ku_c6825_11858665	3B	42.9
IWA7333	wsnp_Ku_c8722_14766699	3B	42.9
IWA2022	wsnp_Ex_c15399_23662312	3B	49.0
IWA3710	wsnp_Ex_c40060_47197384	3B	49.0
IWA5902	wsnp_JD_c19725_17732526	3B	49.0
IWA2782	wsnp_Ex_c2314_4333242	3B	49.6
IWA4439	wsnp_Ex_c6162_10773908	3B	50.1
IWA5626	wsnp_Ex_rep_c69664_68618163	3B	50.1
IWA6510	wsnp_Ku_c1391_2771050	3B	50.1
IWA7510	wsnp_Ku_rep_c72504_72191206	3B	50.1
IWA4507	wsnp_Ex_c6445_11200449	3B	51.1
IWA7512	wsnp_Ku_rep_c72700_72370664	3B	51.8
IWA6493	wsnp_Ku_c13311_21255891	3B	52.0
BARC164	BARC164	3B	52.2
IWA2573	wsnp_Ex_c21094_30222280	3B	52.2
IWA3304	wsnp_Ex_c3096_5708642	3B	52.2
IWA3305	wsnp_Ex_c3096_5709257	3B	52.2
IWA3306	wsnp_Ex_c3096_5709369	3B	52.2



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4218	wsnp_Ex_c5418_9575485	3B	52.2
IWA4219	wsnp_Ex_c5418_9575513	3B	52.2
IWA5710	wsnp_Ex_rep_c70809_69689636	3B	52.2
IWA5711	wsnp_Ex_rep_c70809_69690102	3B	52.2
IWA7692	wsnp_Ra_c18873_27993835	3B	52.2
IWA8290	wsnp_RFL_Contig2073_1317762	3B	52.2
IWA8583	wsnp_RFL_Contig4320_5027794	3B	52.2
IWA4653	wsnp_Ex_c7291_12517871	3B	52.6
IWA5775	wsnp_JD_c10602_11238420	3B	52.6
IWA6104	wsnp_JD_c5643_6802088	3B	54.3
IWA6105	wsnp_JD_c5643_6802211	3B	54.3
IWA1598	wsnp_Ex_c12220_19528388	3B	57.7
IWA2862	wsnp_Ex_c2400_4498931	3B	61.8
IWA3901	wsnp_Ex_c4457_8018164	3B	61.8
IWA624	wsnp_BQ167580B_Ta_2_1	3B	61.8
IWA81	wsnp_BE424246B_Ta_2_2	3B	61.8
IWA1095	wsnp_CAP7_c522_274783	3B	62.0
IWA1576	wsnp_Ex_c1204_2313262	3B	62.0
IWA2619	wsnp_Ex_c21491_30636749	3B	62.0
IWA2620	wsnp_Ex_c21491_30637789	3B	62.0
IWA2951	wsnp_Ex_c25104_34368562	3B	62.0
IWA3455	wsnp_Ex_c3389_6223722	3B	62.0
IWA3591	wsnp_Ex_c36937_44788679	3B	62.0
IWA3592	wsnp_Ex_c36937_44789309	3B	62.0
IWA3593	wsnp_Ex_c36937_44790003	3B	62.0
IWA5646	wsnp_Ex_rep_c69845_68804456	3B	62.0
IWA5941	wsnp_JD_c22783_19631797	3B	62.0
IWA5985	wsnp_JD_c29407_23413291	3B	62.0
IWA6299	wsnp_JD_rep_c63810_40704815	3B	62.0
IWA6375	wsnp_Ku_c10196_16926860	3B	62.0
IWA7108	wsnp_Ku_c48167_54427241	3B	62.0
IWA7125	wsnp_Ku_c49975_55719349	3B	62.0
IWA714	wsnp_CAP11_c2309_1201554	3B	62.0
IWA7391	wsnp_Ku_rep_c102162_89197212	3B	62.0
IWA7819	wsnp_Ra_c27984_37479613	3B	62.0
IWA7820	wsnp_Ra_c27984_37480491	3B	62.0
IWA7888	wsnp_Ra_c35520_44041887	3B	62.0
IWA7889	wsnp_Ra_c35520_44043347	3B	62.0
IWA8086	wsnp_Ra_c8570_14489763	3B	62.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA8104	wsnp_Ra_c9693_16109264	3B	62.0
IWA8287	wsnp_RFL_Contig204_1272643	3B	62.0
IWA125	wsnp_BE443288B_Ta_2_1	3B	62.2
IWA7561	wsnp_Ra_c11243_18269800	3B	62.2
IWA8594	wsnp_RFL_Contig4437_5225442	3B	62.2
IWA1541	wsnp_Ex_c11837_18996495	3B	62.4
IWA1682	wsnp_Ex_c12781_20280445	3B	62.4
IWA1683	wsnp_Ex_c12781_20280572	3B	62.4
IWA1684	wsnp_Ex_c12781_20280815	3B	62.4
IWA1974	wsnp_Ex_c15047_23217632	3B	62.4
IWA3273	wsnp_Ex_c3040_5615597	3B	62.4
IWA6900	wsnp_Ku_c31407_41142340	3B	62.4
IWA2063	wsnp_Ex_c15795_24169367	3B	62.6
IWA2167	wsnp_Ex_c1676_3185400	3B	62.6
IWA4906	wsnp_Ex_c9390_15586085	3B	62.6
IWA6542	wsnp_Ku_c14875_23320708	3B	62.6
IWA3669	wsnp_Ex_c39124_46489956	3B	63.1
IWA5871	wsnp_JD_c16245_15468917	3B	63.1
IWA5984	wsnp_JD_c2937_3905238	3B	63.3
IWA1548	wsnp_Ex_c11893_19077166	3B	63.7
IWA1731	wsnp_Ex_c13154_20784321	3B	63.7
IWA1732	wsnp_Ex_c13154_20784674	3B	63.7
IWA1733	wsnp_Ex_c13154_20785032	3B	63.7
IWA4497	wsnp_Ex_c64005_62986957	3B	63.7
IWA4498	wsnp_Ex_c64005_62987015	3B	63.7
IWA5432	wsnp_Ex_rep_c67645_66305241	3B	63.7
IWA6856	wsnp_Ku_c29102_39008953	3B	63.7
IWA5323	wsnp_Ex_rep_c66893_65301177	3B	63.9
IWA5324	wsnp_Ex_rep_c66893_65301351	3B	63.9
IWA8576	wsnp_RFL_Contig4270_4938701	3B	63.9
IWA5510	wsnp_Ex_rep_c68193_66971396	3B	64.3
IWA5511	wsnp_Ex_rep_c68193_66971472	3B	64.3
IWA3170	wsnp_Ex_c2850_5263978	3B	64.5
IWA6002	wsnp_JD_c3183_4178470	3B	64.5
IWA2360	wsnp_Ex_c18915_27811736	3B	65.6
IWA298	wsnp_BE497740B_Ta_2_1	3B	65.6
IWA299	wsnp_BE497740B_Ta_2_2	3B	65.6
IWA3330	wsnp_Ex_c3130_5789791	3B	66.6
IWA3331	wsnp_Ex_c3130_5789888	3B	66.6

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3332	wsnp_Ex_c3130_5790163	3B	66.6
IWA8053	wsnp_Ra_c69_149394	3B	66.6
IWA8054	wsnp_Ra_c69_149518	3B	66.6
IWA5013	wsnp_Ex_rep_c101457_86817938	3B	67.1
IWA4324	wsnp_Ex_c57007_58898157	3B	67.5
IWA4778	wsnp_Ex_c8208_13870372	3B	67.5
IWA6056	wsnp_JD_c4413_5541190	3B	67.5
IWA2462	wsnp_Ex_c19778_28779907	3B	67.9
IWA4171	wsnp_Ex_c5335_9429726	3B	96.4
IWA4312	wsnp_Ex_c56591_58653455	3B	105.3
IWA3159	wsnp_Ex_c284_548711	3B	106.1
IWA149	wsnp_BE444579B_Ta_2_1	3B	107.2
IWA150	wsnp_BE444579B_Ta_2_2	3B	107.2
IWA8479	wsnp_RFL_Contig3524_3689801	3B	107.6
IWA2148	wsnp_Ex_c16569_25082817	3B	108.3
IWA1756	wsnp_Ex_c13284_20948460	3B	108.9
IWA3950	wsnp_Ex_c45877_51548309	3B	108.9
IWA5892	wsnp_JD_c18509_16968425	3B	109.3
IWA2293	wsnp_Ex_c18250_27065775	3D1	0.0
IWA4647	wsnp_Ex_c7260_12463738	3D1	1.9
IWA4209	wsnp_Ex_c54003_57045475	3D1	2.8
IWA8179	wsnp_Ra_rep_c71290_69343893	3D1	3.0
IWA1321	wsnp_Ex_c104027_88843215	3D1	7.5
IWA4559	wsnp_Ex_c6630_11483544	3D1	8.0
IWA5695	wsnp_Ex_rep_c70527_69450183	3D1	8.0
IWA3310	wsnp_Ex_c3099_5716150	3D1	10.1
IWA3944	wsnp_Ex_c456_896962	3D1	26.5
IWA5367	wsnp_Ex_rep_c67177_65672527	3D2	0.0
IWA151	wsnp_BE444579D_Ta_2_1	3D2	15.2
IWA152	wsnp_BE444579D_Ta_2_2	3D2	15.2
IWA153	wsnp_BE444579D_Ta_2_3	3D2	15.2
IWA1624	wsnp_Ex_c12424_19815550	3D2	15.2
IWA4792	wsnp_Ex_c8316_14023638	3D2	15.2
IWA4877	wsnp_Ex_c9113_15166656	3D2	15.2
IWA8059	wsnp_Ra_c8297_14095831	3D2	15.2
IWA1847	wsnp_Ex_c14027_21925404	3D2	15.5
IWA1848	wsnp_Ex_c14027_21925629	3D2	15.5
IWA3186	wsnp_Ex_c28705_37809171	3D2	15.5
IWA4081	wsnp_Ex_c5061_8986366	3D2	25.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6058	wsnp_JD_c4418_5545792	3D2	25.2
IWA643	wsnp_CAP11_c1051_622082	3D2	25.2
IWA7526	wsnp_Ku_rep_c87658_81274182	3D2	25.2
IWA1766	wsnp_Ex_c13354_21047873	4A	0.0
IWA6137	wsnp_JD_c64_103934	4A	4.3
IWA85	wsnp_BE425146A_Ta_2_1	4A	7.1
IWA4981	wsnp_Ex_c9928_16346945	4A	10.2
IWA285	wsnp_BE497160A_Ta_1_1	4A	16.3
IWA54	wsnp_BE405275A_Ta_1_1	4A	16.3
IWA8389	wsnp_RFL_Contig2771_2524880	4A	16.3
IWA4232	wsnp_Ex_c54453_57331510	4A	30.8
IWA2533	wsnp_Ex_c20386_29451037	4A	31.0
IWA4321	wsnp_Ex_c5690_9994334	4A	32.1
IWA1728	wsnp_Ex_c13105_20721321	4A	33.0
IWA2066	wsnp_Ex_c15801_24178779	4A	33.0
IWA2108	wsnp_Ex_c16228_24682090	4A	33.0
IWA4480	wsnp_Ex_c6320_11003591	4A	33.0
IWA5831	wsnp_JD_c13364_13377722	4A	33.0
IWA6100	wsnp_JD_c5499_6647799	4A	33.0
IWA6394	wsnp_Ku_c10451_17281845	4A	33.0
IWA3119	wsnp_Ex_c27570_36762421	4A	33.2
IWA371	wsnp_BE591195A_Ta_1_1	4A	33.2
IWA3818	wsnp_Ex_c4220_7623030	4A	33.2
IWA4251	wsnp_Ex_c5487_9685671	4A	33.2
IWA5457	wsnp_Ex_rep_c67799_66488792	4A	33.2
IWA5705	wsnp_Ex_rep_c70681_69583486	4A	33.2
IWA6701	wsnp_Ku_c2114_4088174	4A	33.2
IWA7382	wsnp_Ku_rep_c101597_88729428	4A	33.2
IWA7395	wsnp_Ku_rep_c102728_89637829	4A	33.2
IWA7521	wsnp_Ku_rep_c76865_75281903	4A	33.2
IWA7537	wsnp_Ra_c10536_17322563	4A	33.2
IWA8150	wsnp_Ra_rep_c113072_94706239	4A	33.2
IWA8342	wsnp_RFL_Contig2500_2084385	4A	33.2
IWA1969	wsnp_Ex_c15000_23158167	4A	33.4
IWA3308	wsnp_Ex_c30989_39836034	4A	33.4
IWA3309	wsnp_Ex_c30989_39836304	4A	33.4
IWA3671	wsnp_Ex_c39168_46522625	4A	33.4
IWA3763	wsnp_Ex_c41192_48071978	4A	33.4
IWA5127	wsnp_Ex_rep_c105114_89631277	4A	33.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5196	wsnp_Ex_rep_c66304_64468123	4A	33.4
IWA5490	wsnp_Ex_rep_c68052_66798492	4A	33.4
IWA5647	wsnp_Ex_rep_c69852_68811339	4A	33.4
IWA5648	wsnp_Ex_rep_c69852_68811496	4A	33.4
IWA5676	wsnp_Ex_rep_c70163_69115039	4A	33.4
IWA6659	wsnp_Ku_c18734_28082266	4A	33.4
IWA6678	wsnp_Ku_c19762_29300876	4A	33.4
IWA6911	wsnp_Ku_c32619_42216179	4A	33.4
IWA7080	wsnp_Ku_c45402_52441010	4A	33.4
IWA7082	wsnp_Ku_c45402_52441586	4A	33.4
IWA750	wsnp_CAP11_c3346_1639010	4A	33.4
IWA8265	wsnp_RFL_Contig1883_1034534	4A	33.4
IWA8296	wsnp_RFL_Contig2124_1400618	4A	33.4
IWA8494	wsnp_RFL_Contig362_3816537	4A	33.4
IWA912	wsnp_CAP12_c124_70843	4A	33.4
IWA5897	wsnp_JD_c19109_17348071	4A	33.8
IWA1077	wsnp_CAP7_c32_19340	4A	34.4
IWA1693	wsnp_Ex_c12818_20334501	4A	34.4
IWA4230	wsnp_Ex_c54395_57291841	4A	34.4
IWA4405	wsnp_Ex_c6044_10590220	4A	34.4
IWA4406	wsnp_Ex_c6044_10590322	4A	34.4
IWA4560	wsnp_Ex_c6644_11508418	4A	34.4
IWA4700	wsnp_Ex_c7550_12907422	4A	34.4
IWA6392	wsnp_Ku_c10434_17255840	4A	34.4
IWA6531	wsnp_Ku_c14515_22860258	4A	34.4
IWA6873	wsnp_Ku_c30381_40208899	4A	34.4
IWA8459	wsnp_RFL_Contig3341_3436476	4A	34.4
IWA4608	wsnp_Ex_c7011_12080274	4A	35.9
IWA1071	wsnp_CAP7_c2731_1307600	4A	36.3
IWA1074	wsnp_CAP7_c2931_1395666	4A	36.3
IWA1295	wsnp_Ex_c10186_16720660	4A	36.3
IWA1329	wsnp_Ex_c10479_17138283	4A	36.3
IWA142	wsnp_BE443973A_Ta_2_1	4A	36.3
IWA157	wsnp_BE444811A_Ta_2_1	4A	36.3
IWA160	wsnp_BE444858A_Ta_2_1	4A	36.3
IWA1639	wsnp_Ex_c12481_19890975	4A	36.3
IWA3604	wsnp_Ex_c37383_45143321	4A	36.3
IWA385	wsnp_BE591861A_Ta_2_5	4A	36.3
IWA40	wsnp_BE403900A_Ta_2_1	4A	36.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA401	wsnp_BE637507A_Ta_2_1	4A	36.3
IWA493	wsnp_BF482269A_Ta_2_1	4A	36.3
IWA5335	wsnp_Ex_rep_c66930_65358529	4A	36.3
IWA6443	wsnp_Ku_c11945_19406789	4A	36.3
IWA8131	wsnp_Ra_rep_c107017_90667618	4A	36.3
IWA8495	wsnp_RFL_Contig3634_3841260	4A	36.3
IWA4395	wsnp_Ex_c5979_10480527	4A	36.5
IWA1727	wsnp_Ex_c13091_20706489	4A	37.0
IWA3489	wsnp_Ex_c3463_6348659	4A	37.0
IWA3490	wsnp_Ex_c3463_6348808	4A	37.0
IWA5687	wsnp_Ex_rep_c70327_69270561	4A	37.0
IWA1527	wsnp_Ex_c11663_18779609	4A	37.2
IWA5036	wsnp_Ex_rep_c101826_87124211	4A	37.2
IWA7072	wsnp_Ku_c44600_51841068	4A	37.2
IWA8	wsnp_BE398523A_Ta_2_1	4A	37.2
IWA1795	wsnp_Ex_c13623_21404172	4A	37.4
IWA2593	wsnp_Ex_c2128_3998228	4A	37.6
IWA2734	wsnp_Ex_c2266_4247520	4A	37.6
IWA3302	wsnp_Ex_c30876_39741201	4A	37.6
IWA4253	wsnp_Ex_c5492_9691241	4A	37.6
IWA4254	wsnp_Ex_c5492_9691880	4A	37.6
IWA4359	wsnp_Ex_c58286_59646499	4A	37.6
IWA4768	wsnp_Ex_c8092_13695482	4A	37.6
IWA4921	wsnp_Ex_c9464_15689857	4A	37.6
IWA5583	wsnp_Ex_rep_c69093_68002098	4A	37.6
IWA6377	wsnp_Ku_c10224_16965872	4A	37.6
IWA7107	wsnp_Ku_c48043_54334230	4A	37.6
IWA7203	wsnp_Ku_c5979_10559245	4A	37.6
IWA5452	wsnp_Ex_rep_c67779_66463627	4A	37.8
IWA5453	wsnp_Ex_rep_c67779_66463916	4A	37.8
IWA7875	wsnp_Ra_c33762_42584098	4A	37.8
IWA2585	wsnp_Ex_c21197_30325539	4A	38.9
IWA2900	wsnp_Ex_c24443_33687802	4A	38.9
IWA2901	wsnp_Ex_c24443_33688235	4A	38.9
IWA3191	wsnp_Ex_c2884_5319215	4A	38.9
IWA7699	wsnp_Ra_c19085_28218299	4A	38.9
IWA1804	wsnp_Ex_c1373_2628597	4A	39.5
IWA402	wsnp_BE637808A_Ta_2_1	4A	41.0
IWA1793	wsnp_Ex_c13615_21393638	4A	41.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5123	wsnp_Ex_rep_c104859_89444355	4A	41.2
IWA8341	wsnp_RFL_Contig25_2082245	4A	41.2
IWA5026	wsnp_Ex_rep_c101638_86971861	4A	42.2
IWA2044	wsnp_Ex_c1563_2986030	4A	42.5
IWA2045	wsnp_Ex_c1563_2987002	4A	42.5
IWA2211	wsnp_Ex_c17361_26054611	4A	42.5
IWA4471	wsnp_Ex_c62821_62299834	4A	42.5
IWA5269	wsnp_Ex_rep_c66600_64897324	4A	42.5
IWA5291	wsnp_Ex_rep_c66706_65037564	4A	43.1
IWA8500	wsnp_RFL_Contig3667_3877953	4A	43.1
IWA1711	wsnp_Ex_c12933_20488438	4A	43.5
IWA2501	wsnp_Ex_c2002_3768258	4A	43.5
IWA2864	wsnp_Ex_c2403_4502745	4A	43.5
IWA3664	wsnp_Ex_c39021_46412977	4A	43.5
IWA4200	wsnp_Ex_c53906_56983000	4A	43.5
IWA4201	wsnp_Ex_c53906_56983357	4A	43.5
IWA4431	wsnp_Ex_c6139_10739829	4A	43.5
IWA4432	wsnp_Ex_c6139_10740143	4A	43.5
IWA4512	wsnp_Ex_c64593_63334637	4A	43.5
IWA4657	wsnp_Ex_c7335_12579818	4A	43.5
IWA4742	wsnp_Ex_c7899_13416350	4A	43.5
IWA4743	wsnp_Ex_c7899_13416443	4A	43.5
IWA4784	wsnp_Ex_c829_1620518	4A	43.5
IWA4785	wsnp_Ex_c829_1620563	4A	43.5
IWA4786	wsnp_Ex_c829_1620740	4A	43.5
IWA4787	wsnp_Ex_c829_1621908	4A	43.5
IWA482	wsnp_BF474615A_Ta_1_1	4A	43.5
IWA483	wsnp_BF474615A_Ta_1_4	4A	43.5
IWA53	wsnp_BE404977A_Ta_1_1	4A	43.5
IWA568	wsnp_BG604678A_Ta_1_2	4A	43.5
IWA569	wsnp_BG604678A_Ta_1_3	4A	43.5
IWA5765	wsnp_Ex_rep_c97236_84366722	4A	43.5
IWA8269	wsnp_RFL_Contig1910_1074716	4A	43.5
IWA8410	wsnp_RFL_Contig2966_2832493	4A	43.5
IWA8593	wsnp_RFL_Contig4429_5204995	4A	43.5
IWA3208	wsnp_Ex_c29039_38111347	4A	43.7
IWA49	wsnp_BE404378A_Ta_2_1	4A	43.7
IWA7346	wsnp_Ku_c9208_15488367	4A	43.7
IWA101	wsnp_BE442666A_Ta_2_1	4A	43.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2460	wsnp_Ex_c19773_28772235	4A	46.3
IWA8432	wsnp_RFL_Contig3138_3094305	4A	48.9
IWA6454	wsnp_Ku_c1205_2398925	4A	49.1
IWA1691	wsnp_Ex_c12812_20324273	4A	52.7
IWA1692	wsnp_Ex_c12812_20324622	4A	52.7
BARC170	BARC170	4A	53.6
IWA6906	wsnp_Ku_c3237_6024936	4A	55.8
IWA3757	wsnp_Ex_c41074_47987998	4A	61.6
IWA3758	wsnp_Ex_c41074_47988141	4A	61.6
IWA3774	wsnp_Ex_c41313_48161689	4A	67.9
IWA2505	wsnp_Ex_c20041_29076295	4A	69.0
IWA6418	wsnp_Ku_c11227_18378980	4A	70.5
IWA8168	wsnp_Ra_rep_c70233_67968353	4A	70.5
IWA3188	wsnp_Ex_c28728_37832012	4A	70.9
IWA485	wsnp_BF474862A_Ta_2_1	4A	70.9
IWA5152	wsnp_Ex_rep_c106527_90571247	4A	70.9
IWA2816	wsnp_Ex_c2352_4405961	4A	75.2
IWA811	wsnp_CAP11_c8366_3622210	4A	81.6
IWA3061	wsnp_Ex_c26740_35969367	4A	84.9
IWA3698	wsnp_Ex_c3988_7221220	4A	84.9
IWA4527	wsnp_Ex_c6514_11307200	4A	86.2
IWA5968	wsnp_JD_c27162_22206547	4A	86.2
IWA3068	wsnp_Ex_c26776_36003586	4A	87.0
IWA1634	wsnp_Ex_c1246_2393249	4A	102.6
IWA3864	wsnp_Ex_c4331_7808746	4A	102.6
IWA2170	wsnp_Ex_c16814_25373602	4A	103.1
IWA6690	wsnp_Ku_c20783_30448706	4A	103.1
IWA6696	wsnp_Ku_c20949_30631810	4A	106.6
IWA7264	wsnp_Ku_c7102_12271432	4A	107.0
IWA7265	wsnp_Ku_c7102_12271493	4A	107.0
IWA3746	wsnp_Ex_c410_808635	4A	107.3
IWA4651	wsnp_Ex_c7280_12498193	4A	107.3
IWA1250	wsnp_CD452610A_Ta_1_1	4A	108.5
IWA5858	wsnp_JD_c152_245708	4A	108.5
IWA1410	wsnp_Ex_c10955_17794520	4A	109.6
IWA4688	wsnp_Ex_c7489_12809914	4A	109.6
IWA4690	wsnp_Ex_c7489_12810235	4A	109.6
IWA7939	wsnp_Ra_c4400_7986499	4A	109.6
IWA3317	wsnp_Ex_c31121_39955117	4B	0.0



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7729	wsnp_Ra_c2078_4037878	4B	0.0
IWA506	wsnp_BF483640B_Ta_2_2	4B	9.8
IWA1768	wsnp_Ex_c13357_21054802	4B	12.2
IWA2298	wsnp_Ex_c18318_27140346	4B	14.4
IWA8107	wsnp_Ra_c9755_16199734	4B	14.4
IWA8108	wsnp_Ra_c9755_16200944	4B	14.4
IWA2125	wsnp_Ex_c16389_24884851	4B	15.9
IWA2126	wsnp_Ex_c16389_24884920	4B	15.9
IWA8178	wsnp_Ra_rep_c71114_69138821	4B	15.9
IWA4569	wsnp_Ex_c6739_11646407	4B	18.3
IWA3290	wsnp_Ex_c30695_39579408	4B	18.9
IWA7311	wsnp_Ku_c8075_13785546	4B	20.0
WMC710	WMC710	4B	22.9
IWA4662	wsnp_Ex_c7362_12622736	4B	23.4
IWA645	wsnp_CAP11_c1103_647926	4B	23.4
IWA7218	wsnp_Ku_c6242_10965132	4B	23.4
IWA8109	wsnp_Ra_c9823_16313377	4B	23.4
IWA566	wsnp_BG604493B_Ta_1_1	4B	23.8
IWA1135	wsnp_CAP8_c10_37096	4B	24.2
IWA917	wsnp_CAP12_c13_8078	4B	24.2
IWA4854	wsnp_Ex_c8913_14881924	4B	27.1
IWA2313	wsnp_Ex_c18433_27269748	4B	27.7
IWA5863	wsnp_JD_c1549_2185341	4B	32.7
IWA7711	wsnp_Ra_c1992_3876325	4B	36.3
IWA4055	wsnp_Ex_c49319_53953814	4B	37.3
IWA6480	wsnp_Ku_c13052_20918857	4B	39.7
GWM149	GWM149	4B	41.6
IWA1105	wsnp_CAP7_c8429_3785777	4B	42.1
IWA1344	wsnp_Ex_c10548_17228697	4B	42.1
IWA1405	wsnp_Ex_c10904_17717813	4B	42.1
IWA1961	wsnp_Ex_c14962_23115336	4B	42.1
IWA2155	wsnp_Ex_c16611_25142774	4B	42.1
IWA2532	wsnp_Ex_c20377_29442562	4B	42.1
IWA2666	wsnp_Ex_c220_432519	4B	42.1
IWA2745	wsnp_Ex_c22740_31947788	4B	42.1
IWA3736	wsnp_Ex_c40815_47789152	4B	42.1
IWA3846	wsnp_Ex_c42895_49355806	4B	42.1
IWA4330	wsnp_Ex_c57212_59019379	4B	42.1
IWA4347	wsnp_Ex_c5769_10136243	4B	42.1

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4348	wsnp_Ex_c5769_10136788	4B	42.1
IWA5195	wsnp_Ex_rep_c66285_64443309	4B	42.1
IWA5725	wsnp_Ex_rep_c71154_69976915	4B	42.1
IWA5955	wsnp_JD_c2488_3379427	4B	42.1
IWA6495	wsnp_Ku_c13381_21349778	4B	42.1
IWA6898	wsnp_Ku_c31283_41033384	4B	42.1
IWA7437	wsnp_Ku_rep_c68318_67259259	4B	42.1
IWA7752	wsnp_Ra_c22026_31453420	4B	42.1
IWA8019	wsnp_Ra_c59050_60525086	4B	42.1
IWA1028	wsnp_CAP7_c1259_634919	4B	43.6
IWA2823	wsnp_Ex_c23638_32875196	4B	43.6
IWA4041	wsnp_Ex_c48922_53681502	4B	44.2
IWA99	wsnp_BE442582B_Ta_1_3	4B	44.2
IWA6461	wsnp_Ku_c12503_20174234	4B	50.0
IWA3038	wsnp_Ex_c26285_35531324	4B	50.6
IWA3039	wsnp_Ex_c26285_35531493	4B	50.6
IWA3041	wsnp_Ex_c26285_35531618	4B	50.6
IWA3042	wsnp_Ex_c26285_35532440	4B	50.6
IWA3279	wsnp_Ex_c30473_39386277	4B	56.5
IWA1861	wsnp_Ex_c14138_22066009	4B	59.3
IWA3697	wsnp_Ex_c39876_47057394	4B	60.2
IWA5885	wsnp_JD_c17976_16616890	4B	60.2
IWA7202	wsnp_Ku_c59634_61875085	4B	60.2
IWA8197	wsnp_Ra_rep_c74879_72651462	4B	60.8
IWA2031	wsnp_Ex_c15490_23776560	4B	61.2
IWA1100	wsnp_CAP7_c599_312057	4B	61.6
IWA2595	wsnp_Ex_c21293_30421496	4B	61.6
IWA3994	wsnp_Ex_c47536_52716088	4B	61.6
IWA4490	wsnp_Ex_c6381_11093111	4B	61.6
IWA5408	wsnp_Ex_rep_c67510_66116823	4B	61.6
IWA6397	wsnp_Ku_c10515_17368422	4B	61.6
IWA6426	wsnp_Ku_c11570_18860306	4B	61.6
IWA6465	wsnp_Ku_c12557_20249122	4B	61.6
IWA968	wsnp_CAP12_c4769_2174195	4B	61.6
IWA5358	wsnp_Ex_rep_c67136_65617520	4B	63.3
IWA3779	wsnp_Ex_c4148_7494665	4B	64.2
IWA3780	wsnp_Ex_c4148_7494801	4B	64.2
IWA3781	wsnp_Ex_c4148_7495656	4B	64.2
IWA564	wsnp_BG604404B_Ta_2_1	4B	64.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6719	wsnp_Ku_c21787_31570491	4B	64.2
IWA465	wsnp_BF473052D_Ta_2_1	4D1	0.0
IWA6613	wsnp_Ku_c16998_25992746	4D1	4.8
WMC720	WMC720	4D1	7.1
IWA752	wsnp_CAP11_c356_280910	4D1	17.8
IWA1783	wsnp_Ex_c13522_21273080	4D2	0.0
IWA6591	wsnp_Ku_c16354_25219645	4D2	0.6
WMC622	WMC622	4D2	11.6
IWA2991	wsnp_Ex_c25707_34968426	5A	0.0
IWA7360	wsnp_Ku_c9559_15999945	5A	0.0
IWA14	wsnp_BE399966A_Ta_2_3	5A	0.9
IWA4932	wsnp_Ex_c95453_83448583	5A	0.9
IWA5052	wsnp_Ex_rep_c102143_87374122	5A	0.9
IWA5053	wsnp_Ex_rep_c102143_87374435	5A	0.9
IWA6022	wsnp_JD_c3632_4663459	5A	0.9
IWA7801	wsnp_Ra_c26916_36465414	5A	1.1
IWA1568	wsnp_Ex_c11992_19213600	5A	3.9
IWA1569	wsnp_Ex_c11992_19213872	5A	3.9
IWA4970	wsnp_Ex_c9842_16228523	5A	5.6
IWA5368	wsnp_Ex_rep_c67179_65674582	5A	6.3
IWA6859	wsnp_Ku_c29319_39227528	5A	6.9
IWA330	wsnp_BE499835A_Ta_2_1	5A	7.3
IWA331	wsnp_BE499835A_Ta_2_2	5A	7.6
IWA4767	wsnp_Ex_c807_1586396	5A	7.6
IWA1062	wsnp_CAP7_c2282_1107112	5A	7.8
IWA2378	wsnp_Ex_c19134_28056012	5A	8.0
IWA3811	wsnp_Ex_c4211_7606269	5A	8.0
IWA4069	wsnp_Ex_c5013_8914160	5A	8.0
IWA5615	wsnp_Ex_rep_c69526_68472787	5A	8.0
IWA3365	wsnp_Ex_c31830_40573624	5A	8.2
IWA5614	wsnp_Ex_rep_c69526_68472665	5A	8.2
IWA4068	wsnp_Ex_c501_995323	5A	10.3
IWA4465	wsnp_Ex_c62701_62229607	5A	10.3
IWA5728	wsnp_Ex_rep_c71219_70023450	5A	10.3
IWA3190	wsnp_Ex_c28827_37918346	5A	16.7
IWA6287	wsnp_JD_rep_c61843_39601402	5A	16.7
IWA8154	wsnp_Ra_rep_c69221_66574148	5A	16.7
IWA8155	wsnp_Ra_rep_c69221_66574260	5A	16.7
IWA3263	wsnp_Ex_c30178_39124189	5A	18.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4149	wsnp_Ex_c5267_9318903	5A	19.7
IWA7777	wsnp_Ra_c24707_34262900	5A	19.7
IWA1301	wsnp_Ex_c10231_16783750	5A	19.9
IWA3099	wsnp_Ex_c2718_5038502	5A	19.9
IWA3100	wsnp_Ex_c2718_5038582	5A	19.9
IWA4454	wsnp_Ex_c62351_62025689	5A	19.9
IWA5395	wsnp_Ex_rep_c67394_65974276	5A	19.9
IWA6412	wsnp_Ku_c1102_2211433	5A	19.9
IWA6665	wsnp_Ku_c18935_28337577	5A	19.9
IWA7565	wsnp_Ra_c11420_18529863	5A	19.9
IWA7739	wsnp_Ra_c212_447994	5A	19.9
IWA1280	wsnp_Ex_c10109_16614013	5A	20.1
IWA1697	wsnp_Ex_c12845_20371496	5A	20.1
IWA2075	wsnp_Ex_c15950_24357724	5A	20.1
IWA2463	wsnp_Ex_c1981_3728899	5A	20.1
IWA2480	wsnp_Ex_c19892_28910730	5A	20.1
IWA2814	wsnp_Ex_c23509_32746806	5A	20.1
IWA2815	wsnp_Ex_c23509_32746909	5A	20.1
IWA3212	wsnp_Ex_c29061_38130966	5A	20.1
IWA3775	wsnp_Ex_c41347_48189975	5A	20.1
IWA3776	wsnp_Ex_c41347_48190370	5A	20.1
IWA3921	wsnp_Ex_c4501_8092034	5A	20.1
IWA4450	wsnp_Ex_c6212_10842181	5A	20.1
IWA5294	wsnp_Ex_rep_c66733_65077531	5A	20.1
IWA5295	wsnp_Ex_rep_c66733_65077608	5A	20.1
IWA5384	wsnp_Ex_rep_c67313_65859799	5A	20.1
IWA5431	wsnp_Ex_rep_c67636_66293429	5A	20.1
IWA6166	wsnp_JD_c7404_8500079	5A	20.1
IWA6237	wsnp_JD_c9771_10559815	5A	20.1
IWA7226	wsnp_Ku_c644_1332610	5A	20.1
IWA7392	wsnp_Ku_rep_c102220_89250165	5A	20.1
IWA7865	wsnp_Ra_c323_681466	5A	20.1
IWA7980	wsnp_Ra_c5057_9025399	5A	20.1
IWA8119	wsnp_Ra_rep_c105791_89683548	5A	20.1
IWA8201	wsnp_Ra_rep_c75364_72953286	5A	20.1
IWA8202	wsnp_Ra_rep_c75364_72953405	5A	20.1
IWA1465	wsnp_Ex_c11309_18272122	5A	20.3
IWA1466	wsnp_Ex_c11309_18272248	5A	20.3
IWA1716	wsnp_Ex_c130_258776	5A	20.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1717	wsnp_Ex_c130_259006	5A	20.3
IWA1718	wsnp_Ex_c130_259533	5A	20.3
IWA1978	wsnp_Ex_c15084_23263641	5A	20.3
IWA2354	wsnp_Ex_c18805_27686000	5A	20.3
IWA2548	wsnp_Ex_c20611_29693561	5A	20.3
IWA3220	wsnp_Ex_c2922_5391083	5A	20.3
IWA4424	wsnp_Ex_c6117_10704945	5A	20.3
IWA5120	wsnp_Ex_rep_c104567_89248000	5A	20.3
IWA5175	wsnp_Ex_rep_c110023_92574403	5A	20.3
IWA5914	wsnp_JD_c20604_18293112	5A	20.3
IWA6196	wsnp_JD_c8448_9444839	5A	20.3
IWA6606	wsnp_Ku_c16812_25759885	5A	20.3
IWA6912	wsnp_Ku_c328_679106	5A	20.3
IWA7473	wsnp_Ku_rep_c70261_69822367	5A	20.3
IWA7530	wsnp_Ra_c10053_16636851	5A	20.3
IWA7623	wsnp_Ra_c14112_22155312	5A	20.3
IWA7669	wsnp_Ra_c17541_26430903	5A	20.3
IWA7687	wsnp_Ra_c18459_27525981	5A	20.3
IWA7758	wsnp_Ra_c2228_4309233	5A	20.3
IWA7759	wsnp_Ra_c2228_4310870	5A	20.3
IWA8048	wsnp_Ra_c6788_11804894	5A	20.3
IWA154	wsnp_BE444644A_Ta_2_1	5A	20.5
IWA333	wsnp_BE500291A_Ta_2_1	5A	20.5
IWA3055	wsnp_Ex_c26581_35828388	5A	20.9
IWA1546	wsnp_Ex_c11874_19050989	5A	21.1
IWA6415	wsnp_Ku_c11110_18216209	5A	22.6
IWA5735	wsnp_Ex_rep_c72507_70869798	5A	25.3
IWA5107	wsnp_Ex_rep_c103972_88799335	5A	25.7
IWA3873	wsnp_Ex_c43578_49857984	5A	34.6
IWA5528	wsnp_Ex_rep_c68441_67261679	5A	34.6
IWA5529	wsnp_Ex_rep_c68441_67261799	5A	34.6
IWA300	wsnp_BE497820A_Ta_2_2	5A	36.7
IWA4734	wsnp_Ex_c7830_13323473	5A	36.9
BARC141	BARC141	5A	40.3
IWA1843	wsnp_Ex_c14010_21901313	5A	40.3
IWA2172	wsnp_Ex_c16826_25388915	5A	40.3
IWA2446	wsnp_Ex_c19647_28632858	5A	40.3
IWA2892	wsnp_Ex_c2433_4556063	5A	40.3
IWA3200	wsnp_Ex_c28957_38032772	5A	40.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3201	wsnp_Ex_c28957_38032895	5A	40.3
IWA3683	wsnp_Ex_c39592_46849607	5A	40.3
IWA4047	wsnp_Ex_c4921_8763500	5A	40.3
IWA4048	wsnp_Ex_c4921_8763722	5A	40.3
IWA4049	wsnp_Ex_c4921_8764088	5A	40.3
IWA4476	wsnp_Ex_c6314_10992814	5A	40.3
IWA4477	wsnp_Ex_c6314_10993582	5A	40.3
IWA5060	wsnp_Ex_rep_c102281_87481676	5A	40.3
IWA5327	wsnp_Ex_rep_c66900_65314012	5A	40.3
IWA5328	wsnp_Ex_rep_c66900_65314083	5A	40.3
IWA5330	wsnp_Ex_rep_c66900_65314631	5A	40.3
IWA5726	wsnp_Ex_rep_c71178_69994299	5A	40.3
IWA6015	wsnp_JD_c3499_4517072	5A	40.3
IWA6233	wsnp_JD_c9510_10342089	5A	40.3
IWA6544	wsnp_Ku_c14958_23427256	5A	40.3
IWA6747	wsnp_Ku_c23772_33711538	5A	40.3
IWA6899	wsnp_Ku_c31317_41063833	5A	40.3
IWA703	wsnp_CAP11_c2100_1109583	5A	40.3
IWA7220	wsnp_Ku_c6319_11093041	5A	40.3
IWA7773	wsnp_Ra_c23878_33418076	5A	40.3
IWA8008	wsnp_Ra_c5651_9978752	5A	40.3
IWA8009	wsnp_Ra_c5651_9978896	5A	40.3
IWA8012	wsnp_Ra_c57838_59796220	5A	40.3
IWA8013	wsnp_Ra_c57838_59796310	5A	40.3
IWA8118	wsnp_Ra_rep_c105740_89636179	5A	40.3
IWA8308	wsnp_RFL_Contig2187_1525458	5A	40.3
IWA6255	wsnp_JD_rep_c49046_33288885	5A	41.7
IWA6522	wsnp_Ku_c14275_22535576	5A	41.7
IWA6523	wsnp_Ku_c14275_22535693	5A	41.7
IWA3283	wsnp_Ex_c30551_39457494	5A	42.2
IWA3645	wsnp_Ex_c3838_6980774	5A	42.2
IWA3646	wsnp_Ex_c3838_6980909	5A	42.2
IWA4237	wsnp_Ex_c5461_9636197	5A	42.2
IWA738	wsnp_CAP11_c299_251377	5A	42.2
IWA740	wsnp_CAP11_c299_251594	5A	42.2
IWA7742	wsnp_Ra_c21347_30731133	5A	42.2
IWA7743	wsnp_Ra_c21347_30731229	5A	42.2
IWA4669	wsnp_Ex_c7383_12655468	5A	43.2
IWA3313	wsnp_Ex_c31017_39858962	5A	43.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4667	wsnp_Ex_c7383_12654806	5A	43.6
IWA4668	wsnp_Ex_c7383_12655410	5A	43.6
IWA4670	wsnp_Ex_c7383_12655992	5A	43.6
IWA66	wsnp_BE405849A_Ta_1_1	5A	44.3
IWA1288	wsnp_Ex_c10127_16635328	5A	50.9
IWA2970	wsnp_Ex_c25405_34671802	5A	50.9
IWA7404	wsnp_Ku_rep_c103857_90489584	5A	50.9
IWA7405	wsnp_Ku_rep_c103857_90489662	5A	50.9
IWA4299	wsnp_Ex_c5626_9897389	5A	51.3
IWA5118	wsnp_Ex_rep_c104539_89224552	5A	51.5
IWA7529	wsnp_Ku_rep_c97730_86360387	5A	51.5
IWA2883	wsnp_Ex_c24215_33462239	5A	53.5
IWA3110	wsnp_Ex_c27298_36506245	5A	53.9
IWA7135	wsnp_Ku_c51039_56457361	5A	53.9
IWA1120	wsnp_CAP7_rep_c5427_2436269	5A	56.3
IWA1201	wsnp_CAP8_c606_443906	5A	56.3
IWA2429	wsnp_Ex_c19519_28487099	5A	56.3
IWA4687	wsnp_Ex_c7487_12808011	5A	56.3
IWA687	wsnp_CAP11_c1740_947838	5A	56.3
IWA6935	wsnp_Ku_c3397_6300446	5A	56.3
IWA8093	wsnp_Ra_c8898_14972290	5A	56.3
IWA2364	wsnp_Ex_c18941_27840933	5A	62.4
IWA2365	wsnp_Ex_c18941_27841286	5A	62.4
IWA6456	wsnp_Ku_c12211_19780409	5A	62.4
IWA3996	wsnp_Ex_c47684_52820187	5A	65.0
IWA5668	wsnp_Ex_rep_c70117_69067356	5A	65.0
IWA4980	wsnp_Ex_c9927_16346100	5A	69.8
IWA7833	wsnp_Ra_c29586_38941556	5A	70.4
IWA7834	wsnp_Ra_c29586_38941694	5A	70.4
IWA4205	wsnp_Ex_c53983_57032473	5A	71.0
IWA4207	wsnp_Ex_c53983_57033048	5A	71.0
IWA1343	wsnp_Ex_c10545_17226769	5A	71.4
IWA1486	wsnp_Ex_c1138_2185522	5A	71.7
IWA4144	wsnp_Ex_c52509_56082802	5A	71.7
IWA4648	wsnp_Ex_c7266_12475249	5A	71.7
IWA5623	wsnp_Ex_rep_c69647_68598463	5A	71.9
IWA5624	wsnp_Ex_rep_c69647_68598487	5A	71.9
IWA6637	wsnp_Ku_c17766_26919139	5A	71.9
IWA7553	wsnp_Ra_c10915_17838202	5A	76.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4468	wsnp_Ex_c62818_62296518	5A	76.8
IWA4469	wsnp_Ex_c62818_62296773	5A	76.8
IWA5838	wsnp_JD_c13773_13680294	5A	76.8
IWA6682	wsnp_Ku_c20011_29589289	5A	76.8
IWA6683	wsnp_Ku_c20011_29589514	5A	76.8
IWA6961	wsnp_Ku_c3684_6789632	5A	76.8
IWA2223	wsnp_Ex_c17476_26190830	5A	81.1
IWA2256	wsnp_Ex_c17763_26513562	5A	81.1
IWA2657	wsnp_Ex_c2185_4094843	5A	81.1
IWA3887	wsnp_Ex_c44164_50292954	5A	81.1
IWA4447	wsnp_Ex_c621_1230852	5A	81.1
IWA4448	wsnp_Ex_c621_1231298	5A	81.1
IWA4449	wsnp_Ex_c621_1231444	5A	81.1
IWA5040	wsnp_Ex_rep_c101994_87256479	5A	81.1
IWA7255	wsnp_Ku_c6977_12078791	5A	81.1
IWA7256	wsnp_Ku_c6977_12078885	5A	81.1
IWA8320	wsnp_RFL_Contig2265_1693968	5A	81.1
IWA4276	wsnp_Ex_c55777_58153636	5A	81.3
IWA4805	wsnp_Ex_c8424_14192191	5A	81.3
IWA6460	wsnp_Ku_c12469_20130802	5A	81.7
IWA4744	wsnp_Ex_c790_1554988	5A	87.0
IWA674	wsnp_CAP11_c1506_840938	5A	88.1
IWA675	wsnp_CAP11_c1506_840951	5A	88.1
IWA7043	wsnp_Ku_c42416_50159250	5A	88.3
IWA7044	wsnp_Ku_c42416_50159402	5A	88.3
IWA2412	wsnp_Ex_c1943_3663067	5A	90.2
IWA3623	wsnp_Ex_c3772_6866645	5A	90.2
IWA582	wsnp_BG607308A_Ta_2_1	5A	90.2
IWA583	wsnp_BG607308A_Ta_2_2	5A	90.2
IWA3355	wsnp_Ex_c31672_40435001	5A	95.5
IWA1214	wsnp_CAP8_c7723_3536264	5A	114.9
IWA2837	wsnp_Ex_c23795_33033010	5A	123.5
IWA2838	wsnp_Ex_c23795_33033150	5A	123.5
IWA2839	wsnp_Ex_c23795_33033959	5A	123.5
IWA2840	wsnp_Ex_c23795_33034037	5A	123.5
IWA7262	wsnp_Ku_c7078_12236807	5A	123.5
IWA7491	wsnp_Ku_rep_c71232_70948744	5A	123.5
IWA3334	wsnp_Ex_c3136_5798185	5A	127.1
IWA3335	wsnp_Ex_c3136_5798236	5A	127.1



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA648	wsnp_CAP11_c1116_654940	5A	127.1
IWA649	wsnp_CAP11_c1116_654975	5A	127.1
IWA5002	wsnp_Ex_rep_c101323_86702413	5A	127.5
IWA5003	wsnp_Ex_rep_c101323_86702546	5A	127.5
IWA6988	wsnp_Ku_c38543_47157828	5A	130.3
IWA7509	wsnp_Ku_rep_c72362_72059764	5A	130.3
IWA2558	wsnp_Ex_c20899_30011827	5A	135.4
IWA2641	wsnp_Ex_c2171_4072774	5A	135.4
IWA2642	wsnp_Ex_c2171_4072995	5A	135.4
IWA2646	wsnp_Ex_c2171_4074003	5A	135.4
IWA6082	wsnp_JD_c493_749195	5A	135.4
IWA4313	wsnp_Ex_c56629_58677561	5B	0.0
IWA4415	wsnp_Ex_c607_1204733	5B	0.0
IWA4416	wsnp_Ex_c607_1204908	5B	0.0
IWA4790	wsnp_Ex_c831_1625061	5B	0.0
IWA2915	wsnp_Ex_c2459_4591587	5B	0.4
IWA7400	wsnp_Ku_rep_c103274_90057407	5B	0.8
IWA5536	wsnp_Ex_rep_c68504_67334573	5B	1.1
IWA3457	wsnp_Ex_c33932_42333941	5B	1.3
IWA5537	wsnp_Ex_rep_c68504_67334656	5B	1.3
IWA3606	wsnp_Ex_c37410_45162707	5B	3.0
IWA3607	wsnp_Ex_c37410_45162932	5B	3.0
IWA6251	wsnp_JD_rep_c48937_33188230	5B	3.2
IWA3514	wsnp_Ex_c35103_43312537	5B	6.1
IWA420	wsnp_BF201102B_Ta_2_1	5B	6.7
IWA421	wsnp_BF201102B_Ta_2_5	5B	6.7
IWA7223	wsnp_Ku_c64203_64579087	5B	6.7
IWA7210	wsnp_Ku_c6125_10774396	5B	11.7
IWA3033	wsnp_Ex_c26252_35497729	5B	12.6
IWA3211	wsnp_Ex_c29051_38120784	5B	13.0
IWA4856	wsnp_Ex_c8962_14947544	5B	13.0
IWA6405	wsnp_Ku_c10720_17663337	5B	13.0
IWA6946	wsnp_Ku_c35090_44349446	5B	13.0
IWA6947	wsnp_Ku_c35090_44349517	5B	13.0
IWA3870	wsnp_Ex_c43518_49814933	5B	18.1
IWA1024	wsnp_CAP7_c10376_4586373	5B	18.3
IWA1379	wsnp_Ex_c1067_2039707	5B	18.3
IWA1770	wsnp_Ex_c13386_21097743	5B	18.3
IWA1771	wsnp_Ex_c13386_21098430	5B	18.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1908	wsnp_Ex_c14549_22577209	5B	18.3
IWA1915	wsnp_Ex_c1462_2803179	5B	18.3
IWA2310	wsnp_Ex_c18413_27247064	5B	18.3
IWA2311	wsnp_Ex_c18413_27247408	5B	18.3
IWA2833	wsnp_Ex_c2376_4454515	5B	18.3
IWA2834	wsnp_Ex_c2376_4454741	5B	18.3
IWA4656	wsnp_Ex_c7334_12577656	5B	18.3
IWA468	wsnp_BF473658B_Ta_2_1	5B	18.3
IWA4684	wsnp_Ex_c7469_12780118	5B	18.3
IWA5062	wsnp_Ex_rep_c102297_87495486	5B	18.3
IWA5086	wsnp_Ex_rep_c103148_88169427	5B	18.3
IWA5113	wsnp_Ex_rep_c104290_89051908	5B	18.3
IWA5517	wsnp_Ex_rep_c68226_67010649	5B	18.3
IWA5519	wsnp_Ex_rep_c68243_67030425	5B	18.3
IWA5608	wsnp_Ex_rep_c69401_68338942	5B	18.3
IWA5609	wsnp_Ex_rep_c69401_68339012	5B	18.3
IWA6451	wsnp_Ku_c11988_19476255	5B	18.3
IWA6584	wsnp_Ku_c16188_25014042	5B	18.3
IWA7096	wsnp_Ku_c46323_53087840	5B	18.3
IWA7244	wsnp_Ku_c6765_11767282	5B	18.3
IWA8193	wsnp_Ra_rep_c73864_71913206	5B	18.3
IWA1030	wsnp_CAP7_c12931_5460221	5B	18.5
IWA1057	wsnp_CAP7_c2086_1018815	5B	18.5
IWA2065	wsnp_Ex_c15797_24174436	5B	18.5
IWA2410	wsnp_Ex_c1938_3656802	5B	18.5
IWA2553	wsnp_Ex_c20716_29802313	5B	18.5
IWA2669	wsnp_Ex_c2201_4125015	5B	18.5
IWA271	wsnp_BE495896B_Ta_2_1	5B	18.5
IWA2715	wsnp_Ex_c2243_4201831	5B	18.5
IWA2757	wsnp_Ex_c22835_32041284	5B	18.5
IWA4060	wsnp_Ex_c49809_54305634	5B	18.5
IWA4127	wsnp_Ex_c5217_9237399	5B	18.5
IWA4400	wsnp_Ex_c60190_60742719	5B	18.5
IWA4540	wsnp_Ex_c6576_11396672	5B	18.5
IWA4542	wsnp_Ex_c658_1293780	5B	18.5
IWA4543	wsnp_Ex_c658_1293865	5B	18.5
IWA4544	wsnp_Ex_c658_1294003	5B	18.5
IWA4545	wsnp_Ex_c658_1294440	5B	18.5
IWA4546	wsnp_Ex_c658_1294487	5B	18.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4547	wsnp_Ex_c658_1295291	5B	18.5
IWA4631	wsnp_Ex_c7173_12319519	5B	18.5
IWA4756	wsnp_Ex_c7982_13546427	5B	18.5
IWA4780	wsnp_Ex_c8229_13899351	5B	18.5
IWA4839	wsnp_Ex_c871_1693682	5B	18.5
IWA4872	wsnp_Ex_c9063_15093396	5B	18.5
IWA5281	wsnp_Ex_rep_c66654_64966507	5B	18.5
IWA5412	wsnp_Ex_rep_c67549_66173636	5B	18.5
IWA5603	wsnp_Ex_rep_c69349_68285613	5B	18.5
IWA5604	wsnp_Ex_rep_c69349_68285836	5B	18.5
IWA5730	wsnp_Ex_rep_c71332_70107094	5B	18.5
IWA6030	wsnp_JD_c38123_27754848	5B	18.5
IWA6404	wsnp_Ku_c10646_17556670	5B	18.5
IWA6527	wsnp_Ku_c14373_22670517	5B	18.5
IWA6602	wsnp_Ku_c1661_3262505	5B	18.5
IWA6603	wsnp_Ku_c1661_3262637	5B	18.5
IWA6676	wsnp_Ku_c1963_3820177	5B	18.5
IWA6694	wsnp_Ku_c20874_30544139	5B	18.5
IWA6748	wsnp_Ku_c23836_33776356	5B	18.5
IWA6765	wsnp_Ku_c248_502374	5B	18.5
IWA6967	wsnp_Ku_c3755_6907064	5B	18.5
IWA6968	wsnp_Ku_c3755_6908477	5B	18.5
IWA6987	wsnp_Ku_c3849_7064369	5B	18.5
IWA7079	wsnp_Ku_c45384_52426619	5B	18.5
IWA7186	wsnp_Ku_c57172_60417550	5B	18.5
IWA7222	wsnp_Ku_c63877_64391745	5B	18.5
IWA7292	wsnp_Ku_c7554_12995667	5B	18.5
IWA7307	wsnp_Ku_c796_1645905	5B	18.5
IWA7515	wsnp_Ku_rep_c72803_72467300	5B	18.5
IWA7882	wsnp_Ra_c34608_43291682	5B	18.5
IWA3682	wsnp_Ex_c39535_46808105	5B	18.9
IWA4526	wsnp_Ex_c65091_63634826	5B	18.9
IWA6846	wsnp_Ku_c28491_38419391	5B	18.9
IWA7613	wsnp_Ra_c13646_21523723	5B	18.9
IWA7953	wsnp_Ra_c46527_52361888	5B	18.9
IWA2139	wsnp_Ex_c16499_25005415	5B	19.9
IWA2257	wsnp_Ex_c17768_26519434	5B	20.4
IWA1155	wsnp_CAP8_c1594_914839	5B	20.6
IWA3056	wsnp_Ex_c26616_35855805	5B	20.6

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4015	wsnp_Ex_c48257_53217539	5B	20.6
IWA4016	wsnp_Ex_c4826_8610827	5B	20.6
IWA4757	wsnp_Ex_c7988_13555166	5B	20.6
IWA4759	wsnp_Ex_c7988_13555434	5B	20.6
IWA4835	wsnp_Ex_c8676_14535027	5B	20.6
IWA4836	wsnp_Ex_c8676_14535174	5B	20.6
IWA5394	wsnp_Ex_rep_c67392_65972196	5B	20.6
IWA5438	wsnp_Ex_rep_c67690_66354563	5B	20.6
IWA5439	wsnp_Ex_rep_c67690_66354791	5B	20.6
IWA5440	wsnp_Ex_rep_c67690_66354931	5B	20.6
IWA5633	wsnp_Ex_rep_c69760_68718561	5B	20.6
IWA5634	wsnp_Ex_rep_c69760_68719014	5B	20.6
IWA5773	wsnp_JD_c10416_11077664	5B	20.6
IWA7137	wsnp_Ku_c51284_56622767	5B	20.6
IWA7318	wsnp_Ku_c8270_14083963	5B	20.6
IWA7372	wsnp_Ku_c99567_87349060	5B	20.6
IWA2596	wsnp_Ex_c2132_4004831	5B	21.8
IWA2597	wsnp_Ex_c2132_4006417	5B	21.8
IWA3106	wsnp_Ex_c27272_36480685	5B	21.8
IWA3706	wsnp_Ex_c40022_47169698	5B	21.8
IWA3707	wsnp_Ex_c40022_47169752	5B	21.8
IWA4158	wsnp_Ex_c53011_56395185	5B	21.8
IWA4300	wsnp_Ex_c5632_9904112	5B	21.8
IWA4414	wsnp_Ex_c60683_61038062	5B	21.8
IWA4494	wsnp_Ex_c6391_11109898	5B	21.8
IWA4862	wsnp_Ex_c8985_14979134	5B	21.8
IWA8005	wsnp_Ra_c5634_9952011	5B	21.8
IWA5784	wsnp_JD_c11594_12033647	5B	22.1
IWA5954	wsnp_JD_c24508_20671551	5B	22.1
IWA2003	wsnp_Ex_c15304_23532301	5B	22.9
IWA1777	wsnp_Ex_c13440_21171391	5B	23.5
IWA5279	wsnp_Ex_rep_c66651_64962429	5B	23.5
IWA5280	wsnp_Ex_rep_c66651_64963120	5B	23.5
IWA6344	wsnp_JG_c402_268605	5B	23.5
IWA6689	wsnp_Ku_c20701_30355248	5B	23.5
IWA7127	wsnp_Ku_c50354_55979952	5B	23.5
IWA8518	wsnp_RFL_Contig3811_4130639	5B	23.5
IWA123	wsnp_BE443187B_Ta_2_1	5B	23.7
IWA1584	wsnp_Ex_c12119_19382764	5B	23.7

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1585	wsnp_Ex_c12119_19382820	5B	23.7
IWA301	wsnp_BE497820B_Ta_2_1	5B	23.7
IWA302	wsnp_BE497820B_Ta_2_2	5B	23.7
IWA303	wsnp_BE497820B_Ta_2_3	5B	23.7
IWA5289	wsnp_Ex_rep_c66696_65023462	5B	23.7
IWA4422	wsnp_Ex_c6100_10676217	5B	24.0
IWA1588	wsnp_Ex_c12127_19394952	5B	24.2
IWA6837	wsnp_Ku_c28245_38183393	5B	25.0
IWA2791	wsnp_Ex_c23238_32474842	5B	25.9
IWA3633	wsnp_Ex_c3817_6937184	5B	25.9
IWA2162	wsnp_Ex_c16704_25250247	5B	26.1
IWA5743	wsnp_Ex_rep_c75281_72691771	5B	26.1
IWA5845	wsnp_JD_c14223_14014177	5B	26.1
IWA6980	wsnp_Ku_c3826_7020960	5B	26.1
IWA6992	wsnp_Ku_c3869_7094615	5B	26.1
IWA3735	wsnp_Ex_c40732_47728890	5B	26.5
IWA138	wsnp_BE443745A_Ta_2_1	5B	28.4
IWA2180	wsnp_Ex_c16963_25554152	5B	30.1
IWA2181	wsnp_Ex_c16963_25554400	5B	30.1
IWA2182	wsnp_Ex_c16963_25554867	5B	30.1
IWA5620	wsnp_Ex_rep_c69631_68583202	5B	30.1
IWA5621	wsnp_Ex_rep_c69631_68583363	5B	30.1
IWA7507	wsnp_Ku_rep_c72211_71920520	5B	30.1
IWA7562	wsnp_Ra_c11257_18287816	5B	30.1
IWA8343	wsnp_RFL_Contig2504_2093982	5B	30.1
IWA1380	wsnp_Ex_c10674_17400603	5B	30.8
IWA2536	wsnp_Ex_c20440_29511162	5B	31.6
IWA2432	wsnp_Ex_c19542_28513205	5B	32.7
IWA2934	wsnp_Ex_c24933_34187952	5B	32.7
IWA6291	wsnp_JD_rep_c63013_40187485	5B	32.7
IWA5217	wsnp_Ex_rep_c66375_64566329	5B	32.9
IWA1018	wsnp_CAP12_rep_c8723_3660715	5B	33.1
IWA4346	wsnp_Ex_c57667_59284398	5B	33.3
IWA4958	wsnp_Ex_c974_1865513	5B	33.3
IWA2453	wsnp_Ex_c19724_28720939	5B	34.4
IWA2454	wsnp_Ex_c19724_28721128	5B	34.4
IWA2133	wsnp_Ex_c16432_24932860	5B	35.2
IWA4222	wsnp_Ex_c54206_57165374	5B	35.2
IWA4571	wsnp_Ex_c6748_11659366	5B	35.2

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5139	wsnp_Ex_rep_c105478_89891634	5B	35.2
IWA7447	wsnp_Ku_rep_c68797_67943795	5B	35.2
IWA7795	wsnp_Ra_c26091_35652620	5B	35.2
IWA4641	wsnp_Ex_c7244_12439355	5B	37.8
IWA7485	wsnp_Ku_rep_c70914_70585079	5B	37.8
IWA6516	wsnp_Ku_c14202_22436656	5B	43.4
IWA4003	wsnp_Ex_c47991_53037623	5B	44.0
IWA7815	wsnp_Ra_c27733_37249132	5B	44.4
IWA6111	wsnp_JD_c5795_6955031	5B	45.1
IWA6112	wsnp_JD_c5795_6955627	5B	45.1
IWA3640	wsnp_Ex_c3834_6971470	5B	46.3
IWA3641	wsnp_Ex_c3834_6971529	5B	46.3
IWA3642	wsnp_Ex_c3834_6971680	5B	46.3
IWA3643	wsnp_Ex_c3834_6971712	5B	46.3
IWA3644	wsnp_Ex_c3834_6972322	5B	46.3
IWA6905	wsnp_Ku_c3201_5970486	5B	46.3
IWA7378	wsnp_Ku_rep_c101212_88410320	5B	46.3
IWA1755	wsnp_Ex_c13277_20936069	5B	49.4
IWA6627	wsnp_Ku_c17396_26488733	5B	49.4
IWA7024	wsnp_Ku_c40334_48581010	5B	49.4
IWA4566	wsnp_Ex_c6695_11577150	5B	50.3
IWA4774	wsnp_Ex_c8142_13769831	5B	54.1
IWA8375	wsnp_RFL_Contig2726_2441798	5B	54.1
IWA7735	wsnp_Ra_c2105_4092507	5B	54.7
IWA4103	wsnp_Ex_c5155_9140608	5B	55.1
IWA8508	wsnp_RFL_Contig3739_3996324	5B	55.1
IWA1780	wsnp_Ex_c13485_21225504	5B	56.2
IWA1797	wsnp_Ex_c13641_21428268	5B	56.8
IWA3800	wsnp_Ex_c4189_7565086	5B	73.2
IWA1441	wsnp_Ex_c11131_18036595	5B	76.3
IWA1443	wsnp_Ex_c11131_18037020	5B	76.3
IWA4539	wsnp_Ex_c6571_11387527	5B	76.3
IWA7014	wsnp_Ku_c3973_7261765	5B	76.3
IWA1591	wsnp_Ex_c12152_19429932	5B	77.2
IWA1592	wsnp_Ex_c12152_19431363	5B	77.2
IWA584	wsnp_BG607308B_Ta_2_1	5B	80.0
IWA1259	wsnp_CD454152B_Ta_2_1	5B	81.1
IWA4182	wsnp_Ex_c53426_56666463	5B	81.1
IWA4184	wsnp_Ex_c53426_56666788	5B	81.1

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4185	wsnp_Ex_c53426_56667282	5B	81.1
IWA7393	wsnp_Ku_rep_c102339_89347150	5B	81.1
IWA2388	wsnp_Ex_c1925_3632756	5B	83.3
IWA7585	wsnp_Ra_c12489_19996904	5B	83.3
IWA7965	wsnp_Ra_c48052_53424445	5B	83.3
IWA7966	wsnp_Ra_c48052_53424490	5B	83.3
IWA3394	wsnp_Ex_c32488_41134388	5B	83.7
IWA8031	wsnp_Ra_c6374_11143280	5B	92.3
IWA1564	wsnp_Ex_c11951_19164786	5B	92.7
IWA4635	wsnp_Ex_c7196_12357989	5B	98.8
IWA5454	wsnp_Ex_rep_c67783_66469848	5B	98.8
IWA6211	wsnp_JD_c8978_9893945	5B	98.8
IWA1658	wsnp_Ex_c12599_20053652	5B	99.2
IWA5804	wsnp_JD_c12269_12546501	5B	99.2
IWA6994	wsnp_Ku_c38713_47298856	5B	102.5
IWA3658	wsnp_Ex_c3874_7036132	5B	104.0
IWA3358	wsnp_Ex_c3175_5864291	5B	104.9
IWA3359	wsnp_Ex_c3175_5864335	5B	104.9
IWA3360	wsnp_Ex_c3175_5864594	5B	104.9
IWA2321	wsnp_Ex_c1857_3498024	5B	107.3
IWA2322	wsnp_Ex_c1857_3498746	5B	107.3
IWA3183	wsnp_Ex_c28687_37791888	5B	107.3
IWA4726	wsnp_Ex_c7781_13255634	5B	107.3
IWA4329	wsnp_Ex_c57209_59016692	5B	112.5
IWA5802	wsnp_JD_c12221_12509932	5B	112.5
IWA5803	wsnp_JD_c12221_12509984	5B	112.5
IWA7701	wsnp_Ra_c19242_28392064	5B	112.5
IWA8006	wsnp_Ra_c5637_9955966	5B	112.5
IWA8391	wsnp_RFL_Contig2791_2558632	5B	112.5
IWA2931	wsnp_Ex_c2482_4636722	5B	113.0
IWA4903	wsnp_Ex_c9362_15546626	5B	113.0
IWA2865	wsnp_Ex_c24031_33277293	5B	118.3
IWA3285	wsnp_Ex_c30568_39472172	5B	122.8
IWA6577	wsnp_Ku_c16116_24914891	5B	122.8
IWA6579	wsnp_Ku_c16116_24915829	5B	122.8
IWA6580	wsnp_Ku_c16116_24916749	5B	122.8
IWA2083	wsnp_Ex_c1599_3050573	5D1	0.0
IWA4293	wsnp_Ex_c561_1114645	5D1	0.0
IWA6189	wsnp_JD_c825_1223424	5D1	0.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6190	wsnp_JD_c825_1223454	5D1	0.0
IWA6191	wsnp_JD_c825_1223506	5D1	0.0
IWA2276	wsnp_Ex_c17928_26697183	5D1	0.2
IWA6059	wsnp_JD_c4438_5567834	5D1	0.2
IWA6060	wsnp_JD_c4438_5567972	5D1	0.2
IWA6061	wsnp_JD_c4438_5568170	5D1	0.2
IWA6872	wsnp_Ku_c3022_5674299	5D1	0.2
IWA699	wsnp_CAP11_c209_198432	5D1	0.2
IWA700	wsnp_CAP11_c209_198467	5D1	0.2
IWA701	wsnp_CAP11_c209_198671	5D1	0.2
IWA7147	wsnp_Ku_c5228_9318604	5D1	0.2
IWA7095	wsnp_Ku_c46270_53051831	5D1	0.4
IWA2919	wsnp_Ex_c24659_33912464	5D1	0.6
IWA7383	wsnp_Ku_rep_c101796_88894110	5D1	0.6
IWA7914	wsnp_Ra_c40111_47657505	5D1	0.6
IWA7915	wsnp_Ra_c40111_47657589	5D1	0.6
IWA3470	wsnp_Ex_c3422_6283568	5D2	0.0
IWA5366	wsnp_Ex_rep_c67164_65655648	5D2	18.6
IWA6268	wsnp_JD_rep_c50025_34123405	5D2	18.8
IWA5012	wsnp_Ex_rep_c101445_86808057	5D2	20.3
BARC143	BARC143	5D2	23.4
IWA2413	wsnp_Ex_c19430_28378386	6A	0.0
IWA5417	wsnp_Ex_rep_c67563_66193155	6A	0.0
IWA6711	wsnp_Ku_c21405_31157318	6A	0.0
IWA6803	wsnp_Ku_c26585_36553202	6A	0.0
IWA6937	wsnp_Ku_c34036_43438136	6A	0.0
IWA7612	wsnp_Ra_c13610_21480997	6A	0.0
IWA272	wsnp_BE496826A_Ta_2_2	6A	0.9
IWA7802	wsnp_Ra_c2694_5122122	6A	1.1
GWM334	GWM334	6A	6.1
IWA1749	wsnp_Ex_c13230_20872924	6A	6.9
IWA4551	wsnp_Ex_c6604_11441257	6A	6.9
IWA4552	wsnp_Ex_c6604_11441822	6A	6.9
IWA6601	wsnp_Ku_c16572_25480808	6A	6.9
IWA7287	wsnp_Ku_c7471_12865307	6A	6.9
IWA7288	wsnp_Ku_c7471_12865509	6A	6.9
IWA1205	wsnp_CAP8_c6680_3136899	6A	7.1
IWA4272	wsnp_Ex_c55514_57990612	6A	9.7
IWA5507	wsnp_Ex_rep_c68175_66950387	6A	9.7



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7467	wsnp_Ku_rep_c69924_69422461	6A	9.7
IWA6388	wsnp_Ku_c10377_17180909	6A	11.9
IWA1748	wsnp_Ex_c13223_20866191	6A	13.4
IWA3137	wsnp_Ex_c280_541960	6A	13.4
IWA1522	wsnp_Ex_c11621_18716128	6A	19.4
IWA3322	wsnp_Ex_c31149_39976103	6A	31.1
IWA5400	wsnp_Ex_rep_c67468_66068537	6A	31.1
IWA7443	wsnp_Ku_rep_c68790_67933679	6A	31.1
IWA7444	wsnp_Ku_rep_c68790_67934066	6A	31.1
IWA7445	wsnp_Ku_rep_c68790_67934209	6A	31.1
IWA1086	wsnp_CAP7_c399_215824	6A	35.2
IWA6337	wsnp_JG_c2853_1271983	6A	35.2
IWA233	wsnp_BE490604A_Ta_2_1	6A	35.4
IWA6806	wsnp_Ku_c26784_36747712	6A	35.4
IWA6807	wsnp_Ku_c26784_36748247	6A	35.4
IWA1928	wsnp_Ex_c14692_22766127	6A	36.2
IWA2201	wsnp_Ex_c1728_3271657	6A	38.2
IWA3525	wsnp_Ex_c35465_43610634	6A	39.7
IWA4147	wsnp_Ex_c52577_56128947	6A	39.7
IWA5466	wsnp_Ex_rep_c67878_66584488	6A	39.7
IWA7295	wsnp_Ku_c7794_13356946	6A	39.7
IWA231	wsnp_BE490550A_Ta_1_1	6A	40.5
IWA1285	wsnp_Ex_c10120_16626785	6A	40.7
IWA1498	wsnp_Ex_c11446_18468102	6A	40.7
IWA1520	wsnp_Ex_c11604_18695170	6A	40.7
IWA1606	wsnp_Ex_c12288_19625413	6A	40.7
IWA1813	wsnp_Ex_c1381_2647144	6A	40.7
IWA2033	wsnp_Ex_c1556_2972134	6A	40.7
IWA215	wsnp_BE489896A_Ta_2_1	6A	40.7
IWA2295	wsnp_Ex_c1827_3442984	6A	40.7
IWA2421	wsnp_Ex_c19476_28434084	6A	40.7
IWA2813	wsnp_Ex_c23503_32742849	6A	40.7
IWA3227	wsnp_Ex_c29350_38393488	6A	40.7
IWA3251	wsnp_Ex_c29774_38768716	6A	40.7
IWA3261	wsnp_Ex_c3016_5573603	6A	40.7
IWA3299	wsnp_Ex_c30823_39695268	6A	40.7
IWA3356	wsnp_Ex_c31711_40468407	6A	40.7
IWA3397	wsnp_Ex_c32512_41153735	6A	40.7
IWA3408	wsnp_Ex_c32624_41252144	6A	40.7

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3782	wsnp_Ex_c41551_48349585	6A	40.7
IWA4029	wsnp_Ex_c4865_8679756	6A	40.7
IWA5441	wsnp_Ex_rep_c67692_66357763	6A	40.7
IWA5470	wsnp_Ex_rep_c67908_66629238	6A	40.7
IWA5656	wsnp_Ex_rep_c69901_68864080	6A	40.7
IWA5712	wsnp_Ex_rep_c70831_69710520	6A	40.7
IWA5713	wsnp_Ex_rep_c70831_69710886	6A	40.7
IWA6084	wsnp_JD_c5028_6151168	6A	40.7
IWA6469	wsnp_Ku_c12588_20290369	6A	40.7
IWA6679	wsnp_Ku_c19799_29342935	6A	40.7
IWA7352	wsnp_Ku_c9363_15709623	6A	40.7
IWA7424	wsnp_Ku_rep_c109033_93852557	6A	40.7
IWA7438	wsnp_Ku_rep_c68351_67302372	6A	40.7
IWA7483	wsnp_Ku_rep_c70860_70522328	6A	40.7
IWA7492	wsnp_Ku_rep_c71238_70957970	6A	40.7
IWA7511	wsnp_Ku_rep_c72681_72356010	6A	40.7
IWA8346	wsnp_RFL_Contig2517_2117956	6A	40.7
IWA2416	wsnp_Ex_c19454_28409258	6A	41.1
IWA3526	wsnp_Ex_c35545_43677480	6A	41.1
IWA3527	wsnp_Ex_c35545_43677576	6A	41.1
IWA6820	wsnp_Ku_c27273_37219950	6A	41.1
IWA8110	wsnp_Ra_rep_c100410_86374467	6A	41.1
IWA8241	wsnp_RFL_Contig1340_448996	6A	41.1
IWA2660	wsnp_Ex_c2192_4108709	6A	41.3
IWA428	wsnp_BF202329A_Ta_2_2	6A	41.3
IWA5898	wsnp_JD_c19278_17450072	6A	41.3
IWA5899	wsnp_JD_c19278_17450210	6A	41.3
IWA595	wsnp_BM134512A_Ta_2_2	6A	41.3
IWA8348	wsnp_RFL_Contig2523_2130662	6A	41.3
IWA6973	wsnp_Ku_c37942_46693718	6A	43.1
IWA7052	wsnp_Ku_c4296_7807837	6A	44.3
IWA4418	wsnp_Ex_c608_1206143	6A	44.5
IWA664	wsnp_CAP11_c1244_714229	6A	45.0
IWA6724	wsnp_Ku_c22358_32187765	6A	45.0
IWA8585	wsnp_RFL_Contig4353_5066954	6A	45.0
IWA1011	wsnp_CAP12_rep_c4851_2209148	6A	45.4
IWA1112	wsnp_CAP7_rep_c10136_4493502	6A	45.4
IWA1194	wsnp_CAP8_c4597_2237727	6A	45.4
IWA1235	wsnp_CAP8_rep_c5136_2472055	6A	45.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1474	wsnp_Ex_c11348_18326787	6A	45.4
IWA1475	wsnp_Ex_c11348_18327861	6A	45.4
IWA1514	wsnp_Ex_c11578_18655261	6A	45.4
IWA1856	wsnp_Ex_c14087_21997101	6A	45.4
IWA218	wsnp_BE490147A_Ta_2_1	6A	45.4
IWA2192	wsnp_Ex_c17185_25829084	6A	45.4
IWA2333	wsnp_Ex_c18639_27511306	6A	45.4
IWA281	wsnp_BE496986A_Ta_2_1	6A	45.4
IWA4737	wsnp_Ex_c7844_13341797	6A	45.4
IWA4928	wsnp_Ex_c9502_15748251	6A	45.4
IWA4929	wsnp_Ex_c9502_15748469	6A	45.4
IWA5459	wsnp_Ex_rep_c67819_66516786	6A	45.4
IWA650	wsnp_CAP11_c1137_665073	6A	45.4
IWA651	wsnp_CAP11_c1137_665340	6A	45.4
IWA653	wsnp_CAP11_c1155_673549	6A	45.4
IWA6699	wsnp_Ku_c21021_30712963	6A	45.4
IWA7283	wsnp_Ku_c7426_12791188	6A	45.4
IWA741	wsnp_CAP11_c303_253438	6A	45.4
IWA7563	wsnp_Ra_c11269_18309313	6A	45.4
IWA879	wsnp_CAP11_rep_c6492_2992504	6A	45.4
IWA1997	wsnp_Ex_c15268_23489498	6A	45.6
IWA3269	wsnp_Ex_c30264_39202224	6A	45.6
IWA3767	wsnp_Ex_c4124_7454026	6A	45.6
IWA4865	wsnp_Ex_c902_1745108	6A	45.6
IWA5073	wsnp_Ex_rep_c102807_87894515	6A	45.6
IWA5074	wsnp_Ex_rep_c102807_87894833	6A	45.6
IWA5437	wsnp_Ex_rep_c67689_66353644	6A	45.6
IWA5757	wsnp_Ex_rep_c86110_78630016	6A	45.6
IWA6508	wsnp_Ku_c13904_22032552	6A	45.6
IWA6811	wsnp_Ku_c2700_5121331	6A	45.6
IWA6812	wsnp_Ku_c2700_5121383	6A	45.6
IWA6938	wsnp_Ku_c3450_6387847	6A	45.6
IWA7666	wsnp_Ra_c17221_26052231	6A	45.6
IWA1671	wsnp_Ex_c1269_2435294	6A	46.0
IWA224	wsnp_BE490226A_Ta_2_2	6A	46.0
IWA2895	wsnp_Ex_c24379_33621872	6A	46.0
IWA4035	wsnp_Ex_c48789_53586406	6A	46.0
IWA4036	wsnp_Ex_c48789_53586502	6A	46.0
IWA6596	wsnp_Ku_c16432_25320146	6A	46.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA8431	wsnp_RFL_Contig3136_3092151	6A	50.1
IWA5458	wsnp_Ex_rep_c67801_66492414	6A	50.3
IWA5940	wsnp_JD_c22766_19622512	6A	50.5
IWA654	wsnp_CAP11_c1178_684471	6A	50.5
IWA992	wsnp_CAP12_c928_486444	6A	50.9
IWA7397	wsnp_Ku_rep_c102901_89769309	6A	51.3
IWA7575	wsnp_Ra_c12086_19452422	6A	51.3
IWA3585	wsnp_Ex_c36801_44683992	6A	51.5
IWA4111	wsnp_Ex_c51820_55631329	6A	51.5
IWA4112	wsnp_Ex_c51820_55631560	6A	51.5
IWA5717	wsnp_Ex_rep_c70951_69805840	6A	51.5
IWA5718	wsnp_Ex_rep_c70951_69806211	6A	51.5
IWA5719	wsnp_Ex_rep_c70951_69806455	6A	51.5
IWA6406	wsnp_Ku_c1075_2160065	6A	51.5
IWA6517	wsnp_Ku_c14219_22455933	6A	51.5
IWA6550	wsnp_Ku_c15096_23605606	6A	51.5
IWA7063	wsnp_Ku_c44079_51438574	6A	51.5
IWA2241	wsnp_Ex_c17637_26370812	6A	52.4
IWA3023	wsnp_Ex_c26147_35395059	6A	52.4
IWA3024	wsnp_Ex_c26147_35395259	6A	52.4
IWA6194	wsnp_JD_c8334_9342604	6A	52.4
IWA5142	wsnp_Ex_rep_c105594_89968727	6A	56.9
IWA4950	wsnp_Ex_c965_1845676	6A	57.1
IWA4951	wsnp_Ex_c965_1846161	6A	57.1
IWA5479	wsnp_Ex_rep_c68010_66754171	6A	59.3
IWA5480	wsnp_Ex_rep_c68010_66754534	6A	59.3
IWA5481	wsnp_Ex_rep_c68010_66754801	6A	59.3
IWA1497	wsnp_Ex_c11439_18459047	6A	59.5
IWA7337	wsnp_Ku_c8799_14875841	6A	66.6
IWA6434	wsnp_Ku_c11846_19262918	6A	70.0
IWA5783	wsnp_JD_c11443_11907542	6A	71.2
IWA6355	wsnp_JG_c474_302785	6A	71.2
IWA2538	wsnp_Ex_c20457_29526260	6A	71.9
IWA2539	wsnp_Ex_c20457_29526403	6A	71.9
IWA4809	wsnp_Ex_c8510_14306239	6A	71.9
IWA5035	wsnp_Ex_rep_c101766_87073440	6A	71.9
IWA5398	wsnp_Ex_rep_c67436_66026057	6A	72.3
IWA2129	wsnp_Ex_c16423_24920805	6A	72.5
IWA2705	wsnp_Ex_c2236_4189774	6A	74.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3487	wsnp_Ex_c34597_42879693	6A	74.0
IWA3488	wsnp_Ex_c34597_42879718	6A	74.0
IWA4478	wsnp_Ex_c632_1250362	6A	76.2
IWA6858	wsnp_Ku_c29287_39194579	6A	76.2
IWA8568	wsnp_RFL_Contig420_4824600	6A	76.2
IWA214	wsnp_BE489894A_Ta_2_1	6A	76.6
IWA1000	wsnp_CAP12_rep_c4048_1842112	6A	79.9
IWA2580	wsnp_Ex_c21129_30256617	6A	79.9
IWA5338	wsnp_Ex_rep_c66977_65417397	6A	79.9
IWA8222	wsnp_RFL_Contig1075_104560	6A	79.9
IWA8386	wsnp_RFL_Contig2765_2513854	6A	79.9
IWA8438	wsnp_RFL_Contig3175_3154256	6A	79.9
IWA928	wsnp_CAP12_c1663_836753	6A	79.9
IWA929	wsnp_CAP12_c1663_836928	6A	79.9
IWA935	wsnp_CAP12_c2124_1043228	6A	79.9
IWA4691	wsnp_Ex_c749_1472258	6A	80.1
IWA6316	wsnp_JD_rep_c65886_41872083	6A	80.1
IWA6864	wsnp_Ku_c2956_5558754	6A	80.1
IWA7747	wsnp_Ra_c21546_30949373	6A	80.1
IWA5582	wsnp_Ex_rep_c69054_67959458	6A	80.3
IWA8595	wsnp_RFL_Contig4456_5258284	6A	80.3
IWA5172	wsnp_Ex_rep_c109274_92142043	6A	80.7
IWA1391	wsnp_Ex_c10824_17611901	6A	84.5
IWA202	wsnp_BE471213B_Ta_2_2	6B1	0.0
IWA5606	wsnp_Ex_rep_c69373_68312188	6B1	12.4
IWA3268	wsnp_Ex_c3025_5587183	6B1	12.6
IWA4773	wsnp_Ex_c8134_13758366	6B1	12.6
IWA1484	wsnp_Ex_c11379_18370310	6B1	19.5
IWA1485	wsnp_Ex_c11379_18370982	6B1	19.5
IWA4868	wsnp_Ex_c9038_15058264	6B1	19.5
IWA4869	wsnp_Ex_c9038_15058444	6B1	19.5
IWA5666	wsnp_Ex_rep_c70036_68988728	6B1	29.6
IWA5732	wsnp_Ex_rep_c71537_70252046	6B1	29.6
IWA1816	wsnp_Ex_c1383_2651887	6B1	36.8
IWA1817	wsnp_Ex_c1383_2652398	6B1	36.8
IWA7056	wsnp_Ku_c43368_50890819	6B1	37.6
IWA1628	wsnp_Ex_c12433_19826311	6B1	39.3
IWA1629	wsnp_Ex_c12433_19827016	6B1	39.3
IWA1666	wsnp_Ex_c12674_20142989	6B1	39.3

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3221	wsnp_Ex_c2925_5397331	6B1	39.5
IWA307	wsnp_BE498419B_Ta_1_2	6B1	42.4
IWA308	wsnp_BE498419B_Ta_1_3	6B1	42.4
IWA967	wsnp_CAP12_c475_258416	6B1	42.4
IWA1267	wsnp_CV776265A_Ta_2_1	6B1	44.8
IWA1268	wsnp_CV776265A_Ta_2_2	6B1	44.8
IWA221	wsnp_BE490200B_Ta_2_1	6B1	46.5
IWA2305	wsnp_Ex_c18372_27196625	6B1	46.5
IWA4337	wsnp_Ex_c5744_10087758	6B1	46.5
IWA4959	wsnp_Ex_c9750_16105678	6B1	46.5
IWA5148	wsnp_Ex_rep_c106072_90285324	6B1	46.5
IWA6534	wsnp_Ku_c14603_22966714	6B1	46.5
IWA676	wsnp_CAP11_c1541_857160	6B1	47.1
IWA1434	wsnp_Ex_c11073_17956329	6B1	49.3
IWA2927	wsnp_Ex_c24766_34017588	6B1	49.3
IWA3234	wsnp_Ex_c29387_38429452	6B1	49.3
IWA3650	wsnp_Ex_c3854_7003399	6B1	49.3
IWA3651	wsnp_Ex_c3854_7003482	6B1	49.3
IWA3801	wsnp_Ex_c4190_7567262	6B1	49.3
IWA4564	wsnp_Ex_c6674_11544930	6B1	49.3
IWA5197	wsnp_Ex_rep_c66315_64480362	6B1	49.3
IWA5198	wsnp_Ex_rep_c66315_64480670	6B1	49.3
IWA5308	wsnp_Ex_rep_c66835_65228400	6B1	49.3
IWA6295	wsnp_JD_rep_c63567_40552622	6B1	49.3
IWA657	wsnp_CAP11_c1185_687769	6B1	49.3
IWA6570	wsnp_Ku_c15761_24469459	6B1	49.3
IWA6571	wsnp_Ku_c15761_24469519	6B1	49.3
IWA683	wsnp_CAP11_c166_172556	6B1	49.3
IWA6904	wsnp_Ku_c3185_5949143	6B1	49.3
IWA7886	wsnp_Ra_c35443_43984178	6B1	49.3
IWA7954	wsnp_Ra_c46591_52408053	6B1	49.3
IWA8087	wsnp_Ra_c8715_14697086	6B1	49.3
IWA2039	wsnp_Ex_c15595_23910900	6B1	49.5
IWA2173	wsnp_Ex_c16836_25401702	6B1	49.5
IWA4383	wsnp_Ex_c5936_10411877	6B1	49.5
IWA4384	wsnp_Ex_c5936_10412246	6B1	49.5
IWA1017	wsnp_CAP12_rep_c8688_3644383	6B1	51.4
IWA3289	wsnp_Ex_c30689_39574415	6B1	51.4
IWA3353	wsnp_Ex_c31670_40431546	6B1	51.4

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3354	wsnp_Ex_c31670_40433594	6B1	51.4
IWA3679	wsnp_Ex_c3940_7144946	6B1	51.4
IWA5722	wsnp_Ex_rep_c71062_69901558	6B1	51.4
IWA6770	wsnp_Ku_c24981_34948114	6B1	51.4
IWA7084	wsnp_Ku_c4565_8238445	6B1	51.4
IWA800	wsnp_CAP11_c681_443861	6B1	51.4
IWA4484	wsnp_Ex_c6356_11055912	6B1	51.7
IWA4485	wsnp_Ex_c6356_11056222	6B1	51.7
IWA4486	wsnp_Ex_c6356_11056696	6B1	51.7
IWA7189	wsnp_Ku_c5744_10166561	6B1	51.7
IWA2085	wsnp_Ex_c16002_24419222	6B1	51.9
IWA3172	wsnp_Ex_c2854_5270318	6B1	51.9
IWA3574	wsnp_Ex_c3640_6644345	6B1	51.9
IWA4435	wsnp_Ex_c6143_10747643	6B1	51.9
IWA4436	wsnp_Ex_c6143_10747716	6B1	51.9
IWA5625	wsnp_Ex_rep_c69660_68614071	6B1	51.9
IWA1857	wsnp_Ex_c14101_22012676	6B1	52.5
IWA5345	wsnp_Ex_rep_c67012_65465341	6B1	53.5
IWA5346	wsnp_Ex_rep_c67012_65465394	6B1	53.5
IWA5360	wsnp_Ex_rep_c67142_65625774	6B1	53.5
IWA7901	wsnp_Ra_c38398_46315538	6B1	53.5
IWA8165	wsnp_Ra_rep_c69821_67403173	6B1	53.5
IWA3459	wsnp_Ex_c34011_42398362	6B1	54.0
IWA3460	wsnp_Ex_c34011_42398664	6B1	54.0
IWA1838	wsnp_Ex_c1398_2676484	6B1	55.0
IWA1839	wsnp_Ex_c1398_2677127	6B1	55.0
IWA1911	wsnp_Ex_c14586_22625563	6B1	55.0
IWA2198	wsnp_Ex_c1725_3267186	6B1	55.0
IWA2780	wsnp_Ex_c23122_32350412	6B1	55.0
IWA2811	wsnp_Ex_c23474_32717535	6B1	55.0
IWA3132	wsnp_Ex_c27934_37093737	6B1	55.0
IWA3632	wsnp_Ex_c38150_45749359	6B1	55.0
IWA3652	wsnp_Ex_c3858_7011837	6B1	55.0
IWA3797	wsnp_Ex_c4180_7550457	6B1	55.0
IWA3917	wsnp_Ex_c44857_50804565	6B1	55.0
IWA4169	wsnp_Ex_c5334_9427658	6B1	55.0
IWA4170	wsnp_Ex_c5334_9427824	6B1	55.0
IWA4848	wsnp_Ex_c8843_14783989	6B1	55.0
IWA4924	wsnp_Ex_c9470_15701734	6B1	55.0

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5029	wsnp_Ex_rep_c101703_87021883	6B1	55.0
IWA5095	wsnp_Ex_rep_c103466_88415738	6B1	55.0
IWA5096	wsnp_Ex_rep_c103466_88415994	6B1	55.0
IWA5098	wsnp_Ex_rep_c103497_88437811	6B1	55.0
IWA5102	wsnp_Ex_rep_c103517_88455567	6B1	55.0
IWA5504	wsnp_Ex_rep_c68169_66940235	6B1	55.0
IWA5531	wsnp_Ex_rep_c68480_67305954	6B1	55.0
IWA5966	wsnp_JD_c2691_3617481	6B1	55.0
IWA6101	wsnp_JD_c5591_6743599	6B1	55.0
IWA617	wsnp_BQ161448B_Ta_2_1	6B1	55.0
IWA7571	wsnp_Ra_c11600_18784716	6B1	55.0
IWA7574	wsnp_Ra_c11942_19247669	6B1	55.0
IWA7663	wsnp_Ra_c16850_25605248	6B1	55.0
IWA7818	wsnp_Ra_c27839_37354085	6B1	55.0
IWA7995	wsnp_Ra_c54050_57499377	6B1	55.0
IWA8184	wsnp_Ra_rep_c72450_70610212	6B1	55.0
IWA8189	wsnp_Ra_rep_c73725_71801046	6B1	55.0
IWA8190	wsnp_Ra_rep_c73725_71801179	6B1	55.0
IWA997	wsnp_CAP12_rep_c3885_1758057	6B1	55.0
IWA8166	wsnp_Ra_rep_c70110_67803925	6B1	55.2
IWA2209	wsnp_Ex_c17349_26035281	6B1	56.1
IWA2653	wsnp_Ex_c21783_30945248	6B1	56.1
IWA3825	wsnp_Ex_c42372_48966781	6B1	56.1
IWA3963	wsnp_Ex_c46160_51746546	6B1	56.1
IWA4086	wsnp_Ex_c5075_9013594	6B1	56.1
IWA434	wsnp_BF291478B_Ta_2_1	6B1	56.1
IWA4515	wsnp_Ex_c6466_11234080	6B1	56.1
IWA4570	wsnp_Ex_c6740_11647359	6B1	56.1
IWA613	wsnp_BQ159615B_Ta_2_1	6B1	56.1
IWA6293	wsnp_JD_rep_c63108_40258378	6B1	56.1
IWA6628	wsnp_Ku_c1755_3431396	6B1	56.1
IWA685	wsnp_CAP11_c1724_940246	6B1	56.1
IWA6855	wsnp_Ku_c29041_38942940	6B1	56.1
IWA7782	wsnp_Ra_c24962_34524503	6B1	56.1
IWA7783	wsnp_Ra_c24962_34524602	6B1	56.1
IWA2135	wsnp_Ex_c16466_24967033	6B1	56.3
IWA3450	wsnp_Ex_c33813_42239400	6B1	56.3
IWA1151	wsnp_CAP8_c1540_889753	6B1	56.5
IWA2244	wsnp_Ex_c17667_26408733	6B1	56.5



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4078	wsnp_Ex_c5058_8981554	6B1	57.3
IWA8011	wsnp_Ra_c57648_59682822	6B1	57.3
IWA2342	wsnp_Ex_c18669_27544717	6B1	58.2
IWA5266	wsnp_Ex_rep_c66552_64837613	6B1	58.4
IWA5267	wsnp_Ex_rep_c66552_64838102	6B1	58.4
IWA2976	wsnp_Ex_c25505_34772008	6B1	59.2
IWA6958	wsnp_Ku_c36658_45640758	6B1	59.2
IWA3676	wsnp_Ex_c39304_46634878	6B1	59.4
IWA3677	wsnp_Ex_c39304_46635517	6B1	59.4
IWA5042	wsnp_Ex_rep_c102044_87296690	6B1	59.4
IWA5043	wsnp_Ex_rep_c102044_87297599	6B1	59.4
IWA7786	wsnp_Ra_c25255_34824465	6B1	59.4
IWA7895	wsnp_Ra_c3766_6947230	6B1	59.4
IWA7896	wsnp_Ra_c3766_6947263	6B1	59.4
IWA7974	wsnp_Ra_c48999_54089942	6B1	59.4
IWA1212	wsnp_CAP8_c7510_3461645	6B1	59.9
IWA206	wsnp_BE488206B_Ta_2_1	6B1	59.9
IWA3501	wsnp_Ex_c34962_43193869	6B1	59.9
IWA7689	wsnp_Ra_c18735_27835674	6B1	59.9
IWA1657	wsnp_Ex_c12577_20022294	6B1	61.6
IWA1905	wsnp_Ex_c14530_22548314	6B1	61.8
IWA1660	wsnp_Ex_c12618_20079758	6B1	64.4
IWA4408	wsnp_Ex_c6057_10611952	6B1	64.6
IWA7369	wsnp_Ku_c9872_16447091	6B1	64.6
IWA5468	wsnp_Ex_rep_c67887_66598188	6B1	64.8
IWA6071	wsnp_JD_c46225_31654736	6B1	64.8
IWA7239	wsnp_Ku_c67375_66441929	6B1	64.8
IWA7240	wsnp_Ku_c67375_66442176	6B1	64.8
IWA842	wsnp_CAP11_rep_c4122_1949294	6B1	64.8
IWA861	wsnp_CAP11_rep_c4300_2030142	6B1	64.8
IWA862	wsnp_CAP11_rep_c4300_2030261	6B1	64.8
IWA7257	wsnp_Ku_c7002_12116034	6B1	65.0
IWA3228	wsnp_Ex_c2936_5415651	6B1	68.1
IWA3708	wsnp_Ex_c40044_47184747	6B1	69.2
IWA52	wsnp_BE404947B_Ta_2_12	6B1	73.3
IWA5185	wsnp_Ex_rep_c115803_95396724	6B1	79.2
IWA2495	wsnp_Ex_c20_42503	6B1	91.5
IWA921	wsnp_CAP12_c1388_706924	6B1	92.4
IWA2475	wsnp_Ex_c1988_3741706	6B1	95.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2476	wsnp_Ex_c1988_3742022	6B1	95.5
IWA2477	wsnp_Ex_c1988_3742145	6B1	95.5
IWA2479	wsnp_Ex_c1988_3742291	6B1	95.5
IWA6759	wsnp_Ku_c24391_34351602	6B1	95.5
IWA6760	wsnp_Ku_c24391_34351606	6B1	95.5
IWA1492	wsnp_Ex_c1143_2194680	6B1	95.7
IWA1493	wsnp_Ex_c1143_2195442	6B1	95.7
IWA1494	wsnp_Ex_c1143_2195598	6B1	95.7
IWA1495	wsnp_Ex_c1143_2196102	6B1	95.7
IWA6704	wsnp_Ku_c2119_4098330	6B1	95.7
IWA2098	wsnp_Ex_c16090_24522660	6B1	96.1
IWA969	wsnp_CAP12_c4924_2241879	6B1	96.1
GWM508	GWM508	6B2	0.0
IWA5275	wsnp_Ex_rep_c66622_64925837	6B2	12.4
IWA3461	wsnp_Ex_c3405_6252997	6B2	13.9
IWA1895	wsnp_Ex_c14439_22424715	6B2	14.5
IWA1896	wsnp_Ex_c14439_22426200	6B2	14.5
IWA5576	wsnp_Ex_rep_c69023_67923545	6B2	14.5
IWA6625	wsnp_Ku_c17328_26400537	6B2	14.5
IWA1924	wsnp_Ex_c14691_22763171	6D	0.0
IWA1925	wsnp_Ex_c14691_22763609	6D	0.0
IWA1926	wsnp_Ex_c14691_22763753	6D	0.0
IWA1927	wsnp_Ex_c14691_22765150	6D	0.0
IWA5591	wsnp_Ex_rep_c69248_68171036	6D	0.0
IWA6141	wsnp_JD_c6439_7601968	6D	0.0
IWA6179	wsnp_JD_c7793_8866097	6D	0.0
IWA6274	wsnp_JD_rep_c50999_34772439	6D	0.0
IWA4056	wsnp_Ex_c4942_8793029	6D	0.4
IWA4455	wsnp_Ex_c62371_62036044	6D	0.4
IWA4918	wsnp_Ex_c946_1813956	6D	0.4
IWA4919	wsnp_Ex_c946_1814027	6D	0.4
IWA4920	wsnp_Ex_c946_1814084	6D	0.4
IWA5354	wsnp_Ex_rep_c67100_65576598	6D	0.4
IWA5931	wsnp_JD_c2198_3021879	6D	0.4
IWA7091	wsnp_Ku_c4603_8305972	6D	0.4
IWA1741	wsnp_Ex_c13188_20825019	6D	0.8
IWA2637	wsnp_Ex_c21688_30845705	6D	0.8
IWA2638	wsnp_Ex_c21688_30845899	6D	0.8
IWA3910	wsnp_Ex_c4480_8055163	6D	0.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3911	wsnp_Ex_c4480_8055475	6D	0.8
IWA3912	wsnp_Ex_c4480_8056013	6D	0.8
IWA3913	wsnp_Ex_c4480_8056354	6D	0.8
IWA3914	wsnp_Ex_c4480_8057184	6D	0.8
IWA7490	wsnp_Ku_rep_c71225_70941765	6D	0.8
IWA6419	wsnp_Ku_c1139_2275182	6D	4.4
IWA6735	wsnp_Ku_c23257_33160693	7A	0.0
IWA7592	wsnp_Ra_c12773_20367106	7A	0.2
IWA179	wsnp_BE445506A_Ta_2_2	7A	2.8
IWA5873	wsnp_JD_c1635_2290177	7A	2.8
IWA6833	wsnp_Ku_c28104_38042857	7A	2.8
IWA736	wsnp_CAP11_c298_250735	7A	2.8
IWA737	wsnp_CAP11_c298_250917	7A	2.8
IWA795	wsnp_CAP11_c639_424134	7A	2.8
IWA1518	wsnp_Ex_c1159_2225557	7A	5.7
IWA4173	wsnp_Ex_c53387_56639804	7A	5.7
IWA4175	wsnp_Ex_c53387_56639949	7A	5.7
IWA4176	wsnp_Ex_c53387_56640789	7A	5.7
IWA4177	wsnp_Ex_c53387_56641291	7A	5.7
IWA4363	wsnp_Ex_c5839_10246812	7A	5.7
IWA4364	wsnp_Ex_c5839_10246915	7A	5.7
IWA4433	wsnp_Ex_c6142_10746143	7A	5.7
IWA4434	wsnp_Ex_c6142_10746442	7A	5.7
IWA7728	wsnp_Ra_c2063_4012957	7A	5.7
IWA8057	wsnp_Ra_c7112_12318340	7A	5.7
IWA1054	wsnp_CAP7_c1860_918210	7A	7.2
IWA1223	wsnp_CAP8_rep_c3844_1896355	7A	7.2
IWA2929	wsnp_Ex_c24796_34049469	7A	7.2
IWA7964	wsnp_Ra_c47942_53349897	7A	7.2
IWA865	wsnp_CAP11_rep_c4346_2050918	7A	7.2
IWA4594	wsnp_Ex_c6961_11998812	7A	7.8
IWA4595	wsnp_Ex_c6961_12000176	7A	7.8
IWA2905	wsnp_Ex_c24486_33732900	7A	8.0
IWA6115	wsnp_JD_c5861_7018974	7A	8.0
IWA7185	wsnp_Ku_c5693_10079343	7A	8.0
IWA4124	wsnp_Ex_c52115_55827442	7A	8.7
IWA2402	wsnp_Ex_c1935_3649406	7A	8.9
IWA2403	wsnp_Ex_c1935_3650303	7A	8.9
IWA4925	wsnp_Ex_c9476_15710162	7A	9.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2723	wsnp_Ex_c22547_31737663	7A	18.3
IWA2724	wsnp_Ex_c22547_31738007	7A	18.3
IWA7325	wsnp_Ku_c8437_14341371	7A	21.9
IWA2270	wsnp_Ex_c17899_26666328	7A	31.3
IWA1117	wsnp_CAP7_rep_c5204_2330201	7A	32.0
IWA4443	wsnp_Ex_c61895_61760112	7A	32.0
IWA1031	wsnp_CAP7_c1321_664478	7A	32.8
IWA1032	wsnp_CAP7_c1321_664480	7A	32.8
IWA5912	wsnp_JD_c20555_18262260	7A	37.1
IWA5913	wsnp_JD_c20555_18262317	7A	37.1
IWA7409	wsnp_Ku_rep_c104159_90704469	7A	37.1
IWA4910	wsnp_Ex_c9428_15641609	7A	38.6
IWA4911	wsnp_Ex_c9428_15641639	7A	38.6
IWA6535	wsnp_Ku_c14678_23061894	7A	38.6
IWA1726	wsnp_Ex_c1309_2503198	7A	39.4
IWA7045	wsnp_Ku_c42539_50247333	7A	39.4
IWA7046	wsnp_Ku_c42539_50247426	7A	39.4
IWA7933	wsnp_Ra_c42862_49716715	7A	50.2
IWA8076	wsnp_Ra_c8394_14242358	7A	50.2
IWA8077	wsnp_Ra_c8394_14242442	7A	50.2
IWA2009	wsnp_Ex_c15341_23591761	7A	53.7
IWA2011	wsnp_Ex_c15341_23592075	7A	53.7
IWA2012	wsnp_Ex_c15341_23592177	7A	53.7
IWA4288	wsnp_Ex_c5608_9867710	7A	53.7
IWA6004	wsnp_JD_c3225_4227048	7A	53.7
IWA4845	wsnp_Ex_c8823_14754501	7A	56.8
IWA4846	wsnp_Ex_c8823_14754992	7A	56.8
IWA7755	wsnp_Ra_c22201_31650505	7A	56.8
IWA7756	wsnp_Ra_c22201_31650648	7A	56.8
IWA6868	wsnp_Ku_c2990_5622678	7A	57.0
IWA1110	wsnp_CAP7_c949_486485	7A	57.4
IWA1111	wsnp_CAP7_c949_486600	7A	57.4
IWA810	wsnp_CAP11_c827_513472	7A	57.4
IWA6940	wsnp_Ku_c34643_43968242	7A	57.6
IWA707	wsnp_CAP11_c2211_1157166	7A	57.6
IWA1421	wsnp_Ex_c11035_17897914	7A	57.8
IWA1502	wsnp_Ex_c1146_2200823	7A	59.3
IWA3639	wsnp_Ex_c38326_45883440	7A	59.3
IWA7368	wsnp_Ku_c984_2003685	7A	59.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7650	wsnp_Ra_c16287_24904962	7A	59.5
IWA7651	wsnp_Ra_c16287_24905062	7A	59.5
IWA2385	wsnp_Ex_c19214_28132186	7A	60.0
IWA2387	wsnp_Ex_c1924_3630519	7A	60.0
IWA2437	wsnp_Ex_c19582_28564743	7A	60.0
IWA2621	wsnp_Ex_c21494_30640657	7A	60.0
IWA3456	wsnp_Ex_c3391_6227311	7A	60.0
IWA4037	wsnp_Ex_c4883_8705816	7A	60.0
IWA476	wsnp_BF474379A_Ta_2_1	7A	60.0
IWA477	wsnp_BF474379A_Ta_2_2	7A	60.0
IWA5808	wsnp_JD_c12343_12604782	7A	60.0
IWA635	wsnp_BQ171683A_Ta_2_1	7A	60.0
IWA3701	wsnp_Ex_c40011_47158369	7A	60.4
IWA6529	wsnp_Ku_c14483_22820120	7A	60.4
IWA3668	wsnp_Ex_c39119_46485649	7A	60.6
IWA4996	wsnp_Ex_c9982_16429661	7A	60.6
IWA7090	wsnp_Ku_c4591_8286910	7A	60.6
IWA4002	wsnp_Ex_c47919_52987043	7A	60.8
IWA5207	wsnp_Ex_rep_c66349_64528826	7A	60.8
IWA5208	wsnp_Ex_rep_c66349_64528880	7A	60.8
IWA5209	wsnp_Ex_rep_c66349_64530060	7A	60.8
IWA8186	wsnp_Ra_rep_c72915_71066676	7A	60.8
IWA7718	wsnp_Ra_c20189_29442564	7A	65.1
IWA7682	wsnp_Ra_c18364_27416387	7A	66.4
IWA1802	wsnp_Ex_c13721_21532196	7A	67.4
IWA4063	wsnp_Ex_c4996_8885500	7A	67.4
IWA6866	wsnp_Ku_c2958_5561339	7A	67.4
IWA8113	wsnp_Ra_rep_c104968_88985755	7A	67.4
IWA2082	wsnp_Ex_c15988_24402251	7A	68.1
IWA2301	wsnp_Ex_c18352_27178687	7A	68.1
IWA2302	wsnp_Ex_c18352_27178789	7A	68.1
IWA5119	wsnp_Ex_rep_c104560_89241494	7A	68.1
IWA7193	wsnp_Ku_c58044_60941831	7A	68.1
IWA3843	wsnp_Ex_c42836_49314564	7A	68.5
IWA497	wsnp_BF482529A_Ta_2_5	7A	68.5
IWA1524	wsnp_Ex_c11636_18742884	7A	68.9
IWA208	wsnp_be488670A_Ta_2_1	7A	68.9
IWA6207	wsnp_JD_c8919_9843202	7A	68.9
IWA6208	wsnp_JD_c8919_9843237	7A	68.9

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5844	wsnp_JD_c14118_13933380	7A	69.5
IWA3693	wsnp_Ex_c398_784427	7A	69.9
IWA3694	wsnp_Ex_c398_784645	7A	69.9
IWA484	wsnp_bf474746A_Ta_1_1	7A	69.9
IWA5132	wsnp_Ex_rep_c105174_89674370	7A	69.9
IWA5703	wsnp_Ex_rep_c70629_69539466	7A	69.9
IWA7976	wsnp_Ra_c4990_8920762	7A	69.9
IWA7990	wsnp_Ra_c5251_9356517	7A	69.9
IWA2954	wsnp_Ex_c25188_34454616	7A	70.2
IWA3727	wsnp_Ex_c40666_47674310	7A	70.4
IWA1842	wsnp_Ex_c14009_21899923	7A	71.0
IWA2497	wsnp_Ex_c200_391493	7A	71.4
IWA486	wsnp_bf474966A_Ta_2_1	7A	71.6
IWA5887	wsnp_JD_c18167_16742264	7A	71.6
IWA6028	wsnp_JD_c38071_27729378	7A	71.6
IWA6029	wsnp_JD_c38071_27729494	7A	71.6
IWA7855	wsnp_Ra_c31751_40835513	7A	71.6
IWA796	wsnp_CAP11_c651_429138	7A	71.6
IWA797	wsnp_CAP11_c651_429263	7A	71.6
IWA798	wsnp_CAP11_c651_429294	7A	71.6
IWA8122	wsnp_Ra_rep_c105976_89839782	7A	71.6
IWA65	wsnp_be405835A_Ta_1_1	7A	73.3
IWA1156	wsnp_CAP8_c1725_973916	7A	73.5
IWA1264	wsnp_cd454870A_Ta_1_1	7A	73.5
IWA1265	wsnp_cd454870A_Ta_1_2	7A	73.5
IWA2576	wsnp_Ex_c21108_30237509	7A	73.5
IWA3	wsnp_be352570A_Ta_1_1	7A	73.5
IWA305	wsnp_BE498209A_Ta_2_1	7A	73.5
IWA363	wsnp_BE590553A_Ta_2_1	7A	73.5
IWA369	wsnp_BE591002A_Ta_2_3	7A	73.5
IWA370	wsnp_BE591002A_Ta_2_4	7A	73.5
IWA529	wsnp_BG263266A_Ta_1_1	7A	73.5
IWA631	wsnp_BQ169501A_Ta_1_1	7A	73.5
IWA7500	wsnp_Ku_rep_c71755_71490557	7A	73.5
IWA2820	wsnp_Ex_c2360_4422599	7A	74.2
IWA7731	wsnp_Ra_c2094_4066675	7A	74.2
IWA7942	wsnp_Ra_c4418_8012732	7A	77.0
IWA7419	wsnp_Ku_rep_c105954_91953127	7A	77.2
IWA3715	wsnp_Ex_c40247_47349166	7A	77.7

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3672	wsnp_Ex_c39221_46569887	7A	78.3
IWA3673	wsnp_Ex_c39221_46569987	7A	78.3
IWA3674	wsnp_Ex_c39221_46570202	7A	78.3
IWA7205	wsnp_Ku_c6065_10682531	7A	78.5
IWA7206	wsnp_Ku_c6065_10682577	7A	78.5
IWA4180	wsnp_Ex_c5341_9442913	7A	79.3
IWA4181	wsnp_Ex_c5341_9443380	7A	79.3
IWA4386	wsnp_Ex_c5939_10417052	7A	84.4
IWA7121	wsnp_Ku_c4968_8882117	7A	84.4
IWA8161	wsnp_Ra_rep_c69620_67130107	7A	84.4
IWA4426	wsnp_Ex_c61210_61355280	7A	85.2
IWA6802	wsnp_Ku_c26530_36497050	7A	85.2
IWA1353	wsnp_Ex_c10567_17253901	7A	86.1
IWA2535	wsnp_Ex_c2043_3829362	7A	86.1
IWA3831	wsnp_Ex_c42653_49180485	7A	86.1
IWA3832	wsnp_Ex_c42653_49180603	7A	86.1
IWA6472	wsnp_Ku_c12701_20446223	7A	86.1
IWA6473	wsnp_Ku_c12701_20446367	7A	86.1
IWA1758	wsnp_Ex_c13337_21022241	7A	87.8
IWA1759	wsnp_Ex_c13337_21022658	7A	87.8
IWA7192	wsnp_Ku_c57674_60718050	7A	87.8
IWA655	wsnp_CAP11_c1182_686503	7A	89.5
IWA2513	wsnp_Ex_c2017_3787478	7A	94.0
IWA1805	wsnp_Ex_c13735_21548067	7A	94.3
IWA1845	wsnp_Ex_c1402_2686072	7A	94.3
IWA7200	wsnp_Ku_c5938_10491100	7A	94.9
IWA7201	wsnp_Ku_c5938_10491311	7A	94.9
IWA6475	wsnp_Ku_c12886_20706969	7A	105.3
IWA954	wsnp_CAP12_c3056_1439567	7A	106.8
IWA834	wsnp_CAP11_rep_c4066_1921894	7A	122.8
IWA930	wsnp_CAP12_c179_101756	7A	122.8
IWA7093	wsnp_Ku_c4615_8326355	7A	123.9
IWA556	wsnp_BG313770A_Ta_2_1	7A	124.3
IWA557	wsnp_BG313770A_Ta_2_3	7A	124.3
IWA6127	wsnp_JD_c6179_7344980	7A	126.0
IWA8032	wsnp_Ra_c63822_63288359	7A	127.0
IWA3267	wsnp_Ex_c30239_39179460	7A	127.3
IWA1735	wsnp_Ex_c13170_20800656	7A	127.5
IWA2879	wsnp_Ex_c24167_33416760	7A	127.5

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2880	wsnp_Ex_c24167_33417032	7A	127.5
IWA5245	wsnp_Ex_rep_c66476_64726880	7A	127.5
IWA6626	wsnp_Ku_c1738_3403677	7A	127.5
IWA7013	wsnp_Ku_c3969_7256560	7A	127.5
IWA2196	wsnp_Ex_c17230_25883590	7A	131.8
GWM233	GWM233	7A	132.0
IWA1920	wsnp_Ex_c14654_22713386	7A	132.0
IWA7196	wsnp_Ku_c5874_10384659	7A	132.0
IWA7978	wsnp_Ra_c5008_8947135	7A	132.0
IWA6642	wsnp_Ku_c1809_3536072	7A	132.4
IWA5337	wsnp_Ex_rep_c66939_65371026	7A	133.7
IWA4558	wsnp_Ex_c662_1301994	7A	137.5
IWA7321	wsnp_Ku_c8358_14210991	7A	137.5
IWA5819	wsnp_JD_c1285_1848292	7B	0.0
IWA4129	wsnp_Ex_c52259_55922750	7B	0.2
IWA1750	wsnp_Ex_c13244_20891347	7B	0.6
IWA1525	wsnp_Ex_c11658_18773086	7B	1.1
IWA8007	wsnp_Ra_c56439_58965239	7B	7.4
IWA1089	wsnp_CAP7_c44_26549	7B	9.1
IWA1315	wsnp_Ex_c10342_16938528	7B	21.9
IWA1437	wsnp_Ex_c11106_18003332	7B	21.9
IWA3958	wsnp_Ex_c46061_51675763	7B	22.3
IWA3959	wsnp_Ex_c46061_51675853	7B	22.3
IWA3960	wsnp_Ex_c46061_51676000	7B	22.3
IWA7242	wsnp_Ku_c6758_11757213	7B	22.3
IWA4017	wsnp_Ex_c4827_8612538	7B	22.5
IWA4018	wsnp_Ex_c4827_8612813	7B	22.5
IWA3553	wsnp_Ex_c3600_6579760	7B	22.7
IWA7232	wsnp_Ku_c665_1371121	7B	22.7
IWA7233	wsnp_Ku_c665_1371448	7B	22.7
IWA2267	wsnp_Ex_c17882_26646153	7B	25.6
IWA276	wsnp_be496863B_Ta_2_1	7B	25.6
IWA277	wsnp_be496863B_Ta_2_2	7B	25.6
IWA4516	wsnp_Ex_c64709_63402325	7B	25.6
IWA479	wsnp_BF474552B_Ta_1_1	7B	25.6
IWA7100	wsnp_Ku_c46846_53470970	7B	25.6
IWA7101	wsnp_Ku_c46846_53471053	7B	25.6
IWA7326	wsnp_Ku_c8497_14429303	7B	25.6
IWA4873	wsnp_Ex_c908_1754208	7B	33.6



**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2534	wsnp_Ex_c204_400545	7B	33.8
IWA6414	wsnp_Ku_c11060_18147688	7B	33.8
IWA3663	wsnp_Ex_c38995_46393506	7B	36.4
IWA5661	wsnp_Ex_rep_c69954_68912773	7B	36.4
IWA6788	wsnp_Ku_c26213_36167499	7B	36.4
IWA1543	wsnp_Ex_c11860_19030807	7B	37.0
IWA3129	wsnp_Ex_c27914_37074773	7B	37.0
IWA3130	wsnp_Ex_c27914_37075168	7B	37.0
IWA3174	wsnp_Ex_c2857_5275817	7B	37.0
IWA4	wsnp_be352570B_Ta_2_1	7B	37.0
IWA8233	wsnp_RFL_Contig1210_295012	7B	37.0
IWA2353	wsnp_Ex_c18800_27681277	7B	37.2
IWA3114	wsnp_Ex_c27373_36578273	7B	37.2
IWA1642	wsnp_Ex_c12535_19963035	7B	37.5
IWA1881	wsnp_Ex_c14248_22204549	7B	37.5
IWA2026	wsnp_Ex_c15456_23734277	7B	37.5
IWA2079	wsnp_Ex_c15972_24385702	7B	37.5
IWA2271	wsnp_Ex_c1790_3378220	7B	37.5
IWA2272	wsnp_Ex_c1790_3378771	7B	37.5
IWA2997	wsnp_Ex_c25755_35018674	7B	37.5
IWA3063	wsnp_Ex_c26747_35974837	7B	37.5
IWA3065	wsnp_Ex_c26747_35976442	7B	37.5
IWA3886	wsnp_Ex_c4408_7939986	7B	37.5
IWA4380	wsnp_Ex_c5925_10397213	7B	37.5
IWA4727	wsnp_Ex_c7783_13259751	7B	37.5
IWA6212	wsnp_JD_c9040_9947841	7B	37.5
IWA6411	wsnp_Ku_c10939_17975681	7B	37.5
IWA6604	wsnp_Ku_c16706_25641134	7B	37.5
IWA7033	wsnp_Ku_c4067_7419106	7B	37.5
IWA8418	wsnp_RFL_Contig3054_2955094	7B	37.5
IWA8525	wsnp_RFL_Contig3854_4205716	7B	37.5
GWM46	GWM46	7B	37.7
IWA5622	wsnp_Ex_rep_c69639_68590556	7B	38.1
IWA6742	wsnp_Ku_c23549_33473349	7B	38.1
IWA8300	wsnp_RFL_Contig2167_1484520	7B	38.1
IWA814	wsnp_CAP11_c847_522893	7B	38.6
IWA7067	wsnp_Ku_c44362_51657973	7B	38.8
IWA6666	wsnp_Ku_c19034_28452132	7B	39.8
IWA6700	wsnp_Ku_c21070_30777150	7B	39.8

**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
BARC267	BARC267	7B	40.0
IWA4362	wsnp_Ex_c5830_10233776	7B	41.8
IWA709	wsnp_CAP11_c2255_1176515	7B	41.8
IWA1286	wsnp_Ex_c10124_16630607	7B	42.4
IWA4535	wsnp_Ex_c65605_63952614	7B	42.7
IWA6313	wsnp_JD_rep_c65181_41511534	7B	43.1
IWA6322	wsnp_JG_c126_94990	7B	43.1
IWA6667	wsnp_Ku_c19037_28455905	7B	43.1
IWA8232	wsnp_RFL_Contig1205_284961	7B	43.1
IWA355	wsnp_be518436B_Ta_2_3	7B	46.4
IWA1027	wsnp_CAP7_c1146_581547	7B	47.0
IWA594	wsnp_BM134363B_Ta_2_7	7B	59.4
IWA6087	wsnp_JD_c5102_6225151	7B	60.2
IWA1346	wsnp_Ex_c10550_17231658	7B	66.3
IWA7207	wsnp_Ku_c60707_62509051	7B	66.3
IWA1297	wsnp_Ex_c10193_16730126	7B	70.6
IWA1298	wsnp_Ex_c10193_16730348	7B	70.6
IWA836	wsnp_CAP11_rep_c4076_1926235	7B	71.4
IWA320	wsnp_BE498985A_Ta_2_1	7B	72.1
IWA394	wsnp_BE605194B_Ta_2_1	7B	72.1
IWA395	wsnp_BE605194B_Ta_2_7	7B	72.1
IWA5110	wsnp_Ex_rep_c104090_88891443	7B	85.1
IWA5129	wsnp_Ex_rep_c105131_89643770	7B	85.1
IWA2191	wsnp_Ex_c17176_25816766	7B	91.5
IWA5420	wsnp_Ex_rep_c67593_66232317	7B	93.2
IWA3003	wsnp_Ex_c25821_35085420	7B	98.0
IWA180	wsnp_BE445506B_Ta_2_1	7B	101.5
IWA182	wsnp_BE445506B_Ta_2_4	7B	101.5
IWA8324	wsnp_RFL_Contig2315_1788036	7B	101.5
IWA6424	wsnp_Ku_c11530_18803034	7B	102.2
IWA7555	wsnp_Ra_c10988_17932922	7B	129.8
IWA6230	wsnp_JD_c9484_10319946	7B	133.7
IWA304	wsnp_BE497845D_Ta_1_1	7D	0.0
BARC172	BARC172	7D	4.3
IWA1537	wsnp_Ex_c11813_18968198	7D	9.5
IWA1257	wsnp_cd454041D_Ta_2_1	7D	13.3
IWA5249	wsnp_Ex_rep_c66483_64738995	7D	13.3
IWA5557	wsnp_Ex_rep_c68671_67525179	7D	13.3
IWA604	wsnp_bm138650D_Ta_2_2	7D	14.0

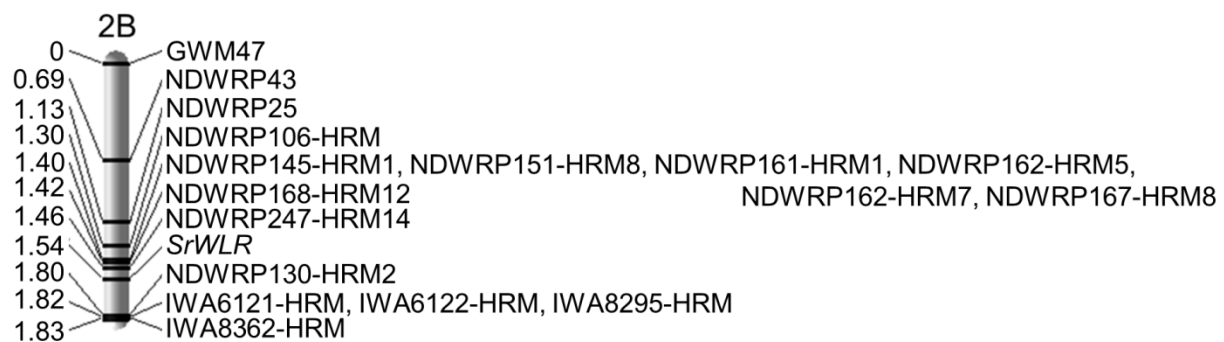
**Table A1.** The LMPG-6/PI 626573 Infinium iSelect SNP map of all 24 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2521	wsnp_Ex_c20320_29383285	7D	36.7
IWA2522	wsnp_Ex_c20320_29383710	7D	36.7
IWA2524	wsnp_Ex_c20320_29384395	7D	36.7
IWA7610	wsnp_Ra_c13568_21427471	7D	36.7
IWA235	wsnp_BE490643D_Ta_2_1	7D	44.4
IWA5391	wsnp_Ex_rep_c67369_65941066	7D	44.4

## APPENDIX B. CURRENT PROGRESS ON THE CLONING OF *SrWLR*

*SrWLR* was mapped to a 1.9 cM region on the long arm of chromosome 2B defined proximally by the SSR GWM47 and distally by the cosegregating iSelect SNP markers IWA6121, IWA6122, IWA7620, IWA8295, and IWA8362 using a 240 individual recombinant inbred population (Page 37). Since then a F<sub>2</sub> population consisting of 3,073 individual was created by crossing LMPG-6 by PI 626573-2 to provide increased resolution for the positional cloning of *SrWLR*. High-resolution meltcurve (HRM) markers were developed for the flanking iSelect markers (Table B1). Critical recombinants were identified by screening the F<sub>2</sub> population with GWM47 and the HRMs. Of the 3,073 individual, 67 critical recombinants were identified and used for mapping. The F<sub>3</sub> families of the critical recombinants were phenotyped for seedling resistance to *Pgt* race TTKSK at the biosafety level 3 facility at the University of Minnesota in St. Paul, MN. Markers were developed to reduce the *SrWLR* region using two related synteny based strategies. In the first strategy, the International Wheat Genome Sequencing Consortium (IWGSC) BLAST server (<https://urgi.versailles.inra.fr/blast/blast.php>) was used to identify wheat sequences on chromosome 2A, 2B, and 2D using syntenic *Brachypodium distachyon* sequences (<http://www.plantgdb.org/BdGDB/>). Chromosome 2B intron spanning primers were developed used to amplify LMPG-6 and PI 626573-2 using Primer3 (<http://bioinfo.ut.ee/primer3-0.4.0/>). If the amplicons were not already polymorphic they were sequenced and aligned using the MultAlin tool (<http://multalin.toulouse.inra.fr/multalin/>) to identify polymorphisms. Upon alignment, new markers were designed on the polymorphisms for mapping. In the second strategy, RNAseq was performed on LMPG-6 and PI 626573-2. The sequencing reads for each parent were assembled against wheat chromosome 2B sequences from the IWGSC which are syntenic to *B. distachyon* using CLC Bio genomic workbench. HRMs

were then developed and mapped for identified SNPs. Including the flanking markers, 17 markers have been mapped reducing the *SrWLR* region to 0.36 cM (Table B1). *SrWLR* is delimited 0.08 cM proximally by NDWRP247-HRM14 and 0.26 cM distally by NDWRP130-HRM2 (Fig. B1). NDWRP247-HRM14 and NDWRP130-HRM2 are syntenic with the *B. distachyon* genes Bradi5g22000 and Bradi5g22410, respectively. Five *B. distachyon* NB-LRR genes are present in the *SrWLR* region based on synteny. These genes are currently the best candidates for *SrWLR*. In addition to the genetic mapping a BAC library was created of PI 626573-2 through collaboration with the French National Institute of Agricultural Research National Plant Genomic Resource Center (INRA-CNRGV). The PI 626573-2 BAC library has a genome coverage of 2.3X with an average insert size of 111 Kb. The mapped markers are currently being screened on the PI 626573-2 library and a minimum tilling path library created from the spring wheat cultivar ‘Chinese Spring’.



**Figure B1.** High resolution map of the *SrWLR* region.

**Table B1.** Markers mapped to the *SrWLR* region.

<b>Marker</b>	<b>Type</b>	<b>Forward Primer Sequence (5'-3')</b>	<b>Reverse Primer Sequence (5'-3')</b>
GWM47	SSR	TTGCTACCATGCATGACCAT	TTCACCTCGATTGAGGTCCT
IWA6121-HRM	HRM	AGTGCTGGTGAAGCGTGA	CTGCCAAATCCCCAACAAAG
IWA6122-HRM	HRM	TGGCAGCTGATGTTACAGAC	CCTTTGCACCCTTCACTG
IWA8295-HRM	HRM	TGCTAAGGTCTTCGCTCCAT	GCTGCAAGTACTGGTCTGGA
IWA8362-HRM	HRM	GATTTGGCAGCTGATGTTAC	TTCACTGAAGGGTAATGGAC
NDWRP25	STS	GCGACCATGCTTGAGAAG	GACTCCTCCGAGAGTGATGA
NDWRP43	STS	CTTTGTTTCTGGTCCCCG	CAGAATGCCGCTTACGCT
NDWRP106-HRM	HRM	TCGCGACTTTGCGAATAAAT	CCAAAACAACCTCCCGTACA
NDWRP130-HRM2	HRM	GGTCCATTACCCTTCAGTG	GAACGCATTGTCATCTTGTC
NDWRP145-HRM1	HRM	CAGATCTGAAACCGCCATC	CTGTCTATTCCCCGGTGT
NDWRP151-HRM8	HRM	CCGGAATAAGAGCGAGCAG	CAGCCACCAACATCACTGTC
NDWRP161-HRM1	HRM	TCCTTCATGTACGGCTCAAA	ATGCCATTGCTCCTGTCAC
NDWRP162-HRM5	HRM	GGATTACCGGACCCCTCT	CCACCACCTGAACCATGC
NDWRP162-HRM7	HRM	GAAGATCAGGCTCGGGAAAG	TTGTCTCAGGAAGACGAAAAGA
NDWRP167-HRM8	HRM	AGAGGGTAGCTGAAGCAGCA	CAGGAAACGAGCCAGCAT
NDWRP168-HRM12	HRM	CCAGACATCAGAAAGCAACTCA	GCCCCAACTTGTCATCTTAGC
NDWRP247-HRM14	HRM	CCAAAACAGACGACTAGCTG	CGCTCTGTCTTCTTTCTTCC

## APPENDIX C. GENETIC MAP OF THE LMPG-6/PI 362698-1 POPULATION

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups.

Grain Genes Marker Name	Marker	Linkage Group	Position (cM)
IWB13141	CAP11_rep_c7878_143	1A	0.0
IWB29495	Excalibur_c9509_1180	1A	0.0
IWB34801	IAAV3919	1A	0.0
IWB61980	RAC875_rep_c110533_92	1A	0.0
IWB71565	Tdurum_contig44888_837	1A	0.0
IWB61124	RAC875_c95364_259	1A	3.2
IWB3240	BobWhite_c4246_367	1A	5.2
IWB3225	BobWhite_c42252_276	1A	5.9
IWB12616	BS00110974_51	1A	5.9
IWB13355	CAP12_c3074_192	1A	5.9
IWA6644	wsnp_Ku_c1818_3557408	1A	6.3
IWB64368	RFL_Contig3481_1669	1A	6.3
IWB74216	tplb0025b13_2054	1A	6.3
IWB8757	BS00058867_51	1A	7.3
IWB32244	GENE-1118_58	1A	10.8
IWA8622	wsnp_RFL_Contig4735_5673999	1A	11.2
IWB8696	BS00056550_51	1A	11.2
IWB11098	BS00079769_51	1A	11.2
IWB17894	D_GA8KES402HR8TV_187	1A	11.2
IWB24740	Excalibur_c2868_451	1A	11.2
IWB57448	RAC875_c38756_141	1A	11.2
IWB7470	BS00023201_51	1A	11.5
IWB61317	RAC875_rep_c101110_474	1A	13.3
IWB61182	RAC875_c97040_104	1A	14.7
IWB37267	JD_c26750_378	1A	17.5
IWA6649	wsnp_Ku_c183_358844	1A	19.8
IWB3087	BobWhite_c39996_126	1A	19.8
IWB23623	Excalibur_c21298_515	1A	19.8
IWB36707	Jagger_c6846_109	1A	19.8
IWB43053	Kukri_c24962_123	1A	19.8
IWB43660	Kukri_c29150_143	1A	19.8
IWB45715	Kukri_c46939_83	1A	19.8
IWB54709	RAC875_c18640_821	1A	19.8
IWB61318	RAC875_rep_c101110_563	1A	19.8
IWB73129	Tdurum_contig68827_61	1A	19.8
IWB386	BobWhite_c1265_247	1A	25.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB53793	RAC875_c13855_882	1A	26.8
IWB58651	RAC875_c50463_808	1A	28.5
IWA4643	wsnp_Ex_c7252_12452995	1A	29.1
IWB6131	BS00009885_51	1A	51.8
IWB3419	BobWhite_c4499_153	1A	52.1
IWB11335	BS00084022_51	1A	52.1
IWB29693	Excalibur_rep_c100567_692	1A	52.1
IWB31932	GENE-0507_285	1A	52.1
IWB45604	Kukri_c46010_872	1A	52.1
IWB44045	Kukri_c31964_109	1A	52.8
IWB44046	Kukri_c31964_56	1A	52.8
IWB63846	RFL_Contig2160_524	1A	52.8
IWB34995	IAAV5252	1A	53.1
IWB48819	Kukri_rep_c102900_1715	1A	53.1
IWA1387	wsnp_Ex_c10783_17554146	1A	55.6
IWB14138	CAP7_c4833_55	1A	55.6
IWB41525	Kukri_c16098_95	1A	55.6
IWB11044	BS00078982_51	1A	56.3
IWA7377	wsnp_Ku_rep_c101175_88380491	1A	56.6
IWA4008	wsnp_Ex_c48087_53105842	1A	59.2
IWB12251	BS00105601_51	1A	59.5
IWA1388	wsnp_Ex_c10783_17555091	1A	60.2
IWA7050	wsnp_Ku_c42878_50516167	1A	60.2
IWB14137	CAP7_c4833_141	1A	60.2
IWB54363	RAC875_c16820_419	1A	60.2
IWA7796	wsnp_Ra_c26191_35761997	1A	62.6
IWB73652	Tdurum_contig8382_300	1A	63.3
IWB51485	Ra_c22663_367	1A	64.3
IWB68106	Tdurum_contig13946_241	1A	64.3
IWB68107	Tdurum_contig13946_329	1A	64.3
IWB9666	BS00065906_51	1A	64.6
IWB61685	RAC875_rep_c107325_644	1A	64.6
IWA7048	wsnp_Ku_c4271_7774388	1A	67.6
IWB26996	Excalibur_c4887_1814	1A	69.7
IWB28622	Excalibur_c7237_1084	1A	70.4
IWB28624	Excalibur_c7237_1208	1A	70.4
IWB47652	Kukri_c7579_559	1A	70.4



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB52903	RAC875_c10090_963	1A	70.4
IWB53853	RAC875_c14066_452	1A	70.4
IWB35755	IACX1465	1A	70.8
IWB62099	RAC875_rep_c111911_116	1A	71.1
IWA217	wsnp_BE490041A_Ta_2_1	1A	72.2
IWB7717	BS00029346_51	1A	72.2
IWB60704	RAC875_c826_2186	1A	72.2
IWB26816	Excalibur_c46833_204	1A	72.9
IWA2496	wsnp_Ex_c200_391015	1A	74.3
IWB35770	IACX1592	1A	74.6
IWB6538	BS00012210_51	1A	75.0
IWB35066	IAAV5652	1A	75.0
IWB64888	RFL_Contig5090_1510	1A	75.0
IWB71771	Tdurum_contig47183_205	1A	75.0
IWB28743	Excalibur_c75270_450	1A	75.3
IWB35572	IAAV8987	1A	75.7
IWA1582	wsnp_Ex_c12117_19381492	1A	79.2
IWB52279	Ra_c56967_900	1A	79.2
IWA1583	wsnp_Ex_c12117_19381493	1A	80.6
IWB35115	IAAV5931	1A	81.9
IWA164	wsnp_BE445121A_Ta_1_8	1A	82.2
IWA5339	wsnp_Ex_rep_c66980_65419811	1A	82.2
IWB34631	IAAV2888	1A	82.2
IWB21167	Ex_c68770_506	1A	83.7
IWA2922	wsnp_Ex_c24686_33942264	1A	84.4
IWA3346	wsnp_Ex_c31525_40302140	1A	84.4
IWB34698	IAAV3306	1A	84.4
IWB34853	IAAV4243	1A	84.4
IWB57257	RAC875_c37183_331	1A	84.4
IWA3398	wsnp_Ex_c3253_5994376	1A	84.7
IWA1450	wsnp_Ex_c111741_93530669	1A	85.1
IWA1580	wsnp_Ex_c12101_19360213	1A	85.1
IWA3347	wsnp_Ex_c31525_40302747	1A	85.1
IWB1215	BobWhite_c18773_75	1A	85.1
IWB20438	Ex_c29914_480	1A	85.1
IWB20986	Ex_c60135_528	1A	85.1
IWB34385	IAAV1463	1A	85.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB43050	Kukri_c24897_140	1A	85.1
IWB45088	Kukri_c4099_321	1A	85.1
IWB52278	Ra_c5696_1556	1A	85.1
IWA1482	wsnp_Ex_c11374_18361760	1A	85.4
IWA2337	wsnp_Ex_c18662_27538313	1A	85.4
IWA3690	wsnp_Ex_c39661_46902689	1A	85.4
IWA4061	wsnp_Ex_c49829_54319220	1A	85.4
IWA4555	wsnp_Ex_c66106_64268316	1A	85.4
IWA5194	wsnp_Ex_rep_c66282_64438053	1A	85.4
IWA6942	wsnp_Ku_c3468_6420199	1A	85.4
IWB1803	BobWhite_c24113_529	1A	85.4
IWB6148	BS00010004_51	1A	85.4
IWB6200	BS00010287_51	1A	85.4
IWB7604	BS00026015_51	1A	85.4
IWB8080	BS00037007_51	1A	85.4
IWB8357	BS00044052_51	1A	85.4
IWB8490	BS00048117_51	1A	85.4
IWB10894	BS00076668_51	1A	85.4
IWB11130	BS00080438_51	1A	85.4
IWB31634	GENE-0041_182	1A	85.4
IWB34538	IAAV2342	1A	85.4
IWB35544	IAAV8824	1A	85.4
IWB43323	Kukri_c26669_515	1A	85.4
IWB55216	RAC875_c21620_1359	1A	85.4
IWB55280	RAC875_c2202_1097	1A	85.4
IWB63072	RAC875_rep_c76047_63	1A	85.4
IWA710	wsnp_CAP11_c23_61357	1A	85.8
IWA2655	wsnp_Ex_c2181_4089639	1A	85.8
IWA2921	wsnp_Ex_c24686_33941368	1A	85.8
IWA3254	wsnp_Ex_c29914_38896441	1A	85.8
IWB35435	IAAV814	1A	85.8
IWA1933	wsnp_Ex_c14733_22819350	1A	86.1
IWA1934	wsnp_Ex_c14733_22819625	1A	86.1
IWA3073	wsnp_Ex_c26800_36025663	1A	86.1
IWA3147	wsnp_Ex_c28165_37310070	1A	86.1
IWA3689	wsnp_Ex_c39661_46902650	1A	86.1
IWA3898	wsnp_Ex_c44498_50537128	1A	86.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4020	wsnp_Ex_c48375_53299028	1A	86.1
IWA4071	wsnp_Ex_c50235_54588957	1A	86.1
IWA4775	wsnp_Ex_c8162_13799067	1A	86.1
IWA4974	wsnp_Ex_c9872_16271161	1A	86.1
IWA5509	wsnp_Ex_rep_c68183_66958099	1A	86.1
IWA7439	wsnp_Ku_rep_c68419_67400635	1A	86.1
IWA8255	wsnp_RFL_Contig1736_858448	1A	86.1
IWB3462	BobWhite_c45409_389	1A	86.1
IWB7640	BS00026917_51	1A	86.1
IWB7700	BS00028874_51	1A	86.1
IWB8491	BS00048118_51	1A	86.1
IWB10001	BS00067277_51	1A	86.1
IWB11503	BS00087437_51	1A	86.1
IWB11756	BS00092422_51	1A	86.1
IWB12821	CAP11_c2984_419	1A	86.1
IWB21346	Ex_c801_555	1A	86.1
IWB21347	Ex_c801_820	1A	86.1
IWB25588	Excalibur_c35312_109	1A	86.1
IWB30193	Excalibur_rep_c106310_500	1A	86.1
IWB35337	IAAV7414	1A	86.1
IWB38904	Ku_c2449_578	1A	86.1
IWB40716	Kukri_c12000_1447	1A	86.1
IWB43755	Kukri_c29652_858	1A	86.1
IWB48097	Kukri_c8682_360	1A	86.1
IWB48617	Kukri_rep_c101218_200	1A	86.1
IWB57230	RAC875_c37025_2027	1A	86.1
IWB60543	RAC875_c7891_426	1A	86.1
IWB61297	RAC875_c9965_354	1A	86.1
IWB62689	RAC875_rep_c70404_755	1A	86.1
IWB74462	tplb0032d09_1393	1A	86.1
IWB3033	BobWhite_c39091_286	1A	87.9
IWB21332	Ex_c78467_1074	1A	89.3
IWB20639	Ex_c3986_1057	1A	90.7
IWB2336	BobWhite_c30109_240	1A	91.7
IWB26360	Excalibur_c42595_581	1A	94.9
IWB34823	IAAV4099	1A	96.2
IWA7021	wsnp_Ku_c4018_7333828	1A	96.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB42650	Kukri_c22434_513	1A	96.6
IWA5740	wsnp_Ex_rep_c73818_71733737	1A	97.9
IWB8994	BS00063068_51	1A	97.9
IWB54092	RAC875_c15426_1713	1A	97.9
IWB20387	Ex_c28144_1843	1A	98.3
IWA2995	wsnp_Ex_c25734_34995416	1A	98.9
IWA7173	wsnp_Ku_c557_1166684	1A	98.9
IWB4741	BobWhite_rep_c49207_243	1A	98.9
IWB7929	BS00033469_51	1A	98.9
IWB34506	IAAV213	1A	98.9
IWB35927	IACX3496	1A	98.9
IWB52305	Ra_c58315_265	1A	98.9
IWB52324	Ra_c6038_588	1A	98.9
IWB57702	RAC875_c41275_131	1A	98.9
IWB35308	IAAV7203	1A	99.6
IWB42357	Kukri_c20672_360	1A	99.9
IWA4328	wsnp_Ex_c572_1138770	1A	100.3
IWB44419	Kukri_c35200_895	1A	100.3
IWB51724	Ra_c2895_591	1A	100.3
IWB75207	tplb0059e14_515	1A	100.3
IWB39366	Ku_c4018_1814	1A	100.9
IWA4326	wsnp_Ex_c572_1138339	1A	101.6
IWA4292	wsnp_Ex_c56097_58352130	1A	102.3
IWA268	wsnp_BE495786A-Ta_2_1	1A	102.9
IWA4126	wsnp_Ex_c5216_9235964	1A	102.9
IWB14601	CAP8_c2296_169	1A	102.9
IWB30576	Excalibur_rep_c112145_271	1A	102.9
IWB46302	Kukri_c52952_315	1A	103.3
IWB10679	BS00073585_51	1A	103.6
IWA1593	wsnp_Ex_c1216_2336458	1A	103.9
IWA1608	wsnp_Ex_c12336_19686808	1A	103.9
IWA3475	wsnp_Ex_c34344_42676379	1A	103.9
IWA3820	wsnp_Ex_c42282_48900922	1A	103.9
IWA3822	wsnp_Ex_c42282_48901677	1A	103.9
IWA3934	wsnp_Ex_c4539_8148835	1A	103.9
IWA4117	wsnp_Ex_c5192_9203682	1A	103.9
IWA4816	wsnp_Ex_c8588_14419007	1A	103.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5277	wsnp_Ex_rep_c66628_64934660	1A	103.9
IWA6751	wsnp_Ku_c23926_33870364	1A	103.9
IWA6756	wsnp_Ku_c24239_34199356	1A	103.9
IWA7018	wsnp_Ku_c39878_48218985	1A	103.9
IWA7644	wsnp_Ra_c16080_24638622	1A	103.9
IWB2563	BobWhite_c32653_369	1A	103.9
IWB6783	BS00021889_51	1A	103.9
IWB7216	BS00022698_51	1A	103.9
IWB12736	CAP11_c1972_285	1A	103.9
IWB13783	CAP7_c12435_63	1A	103.9
IWB20856	Ex_c5192_943	1A	103.9
IWB23639	Excalibur_c21487_129	1A	103.9
IWB24988	Excalibur_c30591_637	1A	103.9
IWB25179	Excalibur_c32167_59	1A	103.9
IWB28550	Excalibur_c7033_159	1A	103.9
IWB30019	Excalibur_rep_c104216_671	1A	103.9
IWB35023	IAAV5406	1A	103.9
IWB35955	IACX4378	1A	103.9
IWB40078	Ku_c8351_2029	1A	103.9
IWB40233	Kukri_c10065_415	1A	103.9
IWB43239	Kukri_c26093_861	1A	103.9
IWB44936	Kukri_c39628_318	1A	103.9
IWB49965	Kukri_rep_c69946_1228	1A	103.9
IWB52412	Ra_c6701_1579	1A	103.9
IWB57465	RAC875_c38916_66	1A	103.9
IWB61100	RAC875_c94534_75	1A	103.9
IWB70213	Tdurum_contig31304_527	1A	104.3
IWA1609	wsnp_Ex_c12336_19687074	1A	104.6
IWA4116	wsnp_Ex_c5192_9203100	1A	104.6
IWB31863	GENE-0410_71	1A	105.3
IWB35691	IACX11338	1A	105.3
IWB22613	Excalibur_c15357_432	1A	109.2
IWA560	wsnp_BG314157A_Ta_2_1	1A	110.3
IWB46316	Kukri_c53153_92	1A	110.3
IWB9512	BS00065324_51	1A	110.6
IWB41966	Kukri_c18413_168	1A	110.6
IWB64537	RFL_Contig3919_1348	1A	110.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6553	wsnp_Ku_c15214_23756800	1A	111.3
IWB44726	Kukri_c37726_285	1A	112.3
IWA7573	wsnp_Ra_c11877_19161832	1A	113.1
IWB6743	BS00021728_51	1A	113.1
IWB46717	Kukri_c58155_786	1A	113.4
IWA3419	wsnp_Ex_c3293_6072122	1A	113.7
IWA8101	wsnp_Ra_c9209_15425473	1A	113.7
IWB10113	BS00067652_51	1A	113.7
IWB40044	Ku_c7975_644	1A	113.7
IWB40969	Kukri_c13107_100	1A	113.7
IWB44918	Kukri_c39377_286	1A	113.7
IWB74828	tplb0045g22_418	1A	114.1
IWB56355	RAC875_c29540_413	1A	114.4
IWA2540	wsnp_Ex_c20489_29564938	1A	115.4
IWA4511	wsnp_Ex_c6452_11213329	1A	115.4
IWB7753	BS00030036_51	1A	115.4
IWB10133	BS00067742_51	1A	115.4
IWB25442	Excalibur_c3429_236	1A	115.4
IWB25493	Excalibur_c3475_113	1A	115.4
IWB25494	Excalibur_c3475_903	1A	115.4
IWB31939	GENE-0511_403	1A	115.4
IWB44038	Kukri_c31891_1355	1A	115.4
IWB45341	Kukri_c43410_348	1A	115.4
IWB52879	RAC875_c100147_55	1A	115.4
IWB58262	RAC875_c46551_339	1A	115.4
IWB58517	RAC875_c49074_374	1A	115.4
IWB59527	RAC875_c60514_90	1A	115.4
IWA3406	wsnp_Ex_c32590_41222878	1A	116.1
IWB3489	BobWhite_c46007_582	1A	116.1
IWB11543	BS00088035_51	1A	116.1
IWB56795	RAC875_c32979_440	1A	117.2
IWA2488	wsnp_Ex_c1997_3757415	1A	117.9
IWA2490	wsnp_Ex_c1997_3757508	1A	117.9
IWA2703	wsnp_Ex_c22284_31478675	1A	117.9
IWB37733	JD_c6544_506	1A	117.9
IWB45961	Kukri_c49170_655	1A	117.9
IWB60627	RAC875_c80876_67	1A	117.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6729	wsnp_Ku_c23012_32893918	1A	118.3
IWB6935	BS00022158_51	1A	118.3
IWB46448	Kukri_c54678_88	1A	119.0
IWB26566	Excalibur_c44668_382	1A	120.3
IWB55	BobWhite_c104_89	1A	123.9
IWB34600	IAAV2694	1A	123.9
IWB24862	Excalibur_c29605_100	1A	124.2
IWB24863	Excalibur_c29605_535	1A	124.2
IWA339	wsnp_BE517729A_Ta_2_1	1A	124.5
IWB1981	BobWhite_c26212_208	1A	124.5
IWB12650	CAP11_c1021_200	1A	124.5
IWB27098	Excalibur_c49946_169	1A	124.5
IWB46604	Kukri_c56494_585	1A	124.5
IWB61089	RAC875_c93814_292	1A	124.5
IWB74432	tplb0031d22_1107	1A	124.5
IWA2541	wsnp_Ex_c20495_29571203	1A	124.9
IWA3340	wsnp_Ex_c3145_5812670	1A	124.9
IWA6624	wsnp_Ku_c17322_26392311	1A	124.9
IWA7144	wsnp_Ku_c5210_9289260	1A	124.9
IWB2101	BobWhite_c27438_81	1A	124.9
IWB8166	BS00039377_51	1A	124.9
IWB8167	BS00039378_51	1A	124.9
IWB9545	BS00065430_51	1A	124.9
IWB13768	CAP7_c12113_171	1A	124.9
IWB31849	GENE-0392_97	1A	124.9
IWB38589	Ku_c17322_2436	1A	124.9
IWA3859	wsnp_Ex_c43228_49605281	1A	125.2
IWA5493	wsnp_Ex_rep_c68085_66839109	1A	125.2
IWA5534	wsnp_Ex_rep_c68493_67320068	1A	125.2
IWB7965	BS00034278_51	1A	125.2
IWB13864	CAP7_c1891_230	1A	125.2
IWB47390	Kukri_c67383_102	1A	125.2
IWA5125	wsnp_Ex_rep_c104894_89466993	1A	125.5
IWA3405	wsnp_Ex_c3258_6004611	1A	125.9
IWB6118	BS00009808_51	1A	125.9
IWB8943	BS00062876_51	1A	125.9
IWB54111	RAC875_c15564_729	1A	125.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB4630	BobWhite_c96_170	1A	127.3
IWB13749	CAP7_c11581_78	1A	127.3
IWA3980	wsnp_Ex_c4685_8377545	1A	127.6
IWB11513	BS00087588_51	1A	127.9
IWA4538	wsnp_Ex_c6563_11378915	1A	129.3
IWA6934	wsnp_Ku_c33917_43336069	1A	129.3
IWB1972	BobWhite_c26122_129	1A	129.3
IWB7676	BS00028146_51	1A	129.3
IWB14141	CAP7_c4879_249	1A	129.3
IWB35531	IAAV8743	1A	129.3
IWB2243	BobWhite_c28971_184	1A	130.6
IWA1081	wsnp_CAP7_c3472_1623955	1A	131.7
IWA5832	wsnp_JD_c13384_13393159	1A	131.7
IWB544	BobWhite_c13761_242	1A	131.7
IWB6029	BS00009104_51	1A	131.7
IWB6517	BS00012042_51	1A	131.7
IWB6984	BS00022239_51	1A	131.7
IWB26708	Excalibur_c45861_189	1A	131.7
IWB45538	Kukri_c45512_193	1A	131.7
IWB45987	Kukri_c49463_154	1A	131.7
IWB52960	RAC875_c102343_204	1A	131.7
IWB54196	RAC875_c15975_1208	1A	131.7
IWB57232	RAC875_c37031_312	1A	131.7
IWB66603	Tdurum_contig10572_453	1A	131.7
IWB7058	BS00022396_51	1A	132.3
IWB11161	BS00081002_51	1A	132.3
IWB11558	BS00088350_51	1A	132.3
IWB60140	RAC875_c6798_467	1A	132.3
IWB6995	BS00022261_51	1A	132.7
IWB7289	BS00022848_51	1A	132.7
IWB12454	BS00109991_51	1A	132.7
IWB12579	BS00110627_51	1A	132.7
IWB31771	GENE-0262_431	1A	132.7
IWA3804	wsnp_Ex_c41953_48657850	1A	133.7
IWA5046	wsnp_Ex_rep_c102067_87313597	1A	133.7
IWA5047	wsnp_Ex_rep_c102067_87314043	1A	133.7
IWA6042	wsnp_JD_c3973_5044238	1A	133.7



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB4307	BobWhite_c721_74	1A	133.7
IWB11406	BS00085366_51	1A	133.7
IWB35025	IAAV544	1A	133.7
IWB40130	Ku_c8992_405	1A	133.7
IWB49670	Kukri_rep_c115111_251	1A	133.7
IWB61497	RAC875_rep_c105766_652	1A	133.7
IWB62911	RAC875_rep_c72890_63	1A	133.7
IWB65422	TA001600-1603	1A	133.7
IWB72493	Tdurum_contig56158_60	1A	133.7
IWB64984	RFL_Contig5334_831	1A	134.0
IWB10986	BS00078085_51	1A	134.7
IWB11109	BS00080076_51	1A	134.7
IWB11932	BS00095510_51	1A	134.7
IWB20162	Ex_c2226_244	1A	135.4
IWB56724	RAC875_c32379_216	1A	135.4
IWA254	w SNP_BE494527A_Ta_2_1	1A	137.8
IWA1790	w SNP_Ex_c1359_2604298	1A	137.8
IWA5333	w SNP_Ex_rep_c66919_65342127	1A	137.8
IWA5754	w SNP_Ex_rep_c81556_76277906	1A	137.8
IWB8040	BS00036104_51	1A	137.8
IWB27519	Excalibur_c54842_340	1A	137.8
IWB41933	Kukri_c18274_551	1A	137.8
IWB54223	RAC875_c16136_129	1A	137.8
IWB69322	Tdurum_contig27799_114	1A	137.8
IWB72959	Tdurum_contig63715_235	1A	137.8
IWA735	w SNP_CAP11_c29_68486	1A	143.3
IWB7991	BS00034899_51	1A	144.7
IWA4931	w SNP_Ex_c9534_15793556	1A	145.1
IWB63661	RFL_Contig1493_657	1A	145.7
IWB54366	RAC875_c16824_202	1A	146.4
IWB64554	RFL_Contig399_1148	1A	146.4
IWB64556	RFL_Contig399_976	1A	146.4
IWA2404	w SNP_Ex_c19353_28290393	1A	149.3
IWA2405	w SNP_Ex_c19353_28290651	1A	149.3
IWB1403	BobWhite_c20553_568	1A	149.3
IWB41243	Kukri_c14635_73	1A	149.3
IWB52033	Ra_c41164_730	1A	149.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB52276	Ra_c5683_1762	1A	149.3
IWB74445	tplb0031106_747	1A	149.3
IWB45733	Kukri_c47131_569	1A	149.6
IWA5910	wsnp_JD_c20553_18260620	1A	150.0
IWA5911	wsnp_JD_c20553_18260731	1A	150.0
IWB34758	IAAV3695	1A	150.0
IWB37168	JD_c20553_448	1A	150.0
IWB52277	Ra_c5683_2584	1A	150.0
IWB39440	Ku_c4369_354	1A	150.6
IWB39439	Ku_c4369_351	1A	151.0
IWB66930	Tdurum_contig11106_264	1A	152.3
IWB66931	Tdurum_contig11106_340	1A	152.3
IWA475	wsnp_BF474340A_Ta_2_1	1A	154.8
IWA3284	wsnp_Ex_c30552_39457767	1A	154.8
IWA5505	wsnp_Ex_rep_c68171_66944702	1A	154.8
IWB3768	BobWhite_c5242_400	1A	154.8
IWB65541	TA002362-0785	1A	154.8
IWB25046	Excalibur_c30974_65	1A	157.9
IWB43918	Kukri_c30924_203	1A	157.9
IWB9856	BS00066659_51	1A	158.3
IWB62537	RAC875_rep_c69152_184	1A	158.3
IWA1015	wsnp_CAP12_rep_c8598_3608465	1A	158.6
IWA1118	wsnp_CAP7_rep_c5385_2417464	1A	158.6
IWA1618	wsnp_Ex_c12399_19776420	1A	158.6
IWA3485	wsnp_Ex_c34594_42877119	1A	158.6
IWA7924	wsnp_Ra_c4184_7637695	1A	158.6
IWA8135	wsnp_Ra_rep_c108284_91604017	1A	158.6
IWB3536	BobWhite_c46857_82	1A	158.6
IWB8695	BS00056547_51	1A	158.6
IWB10613	BS00072408_51	1A	158.6
IWB47411	Kukri_c67703_174	1A	158.6
IWB55224	RAC875_c21673_641	1A	158.6
IWB58389	RAC875_c47930_448	1A	158.6
IWB61773	RAC875_rep_c108284_98	1A	158.6
IWB73444	Tdurum_contig78830_348	1A	158.6
IWB73445	Tdurum_contig78830_745	1A	158.6
IWB73464	Tdurum_contig80278_250	1A	158.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB75	BobWhite_c10542_532	1A	167.5
IWA886	wsnp_CAP11_rep_c7847_3468669	1A	168.9
IWA1403	wsnp_Ex_c10903_17716723	1A	168.9
IWA6253	wsnp_JD_rep_c49006_33254974	1A	168.9
IWB766	BobWhite_c15256_225	1A	168.9
IWB1256	BobWhite_c19182_280	1A	168.9
IWB24000	Excalibur_c23598_1502	1A	168.9
IWB50952	Ra_c11613_81	1A	168.9
IWB54893	RAC875_c19751_166	1A	168.9
IWB59427	RAC875_c59190_384	1A	168.9
IWB61555	RAC875_rep_c106165_772	1A	168.9
IWB62751	RAC875_rep_c71093_1070	1A	168.9
IWB56959	RAC875_c34515_343	1A	170.2
IWB48122	Kukri_c8757_107	1A	170.6
IWB13551	CAP12_c8163_118	1A	171.9
IWB46190	Kukri_c51781_199	1A	171.9
IWB26250	Excalibur_c41553_213	1A	173.6
IWB73557	Tdurum_contig8224_378	1A	173.6
IWA3783	wsnp_Ex_c41553_48351921	1A	174.0
IWA4713	wsnp_Ex_c7684_13109335	1A	174.0
IWA7316	wsnp_Ku_c816_1684613	1A	174.0
IWB42798	Kukri_c2338_533	1A	174.0
IWB65396	TA001430-0733	1A	174.0
IWB65681	TA003411-0583	1A	174.0
IWB14279	CAP7_c821_239	1A	175.4
IWA7757	wsnp_Ra_c2227_4304970	1A	176.0
IWB51467	Ra_c2227_825	1A	176.7
IWB51468	Ra_c2227_855	1A	176.7
IWB64453	RFL_Contig3683_1784	1A	177.4
IWA1368	wsnp_Ex_c10631_17340809	1A	178.1
IWA6152	wsnp_JD_c6664_7807201	1A	179.5
IWB4214	BobWhite_c6664_644	1A	179.5
IWB54198	RAC875_c1599_342	1A	180.2
IWB22955	Excalibur_c17320_833	1A	181.2
IWB29697	Excalibur_rep_c101018_254	1A	181.2
IWB24149	Excalibur_c2439_283	1A	181.9
IWB34929	IAAV4820	1A	182.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4898	wsnp_Ex_c9343_15514687	1A	184.0
IWB42330	Kukri_c20480_121	1A	184.0
IWA4897	wsnp_Ex_c9343_15514531	1A	184.6
IWA6530	wsnp_Ku_c14496_22838796	1A	184.6
IWB58979	RAC875_c53725_217	1A	184.6
IWA3377	wsnp_Ex_c3201_5910642	1A	185.3
IWB53222	RAC875_c11016_495	1A	185.6
IWB31719	GENE-0171_87	1A	186.0
IWA6458	wsnp_Ku_c12441_20092792	1A	186.3
IWB34851	IAAV4238	1A	186.6
IWB45183	Kukri_c4204_1673	1A	187.0
IWB11595	BS00089098_51	1A	187.3
IWA1710	wsnp_Ex_c12932_20486842	1A	187.6
IWA8020	wsnp_Ra_c59303_60669172	1A	187.6
IWB38	BobWhite_c1027_1127	1A	187.6
IWB39	BobWhite_c1027_360	1A	187.6
IWB7128	BS00022514_51	1A	187.6
IWB9141	BS00063847_51	1A	187.6
IWB9191	BS00064087_51	1A	187.6
IWB10491	BS00070695_51	1A	187.6
IWB10516	BS00070951_51	1A	187.6
IWB10518	BS00070991_51	1A	187.6
IWB11593	BS00089094_51	1A	187.6
IWB13624	CAP12_rep_c5332_341	1A	187.6
IWB22174	Excalibur_c12932_2102	1A	187.6
IWB24575	Excalibur_c27376_74	1A	187.6
IWB30871	Excalibur_rep_c67492_1119	1A	187.6
IWB31955	GENE-0543_1074	1A	187.6
IWB35476	IAAV8446	1A	187.6
IWB45184	Kukri_c4204_1946	1A	187.6
IWB45449	Kukri_c44500_315	1A	187.6
IWB49951	Kukri_rep_c69829_735	1A	187.6
IWB58726	RAC875_c5119_2696	1A	187.6
IWB67027	Tdurum_contig11349_810	1A	187.6
IWA1557	wsnp_Ex_c11939_19147421	1A	188.0
IWA1558	wsnp_Ex_c11939_19147514	1A	188.0
IWA7182	wsnp_Ku_c5687_10068945	1A	188.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA8051	wsnp_Ra_c6891_11974621	1A	188.0
IWB12340	BS00107935_51	1A	188.0
IWB21667	Excalibur_c10538_1153	1A	188.0
IWB38851	Ku_c23222_204	1A	188.0
IWB51036	Ra_c1295_635	1A	188.0
IWB53622	RAC875_c1295_1603	1A	188.0
IWB69908	Tdurum_contig29886_139	1A	188.0
IWA3089	wsnp_Ex_c271_521429	1A	188.3
IWB6843	BS00021990_51	1A	188.3
IWB43929	Kukri_c310_1953	1A	188.3
IWA4021	wsnp_Ex_c48407_53323483	1A	188.6
IWB6426	BS00011521_51	1A	188.6
IWA3378	wsnp_Ex_c3201_5910659	1A	189.0
IWB73184	Tdurum_contig70803_475	1A	189.6
IWB45411	Kukri_c44201_497	1A	190.0
IWB28321	Excalibur_c6476_163	1A	191.0
IWA6916	wsnp_Ku_c330_683203	1A	192.4
IWB34353	IAAV1301	1A	192.7
IWB31545	Excalibur_s112663_236	1A	193.8
IWB45352	Kukri_c43479_207	1A	194.1
IWA2327	wsnp_Ex_c1861_3507281	1A	194.5
IWB7011	BS00022296_51	1B	0.0
IWB8589	BS00050522_51	1B	1.0
IWB6864	BS00022020_51	1B	1.3
IWB11788	BS00093078_51	1B	1.3
IWB21697	Excalibur_c10657_1280	1B	1.3
IWB21698	Excalibur_c10657_796	1B	1.3
IWB23711	Excalibur_c21898_1423	1B	1.3
IWB36662	Jagger_c5878_119	1B	1.3
IWB45437	Kukri_c44369_131	1B	1.3
IWB4184	BobWhite_c65478_119	1B	1.7
IWB42054	Kukri_c18951_493	1B	1.7
IWB19825	Ex_c13871_694	1B	2.4
IWB3983	BobWhite_c5793_372	1B	5.2
IWB47800	Kukri_c79308_278	1B	5.8
IWB7123	BS00022505_51	1B	6.2
IWB49209	Kukri_rep_c106834_139	1B	6.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB74219	tplb0025b13_2792	1B	6.9
IWB56205	RAC875_c28583_451	1B	7.9
IWB6303	BS00010868_51	1B	9.7
IWB7109	BS00022482_51	1B	9.7
IWB7795	BS00030768_51	1B	9.7
IWB9843	BS00066601_51	1B	9.7
IWB27585	Excalibur_c5562_380	1B	9.7
IWB36466	Jagger_c1888_277	1B	9.7
IWB52681	Ra_c78638_309	1B	9.7
IWB7076	BS00022429_51	1B	21.7
IWB5753	BS00000487_51	1B	22.4
IWB27496	Excalibur_c54611_735	1B	23.7
IWA4073	wsnp_Ex_c50340_54659660	1B	24.8
IWB1453	BobWhite_c2092_519	1B	24.8
IWB72908	Tdurum_contig62624_190	1B	24.8
IWB48324	Kukri_c92979_195	1B	25.1
IWA6489	wsnp_Ku_c13229_21142792	1B	25.4
IWA7398	wsnp_Ku_rep_c103074_89904851	1B	25.4
IWB5922	BS00003917_51	1B	25.4
IWB6448	BS00011608_51	1B	25.4
IWB7368	BS00023004_51	1B	25.4
IWB7884	BS00032266_51	1B	25.4
IWB10312	BS00068429_51	1B	25.4
IWB10492	BS00070706_51	1B	25.4
IWB12603	BS00110900_51	1B	25.4
IWB13067	CAP11_c852_366	1B	25.4
IWB34190	GENE-4832_103	1B	25.4
IWB38627	Ku_c17846_363	1B	25.4
IWB44529	Kukri_c36151_170	1B	25.4
IWB64595	RFL_Contig4140_1135	1B	25.4
IWB71754	Tdurum_contig47083_278	1B	25.4
IWA1958	wsnp_Ex_c1493_2862065	1B	26.6
IWB7731	BS00029539_51	1B	27.3
IWB14010	CAP7_c3299_316	1B	29.7
IWB14011	CAP7_c3299_342	1B	30.0
IWB12258	BS00105846_51	1B	31.7
IWB12346	BS00108057_51	1B	32.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB11616	BS00089524_51	1B	32.4
IWB6457	BS00011695_51	1B	33.1
IWB65685	TA003422-0757	1B	33.1
IWB66317	Tdurum_contig10180_271	1B	33.8
IWB21945	Excalibur_c11666_996	1B	34.1
IWB46601	Kukri_c5638_1087	1B	34.1
IWB48443	Kukri_c964_1482	1B	34.1
IWB61919	RAC875_rep_c109901_811	1B	34.1
IWB65158	RFL_Contig5906_622	1B	34.8
IWB23985	Excalibur_c23515_1177	1B	36.2
IWB4247	BobWhite_c685_1231	1B	36.9
IWB11213	BS00081773_51	1B	36.9
IWB25852	Excalibur_c37693_203	1B	36.9
IWB47794	Kukri_c79135_136	1B	36.9
IWB14518	CAP8_c1356_189	1B	37.9
IWB34847	IAAV4194	1B	38.6
IWB36330	IACX8860	1B	38.6
IWB11671	BS00090770_51	1B	39.0
IWB64585	RFL_Contig4104_3352	1B	39.0
IWB72107	Tdurum_contig50667_306	1B	39.0
IWB8104	BS00037387_51	1B	40.3
IWA1883	w SNP_Ex_c14273_22230844	1B	48.0
IWB9664	BS00065896_51	1B	49.4
IWB40093	Ku_c8505_1424	1B	51.1
IWB1964	BobWhite_c26045_230	1B	51.8
IWB9932	BS00067003_51	1B	51.8
IWB12279	BS00106306_51	1B	51.8
IWB45758	Kukri_c47342_73	1B	51.8
IWB29515	Excalibur_c95656_129	1B	53.6
IWB35982	IACX502	1B	53.6
IWB69962	Tdurum_contig30113_214	1B	53.9
IWB9236	BS00064263_51	1B	54.2
IWA7703	w SNP_Ra_c19335_28504388	1B	54.6
IWB16228	D_contig25392_201	1B	54.6
IWB58595	RAC875_c49924_324	1B	54.6
IWB64822	RFL_Contig4873_542	1B	54.6
IWB72487	Tdurum_contig56148_382	1B	54.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB33538	GENE-3653_580	1B	54.9
IWB8781	BS00059502_51	1B	55.2
IWB9645	BS00065844_51	1B	55.2
IWB9942	BS00067043_51	1B	55.2
IWB60993	RAC875_c90169_393	1B	55.2
IWA1578	wsnp_Ex_c12063_19310114	1B	55.6
IWA4504	wsnp_Ex_c6417_11155739	1B	55.6
IWA6448	wsnp_Ku_c11987_19472688	1B	55.6
IWA6450	wsnp_Ku_c11987_19473636	1B	55.6
IWA7480	wsnp_Ku_rep_c70742_70379526	1B	55.6
IWB9900	BS00066880_51	1B	55.6
IWB12252	BS00105606_51	1B	55.6
IWB23213	Excalibur_c1886_1288	1B	55.6
IWB24659	Excalibur_c28016_132	1B	55.6
IWB28269	Excalibur_c6417_938	1B	55.6
IWB35128	IAAV6	1B	55.6
IWB35375	IAAV7704	1B	55.6
IWB35406	IAAV7915	1B	55.6
IWB41164	Kukri_c14149_462	1B	55.6
IWB41867	Kukri_c18006_1568	1B	55.6
IWB45383	Kukri_c4376_388	1B	55.6
IWB51241	Ra_c16879_977	1B	55.6
IWB51586	Ra_c24839_215	1B	55.6
IWB51732	Ra_c29142_340	1B	55.6
IWB60710	RAC875_c8271_1352	1B	55.6
IWB60711	RAC875_c8271_1469	1B	55.6
IWB63556	RFL_Contig1081_570	1B	55.6
IWB68665	Tdurum_contig17609_117	1B	55.6
IWB69254	Tdurum_contig26281_139	1B	55.6
IWB73332	Tdurum_contig75938_1546	1B	55.6
IWB73550	Tdurum_contig82187_189	1B	55.6
IWB10065	BS00067507_51	1B	55.9
IWB56393	RAC875_c29906_275	1B	55.9
IWB2579	BobWhite_c32835_152	1B	56.6
IWB6368	BS00011205_51	1B	56.6
IWB11797	BS00093231_51	1B	56.6
IWB7004	BS00022281_51	1B	57.0



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2998	wsnp_Ex_c25782_35041189	1B	57.6
IWB7314	BS00022902_51	1B	57.6
IWB7321	BS00022916_51	1B	57.6
IWB10318	BS00068456_51	1B	57.6
IWB10664	BS00073403_51	1B	57.6
IWB22143	Excalibur_c12710_740	1B	57.6
IWB23553	Excalibur_c20863_318	1B	57.6
IWB46756	Kukri_c5861_360	1B	57.6
IWB65786	TA004123-0331	1B	57.6
IWB23293	Excalibur_c19341_673	1B	58.0
IWB64963	RFL_Contig529_963	1B	58.0
IWA1530	wsnp_Ex_c11697_18821490	1B	64.8
IWB1850	BobWhite_c24761_508	1B	68.8
IWB2923	BobWhite_c3771_441	1B	68.8
IWB4440	BobWhite_c8218_162	1B	68.8
IWB21760	Excalibur_c109123_462	1B	68.8
IWB34367	IAAV1364	1B	68.8
IWB41254	Kukri_c147_1620	1B	68.8
IWA6728	wsnp_Ku_c230_460618	1B	69.1
IWA7504	wsnp_Ku_rep_c71900_71624324	1B	69.1
IWA7934	wsnp_Ra_c4296_7819139	1B	69.1
IWA8084	wsnp_Ra_c8506_14401408	1B	69.1
IWB8379	BS00044869_51	1B	69.1
IWB55211	RAC875_c21598_248	1B	69.1
IWB62640	RAC875_rep_c70022_1648	1B	69.1
IWA403	wsnp_BE637864B-Ta_1_1	1B	69.5
IWA6062	wsnp_JD_c4444_5575748	1B	70.5
IWB27669	Excalibur_c56657_282	1B	70.5
IWA2197	wsnp_Ex_c17238_25895129	1B	71.2
IWB60849	RAC875_c864_88	1B	72.6
IWB19691	Ex_c11539_279	1B	73.3
IWB34798	IAAV3905	1B	75.4
IWB6495	BS00011918_51	1B	77.9
IWB69495	Tdurum_contig28316_243	1B	77.9
IWB39521	Ku_c48433_164	1B	80.4
IWB2223	BobWhite_c28635_896	1B	83.3
IWB25239	Excalibur_c32708_488	1B	83.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA128	wsnp_BE443332B_Ta_2_2	1B	83.6
IWA189	wsnp_BE446240B_Ta_2_3	1B	83.6
IWA890	wsnp_CAP11_rep_c8576_3700031	1B	83.6
IWA1109	wsnp_CAP7_c940_480745	1B	83.6
IWA2517	wsnp_Ex_c2025_3799847	1B	83.6
IWA4197	wsnp_Ex_c5388_9526777	1B	83.6
IWA4987	wsnp_Ex_c9960_16397347	1B	83.6
IWA5322	wsnp_Ex_rep_c66883_65286958	1B	83.6
IWA5561	wsnp_Ex_rep_c68712_67571580	1B	83.6
IWA5664	wsnp_Ex_rep_c69986_68942834	1B	83.6
IWA6073	wsnp_JD_c4641_5774711	1B	83.6
IWA7594	wsnp_Ra_c12888_20519578	1B	83.6
IWA7722	wsnp_Ra_c2027_3945713	1B	83.6
IWA7723	wsnp_Ra_c2027_3945764	1B	83.6
IWB1296	BobWhite_c1967_175	1B	83.6
IWB1297	BobWhite_c1967_388	1B	83.6
IWB2709	BobWhite_c346_253	1B	83.6
IWB3348	BobWhite_c441_976	1B	83.6
IWB4840	BobWhite_rep_c50058_84	1B	83.6
IWB4968	BobWhite_rep_c51642_1057	1B	83.6
IWB5590	BobWhite_rep_c66032_270	1B	83.6
IWB7443	BS00023142_51	1B	83.6
IWB7992	BS00034925_51	1B	83.6
IWB10551	BS00071465_51	1B	83.6
IWB12462	BS00110052_51	1B	83.6
IWB13266	CAP12_c1981_78	1B	83.6
IWB14021	CAP7_c3456_113	1B	83.6
IWB14484	CAP7_s12849_67	1B	83.6
IWB14999	CAP8_c9553_109	1B	83.6
IWB27169	Excalibur_c50665_1323	1B	83.6
IWB30117	Excalibur_rep_c105376_485	1B	83.6
IWB30238	Excalibur_rep_c107001_320	1B	83.6
IWB31478	Excalibur_s102212_259	1B	83.6
IWB32261	GENE-1150_214	1B	83.6
IWB33517	GENE-3626_308	1B	83.6
IWB34528	IAAV2287	1B	83.6
IWB35076	IAAV5704	1B	83.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB35332	IAAV7383	1B	83.6
IWB35532	IAAV8763	1B	83.6
IWB35764	IACX15424	1B	83.6
IWB39738	Ku_c6201_2890	1B	83.6
IWB43382	Kukri_c27114_294	1B	83.6
IWB44379	Kukri_c34894_112	1B	83.6
IWB44766	Kukri_c38105_143	1B	83.6
IWB45935	Kukri_c49015_1037	1B	83.6
IWB45936	Kukri_c49015_1606	1B	83.6
IWB45937	Kukri_c49015_1700	1B	83.6
IWB46165	Kukri_c51474_334	1B	83.6
IWB47330	Kukri_c667_1073	1B	83.6
IWB47412	Kukri_c67707_114	1B	83.6
IWB47625	Kukri_c75097_56	1B	83.6
IWB51782	Ra_c3083_982	1B	83.6
IWB52131	Ra_c45721_2630	1B	83.6
IWB52443	Ra_c68984_1882	1B	83.6
IWB57166	RAC875_c3617_396	1B	83.6
IWB58266	RAC875_c46646_549	1B	83.6
IWB58729	RAC875_c51240_89	1B	83.6
IWB59187	RAC875_c56417_377	1B	83.6
IWB65360	TA001197-0204	1B	83.6
IWB68856	Tdurum_contig20191_171	1B	83.6
IWB72532	Tdurum_contig56873_1237	1B	83.6
IWB72563	Tdurum_contig57183_368	1B	83.6
IWB72564	Tdurum_contig57183_581	1B	83.6
IWB73370	Tdurum_contig76481_798	1B	83.6
IWB69494	Tdurum_contig28316_228	1B	84.0
IWA141	wsnp_BE443930B-Ta_2_2	1B	84.3
IWA188	wsnp_BE446240B-Ta_2_1	1B	84.3
IWA2504	wsnp_Ex_c2004_3770146	1B	84.3
IWA3348	wsnp_Ex_c31567_40338517	1B	84.3
IWA3587	wsnp_Ex_c3681_6715277	1B	84.3
IWA3588	wsnp_Ex_c3681_6716255	1B	84.3
IWA4198	wsnp_Ex_c5388_9527189	1B	84.3
IWA5665	wsnp_Ex_rep_c69986_68942866	1B	84.3
IWA7721	wsnp_Ra_c2027_3943938	1B	84.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB2222	BobWhite_c28635_785	1B	84.3
IWB5511	BobWhite_rep_c64920_402	1B	84.3
IWB12316	BS00107420_51	1B	84.3
IWB13110	CAP11_rep_c5039_201	1B	84.3
IWB31711	GENE-0142_178	1B	84.3
IWB39896	Ku_c70461_480	1B	84.3
IWB44767	Kukri_c38105_452	1B	84.3
IWB51889	Ra_c34433_417	1B	84.3
IWB54683	RAC875_c1848_258	1B	84.3
IWB60853	RAC875_c865_1936	1B	84.3
IWB63003	RAC875_rep_c74070_518	1B	84.3
IWB63392	RAC875_s105188_92	1B	84.3
IWB63690	RFL_Contig1601_750	1B	84.3
IWB65832	TA004407-0898	1B	84.3
IWB68429	Tdurum_contig15593_407	1B	84.3
IWB69496	Tdurum_contig28316_442	1B	84.3
IWB71512	Tdurum_contig44255_814	1B	84.3
IWB72533	Tdurum_contig56874_562	1B	84.3
IWA4556	wsnp_Ex_c6611_11451949	1B	84.6
IWA4557	wsnp_Ex_c6611_11452297	1B	84.6
IWA6674	wsnp_Ku_c19618_29134473	1B	84.6
IWA7017	wsnp_Ku_c39862_48205590	1B	84.6
IWB11168	BS00081125_51	1B	84.6
IWB29292	Excalibur_c90096_77	1B	84.6
IWB35581	IAAV9039	1B	84.6
IWB35922	IACX3408	1B	84.6
IWB64308	RFL_Contig3343_2115	1B	84.6
IWB8272	BS00041355_51	1B	85.0
IWB27095	Excalibur_c49906_242	1B	85.0
IWB28554	Excalibur_c7035_155	1B	85.0
IWB35864	IACX2578	1B	85.0
IWB47132	Kukri_c64195_104	1B	85.0
IWB72646	Tdurum_contig59449_249	1B	85.0
IWA3057	wsnp_Ex_c26620_35859364	1B	85.3
IWA3307	wsnp_Ex_c30969_39821293	1B	85.3
IWA5278	wsnp_Ex_rep_c66643_64952627	1B	85.3
IWB7365	BS00023001_51	1B	85.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB11169	BS00081127_51	1B	85.3
IWB11284	BS00083072_51	1B	85.3
IWB11607	BS00089313_51	1B	85.3
IWB24627	Excalibur_c27798_1068	1B	85.3
IWB30875	Excalibur_rep_c67541_1585	1B	85.3
IWB31673	GENE-0107_807	1B	85.3
IWB31716	GENE-0165_389	1B	85.3
IWB44100	Kukri_c32430_109	1B	85.3
IWB47134	Kukri_c64195_1203	1B	85.3
IWB60913	RAC875_c87890_312	1B	85.3
IWB63890	RFL_Contig2270_1560	1B	85.3
IWB29130	Excalibur_c85140_173	1B	86.0
IWA1953	wsnp_Ex_c14871_23001630	1B	89.3
IWA6107	wsnp_JD_c5659_6814240	1B	89.6
IWA515	wsnp_BF485168B_Ta_2_1	1B	93.2
IWB9692	BS00066006_51	1B	93.9
IWB23636	Excalibur_c21451_352	1B	93.9
IWB26192	Excalibur_c40993_1129	1B	93.9
IWA540	wsnp_BG274294B_Ta_2_3	1B	94.6
IWB8134	BS00038643_51	1B	94.6
IWB8507	BS00048610_51	1B	94.6
IWB29159	Excalibur_c8613_1266	1B	94.6
IWB31909	GENE-0480_265	1B	94.6
IWB48422	Kukri_c9593_381	1B	94.6
IWB55418	RAC875_c22886_235	1B	94.6
IWB56696	RAC875_c32077_759	1B	95.2
IWB10066	BS00067512_51	1B	95.9
IWA3713	wsnp_Ex_c402_791233	1B	97.3
IWA6134	wsnp_JD_c6331_7499499	1B	97.3
IWB3191	BobWhite_c41673_67	1B	97.3
IWB20648	Ex_c402_1223	1B	97.3
IWB38882	Ku_c241_1597	1B	97.3
IWB42085	Kukri_c1918_1074	1B	97.3
IWB47303	Kukri_c66451_128	1B	97.3
IWB53061	RAC875_c1045_445	1B	97.3
IWB71351	Tdurum_contig42797_1576	1B	97.3
IWB71354	Tdurum_contig42797_3196	1B	97.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB71355	Tdurum_contig42797_4145	1B	97.3
IWB71530	Tdurum_contig44540_510	1B	97.3
IWB73005	Tdurum_contig64811_332	1B	97.3
IWB73745	Tdurum_contig892_633	1B	97.3
IWB40176	Ku_c9614_1657	1B	97.6
IWB14755	CAP8_c4697_108	1B	98.3
IWA2709	wsnp_Ex_c22377_31571527	1B	99.7
IWB10226	BS00068083_51	1B	100.4
IWB34917	IAAV4729	1B	100.4
IWB39431	Ku_c4348_862	1B	100.4
IWB73004	Tdurum_contig64811_273	1B	100.8
IWB26560	Excalibur_c4459_1867	1B	101.1
IWB35192	IAAV6383	1B	101.1
IWB31681	GENE-0120_431	1B	101.5
IWB23054	Excalibur_c17977_71	1B	101.8
IWB36985	JD_c13631_863	1B	101.8
IWB38843	Ku_c23096_550	1B	101.8
IWB38883	Ku_c241_460	1B	101.8
IWB39932	Ku_c71568_374	1B	101.8
IWB40124	Ku_c892_425	1B	101.8
IWB49515	Kukri_rep_c111676_103	1B	101.8
IWB57391	RAC875_c3835_782	1B	101.8
IWB72079	Tdurum_contig50499_1121	1B	101.8
IWB29015	Excalibur_c82_71	1B	102.5
IWB41967	Kukri_c18413_496	1B	102.5
IWA4139	wsnp_Ex_c5245_9283053	1B	102.8
IWA5635	wsnp_Ex_rep_c69766_68723140	1B	103.1
IWB31680	GENE-0120_397	1B	103.1
IWA2717	wsnp_Ex_c22439_31632880	1B	105.2
IWA3684	wsnp_Ex_c39616_46871127	1B	105.2
IWB5796	BS00001835_51	1B	105.2
IWB6730	BS00021710_51	1B	105.2
IWB8999	BS00063092_51	1B	105.2
IWB10880	BS00076405_51	1B	105.2
IWB27998	Excalibur_c60931_1260	1B	105.2
IWB36872	JD_c107_683	1B	105.2
IWB57213	RAC875_c36737_316	1B	105.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB5926	BS00003934_51	1B	105.5
IWB9482	BS00065217_51	1B	105.5
IWB35698	IACX11374	1B	105.5
IWB71367	Tdurum_contig42852_667	1B	105.5
IWB73514	Tdurum_contig8158_269	1B	105.5
IWB59152	RAC875_c55891_659	1B	105.9
IWB59153	RAC875_c55891_712	1B	105.9
IWA8313	wsnp_RFL_Contig2220_1597321	1B	110.6
IWB751	BobWhite_c15152_341	1B	111.0
IWB1073	BobWhite_c17644_456	1B	111.0
IWB3067	BobWhite_c39656_106	1B	111.0
IWB22506	Excalibur_c14859_394	1B	111.0
IWB30173	Excalibur_rep_c106078_822	1B	111.0
IWB8677	BS00055864_51	1B	113.1
IWB8678	BS00055866_51	1B	113.1
IWB60916	RAC875_c87950_333	1B	113.1
IWB34598	IAAV2683	1B	113.5
IWB35053	IAAV5588	1B	113.5
IWB36145	IACX6346	1B	113.5
IWB43219	Kukri_c25961_108	1B	113.5
IWB27264	Excalibur_c51898_470	1B	114.5
IWB47726	Kukri_c7770_176	1B	116.6
IWB71822	Tdurum_contig47550_699	1B	116.6
IWB164	BobWhite_c11044_322	1B	116.9
IWB73694	Tdurum_contig85620_467	1B	116.9
IWA6614	wsnp_Ku_c17017_26019611	1B	118.3
IWB34607	IAAV2757	1B	118.7
IWB11589	BS00089031_51	1B	119.7
IWB31916	GENE-0487_644	1B	119.7
IWB31917	GENE-0487_795	1B	119.7
IWB35678	IACX11274	1B	119.7
IWB43220	Kukri_c25961_166	1B	119.7
IWB53013	RAC875_c103613_441	1B	119.7
IWB5884	BS00003743_51	1B	120.1
IWB7151	BS00022551_51	1B	120.1
IWB10877	BS00076394_51	1B	120.1
IWB22662	Excalibur_c15617_425	1B	120.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB28295	Excalibur_c64439_87	1B	120.1
IWB35892	IACX299	1B	120.1
IWB36733	Jagger_c7242_85	1B	120.1
IWB42331	Kukri_c20486_255	1B	120.1
IWB46202	Kukri_c51864_225	1B	120.1
IWB47687	Kukri_c7657_651	1B	120.1
IWB47688	Kukri_c7657_986	1B	120.1
IWB47886	Kukri_c8143_355	1B	120.1
IWB48469	Kukri_c9752_793	1B	120.1
IWB53874	RAC875_c1413_597	1B	120.1
IWB67348	Tdurum_contig11896_550	1B	120.1
IWB73156	Tdurum_contig69792_167	1B	120.1
IWA5382	wsnp_Ex_rep_c67299_65844168	1B	120.4
IWB10982	BS00078029_51	1B	120.4
IWA3120	wsnp_Ex_c27644_36826484	1B	122.1
IWB31027	Excalibur_rep_c69066_270	1B	122.1
IWB7579	BS00025527_51	1B	122.5
IWB8245	BS00040743_51	1B	122.5
IWA3384	wsnp_Ex_c32284_40970312	1B	122.8
IWB21176	Ex_c69066_186	1B	122.8
IWB52498	Ra_c7005_420	1B	122.8
IWB59663	RAC875_c62171_386	1B	122.8
IWA4488	wsnp_Ex_c6378_11086366	1B	123.1
IWA579	wsnp_BG606986B-Ta_2_1	1B	123.8
IWB52875	RAC875_c100059_123	1B	124.1
IWB73608	Tdurum_contig83079_133	1B	124.1
IWA6876	wsnp_Ku_c30494_40319867	1B	124.5
IWB1072	BobWhite_c17644_112	1B	124.5
IWB7446	BS00023148_51	1B	124.5
IWB12322	BS00107589_51	1B	124.5
IWB40197	Ku_c9909_1766	1B	124.5
IWB49552	Kukri_rep_c112383_588	1B	124.5
IWB56771	RAC875_c32848_578	1B	124.5
IWB63380	RAC875_rep_c99365_219	1B	124.5
IWB65872	TA004690-1102	1B	124.5
IWB25615	Excalibur_c3557_66	1B	125.5
IWB29959	Excalibur_rep_c103592_955	1B	126.2



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB33179	GENE-3046_367	1B	126.2
IWB54518	RAC875_c17651_1174	1B	127.6
IWB884	BobWhite_c16206_317	1B	127.9
IWB9208	BS00064162_51	1B	127.9
IWB36329	IACX886	1B	128.3
IWB3634	BobWhite_c48071_144	1B	128.6
IWB9256	BS00064349_51	1B	128.6
IWB9764	BS00066278_51	1B	128.6
IWB36283	IACX8280	1B	128.6
IWB36344	IACX906	1B	128.6
IWB42095	Kukri_c19247_53	1B	128.6
IWB42096	Kukri_c19247_711	1B	128.6
IWB65711	TA003586-0637	1B	128.6
IWB66482	Tdurum_contig10362_328	1B	128.6
IWB66483	Tdurum_contig10362_555	1B	128.6
IWA7179	wsnp_Ku_c56140_59771244	1B	129.0
IWB7161	BS00022577_51	1B	129.0
IWB43857	Kukri_c30461_857	1B	129.0
IWA3341	wsnp_Ex_c3147_5816957	1B	129.3
IWA7037	wsnp_Ku_c41261_49287074	1B	129.7
IWB9155	BS00063928_51	1B	129.7
IWB9937	BS00067024_51	1B	129.7
IWA255	wsnp_BE494527B_Ta_2_1	1B	130.0
IWB58520	RAC875_c4908_1539	1B	130.0
IWA4875	wsnp_Ex_c9091_15135511	1B	130.4
IWB58004	RAC875_c43945_807	1B	130.4
IWA368	wsnp_BE590634B_Ta_2_5	1B	131.4
IWA367	wsnp_BE590634B_Ta_2_1	1B	131.7
IWB24662	Excalibur_c28045_741	1B	131.7
IWB35811	IACX1891	1B	131.7
IWB64037	RFL_Contig2736_827	1B	131.7
IWA2308	wsnp_Ex_c18384_27213023	1B	132.4
IWA2411	wsnp_Ex_c194_381656	1B	132.4
IWA8398	wsnp_RFL_Contig2818_2601481	1B	132.4
IWB6709	BS00021680_51	1B	132.4
IWB7290	BS00022851_51	1B	132.4
IWB11914	BS00095088_51	1B	132.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB35479	IAAV8459	1B	132.4
IWB35726	IACX1240	1B	132.4
IWB38554	Ku_c16636_347	1B	132.4
IWB40040	Ku_c79340_308	1B	132.4
IWB40585	Kukri_c11389_59	1B	132.4
IWB59930	RAC875_c65295_290	1B	132.4
IWB8293	BS00041912_51	1B	133.0
IWB10050	BS00067436_51	1B	133.7
IWB31454	Excalibur_rep_c96924_118	1B	133.7
IWA5769	wsnp_JD_c100_159424	1B	134.4
IWB35523	IAAV8693	1B	134.4
IWB50448	Kukri_rep_c86467_51	1B	134.4
IWB56284	RAC875_c291_1860	1B	134.4
IWB56285	RAC875_c291_2201	1B	134.4
IWB56287	RAC875_c291_647	1B	134.4
IWB56288	RAC875_c291_696	1B	134.4
IWB56286	RAC875_c291_2591	1B	134.7
IWB51730	Ra_c291_1516	1B	136.1
IWA8246	wsnp_RFL_Contig1493_681815	1B	138.2
IWB28434	Excalibur_c66196_256	1B	138.2
IWA3017	wsnp_Ex_c26083_35336771	1B	139.3
IWB10768	BS00074911_51	1B	139.3
IWB64555	RFL_Contig399_859	1B	139.3
IWB926	BobWhite_c16543_993	1B	139.6
IWB70705	Tdurum_contig41945_748	1B	139.6
IWB73073	Tdurum_contig67656_387	1B	139.6
IWB26166	Excalibur_c40808_441	1B	140.7
IWB54224	RAC875_c16136_1597	1B	141.0
IWA5186	wsnp_Ex_rep_c66255_64400455	1B	141.4
IWB3260	BobWhite_c42716_71	1B	141.4
IWB27783	Excalibur_c581_1220	1B	141.4
IWB45740	Kukri_c47202_601	1B	141.4
IWB54559	RAC875_c1785_366	1B	141.4
IWA5861	wsnp_JD_c1544_2179305	1B	142.8
IWB71777	Tdurum_contig47253_1624	1B	143.1
IWB51279	Ra_c17685_927	1B	145.9
IWB62674	RAC875_rep_c70332_961	1B	146.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7144	BS00022539_51	1B	146.6
IWB21546	Excalibur_c10111_127	1B	146.6
IWB21547	Excalibur_c10111_85	1B	146.6
IWB30984	Excalibur_rep_c68706_1084	1B	146.6
IWB31152	Excalibur_rep_c70674_83	1B	146.6
IWB46347	Kukri_c5357_323	1B	146.6
IWB74533	tplb0034e16_1165	1B	146.6
IWB74534	tplb0034e16_925	1B	146.6
IWB66919	Tdurum_contig11077_122	1B	148.0
IWB45410	Kukri_c44191_452	1B	149.0
IWA5749	wsnp_Ex_rep_c78209_74462664	1B	149.3
IWA5915	wsnp_JD_c20621_18304110	1B	149.3
IWB456	BobWhite_c13124_430	1B	149.3
IWB1415	BobWhite_c20621_541	1B	149.3
IWB1416	BobWhite_c20621_683	1B	149.3
IWB2203	BobWhite_c2844_569	1B	149.3
IWB3330	BobWhite_c4375_347	1B	149.3
IWB5074	BobWhite_rep_c54139_273	1B	149.3
IWB5855	BS00003633_51	1B	149.3
IWB8152	BS00039135_51	1B	149.3
IWB8318	BS00042340_51	1B	149.3
IWB9452	BS00065108_51	1B	149.3
IWB9493	BS00065257_51	1B	149.3
IWB10068	BS00067525_51	1B	149.3
IWB10286	BS00068327_51	1B	149.3
IWB11512	BS00087544_51	1B	149.3
IWB12536	BS00110435_51	1B	149.3
IWB13458	CAP12_c5744_162	1B	149.3
IWB13488	CAP12_c6260_154	1B	149.3
IWB29141	Excalibur_c85432_106	1B	149.3
IWB35958	IACX4411	1B	149.3
IWB37326	JD_c3082_514	1B	149.3
IWB41896	Kukri_c18109_649	1B	149.3
IWB41897	Kukri_c18109_682	1B	149.3
IWB46187	Kukri_c51735_79	1B	149.3
IWB51677	Ra_c2772_4514	1B	149.3
IWB53690	RAC875_c13258_955	1B	149.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB58214	RAC875_c46093_492	1B	149.3
IWB60344	RAC875_c7357_1107	1B	149.3
IWB60749	RAC875_c839_352	1B	149.3
IWB62270	RAC875_rep_c114694_99	1B	149.3
IWB74775	tplb0043k02_1114	1B	149.3
IWB74776	tplb0043k02_463	1B	149.3
IWB6811	BS00021941_51	1B	150.8
IWB72142	Tdurum_contig50988_500	1B	164.0
IWB12399	BS00109244_51	1B	164.7
IWB29151	Excalibur_c8585_701	1B	164.7
IWB63739	RFL_Contig1823_1044	1B	164.7
IWB13876	CAP7_c199_62	1B	165.0
IWB1725	BobWhite_c23617_167	1B	165.3
IWB29150	Excalibur_c8585_561	1B	165.3
IWB66973	Tdurum_contig11216_942	1B	165.3
IWA1069	wsnp_CAP7_c266_144809	1B	171.7
IWA3043	wsnp_Ex_c26296_35541303	1B	171.7
IWB8004	BS00035267_51	1B	171.7
IWB8005	BS00035268_51	1B	171.7
IWB35891	IACX2984	1B	171.7
IWB64154	RFL_Contig2971_282	1B	171.7
IWB36030	IACX5803	1B	172.1
IWA1825	wsnp_Ex_c13878_21738866	1B	172.4
IWB10224	BS00068077_51	1B	172.4
IWB10933	BS00077498_51	1B	172.4
IWB10934	BS00077499_51	1B	172.4
IWB63689	RFL_Contig16_132	1B	172.4
IWB27057	Excalibur_c49496_705	1B	172.8
IWB43139	Kukri_c25512_53	1B	173.1
IWB15640	D_contig12192_450	1B	173.5
IWB631	BobWhite_c14362_86	1B	174.5
IWB3140	BobWhite_c40868_120	1B	174.5
IWA5847	wsnp_JD_c14411_14148961	1B	175.2
IWB10962	BS00077831_51	1B	180.6
IWA1092	wsnp_CAP7_c4778_2155754	1B	181.0
IWB31691	GENE-0129_110	1B	183.9
IWB31693	GENE-0129_190	1B	183.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB31694	GENE-0129_214	1B	183.9
IWB58538	RAC875_c49225_66	1B	183.9
IWB31740	GENE-0208_279	1B	184.2
IWB31741	GENE-0208_688	1B	184.2
IWB31743	GENE-0208_899	1B	184.2
IWB55535	RAC875_c23586_493	1B	184.6
IWB3373	BobWhite_c44460_821	1B	184.9
IWB10582	BS00071893_51	1B	184.9
IWB11058	BS00079088_51	1B	184.9
IWB48721	Kukri_rep_c102102_273	1B	184.9
IWB59868	RAC875_c64377_732	1B	184.9
IWB31692	GENE-0129_123	1B	185.3
IWB3081	BobWhite_c39901_338	1B	185.6
IWB31742	GENE-0208_695	1B	186.0
IWB4572	BobWhite_c9091_160	1B	186.3
IWB23772	Excalibur_c22205_573	1B	186.3
IWB73131	Tdurum_contig68980_317	1B	186.3
IWB73132	Tdurum_contig68980_448	1B	186.3
IWB7870	BS00032040_51	1B	187.4
IWB28820	Excalibur_c7684_54	1B	187.4
IWB13172	CAP12_c1085_283	1B	190.0
IWB69144	Tdurum_contig25612_195	1B	190.0
IWB31978	GENE-0568_112	1B	192.1
IWB4686	BobWhite_c9963_51	1B	193.1
IWB64455	RFL_Contig3683_668	1B	193.1
IWB40483	Kukri_c11000_1769	1B	193.4
IWB41428	Kukri_c1565_111	1B	194.5
IWB57627	RAC875_c4047_115	1B	194.5
IWB57628	RAC875_c4047_90	1B	194.5
IWB53347	RAC875_c11491_739	1B	195.2
IWB4145	BobWhite_c6348_1341	1B	195.9
IWB7694	BS00028747_51	1B	196.9
IWB14436	CAP7_rep_c6352_375	1B	199.1
IWB48895	Kukri_rep_c103550_213	1B	199.5
IWA846	w SNP_CAP11_rep_c4138_1957291	1B	199.8
IWA848	w SNP_CAP11_rep_c4138_1957470	1B	199.8
IWA3892	w SNP_Ex_c4436_7981037	1B	199.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3893	wsnp_Ex_c4436_7981188	1B	199.8
IWB4454	BobWhite_c8293_236	1B	199.8
IWB20729	Ex_c4436_1947	1B	199.8
IWB34935	IAAV4844	1B	199.8
IWB72835	Tdurum_contig61914_169	1B	199.8
IWB31755	GENE-0223_239	1B	200.5
IWB5732	BS00000010_51	1B	202.3
IWB9706	BS00066052_51	1B	203.0
IWB40850	Kukri_c1259_864	1B	203.0
IWB73866	Tdurum_contig93330_656	1B	203.3
IWB73865	Tdurum_contig93330_263	1B	203.6
IWB5678	BobWhite_s64871_104	1B	204.6
IWB54266	RAC875_c16292_499	1B	206.0
IWB4839	BobWhite_rep_c50057_164	1B	207.0
IWB56410	RAC875_c3001_1236	1B	208.0
IWB41450	Kukri_c15757_1117	1B	209.8
IWB21823	Excalibur_c11190_617	1B	211.5
IWB965	BobWhite_c16824_151	1B	212.2
IWB13853	CAP7_c1788_66	1B	212.2
IWB66474	Tdurum_contig10354_170	1B	212.9
IWB6778	BS00021877_51	1B	213.6
IWB11394	BS00084990_51	1B	213.6
IWB35785	IACX17310	1B	213.6
IWB66475	Tdurum_contig10354_270	1B	214.2
IWB35131	IAAV6011	1B	214.9
IWB13852	CAP7_c1788_146	1B	215.9
IWB62487	RAC875_rep_c118984_119	1B	217.4
IWB73714	Tdurum_contig8669_296	1B	217.4
IWB74944	tplb0049h18_765	1B	225.1
IWB435	BobWhite_c12960_168	1B	225.4
IWB1341	BobWhite_c20073_382	1B	225.4
IWB13057	CAP11_c7969_315	1B	225.4
IWB25940	Excalibur_c38500_494	1B	225.4
IWB72244	Tdurum_contig52086_264	1B	225.4
IWB72245	Tdurum_contig52086_342	1B	225.4
IWA3238	wsnp_Ex_c29452_38489374	1B	226.1
IWB3405	BobWhite_c4482_73	1B	226.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB9110	BS00063686_51	1B	226.1
IWB9931	BS00067000_51	1B	226.1
IWB15244	D_contig03023_692	1B	226.1
IWB20426	Ex_c29452_302	1B	226.1
IWB62110	RAC875_rep_c111993_160	1B	226.1
IWB46800	Kukri_c59535_186	1B	229.0
IWB5319	BobWhite_rep_c62955_567	1B	230.3
IWB34435	IAAV1732	1B	230.3
IWB52979	RAC875_c102886_73	1B	230.3
IWA1504	wsnp_Ex_c11461_18489681	1B	232.0
IWB35036	IAAV5516	1B	232.0
IWA545	wsnp_BG274687B-Ta_2_1	1B	232.4
IWB4789	BobWhite_rep_c49533_93	1B	232.4
IWB27844	Excalibur_c5888_169	1B	235.2
IWA4525	wsnp_Ex_c649_1279852	1B	235.5
IWB46805	Kukri_c59535_427	1B	237.0
IWA3547	wsnp_Ex_c35886_43949442	1D1	0.0
IWA3548	wsnp_Ex_c35886_43950102	1D1	0.0
IWA3549	wsnp_Ex_c35886_43950574	1D1	0.0
IWA5731	wsnp_Ex_rep_c71376_70138381	1D1	0.0
IWB5900	BS00003816_51	1D1	0.3
IWB9896	BS00066855_51	1D1	0.3
IWB10655	BS00073257_51	1D1	0.3
IWB12714	CAP11_c1701_324	1D1	0.3
IWB11807	BS00093390_51	1D1	0.7
IWA2583	wsnp_Ex_c2117_3976893	1D2	0.0
IWB74174	tplb0024b08_432	1D2	1.1
IWB74173	tplb0024b08_1668	1D2	1.9
IWB7916	BS00033088_51	1D2	2.6
IWB8310	BS00042197_51	1D2	2.6
IWB15693	D_contig13475_402	1D2	2.6
IWB17311	D_F1BEJMU01DOR77_203	1D2	2.6
IWB44231	Kukri_c33670_261	1D2	2.6
IWB44232	Kukri_c33670_506	1D2	2.6
IWB55944	RAC875_c2654_1817	1D2	2.6
IWB59245	RAC875_c56994_301	1D2	2.6
IWB5401	BobWhite_rep_c63734_85	1D2	3.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA466	wsnp_BF473056D_Ta_2_1	1D2	3.9
IWB15887	D_contig17787_645	1D2	3.9
IWB17484	D_F5XZDLF01A85DT_301	1D2	3.9
IWB35354	IAAV7510	1D2	3.9
IWB56136	RAC875_c27954_378	1D2	3.9
IWB6949	BS00022178_51	1D2	5.6
IWB7396	BS00023049_51	1D2	5.6
IWB12219	BS00104199_51	1D2	5.6
IWB17897	D_GA8KES402HUUGV_172	1D2	5.6
IWB18006	D_GB5Y7FA01CWYQV_234	1D2	5.6
IWB31245	Excalibur_rep_c75168_337	1D2	5.6
IWB42099	Kukri_c19257_78	1D2	5.6
IWB15189	D_contig01296_243	1D2	6.0
IWB17662	D_F5XZDLF02114SZ_56	1D2	6.0
IWB18378	D_GBF1XID01CJH0V_94	1D2	6.0
IWB21001	Ex_c6145_1877	1D2	6.0
IWB21002	Ex_c6145_2193	1D2	6.0
IWB21003	Ex_c6145_833	1D2	6.0
IWB38245	Ku_c11525_211	1D2	6.0
IWB60470	RAC875_c7752_1223	1D2	6.0
IWB60471	RAC875_c7752_145	1D2	6.0
IWB60472	RAC875_c7752_2913	1D2	6.0
IWB60473	RAC875_c7752_549	1D2	6.0
IWB68393	Tdurum_contig15335_452	1D2	6.0
IWB14612	CAP8_c2401_433	1D2	8.4
IWA817	wsnp_CAP11_c8597_3709328	1D2	12.0
IWA5371	wsnp_Ex_rep_c67198_65703538	1D2	12.0
IWA6500	wsnp_Ku_c13622_21660346	1D2	12.0
IWB576	BobWhite_c14032_133	1D2	12.0
IWB577	BobWhite_c14032_277	1D2	12.0
IWB10730	BS00074341_51	1D2	12.0
IWB21104	Ex_c67198_1838	1D2	12.0
IWB38400	Ku_c13622_482	1D2	12.0
IWB41724	Kukri_c17177_1575	1D2	12.0
IWB47907	Kukri_c8211_159	1D2	12.0
IWA1397	wsnp_Ex_c1085_2078944	1D2	15.2
IWA1787	wsnp_Ex_c1358_2600929	1D2	15.2



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1789	wsnp_Ex_c1358_2602235	1D2	15.2
IWA2268	wsnp_Ex_c17884_26647833	1D2	15.2
IWA2449	wsnp_Ex_c1969_3705930	1D2	15.2
IWA6960	wsnp_Ku_c3682_6786230	1D2	15.2
IWA7797	wsnp_Ra_c2633_5017265	1D2	15.2
IWA7968	wsnp_Ra_c48124_53475145	1D2	15.2
IWB1009	BobWhite_c1715_887	1D2	15.2
IWB5125	BobWhite_rep_c55507_100	1D2	15.2
IWB19801	Ex_c13421_2094	1D2	15.2
IWB31552	Excalibur_s113077_141	1D2	15.2
IWB35429	IAAV8085	1D2	15.2
IWB47970	Kukri_c837_436	1D2	15.2
IWB30125	Excalibur_rep_c105429_654	1D2	15.5
IWB44725	Kukri_c37718_187	1D2	15.5
IWB2552	BobWhite_c32528_251	1D2	18.3
IWB1063	BobWhite_c17559_105	1D2	21.1
IWB14030	CAP7_c3533_280	1D2	21.1
IWB28345	Excalibur_c65104_163	1D2	21.1
IWB28966	Excalibur_c8065_1275	1D2	21.1
IWB30124	Excalibur_rep_c105429_528	1D2	21.1
IWB59230	RAC875_c56811_258	1D2	21.1
IWB55046	RAC875_c2070_566	1D2	32.3
IWB8466	BS00047515_51	1D2	32.7
IWB34338	IAAV1194	1D2	33.0
IWB6476	BS00011810_51	1D2	34.0
IWB10784	BS00075116_51	1D2	35.1
IWA3125	wsnp_Ex_c278_538285	1D2	35.4
IWB3277	BobWhite_c4303_524	1D2	35.4
IWB25589	Excalibur_c35316_137	1D2	35.4
IWB42369	Kukri_c20775_56	1D2	35.4
IWB55047	RAC875_c2070_893	1D2	35.4
IWA3753	wsnp_Ex_c41048_47969948	1D2	35.7
IWA5996	wsnp_JD_c3091_4079762	1D2	35.7
IWB5769	BS00000744_51	1D2	35.7
IWB31195	Excalibur_rep_c72050_467	1D2	40.1
IWB12283	BS00106427_51	2A	0.0
IWA1088	wsnp_CAP7_c4346_1985593	2A	0.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2778	wsnp_Ex_c2311_4327681	2A	0.7
IWA3688	wsnp_Ex_c3964_7181151	2A	0.7
IWA4491	wsnp_Ex_c63909_62932437	2A	0.7
IWA4492	wsnp_Ex_c63909_62932669	2A	0.7
IWA4493	wsnp_Ex_c63909_62932893	2A	0.7
IWA5992	wsnp_JD_c30_50478	2A	0.7
IWA6963	wsnp_Ku_c3688_6797159	2A	0.7
IWA7327	wsnp_Ku_c850_1758318	2A	0.7
IWA7638	wsnp_Ra_c15518_23944753	2A	0.7
IWB42	BobWhite_c10290_234	2A	0.7
IWB8810	BS00060594_51	2A	0.7
IWB8811	BS00060596_51	2A	0.7
IWB9315	BS00064541_51	2A	0.7
IWB9316	BS00064544_51	2A	0.7
IWB9379	BS00064836_51	2A	0.7
IWB10614	BS00072462_51	2A	0.7
IWB13647	CAP12_rep_c6900_73	2A	0.7
IWB14834	CAP8_c5840_208	2A	0.7
IWB20424	Ex_c29327_869	2A	0.7
IWB27789	Excalibur_c58231_273	2A	0.7
IWB29886	Excalibur_rep_c102984_157	2A	0.7
IWB32029	GENE-0676_322	2A	0.7
IWB33959	GENE-4443_109	2A	0.7
IWB34494	IAAV2065	2A	0.7
IWB37242	JD_c246_260	2A	0.7
IWB39966	Ku_c7283_915	2A	0.7
IWB41539	Kukri_c1621_107	2A	0.7
IWB44619	Kukri_c3688_407	2A	0.7
IWB46267	Kukri_c52608_142	2A	0.7
IWB47877	Kukri_c81100_105	2A	0.7
IWB49741	Kukri_rep_c68068_95	2A	0.7
IWB50384	Kukri_rep_c80115_213	2A	0.7
IWB52585	Ra_c72517_981	2A	0.7
IWB55638	RAC875_c24364_307	2A	0.7
IWB55640	RAC875_c24364_526	2A	0.7
IWB60198	RAC875_c68649_457	2A	0.7
IWB62573	RAC875_rep_c69411_672	2A	0.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB62879	RAC875_rep_c72517_1215	2A	0.7
IWB64155	RFL_Contig2972_2285	2A	0.7
IWB64722	RFL_Contig4560_1077	2A	0.7
IWB64723	RFL_Contig4560_1206	2A	0.7
IWB64724	RFL_Contig4560_1503	2A	0.7
IWB65356	TA001167-0831	2A	0.7
IWB70340	Tdurum_contig32203_281	2A	0.7
IWB70684	Tdurum_contig41912_893	2A	0.7
IWB45970	Kukri_c49277_476	2A	2.1
IWB56270	RAC875_c29056_299	2A	2.1
IWB60386	RAC875_c75800_331	2A	2.1
IWB71381	Tdurum_contig42937_1564	2A	2.1
IWB5416	BobWhite_rep_c63940_205	2A	2.5
IWB6580	BS00012942_51	2A	2.5
IWB39806	Ku_c68144_387	2A	2.5
IWB39807	Ku_c68144_972	2A	2.5
IWB47431	Kukri_c67873_265	2A	2.5
IWB51274	Ra_c1757_256	2A	2.5
IWB59736	RAC875_c63035_147	2A	2.5
IWB71583	Tdurum_contig45196_487	2A	2.5
IWA4658	wsnp_Ex_c73454_71499715	2A	2.8
IWB8573	BS00049932_51	2A	2.8
IWB24240	Excalibur_c24959_182	2A	2.8
IWB36702	Jagger_c6714_68	2A	2.8
IWB36745	Jagger_c7527_143	2A	2.8
IWB41623	Kukri_c16667_132	2A	2.8
IWB63562	RFL_Contig1115_264	2A	2.8
IWB64957	RFL_Contig5277_888	2A	2.8
IWB72975	Tdurum_contig64286_182	2A	4.6
IWB29506	Excalibur_c95274_133	2A	7.8
IWA3596	wsnp_Ex_c3695_6740339	2A	13.3
IWB55863	RAC875_c259_1339	2A	14.7
IWB56077	RAC875_c27530_860	2A	16.1
IWB13459	CAP12_c575_105	2A	19.3
IWB27309	Excalibur_c52319_257	2A	20.0
IWB55113	RAC875_c21013_1187	2A	20.0
IWA6797	wsnp_Ku_c26323_36285601	2A	20.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6798	wsnp_Ku_c26323_36285697	2A	20.7
IWB26001	Excalibur_c39151_104	2A	20.7
IWB35540	IAAV880	2A	21.3
IWA2602	wsnp_Ex_c2137_4014383	2A	21.7
IWA8036	wsnp_Ra_c6586_11477949	2A	21.7
IWB11978	BS00096927_51	2A	22.4
IWB7413	BS00023075_51	2A	23.7
IWB71816	Tdurum_contig47508_250	2A	23.7
IWB25650	Excalibur_c35919_107	2A	24.1
IWB73906	Tdurum_contig94203_610	2A	24.4
IWB61146	RAC875_c96033_191	2A	26.8
IWB64018	RFL_Contig2656_871	2A	28.5
IWB836	BobWhite_c15773_166	2A	29.5
IWB9798	BS00066409_51	2A	29.5
IWB14076	CAP7_c4056_108	2A	29.5
IWB3440	BobWhite_c4517_120	2A	30.6
IWB3746	BobWhite_c5178_188	2A	31.3
IWB7471	BS00023202_51	2A	31.6
IWB5743	BS00000250_51	2A	36.0
IWB8907	BS00062732_51	2A	36.0
IWB12554	BS00110516_51	2A	36.0
IWB35910	IACX3245	2A	36.0
IWB51443	Ra_c21740_341	2A	36.0
IWB58213	RAC875_c4609_1756	2A	36.0
IWB7444	BS00023144_51	2A	41.2
IWB26553	Excalibur_c44487_642	2A	41.2
IWB34772	IAAV3791	2A	41.2
IWB51957	Ra_c3750_1082	2A	42.2
IWB51958	Ra_c3750_270	2A	42.2
IWA2370	wsnp_Ex_c19003_27913936	2A	42.5
IWB26296	Excalibur_c42110_210	2A	42.5
IWB26297	Excalibur_c42110_66	2A	42.5
IWB43349	Kukri_c2687_1407	2A	42.5
IWB5861	BS00003663_51	2A	43.5
IWB36028	IACX5800	2A	43.5
IWB56801	RAC875_c33037_578	2A	43.8
IWA4336	wsnp_Ex_c5740_10081171	2A	44.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB1937	BobWhite_c25764_348	2A	44.5
IWB7270	BS00022813_51	2A	44.5
IWB20949	Ex_c5740_1133	2A	44.5
IWB39281	Ku_c36209_204	2A	44.5
IWB47478	Kukri_c6944_1636	2A	44.5
IWA5685	wsnp_Ex_rep_c70299_69243401	2A	44.8
IWA5686	wsnp_Ex_rep_c70299_69243835	2A	44.8
IWB43225	Kukri_c25978_561	2A	44.8
IWA8041	wsnp_Ra_c66636_64923321	2A	45.2
IWA8040	wsnp_Ra_c66636_64922359	2A	45.8
IWB43943	Kukri_c31117_93	2A	47.2
IWB12477	BS00110128_51	2A	47.5
IWB24213	Excalibur_c24715_773	2A	47.9
IWA2051	wsnp_Ex_c15681_24015303	2A	48.2
IWA3920	wsnp_Ex_c45_98113	2A	48.2
IWB72716	Tdurum_contig60205_509	2A	48.2
IWB72718	Tdurum_contig60205_806	2A	48.9
IWB72722	Tdurum_contig60298_219	2A	48.9
IWA2052	wsnp_Ex_c15681_24015996	2A	49.2
IWA2053	wsnp_Ex_c15681_24016359	2A	49.2
IWB5787	BS00001260_51	2A	52.8
IWB9526	BS00065366_51	2A	52.8
IWA1539	wsnp_Ex_c11827_18986376	2A	54.9
IWB7683	BS00028315_51	2A	58.0
IWB11232	BS00082084_51	2A	58.0
IWA7876	wsnp_Ra_c3378_6318431	2A	69.3
IWB973	BobWhite_c16923_64	2A	70.0
IWA572	wsnp_BG605368A-Ta_2_4	2A	70.3
IWA3576	wsnp_Ex_c36481_44425685	2A	70.3
IWA3629	wsnp_Ex_c3808_6925015	2A	70.3
IWA4366	wsnp_Ex_c5856_10275959	2A	70.3
IWA5215	wsnp_Ex_rep_c66358_64543218	2A	70.3
IWA5462	wsnp_Ex_rep_c67848_66550913	2A	70.3
IWA5733	wsnp_Ex_rep_c71983_70544041	2A	70.3
IWA6499	wsnp_Ku_c136_271700	2A	70.3
IWA6844	wsnp_Ku_c28467_38394887	2A	70.3
IWA7166	wsnp_Ku_c54793_58953037	2A	70.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7593	wsnp_Ra_c12874_20497763	2A	70.3
IWB1351	BobWhite_c20137_229	2A	70.3
IWB5270	BobWhite_rep_c61500_595	2A	70.3
IWB5469	BobWhite_rep_c64440_83	2A	70.3
IWB12237	BS00105171_51	2A	70.3
IWB13304	CAP12_c2521_103	2A	70.3
IWB14315	CAP7_c9218_89	2A	70.3
IWB22408	Excalibur_c14317_401	2A	70.3
IWB24123	Excalibur_c2426_1756	2A	70.3
IWB24511	Excalibur_c26954_319	2A	70.3
IWB25128	Excalibur_c3171_416	2A	70.3
IWB25724	Excalibur_c36481_1319	2A	70.3
IWB34485	IAAV1990	2A	70.3
IWB36881	JD_c11109_572	2A	70.3
IWB38485	Ku_c15323_908	2A	70.3
IWB39211	Ku_c33828_1209	2A	70.3
IWB43212	Kukri_c25929_155	2A	70.3
IWB51030	Ra_c12874_2263	2A	70.3
IWB52510	Ra_c70418_142	2A	70.3
IWB52511	Ra_c70418_147	2A	70.3
IWB54523	RAC875_c17696_225	2A	70.3
IWB57672	RAC875_c41087_67	2A	70.3
IWB62504	RAC875_rep_c119619_54	2A	70.3
IWB11178	BS00081234_51	2A	71.3
IWA4367	wsnp_Ex_c5856_10276064	2A	72.4
IWA5463	wsnp_Ex_rep_c67848_66550974	2A	72.4
IWB170	BobWhite_c11081_1619	2A	72.4
IWB4615	BobWhite_c9505_515	2A	72.4
IWB5499	BobWhite_rep_c64766_352	2A	72.4
IWB10157	BS00067814_51	2A	72.4
IWB11764	BS00092550_51	2A	72.4
IWB12761	CAP11_c2194_115	2A	72.4
IWB29311	Excalibur_c907_1643	2A	72.4
IWB38412	Ku_c13700_1196	2A	72.4
IWB40153	Ku_c9320_1234	2A	72.4
IWB49914	Kukri_rep_c69608_2762	2A	72.4
IWB49915	Kukri_rep_c69608_375	2A	72.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB59866	RAC875_c64377_350	2A	72.4
IWA1385	wsnp_Ex_c10751_17505459	2A	72.7
IWB49619	Kukri_rep_c113597_88	2A	72.7
IWA4373	wsnp_Ex_c59095_60108097	2A	73.0
IWA5216	wsnp_Ex_rep_c66358_64543401	2A	73.0
IWA6592	wsnp_Ku_c16358_25225060	2A	73.0
IWB1315	BobWhite_c19822_818	2A	73.0
IWB1411	BobWhite_c2058_367	2A	73.0
IWB2479	BobWhite_c31673_296	2A	73.0
IWB2708	BobWhite_c34598_70	2A	73.0
IWB40946	Kukri_c13006_731	2A	73.0
IWB49008	Kukri_rep_c104611_210	2A	73.0
IWB59867	RAC875_c64377_72	2A	73.0
IWB22458	Excalibur_c14536_1129	2A	74.4
IWB29791	Excalibur_rep_c102052_721	2A	74.4
IWB64643	RFL_Contig4324_1348	2A	74.4
IWB53795	RAC875_c13861_1248	2A	75.0
IWA1275	wsnp_Ex_c10084_16572374	2A	76.7
IWA8377	wsnp_RFL_Contig2729_2446041	2A	76.7
IWB1036	BobWhite_c17403_635	2A	76.7
IWB2961	BobWhite_c3833_815	2A	76.7
IWB7202	BS00022666_51	2A	76.7
IWB7479	BS00023214_51	2A	76.7
IWB8030	BS00035883_51	2A	76.7
IWB8172	BS00039422_51	2A	76.7
IWB10941	BS00077597_51	2A	76.7
IWB34429	IAAV1698	2A	76.7
IWB43663	Kukri_c29170_680	2A	76.7
IWB51127	Ra_c14760_520	2A	76.7
IWB60632	RAC875_c8093_605	2A	76.7
IWB68084	Tdurum_contig13837_573	2A	76.7
IWB58832	RAC875_c52458_454	2A	77.1
IWB28453	Excalibur_c6660_716	2A	77.7
IWB32430	GENE-1381_132	2A	77.7
IWB40126	Ku_c8927_2075	2A	77.7
IWB47525	Kukri_c7193_3176	2A	77.7
IWB47527	Kukri_c7193_5892	2A	77.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA200	wsnp_be471201A_Ta_1_1	2A	78.1
IWA5243	wsnp_Ex_rep_c66465_64708628	2A	78.8
IWA5244	wsnp_Ex_rep_c66465_64708722	2A	78.8
IWA7998	wsnp_Ra_c5443_9643191	2A	78.8
IWB9494	BS00065259_51	2A	78.8
IWB24563	Excalibur_c27279_699	2A	78.8
IWB49283	Kukri_rep_c107630_127	2A	78.8
IWB50176	Kukri_rep_c72243_148	2A	78.8
IWB50309	Kukri_rep_c75317_375	2A	78.8
IWB52244	Ra_c5443_527	2A	78.8
IWA5130	wsnp_Ex_rep_c105158_89662129	2A	79.8
IWB44073	Kukri_c32234_413	2A	79.8
IWB32664	GENE-1792_762	2A	83.7
IWA5449	wsnp_Ex_rep_c67751_66428606	2A	84.0
IWB34815	IAAV4015	2A	84.7
IWB65467	TA001859-0887	2A	84.7
IWA3199	wsnp_Ex_c28942_38018762	2A	85.3
IWA4396	wsnp_Ex_c5984_10493714	2A	85.3
IWA5409	wsnp_Ex_rep_c67530_66144244	2A	85.3
IWA5574	wsnp_Ex_rep_c69014_67914888	2A	85.3
IWA5640	wsnp_Ex_rep_c69799_68761171	2A	85.3
IWA6089	wsnp_JD_c514_781859	2A	85.3
IWA7547	wsnp_Ra_c107797_91270622	2A	85.3
IWB7664	BS00027830_51	2A	85.3
IWB8169	BS00039406_51	2A	85.3
IWB10431	BS00070004_51	2A	85.3
IWB10432	BS00070005_51	2A	85.3
IWB11139	BS00080654_51	2A	85.3
IWB11175	BS00081194_51	2A	85.3
IWB12570	BS00110586_51	2A	85.3
IWB12571	BS00110587_51	2A	85.3
IWB31019	Excalibur_rep_c69014_112	2A	85.3
IWB32663	GENE-1792_560	2A	85.3
IWB35280	IAAV6972	2A	85.3
IWB36142	IACX6337	2A	85.3
IWB43378	Kukri_c27100_823	2A	85.3
IWB49894	Kukri_rep_c69422_54	2A	85.3



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB51049	Ra_c13247_528	2A	85.3
IWB53686	RAC875_c13247_1032	2A	85.3
IWB57080	RAC875_c35521_185	2A	85.3
IWB64479	RFL_Contig3780_644	2A	85.3
IWB21968	Excalibur_c11798_363	2A	85.7
IWB7051	BS00022377_51	2A	86.0
IWB11176	BS00081195_51	2A	86.0
IWB25538	Excalibur_c34964_326	2A	86.0
IWB31087	Excalibur_rep_c69799_1999	2A	86.0
IWB62188	RAC875_rep_c113120_326	2A	86.0
IWB62635	RAC875_rep_c69987_930	2A	86.0
IWB6986	BS00022241_51	2A	88.8
IWB28395	Excalibur_c65691_481	2A	90.9
IWB48741	Kukri_rep_c102199_1312	2A	90.9
IWB8290	BS00041816_51	2A	93.0
IWB51885	Ra_c34214_1320	2A	93.0
IWB12057	BS00099128_51	2A	93.7
IWB7315	BS00022903_51	2A	94.7
IWA7947	wsnp_Ra_c4503_8155485	2A	95.4
IWB42913	Kukri_c24064_2095	2A	95.7
IWB8551	BS00049644_51	2A	96.0
IWB39649	Ku_c5710_310	2A	96.0
IWB52068	Ra_c42714_1137	2A	96.0
IWB65306	RFL_Contig89_774	2A	97.4
IWB65286	RFL_Contig852_4295	2A	97.7
IWB3177	BobWhite_c41527_201	2A	98.1
IWA812	wsnp_CAP11_c838_518859	2A	98.4
IWA2807	wsnp_Ex_c2337_4379619	2A	98.4
IWB46062	Kukri_c50378_120	2A	98.4
IWA32	wsnp_BE403597A_Ta_2_1	2A	98.7
IWA33	wsnp_BE403597A_Ta_2_2	2A	98.7
IWA70	wsnp_BE406351A_Ta_2_2	2A	98.7
IWA71	wsnp_BE406351A_Ta_2_3	2A	98.7
IWB70	BobWhite_c1049_338	2A	98.7
IWB2233	BobWhite_c28819_517	2A	98.7
IWB2234	BobWhite_c28819_733	2A	98.7
IWB2235	BobWhite_c28819_787	2A	98.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB8221	BS00040337_51	2A	98.7
IWB8286	BS00041707_51	2A	98.7
IWB10154	BS00067806_51	2A	98.7
IWB10990	BS00078116_51	2A	98.7
IWB11422	BS00085765_51	2A	98.7
IWB13477	CAP12_c6044_69	2A	98.7
IWB23044	Excalibur_c1793_97	2A	98.7
IWB32305	GENE-1213_138	2A	98.7
IWB32434	GENE-1386_36	2A	98.7
IWB34883	IAAV4521	2A	98.7
IWB35496	IAAV8552	2A	98.7
IWB48460	Kukri_c9713_1999	2A	98.7
IWB55200	RAC875_c2154_1488	2A	98.7
IWB59834	RAC875_c63975_307	2A	98.7
IWB61279	RAC875_c992_718	2A	98.7
IWB74717	tplb0041i03_438	2A	99.5
IWA5068	wsnp_Ex_rep_c102538_87682273	2A	100.8
IWB54068	RAC875_c15213_1942	2A	102.5
IWB24910	Excalibur_c2995_259	2A	102.9
IWA6753	wsnp_Ku_c2413_4626451	2A	103.5
IWB35196	IAAV6409	2A	103.5
IWB60241	RAC875_c69068_71	2A	103.5
IWA3839	wsnp_Ex_c42720_49228237	2A	103.9
IWA2195	wsnp_Ex_c17220_25871264	2A	105.6
IWA3294	wsnp_Ex_c30787_39660951	2A	105.6
IWA3368	wsnp_Ex_c31900_40635609	2A	105.6
IWA5092	wsnp_Ex_rep_c103255_88258450	2A	105.6
IWA5272	wsnp_Ex_rep_c66615_64916114	2A	105.6
IWA5273	wsnp_Ex_rep_c66615_64916512	2A	105.6
IWA5305	wsnp_Ex_rep_c66809_65184970	2A	105.6
IWA5306	wsnp_Ex_rep_c66809_65185215	2A	105.6
IWA7429	wsnp_Ku_rep_c110147_94431847	2A	105.6
IWB10151	BS00067792_51	2A	105.6
IWB32405	GENE-1350_36	2A	105.6
IWB37169	JD_c2056_506	2A	105.6
IWB41380	Kukri_c15427_119	2A	105.6
IWB41389	Kukri_c15489_626	2A	105.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB45113	Kukri_c41217_154	2A	105.6
IWB46662	Kukri_c57491_132	2A	105.6
IWB46663	Kukri_c57491_156	2A	105.6
IWB51153	Ra_c1512_410	2A	105.6
IWB51504	Ra_c22880_760	2A	105.6
IWB51622	Ra_c26140_158	2A	105.6
IWB54724	RAC875_c18698_550	2A	105.6
IWB57685	RAC875_c41194_218	2A	105.6
IWB67490	Tdurum_contig12179_75	2A	105.6
IWB74519	tplb0034a02_612	2A	105.6
IWB69340	Tdurum_contig27844_127	2A	106.2
IWB21883	Excalibur_c11437_75	2A	106.6
IWB52548	Ra_c71628_188	2A	106.6
IWA5307	wsnp_Ex_rep_c66809_65185323	2A	106.9
IWB3149	BobWhite_c41006_413	2A	106.9
IWB39681	Ku_c59581_1412	2A	106.9
IWB26940	Excalibur_c4831_1182	2A	107.3
IWB36521	Jagger_c3061_53	2A	107.3
IWA3842	wsnp_Ex_c42815_49298013	2A	108.6
IWB39195	Ku_c331_1124	2A	109.0
IWB64536	RFL_Contig3916_275	2A	113.9
IWA3193	wsnp_Ex_c2887_5330426	2A	118.4
IWA5893	wsnp_JD_c18695_17091254	2A	118.4
IWB36470	Jagger_c2047_362	2A	118.4
IWB38011	JG_c936_115	2A	118.4
IWB39657	Ku_c57425_413	2A	118.4
IWB50267	Kukri_rep_c73477_888	2A	118.4
IWB61437	RAC875_rep_c105312_95	2A	118.4
IWB14764	CAP8_c4813_252	2A	118.8
IWA3194	wsnp_Ex_c2887_5330787	2A	119.1
IWA5022	wsnp_Ex_rep_c101526_86881496	2A	119.1
IWB11023	BS00078612_51	2A	119.1
IWB36058	IACX5910	2A	119.5
IWB10490	BS00070693_51	2A	121.6
IWB63547	RFL_Contig1049_1473	2A	122.3
IWA6566	wsnp_Ku_c15567_24224486	2A	123.0
IWB4625	BobWhite_c9564_587	2A	123.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB65859	TA004602-1630	2A	123.0
IWB71778	Tdurum_contig47258_1039	2A	123.0
IWA2730	wsnp_Ex_c22645_31845530	2A	123.3
IWB872	BobWhite_c1611_1685	2A	124.0
IWB12494	BS00110218_51	2A	124.0
IWB12556	BS00110524_51	2A	124.0
IWB29899	Excalibur_rep_c103108_709	2A	124.0
IWB51951	Ra_c37244_428	2A	124.0
IWB53505	RAC875_c12221_367	2A	124.0
IWB54584	RAC875_c17991_874	2A	124.0
IWA2067	wsnp_Ex_c15822_24204224	2A	124.3
IWB5782	BS00001107_51	2A	126.4
IWA6250	wsnp_JD_rep_c48914_33168544	2A	133.1
IWB10255	BS00068196_51	2A	133.8
IWB9740	BS00066186_51	2A	134.5
IWB27262	Excalibur_c51876_189	2A	134.5
IWB30108	Excalibur_rep_c105284_110	2A	134.5
IWB30109	Excalibur_rep_c105284_131	2A	134.5
IWB48575	Kukri_rep_c100848_221	2A	134.5
IWA4385	wsnp_Ex_c59373_60260876	2A	135.2
IWB24281	Excalibur_c25235_1178	2A	135.2
IWB72863	Tdurum_contig62138_385	2A	135.2
IWB72864	Tdurum_contig62138_414	2A	135.2
IWA6384	wsnp_Ku_c10302_17079851	2A	135.5
IWB28073	Excalibur_c61806_213	2A	135.9
IWB24282	Excalibur_c25235_1289	2A	137.3
IWB35347	IAAV7468	2A	138.8
IWB50806	Ra_c10616_265	2A	138.8
IWA4212	wsnp_Ex_c5412_9564046	2A	141.9
IWA4213	wsnp_Ex_c5412_9564346	2A	141.9
IWA4214	wsnp_Ex_c5412_9564478	2A	141.9
IWA4215	wsnp_Ex_c5412_9564550	2A	141.9
IWB52303	Ra_c58279_684	2A	141.9
IWB52304	Ra_c58279_702	2A	141.9
IWB16752	D_contig38301_325	2A	154.3
IWB1280	BobWhite_c19433_329	2A	156.1
IWB6164	BS00010087_51	2A	156.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7112	BS00022487_51	2A	156.1
IWB10837	BS00075855_51	2A	156.1
IWB17861	D_GA8KES402GRIFZ_148	2A	156.1
IWB31705	GENE-0137_1660	2A	156.1
IWB36297	IACX8391	2A	156.1
IWB43373	Kukri_c27040_309	2A	156.1
IWB44250	Kukri_c33779_1099	2A	156.1
IWB47995	Kukri_c84087_154	2A	156.1
IWB1830	BobWhite_c24495_282	2A	156.5
IWB4418	BobWhite_c8085_498	2A	156.5
IWB13985	CAP7_c3132_150	2A	156.5
IWB1365	BobWhite_c2022_245	2A	157.1
IWB12769	CAP11_c2293_200	2A	157.1
IWB66103	TA012416-0590	2A	157.5
IWB71220	Tdurum_contig42510_1113	2A	157.8
IWA1166	wsnp_CAP8_c2110_1147974	2A	158.1
IWA5762	wsnp_Ex_rep_c93362_82371891	2A	158.1
IWB15066	CAP8_rep_c8022_270	2A	158.1
IWB43984	Kukri_c31508_91	2A	158.1
IWB53862	RAC875_c14082_2606	2A	158.1
IWA1242	wsnp_CAP8_rep_c9132_3977980	2A	158.5
IWB4006	BobWhite_c58481_104	2A	158.5
IWB17580	D_F5XZDLF01EFGMN_252	2A	158.5
IWB45191	Kukri_c42095_196	2A	158.8
IWB25776	Excalibur_c37040_856	2A	160.2
IWB71144	Tdurum_contig42423_2699	2A	163.3
IWA422	wsnp_BF201235A_Ta_2_19	2A	164.0
IWA423	wsnp_BF201235A_Ta_2_4	2A	164.0
IWB2305	BobWhite_c29807_84	2A	164.0
IWB5912	BS00003867_51	2A	164.0
IWB7141	BS00022532_51	2A	164.0
IWB12082	BS00099658_51	2A	164.0
IWB14126	CAP7_c4676_94	2A	164.0
IWB22364	Excalibur_c1408_1577	2A	164.0
IWB35671	IACX11199	2A	164.0
IWB35702	IACX11417	2A	164.0
IWB35720	IACX12130	2A	164.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB42131	Kukri_c19434_504	2A	164.0
IWB42972	Kukri_c24446_306	2A	164.0
IWB46288	Kukri_c5282_622	2A	164.0
IWB47954	Kukri_c833_345	2A	164.0
IWB54180	RAC875_c15909_659	2A	164.0
IWB60728	RAC875_c829_355	2A	164.0
IWB60729	RAC875_c829_611	2A	164.0
IWB61256	RAC875_c98844_403	2A	164.0
IWB63271	RAC875_rep_c88665_100	2A	164.0
IWB63272	RAC875_rep_c88665_52	2A	164.0
IWB68412	Tdurum_contig15438_231	2A	164.0
IWB72948	Tdurum_contig63516_497	2A	164.0
IWB240	BobWhite_c11608_78	2A	164.3
IWB58454	RAC875_c48625_182	2A	164.6
IWA4714	wsnp_Ex_c770_1514612	2A	165.0
IWA8274	wsnp_RFL_Contig1951_1127302	2A	165.0
IWB4170	BobWhite_c6463_340	2A	165.0
IWB5947	BS00004112_51	2A	165.0
IWB5959	BS00004243_51	2A	165.0
IWB6257	BS00010629_51	2A	165.0
IWB6345	BS00011101_51	2A	165.0
IWB6489	BS00011893_51	2A	165.0
IWB6559	BS00012407_51	2A	165.0
IWB6604	BS00014736_51	2A	165.0
IWB8200	BS00039972_51	2A	165.0
IWB8201	BS00039973_51	2A	165.0
IWB9989	BS00067214_51	2A	165.0
IWB10303	BS00068396_51	2A	165.0
IWB11151	BS00080836_51	2A	165.0
IWB11453	BS00086364_51	2A	165.0
IWB12495	BS00110224_51	2A	165.0
IWB12661	CAP11_c1089_168	2A	165.0
IWB13316	CAP12_c259_307	2A	165.0
IWB13756	CAP7_c11806_165	2A	165.0
IWB14009	CAP7_c3284_55	2A	165.0
IWB14543	CAP8_c1562_139	2A	165.0
IWB22049	Excalibur_c12177_285	2A	165.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB22366	Excalibur_c1408_509	2A	165.0
IWB30196	Excalibur_rep_c106338_424	2A	165.0
IWB30585	Excalibur_rep_c112367_329	2A	165.0
IWB32026	GENE-0674_655	2A	165.0
IWB32169	GENE-0977_215	2A	165.0
IWB32397	GENE-1343_153	2A	165.0
IWB32399	GENE-1343_482	2A	165.0
IWB32449	GENE-1397_630	2A	165.0
IWB32473	GENE-1422_774	2A	165.0
IWB35719	IACX12079	2A	165.0
IWB36119	IACX6178	2A	165.0
IWB39115	Ku_c30440_428	2A	165.0
IWB42130	Kukri_c19434_1170	2A	165.0
IWB44846	Kukri_c3882_2021	2A	165.0
IWB46289	Kukri_c5282_726	2A	165.0
IWB51412	Ra_c21039_122	2A	165.0
IWB53778	RAC875_c138_551	2A	165.0
IWB54181	RAC875_c15909_686	2A	165.0
IWB58062	RAC875_c44675_71	2A	165.0
IWB58321	RAC875_c47161_100	2A	165.0
IWB60504	RAC875_c78169_98	2A	165.0
IWB61793	RAC875_rep_c108412_116	2A	165.0
IWB65266	RFL_Contig772_1037	2A	165.0
IWB65450	TA001766-2030	2A	165.0
IWB10120	BS00067684_51	2A	165.7
IWB11847	BS00093990_51	2A	165.7
IWB71139	Tdurum_contig42423_1963	2A	165.7
IWB71141	Tdurum_contig42423_2293	2A	165.7
IWB71142	Tdurum_contig42423_2448	2A	165.7
IWB74256	tplb0025n06_617	2A	166.0
IWB62185	RAC875_rep_c113106_56	2A	168.3
IWB25031	Excalibur_c3084_1843	2A	174.8
IWB65267	RFL_Contig772_2612	2B	0.0
IWB41266	Kukri_c148_1346	2B	4.4
IWB41267	Kukri_c148_1484	2B	4.4
IWB41268	Kukri_c148_1512	2B	4.4
IWB57369	RAC875_c38003_164	2B	4.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB10434	BS00070050_51	2B	6.5
IWB10435	BS00070051_51	2B	6.5
IWB10512	BS00070900_51	2B	6.5
IWB10616	BS00072619_51	2B	6.5
IWB10617	BS00072620_51	2B	6.5
IWB10794	BS00075303_51	2B	6.5
IWB32400	GENE-1343_556	2B	6.5
IWB9206	BS00064153_51	2B	7.5
IWB30584	Excalibur_rep_c112367_293	2B	7.5
IWB43883	Kukri_c3067_398	2B	7.5
IWB26792	Excalibur_c46590_363	2B	12.7
IWA2112	wsnp_Ex_c1629_3104356	2B	14.5
IWB5847	BS00003613_51	2B	14.5
IWB26861	Excalibur_c47288_232	2B	14.5
IWB36011	IACX5750	2B	14.5
IWB45833	Kukri_c48_1058	2B	14.5
IWB45991	Kukri_c4949_261	2B	14.5
IWB48989	Kukri_rep_c104422_192	2B	14.5
IWB69829	Tdurum_contig29563_183	2B	14.5
IWB69830	Tdurum_contig29563_197	2B	14.5
IWB69976	Tdurum_contig30210_226	2B	14.5
IWB72990	Tdurum_contig64563_491	2B	14.5
IWB26791	Excalibur_c46590_290	2B	14.9
IWB7157	BS00022572_51	2B	15.2
IWA7799	wsnp_Ra_c265_560747	2B	24.0
IWA2440	wsnp_Ex_c1962_3696265	2B	26.0
IWA7120	wsnp_Ku_c4962_8872507	2B	26.0
IWB21536	Excalibur_c100910_239	2B	26.4
IWB5373	BobWhite_rep_c63363_160	2B	28.6
IWB65494	TA002079-5951	2B	28.9
IWA1929	wsnp_Ex_c14711_22788263	2B	29.6
IWA1930	wsnp_Ex_c14711_22788586	2B	29.6
IWA5708	wsnp_Ex_rep_c70756_69644826	2B	29.6
IWA6048	wsnp_JD_c42879_30043973	2B	29.6
IWA6085	wsnp_JD_c5064_6183978	2B	29.6
IWB3720	BobWhite_c5072_107	2B	29.6
IWB4233	BobWhite_c6771_697	2B	29.6



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB4956	BobWhite_rep_c51499_280	2B	29.6
IWB5530	BobWhite_rep_c65082_84	2B	29.6
IWB10149	BS00067781_51	2B	29.6
IWB10586	BS00071995_51	2B	29.6
IWB10974	BS00077914_51	2B	29.6
IWB12436	BS00109853_51	2B	29.6
IWB33306	GENE-3260_378	2B	29.6
IWB37539	JD_c49544_37	2B	29.6
IWB43775	Kukri_c29807_476	2B	29.6
IWB43776	Kukri_c29807_713	2B	29.6
IWB48927	Kukri_rep_c103893_875	2B	29.6
IWB54956	RAC875_c2014_153	2B	29.6
IWB23606	Excalibur_c21220_88	2B	30.0
IWB42859	Kukri_c23771_483	2B	30.3
IWB41981	Kukri_c18500_882	2B	30.6
IWB1586	BobWhite_c22412_240	2B	31.3
IWA1359	w SNP_Ex_c10596_17293192	2B	32.4
IWA2391	w SNP_Ex_c19260_28187434	2B	32.4
IWB167	BobWhite_c11059_169	2B	32.4
IWB11939	BS00095573_51	2B	32.4
IWB34673	IAAV3165	2B	32.4
IWB35959	IACX445	2B	32.4
IWB46832	Kukri_c59939_94	2B	32.4
IWB6525	BS00012078_51	2B	33.8
IWA1360	w SNP_Ex_c10596_17293363	2B	35.3
IWB1748	BobWhite_c23790_98	2B	35.3
IWB9207	BS00064155_51	2B	35.3
IWB34415	IAAV1634	2B	35.3
IWB54529	RAC875_c17720_436	2B	35.3
IWB54530	RAC875_c17720_501	2B	35.3
IWB69541	Tdurum_contig28494_288	2B	35.3
IWA413	w SNP_BF146221B_Ta_2_2	2B	35.6
IWB6117	BS00009807_51	2B	35.9
IWB8280	BS00041585_51	2B	35.9
IWB19719	Ex_c12051_875	2B	35.9
IWB34527	IAAV2277	2B	35.9
IWB34849	IAAV4206	2B	35.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB53589	RAC875_c12766_461	2B	35.9
IWB54531	RAC875_c17720_570	2B	35.9
IWB28247	Excalibur_c63941_83	2B	36.3
IWB70198	Tdurum_contig31244_181	2B	36.6
IWB44675	Kukri_c37311_136	2B	37.0
IWB32171	GENE-0989_875	2B	37.7
IWB46423	Kukri_c54262_436	2B	38.3
IWB313	BobWhite_c1214_171	2B	44.4
IWB314	BobWhite_c1214_798	2B	46.9
IWB49740	Kukri_rep_c118476_63	2B	47.6
IWB16370	D_contig28615_96	2B	47.9
IWB43273	Kukri_c26288_419	2B	50.0
IWB35644	IACX1098	2B	50.7
IWB72380	Tdurum_contig54704_176	2B	50.7
IWB10193	BS00067962_51	2B	52.1
IWB82	BobWhite_c10578_272	2B	52.8
IWB256	BobWhite_c11739_325	2B	52.8
IWB11952	BS00096182_51	2B	52.8
IWB28342	Excalibur_c6502_397	2B	52.8
IWB56961	RAC875_c34516_316	2B	52.8
IWB56962	RAC875_c34516_70	2B	52.8
IWB69396	Tdurum_contig27976_414	2B	52.8
IWB32008	GENE-0647_106	2B	54.1
IWB39653	Ku_c5725_615	2B	54.1
IWB49277	Kukri_rep_c107572_121	2B	54.1
IWA6740	w SNP_Ku_c23305_33210841	2B	55.2
IWB65311	RFL_Contig914_2390	2B	55.5
IWA6739	w SNP_Ku_c23305_33210628	2B	55.8
IWB65417	TA001567-0999	2B	56.2
IWA4652	w SNP_Ex_c7285_12506938	2B	56.5
IWB73252	Tdurum_contig74936_456	2B	56.8
IWB72086	Tdurum_contig5056_173	2B	57.2
IWB72776	Tdurum_contig61293_131	2B	57.2
IWB73250	Tdurum_contig74936_264	2B	57.2
IWA8243	w SNP_RFL_Contig1380_498125	2B	57.5
IWB3418	BobWhite_c44986_217	2B	57.8
IWB7072	BS00022422_51	2B	57.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB11187	BS00081428_51	2B	57.8
IWB16695	D_contig36671_269	2B	57.8
IWB24591	Excalibur_c27557_381	2B	57.8
IWB28589	Excalibur_c7136_823	2B	57.8
IWB29748	Excalibur_rep_c101660_869	2B	57.8
IWB31982	GENE-0581_156	2B	57.8
IWB35392	IAAV7837	2B	57.8
IWB35421	IAAV8040	2B	57.8
IWB36310	IACX8565	2B	57.8
IWB41647	Kukri_c16760_259	2B	57.8
IWB43459	Kukri_c27574_725	2B	57.8
IWB46988	Kukri_c62277_80	2B	57.8
IWB48595	Kukri_rep_c101093_572	2B	57.8
IWB49878	Kukri_rep_c69288_529	2B	57.8
IWB57468	RAC875_c38941_230	2B	57.8
IWB60907	RAC875_c8780_441	2B	57.8
IWB62513	RAC875_rep_c119905_116	2B	57.8
IWB63381	RAC875_rep_c99492_65	2B	57.8
IWB65312	RFL_Contig914_2723	2B	57.8
IWB65391	TA001389-0564	2B	57.8
IWB67029	Tdurum_contig11350_629	2B	57.8
IWB68761	Tdurum_contig18901_188	2B	57.8
IWB69853	Tdurum_contig29620_207	2B	57.8
IWB69854	Tdurum_contig29620_285	2B	57.8
IWB74618	tplb0036o16_1626	2B	57.8
IWB28003	Excalibur_c6097_2208	2B	58.6
IWB12550	BS00110490_51	2B	59.3
IWB61862	RAC875_rep_c109207_706	2B	59.6
IWB70087	Tdurum_contig30680_120	2B	60.0
IWB71313	Tdurum_contig42636_1245	2B	60.0
IWA6026	wsnp_JD_c3732_4781170	2B	60.3
IWA6893	wsnp_Ku_c31_62657	2B	60.3
IWB9450	BS00065105_51	2B	60.3
IWB13632	CAP12_rep_c5926_51	2B	60.3
IWB16809	D_contig48213_103	2B	60.3
IWB23422	Excalibur_c20058_339	2B	60.3
IWB27355	Excalibur_c53027_323	2B	60.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB28588	Excalibur_c7136_799	2B	60.3
IWB31001	Excalibur_rep_c68899_1400	2B	60.3
IWB31002	Excalibur_rep_c68899_191	2B	60.3
IWB36769	Jagger_c8098_88	2B	60.3
IWB36919	JD_c11869_1297	2B	60.3
IWB36920	JD_c11869_1300	2B	60.3
IWB40861	Kukri_c12616_353	2B	60.3
IWB45337	Kukri_c43403_346	2B	60.3
IWB45339	Kukri_c43403_594	2B	60.3
IWB47405	Kukri_c67627_393	2B	60.3
IWB55384	RAC875_c22619_364	2B	60.3
IWB60831	RAC875_c86069_65	2B	60.3
IWB66020	TA005827-0874	2B	60.3
IWB67031	Tdurum_contig11350_827	2B	60.3
IWB71775	Tdurum_contig47202_1699	2B	60.3
IWB73904	Tdurum_contig94176_65	2B	60.3
IWA4554	wsnp_Ex_c66052_64232430	2B	60.6
IWB6159	BS00010055_51	2B	60.6
IWB10022	BS00067333_51	2B	60.6
IWB13631	CAP12_rep_c5926_115	2B	60.6
IWB21742	Excalibur_c108170_294	2B	60.6
IWB27354	Excalibur_c53027_302	2B	60.6
IWB29747	Excalibur_rep_c101660_546	2B	60.6
IWB43156	Kukri_c2565_1405	2B	60.6
IWB45338	Kukri_c43403_412	2B	60.6
IWB45731	Kukri_c4710_991	2B	60.6
IWB49735	Kukri_rep_c117487_285	2B	60.6
IWB53158	RAC875_c1072_1130	2B	60.6
IWB69852	Tdurum_contig29620_125	2B	60.6
IWB71895	Tdurum_contig48451_434	2B	60.6
IWB73251	Tdurum_contig74936_387	2B	60.6
IWA5818	wsnp_JD_c12687_12877994	2B	62.0
IWB3116	BobWhite_c40418_289	2B	62.0
IWB53367	RAC875_c11609_62	2B	62.0
IWB72915	Tdurum_contig62852_538	2B	62.0
IWB73496	Tdurum_contig81323_527	2B	62.0
IWB63879	RFL_Contig2231_346	2B	62.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4135	wsnp_Ex_c5239_9272511	2B	62.7
IWB22995	Excalibur_c17633_111	2B	62.7
IWB26449	Excalibur_c43482_141	2B	62.7
IWB46777	Kukri_c5904_80	2B	62.7
IWB47284	Kukri_c66123_88	2B	62.7
IWB63877	RFL_Contig2231_1297	2B	62.7
IWB70580	Tdurum_contig36804_220	2B	62.7
IWB73125	Tdurum_contig68806_321	2B	62.7
IWB73126	Tdurum_contig68806_537	2B	62.7
IWB73495	Tdurum_contig81323_291	2B	62.7
IWB74844	tplb0045o20_699	2B	62.7
IWB41315	Kukri_c15043_326	2B	63.0
IWB55924	RAC875_c26415_350	2B	63.0
IWB60422	RAC875_c76533_442	2B	63.0
IWB65326	RFL_Contig996_350	2B	63.3
IWB34324	IAAV1101	2B	63.7
IWB39832	Ku_c68678_924	2B	63.7
IWB2338	BobWhite_c30112_275	2B	64.0
IWB2380	BobWhite_c30622_180	2B	64.0
IWB3877	BobWhite_c5511_323	2B	64.0
IWB7346	BS00022966_51	2B	64.0
IWB10024	BS00067337_51	2B	64.0
IWB13691	CAP7_c1018_75	2B	64.0
IWB22043	Excalibur_c12135_100	2B	64.0
IWB36124	IACX6223	2B	64.0
IWB36550	Jagger_c36_213	2B	64.0
IWB70147	Tdurum_contig30989_79	2B	64.0
IWB72760	Tdurum_contig60978_352	2B	64.0
IWB72894	Tdurum_contig62458_179	2B	64.0
IWB72685	Tdurum_contig59780_988	2B	64.7
IWB7738	BS00029713_51	2B	65.1
IWB8125	BS00038217_51	2B	65.1
IWB8126	BS00038218_51	2B	65.1
IWB8332	BS00043099_51	2B	65.1
IWB11072	BS00079213_51	2B	65.1
IWB12205	BS00103461_51	2B	65.1
IWB24889	Excalibur_c29769_81	2B	65.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB30853	Excalibur_rep_c67391_476	2B	65.1
IWB40265	Kukri_c1016_1123	2B	65.1
IWB45998	Kukri_c49522_254	2B	65.1
IWB54201	RAC875_c16009_223	2B	65.1
IWB70581	Tdurum_contig36804_98	2B	65.1
IWB72913	Tdurum_contig62852_302	2B	65.1
IWB72916	Tdurum_contig62852_592	2B	65.1
IWB74841	tplb0045o20_1168	2B	65.1
IWB6075	BS00009540_51	2B	66.1
IWB12514	BS00110319_51	2B	66.1
IWB12537	BS00110442_51	2B	66.1
IWB58252	RAC875_c46454_129	2B	66.1
IWA4720	wsnp_Ex_c7738_13195349	2B	71.2
IWB4100	BobWhite_c6166_319	2B	71.2
IWB18439	D_GBF1XID02GVTKX_76	2B	71.2
IWB22744	Excalibur_c16154_246	2B	71.2
IWB42992	Kukri_c24586_1089	2B	71.2
IWB42993	Kukri_c24586_923	2B	71.2
IWB45644	Kukri_c4632_115	2B	71.2
IWB63700	RFL_Contig1633_304	2B	71.2
IWB71006	Tdurum_contig42214_2997	2B	71.2
IWB50839	Ra_c107358_279	2B	71.5
IWB58854	RAC875_c52566_644	2B	71.5
IWB6607	BS00014923_51	2B	71.9
IWB58852	RAC875_c52566_447	2B	71.9
IWB58853	RAC875_c52566_551	2B	71.9
IWA5377	wsnp_Ex_rep_c67257_65786614	2B	72.5
IWA6427	wsnp_Ku_c11665_18999583	2B	72.5
IWB22202	Excalibur_c1305_662	2B	72.5
IWB22543	Excalibur_c15031_73	2B	72.5
IWB24397	Excalibur_c26042_260	2B	72.5
IWB29853	Excalibur_rep_c102657_575	2B	72.5
IWB32007	GENE-0644_421	2B	72.5
IWB34545	IAAV2381	2B	72.5
IWB36153	IACX6411	2B	72.5
IWB36600	Jagger_c4412_265	2B	72.5
IWB37419	JD_c39990_130	2B	72.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB40383	Kukri_c106282_114	2B	72.5
IWB41646	Kukri_c16760_1427	2B	72.5
IWB53910	RAC875_c14362_529	2B	72.5
IWB73607	Tdurum_contig83066_276	2B	72.5
IWB74034	Tdurum_contig98206_211	2B	72.5
IWB44515	Kukri_c36026_68	2B	72.9
IWA4323	wsnp_Ex_c57_116914	2B	73.2
IWB11568	BS00088575_51	2B	73.2
IWB32006	GENE-0644_42	2B	73.2
IWB46839	Kukri_c60090_82	2B	73.2
IWB61973	RAC875_rep_c110493_512	2B	73.2
IWB61587	RAC875_rep_c106400_276	2B	73.9
IWA328	wsnp_BE499478B-Ta_2_1	2B	74.5
IWA4642	wsnp_Ex_c7246_12443506	2B	74.5
IWB1602	BobWhite_c22503_605	2B	74.5
IWB3671	BobWhite_c48532_527	2B	74.5
IWB7198	BS00022657_51	2B	74.5
IWB8772	BS00059315_51	2B	74.5
IWB9690	BS00065994_51	2B	74.5
IWB22236	Excalibur_c13239_85	2B	74.5
IWB25486	Excalibur_c3468_324	2B	74.5
IWB26119	Excalibur_c40229_76	2B	74.5
IWB28615	Excalibur_c721_484	2B	74.5
IWB32005	GENE-0644_370	2B	74.5
IWB38861	Ku_c23446_2209	2B	74.5
IWB44605	Kukri_c36756_316	2B	74.5
IWB59183	RAC875_c5638_1010	2B	74.5
IWB60585	RAC875_c79857_301	2B	74.5
IWB62112	RAC875_rep_c112008_519	2B	74.5
IWB67691	Tdurum_contig12660_192	2B	74.5
IWB36599	Jagger_c4412_103	2B	74.9
IWB47487	Kukri_c6973_344	2B	77.5
IWB11750	BS00092273_51	2B	78.9
IWB11751	BS00092275_51	2B	78.9
IWB42613	Kukri_c22200_1171	2B	78.9
IWA10	wsnp_BE399688B-Ta_2_1	2B	79.2
IWA1914	wsnp_Ex_c14595_22634031	2B	79.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3924	wsnp_Ex_c45094_50985067	2B	79.2
IWA4894	wsnp_Ex_c9248_15372536	2B	79.2
IWB12187	BS00102480_51	2B	79.2
IWB30179	Excalibur_rep_c106124_239	2B	79.2
IWB8214	BS00040251_51	2B	79.6
IWB44610	Kukri_c36783_91	2B	79.6
IWB32440	GENE-1389_458	2B	79.9
IWB43747	Kukri_c29600_68	2B	81.0
IWB29391	Excalibur_c9248_771	2B	82.0
IWB32439	GENE-1389_396	2B	82.0
IWB32441	GENE-1389_59	2B	82.0
IWB35747	IACX1412	2B	82.0
IWA2674	wsnp_Ex_c22018_31193171	2B	83.0
IWA3277	wsnp_Ex_c3044_5620102	2B	83.7
IWA4472	wsnp_Ex_c62844_62315607	2B	83.7
IWA5830	wsnp_JD_c13359_13373795	2B	83.7
IWB35887	IACX2953	2B	83.7
IWB44316	Kukri_c34353_821	2B	83.7
IWA6308	wsnp_JD_rep_c64505_41132927	2B	86.1
IWA6554	wsnp_Ku_c15336_23908130	2B	87.6
IWB7833	BS00031318_51	2B	87.6
IWB9332	BS00064626_51	2B	87.6
IWB74209	tplb0024p13_611	2B	87.6
IWA50	wsnp_BE404601B_Ta_2_1	2B	88.3
IWB10669	BS00073426_51	2B	88.9
IWB4173	BobWhite_c647_668	2B	92.3
IWB59170	RAC875_c56101_368	2B	98.9
IWB68806	Tdurum_contig19413_656	2B	98.9
IWB45925	Kukri_c48944_587	2B	100.0
IWB5274	BobWhite_rep_c61602_139	2B	100.8
IWB7772	BS00030405_51	2B	100.8
IWB8834	BS00061268_51	2B	100.8
IWB11725	BS00091671_51	2B	100.8
IWB12642	BS00111324_51	2B	100.8
IWB12643	BS00111325_51	2B	100.8
IWB13310	CAP12_c2565_239	2B	100.8
IWB23529	Excalibur_c20647_643	2B	100.8



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB24382	Excalibur_c25921_230	2B	100.8
IWB27810	Excalibur_c584_726	2B	100.8
IWB43295	Kukri_c26474_540	2B	100.8
IWB65801	TA004199-0831	2B	100.8
IWB51598	Ra_c2527_1124	2B	101.5
IWB61792	RAC875_rep_c108394_471	2B	101.5
IWB65727	TA003703-0582	2B	101.5
IWA1036	wsnp_CAP7_c1453_728076	2B	109.3
IWB44418	Kukri_c35153_956	2B	109.3
IWA5008	wsnp_Ex_rep_c101349_86725007	2B	110.0
IWB39528	Ku_c4885_448	2B	110.3
IWB69363	Tdurum_contig27880_75	2B	110.6
IWB3657	BobWhite_c4843_282	2B	111.3
IWA3237	wsnp_Ex_c29445_38480890	2B	112.0
IWA4853	wsnp_Ex_c8894_14858193	2B	112.0
IWA5128	wsnp_Ex_rep_c105129_89641882	2B	112.0
IWA6969	wsnp_Ku_c3780_6950286	2B	112.0
IWB39706	Ku_c6050_678	2B	112.0
IWB51163	Ra_c15365_530	2B	112.0
IWB43105	Kukri_c25281_99	2B	112.3
IWA3785	wsnp_Ex_c41558_48356814	2B	112.6
IWA7019	wsnp_Ku_c4004_7311479	2B	112.6
IWB39834	Ku_c68762_669	2B	112.6
IWB51291	Ra_c1799_1066	2B	112.6
IWB51844	Ra_c32699_410	2B	112.6
IWB71484	Tdurum_contig44075_1141	2B	115.0
IWB63897	RFL_Contig2290_184	2B	116.1
IWB63896	RFL_Contig2290_1009	2B	116.4
IWB69151	Tdurum_contig25629_415	2B	117.8
IWA1488	wsnp_Ex_c114_229879	2B	118.1
IWA6403	wsnp_Ku_c10640_17548156	2B	118.1
IWB28529	Excalibur_c6922_1393	2B	118.1
IWB36836	Jagger_rep_c10364_92	2B	118.1
IWB32406	GENE-1351_273	2B	118.4
IWB4713	BobWhite_rep_c48906_121	2B	118.8
IWB46532	Kukri_c55688_361	2B	118.8
IWB59172	RAC875_c56111_61	2B	118.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7263	BS00022800_51	2B	119.1
IWB11848	BS00093992_51	2B	119.1
IWB42187	Kukri_c19751_873	2B	119.1
IWA1304	wsnp_Ex_c10251_16815404	2B	119.8
IWA1305	wsnp_Ex_c10251_16815792	2B	119.8
IWA1393	wsnp_Ex_c10838_17631243	2B	119.8
IWB8535	BS00049378_51	2B	119.8
IWB27601	Excalibur_c55781_129	2B	119.8
IWB30854	Excalibur_rep_c67411_210	2B	120.1
IWB20453	Ex_c30517_1207	2B	120.8
IWB21139	Ex_c68194_1532	2B	120.8
IWB21140	Ex_c68194_1994	2B	120.8
IWB21199	Ex_c69493_1208	2B	120.8
IWB25132	Excalibur_c31737_169	2B	120.8
IWB28486	Excalibur_c6807_1155	2B	120.8
IWB29225	Excalibur_c88037_341	2B	120.8
IWB37941	JG_c2092_196	2B	120.8
IWB40823	Kukri_c12442_454	2B	120.8
IWB47244	Kukri_c6552_542	2B	120.8
IWB49783	Kukri_rep_c68360_1476	2B	120.8
IWB49862	Kukri_rep_c69169_334	2B	120.8
IWB51104	Ra_c14316_850	2B	120.8
IWB53902	RAC875_c14316_584	2B	120.8
IWB59086	RAC875_c54947_108	2B	120.8
IWB70826	Tdurum_contig42095_3235	2B	120.8
IWB73040	Tdurum_contig66317_77	2B	120.8
IWB73022	Tdurum_contig65349_140	2B	121.5
IWB72408	Tdurum_contig54925_225	2B	123.2
IWB1288	BobWhite_c19554_544	2B	123.9
IWB9310	BS00064528_51	2B	123.9
IWB21466	Ex_c960_746	2B	123.9
IWB21467	Ex_c960_776	2B	123.9
IWB25007	Excalibur_c30728_218	2B	123.9
IWB28721	Excalibur_c74466_344	2B	123.9
IWB53611	RAC875_c12886_2359	2B	123.9
IWB64321	RFL_Contig337_1432	2B	123.9
IWB71648	Tdurum_contig45838_263	2B	123.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB72411	Tdurum_contig54925_415	2B	123.9
IWB1556	BobWhite_c22106_204	2B	124.6
IWB13870	CAP7_c1933_170	2B	124.6
IWB73343	Tdurum_contig76090_916	2B	124.6
IWA2261	wsnp_Ex_c17845_26604587	2B	125.3
IWA3395	wsnp_Ex_c32493_41138957	2B	125.3
IWB1093	BobWhite_c17782_194	2B	125.3
IWB1664	BobWhite_c23054_1192	2B	125.3
IWB2440	BobWhite_c31268_254	2B	125.3
IWB6031	BS00009247_51	2B	125.3
IWB6433	BS00011545_51	2B	125.3
IWB6438	BS00011579_51	2B	125.3
IWB11092	BS00079621_51	2B	125.3
IWB12242	BS00105409_51	2B	125.3
IWB17472	D_F5MV3MU01EYV2M_33	2B	125.3
IWB28851	Excalibur_c7755_175	2B	125.3
IWB43828	Kukri_c3024_1163	2B	125.3
IWB45296	Kukri_c4294_371	2B	125.3
IWB47691	Kukri_c7666_1389	2B	125.3
IWB47694	Kukri_c7666_2637	2B	125.3
IWB48474	Kukri_c97631_275	2B	125.3
IWB49572	Kukri_rep_c112754_101	2B	125.3
IWB63291	RAC875_rep_c91134_949	2B	125.3
IWB67608	Tdurum_contig12459_491	2B	125.3
IWB69070	Tdurum_contig25423_72	2B	125.3
IWB73241	Tdurum_contig74826_330	2B	125.3
IWB45652	Kukri_c46361_295	2B	125.6
IWB1665	BobWhite_c23054_1464	2B	125.9
IWB62974	RAC875_rep_c73777_410	2B	125.9
IWA5413	wsnp_Ex_rep_c67561_66188180	2B	126.3
IWB32140	GENE-0910_153	2B	127.0
IWB3192	BobWhite_c41676_137	2B	128.0
IWB28478	Excalibur_c6769_1371	2B	128.0
IWB11868	BS00094373_51	2B	128.4
IWB63053	RAC875_rep_c75375_484	2B	128.4
IWB36126	IACX6231	2B	130.9
IWA1273	wsnp_Ex_c10071_16554911	2B	131.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1708	wsnp_Ex_c12922_20473104	2B	131.2
IWA2676	wsnp_Ex_c2203_4129271	2B	131.2
IWA2678	wsnp_Ex_c2203_4130096	2B	131.2
IWA4097	wsnp_Ex_c5123_9089025	2B	131.2
IWA7615	wsnp_Ra_c13679_21569624	2B	131.2
IWB1735	BobWhite_c2371_520	2B	131.2
IWB3648	BobWhite_c4831_490	2B	131.2
IWB8419	BS00046164_51	2B	131.2
IWB8420	BS00046165_51	2B	131.2
IWB9248	BS00064322_51	2B	131.2
IWB11780	BS00092869_51	2B	131.2
IWB13421	CAP12_c4899_191	2B	131.2
IWB20781	Ex_c47157_508	2B	131.2
IWB34719	IAAV3474	2B	131.2
IWB36140	IACX6309	2B	131.2
IWB42807	Kukri_c2343_108	2B	131.2
IWB43278	Kukri_c26311_891	2B	131.2
IWB43934	Kukri_c31059_130	2B	131.2
IWB52451	Ra_c69196_575	2B	131.2
IWB58061	RAC875_c4465_81	2B	131.2
IWB58059	RAC875_c4465_324	2B	131.5
IWA3148	wsnp_Ex_c2819_5213149	2B	131.9
IWA7371	wsnp_Ku_c9901_16493072	2B	131.9
IWB1188	BobWhite_c18540_351	2B	131.9
IWB66366	Tdurum_contig10219_295	2B	131.9
IWB58736	RAC875_c51349_187	2B	136.2
IWB28002	Excalibur_c60964_203	2B	140.3
IWA7652	wsnp_Ra_c16333_24961476	2B	141.0
IWA2701	wsnp_Ex_c22271_31463382	2B	141.3
IWA4909	wsnp_Ex_c942_1806632	2B	141.3
IWB1593	BobWhite_c2244_259	2B	141.3
IWB11942	BS00095643_51	2B	141.3
IWB22762	Excalibur_c1625_1215	2B	141.3
IWA3075	wsnp_Ex_c26818_36041748	2B	141.6
IWB13786	CAP7_c12727_215	2B	141.6
IWB31293	Excalibur_rep_c78626_295	2B	141.6
IWB68952	Tdurum_contig21896_174	2B	141.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB69372	Tdurum_contig27907_216	2B	141.6
IWB692	BobWhite_c1472_59	2B	142.3
IWB2594	BobWhite_c32938_366	2B	142.3
IWB3551	BobWhite_c4704_304	2B	142.3
IWB8449	BS00047070_51	2B	142.3
IWB8450	BS00047073_51	2B	142.3
IWB9359	BS00064740_51	2B	142.3
IWB22526	Excalibur_c14988_872	2B	142.3
IWB24230	Excalibur_c2484_2113	2B	142.3
IWB24602	Excalibur_c27629_473	2B	142.3
IWB32019	GENE-0663_75	2B	142.3
IWB41390	Kukri_c15498_1679	2B	142.3
IWA7955	wsnp_Ra_c4660_8405634	2B	142.6
IWB9044	BS00063365_51	2B	142.6
IWB73441	Tdurum_contig78534_314	2B	142.6
IWB12190	BS00102614_51	2B	143.0
IWB19787	Ex_c13213_2594	2B	143.0
IWB19788	Ex_c13213_2992	2B	143.0
IWB70765	Tdurum_contig42046_1390	2B	143.3
IWB61305	RAC875_c99953_224	2B	143.7
IWB70766	Tdurum_contig42046_1426	2B	144.0
IWB23660	Excalibur_c2157_173	2B	151.0
IWB69628	Tdurum_contig28795_219	2B	151.0
IWA1821	wsnp_Ex_c13865_21720307	2B	151.3
IWA8534	wsnp_RFL_Contig3917_4326857	2B	151.3
IWB4648	BobWhite_c9690_94	2B	151.3
IWB25869	Excalibur_c37753_754	2B	151.3
IWB57663	RAC875_c40992_113	2B	151.3
IWB69631	Tdurum_contig28795_381	2B	151.3
IWB7050	BS00022374_51	2B	152.3
IWB4272	BobWhite_c7050_564	2B	153.4
IWB4273	BobWhite_c7050_792	2B	153.4
IWB6028	BS00009060_51	2B	153.4
IWB45063	Kukri_c40769_308	2B	153.4
IWB57069	RAC875_c35399_497	2B	153.4
IWB29332	Excalibur_c91034_141	2B	154.1
IWB6323	BS00010988_51	2B	155.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB14677	CAP8_c3234_216	2B	155.1
IWB14959	CAP8_c8516_542	2B	155.1
IWB23230	Excalibur_c18966_1008	2B	155.1
IWB23232	Excalibur_c18966_804	2B	155.1
IWB26011	Excalibur_c39207_880	2B	155.1
IWB32119	GENE-0862_110	2B	155.1
IWB57313	RAC875_c37639_94	2B	155.1
IWA7112	wsnp_Ku_c48694_54811376	2B	158.0
IWA7113	wsnp_Ku_c48694_54811423	2B	158.0
IWB4383	BobWhite_c7773_283	2B	158.0
IWB39525	Ku_c48694_1284	2B	158.0
IWB10846	BS00076003_51	2B	158.7
IWB32354	GENE-1280_188	2B	158.7
IWB7514	BS00023902_51	2B	159.0
IWB7626	BS00026432_51	2B	159.0
IWB26300	Excalibur_c42146_266	2B	159.0
IWB35911	IACX3246	2B	159.0
IWB38059	Ku_c102096_268	2B	159.0
IWB43264	Kukri_c26240_68	2B	159.0
IWA1324	wsnp_Ex_c10441_17078853	2B	172.8
IWB11123	BS00080318_51	2B	172.8
IWB14219	CAP7_c6910_523	2B	172.8
IWB56627	RAC875_c31606_234	2B	172.8
IWB22835	Excalibur_c16679_215	2B	173.1
IWB1091	BobWhite_c17767_396	2B	173.5
IWB35156	IAAV6151	2B	173.8
IWB59226	RAC875_c5673_1209	2B	174.9
IWB6113	BS00009791_51	2B	175.9
IWB8813	BS00060618_51	2B	175.9
IWB29809	Excalibur_rep_c102228_810	2B	175.9
IWB47764	Kukri_c78358_129	2B	176.2
IWB46446	Kukri_c54653_295	2B	177.9
IWB43525	Kukri_c28077_282	2B	179.8
IWB2535	BobWhite_c32319_313	2B	181.4
IWB59281	RAC875_c57353_245	2B	181.4
IWB65621	TA002948-0488	2B	181.4
IWB70813	Tdurum_contig42092_274	2B	181.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB42028	Kukri_c18754_67	2B	181.7
IWB56526	RAC875_c30797_179	2B	182.1
IWB8607	BS00051965_51	2B	183.1
IWB28561	Excalibur_c7051_1027	2B	183.1
IWB28564	Excalibur_c7051_537	2B	183.1
IWB28565	Excalibur_c7051_590	2B	183.1
IWB43464	Kukri_c27631_1329	2B	183.1
IWB61238	RAC875_c98387_130	2B	183.1
IWB64461	RFL_Contig3713_280	2B	183.1
IWB64463	RFL_Contig3713_538	2B	183.1
IWB1769	BobWhite_c23950_145	2B	183.4
IWB10706	BS00074091_51	2B	183.4
IWB44343	Kukri_c34553_188	2B	183.4
IWB44344	Kukri_c34553_89	2B	183.4
IWB54212	RAC875_c16064_217	2B	183.4
IWB64462	RFL_Contig3713_316	2B	183.4
IWB13249	CAP12_c1817_77	2B	183.7
IWB28562	Excalibur_c7051_1115	2B	183.7
IWB65397	TA001447-0564-w	2B	184.1
IWB61988	RAC875_rep_c110690_104	2B	185.1
IWB47253	Kukri_c657_1139	2B	186.2
IWB55172	RAC875_c21358_62	2B	186.2
IWB61115	RAC875_c95081_166	2B	188.6
IWB24545	Excalibur_c27142_145	2B	191.1
IWB40501	Kukri_c11040_787	2B	192.5
IWB46560	Kukri_c55909_1109	2B	192.5
IWB20875	Ex_c52711_584	2B	192.9
IWB28927	Excalibur_c7971_1573	2B	194.6
IWB30421	Excalibur_rep_c109577_698	2B	194.9
IWB5439	BobWhite_rep_c64068_241	2B	195.3
IWB30305	Excalibur_rep_c107890_89	2B	196.4
IWB36313	IACX8602	2B	196.4
IWB4585	BobWhite_c923_208	2B	196.7
IWB429	BobWhite_c12911_788	2B	197.1
IWB501	BobWhite_c13407_242	2B	197.1
IWB1524	BobWhite_c21827_104	2B	197.1
IWB1796	BobWhite_c24069_257	2B	197.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB4318	BobWhite_c7274_197	2B	197.1
IWB6472	BS00011792_51	2B	197.1
IWB7819	BS00031098_51	2B	197.1
IWB8157	BS00039187_51	2B	197.1
IWB22771	Excalibur_c16329_1216	2B	197.1
IWB24454	Excalibur_c26527_82	2B	197.1
IWB29325	Excalibur_c910_946	2B	197.1
IWB31342	Excalibur_rep_c83640_791	2B	197.1
IWB35566	IAAV8940	2B	197.1
IWB55807	RAC875_c25513_403	2B	197.1
IWB66206	Tdurum_contig10048_447	2B	197.1
IWB66207	Tdurum_contig10048_61	2B	197.1
IWB68231	Tdurum_contig14482_1073	2B	197.1
IWB68232	Tdurum_contig14482_423	2B	197.1
IWB72277	Tdurum_contig52627_496	2B	197.1
IWB72278	Tdurum_contig52627_726	2B	197.1
IWB34399	IAAV1535	2B	197.4
IWB7887	BS00032381_51	2B	198.8
IWB25347	Excalibur_c33525_279	2B	198.8
IWB29461	Excalibur_c94383_157	2B	198.8
IWB44399	Kukri_c3501_1175	2B	198.8
IWB23589	Excalibur_c21117_300	2B	199.2
IWA2094	wsnp_Ex_c16074_24502385	2B	199.9
IWB7606	BS00026037_51	2B	199.9
IWB11333	BS00083998_51	2B	199.9
IWB12290	BS00106597_51	2B	199.9
IWB12291	BS00106606_51	2B	199.9
IWB50793	Ra_c105904_1191	2B	199.9
IWB54548	RAC875_c17798_66	2B	199.9
IWA5694	wsnp_Ex_rep_c70525_69448648	2B	200.2
IWA6852	wsnp_Ku_c28820_38731137	2B	200.2
IWB166	BobWhite_c1105_745	2B	200.2
IWB758	BobWhite_c1523_269	2B	200.2
IWB1124	BobWhite_c18071_171	2B	200.2
IWB6444	BS00011599_51	2B	200.2
IWB6563	BS00012463_51	2B	200.2
IWB9495	BS00065264_51	2B	200.2



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB12598	BS00110814_51	2B	200.2
IWB13403	CAP12_c449_277	2B	200.2
IWB22517	Excalibur_c14933_154	2B	200.2
IWB23911	Excalibur_c2311_1563	2B	200.2
IWB24254	Excalibur_c25043_1221	2B	200.2
IWB24255	Excalibur_c25043_357	2B	200.2
IWB24927	Excalibur_c3004_250	2B	200.2
IWB27000	Excalibur_c48871_625	2B	200.2
IWB28533	Excalibur_c6937_1065	2B	200.2
IWB30221	Excalibur_rep_c106698_235	2B	200.2
IWB32031	GENE-0676_715	2B	200.2
IWB36519	Jagger_c2989_134	2B	200.2
IWB41512	Kukri_c16035_685	2B	200.2
IWB41613	Kukri_c16621_417	2B	200.2
IWB42102	Kukri_c19290_596	2B	200.2
IWB44889	Kukri_c39136_675	2B	200.2
IWB45069	Kukri_c408_154	2B	200.2
IWB48017	Kukri_c8494_77	2B	200.2
IWB48530	Kukri_c9898_1618	2B	200.2
IWB48533	Kukri_c9898_328	2B	200.2
IWB50358	Kukri_rep_c78353_161	2B	200.2
IWB54767	RAC875_c19042_443	2B	200.2
IWB6341	BS00011078_51	2B	200.5
IWA216	wsnp_BE489901D_Ta_2_1	2B	200.9
IWB700	BobWhite_c1477_315	2B	200.9
IWB1174	BobWhite_c18406_110	2B	200.9
IWB2181	BobWhite_c2822_228	2B	200.9
IWB8650	BS00054751_51	2B	200.9
IWB24252	Excalibur_c25043_1020	2B	200.9
IWB28681	Excalibur_c7366_1926	2B	200.9
IWB29551	Excalibur_c96447_465	2B	200.9
IWB32030	GENE-0676_649	2B	200.9
IWB43915	Kukri_c30917_250	2B	200.9
IWB45312	Kukri_c43178_438	2B	200.9
IWB48653	Kukri_rep_c101484_438	2B	200.9
IWB56745	RAC875_c3259_276	2B	200.9
IWB57127	RAC875_c35873_1894	2B	200.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB60399	RAC875_c7602_2109	2B	200.9
IWB69974	Tdurum_contig30201_63	2B	200.9
IWB71684	Tdurum_contig46398_534	2B	200.9
IWB74748	tplb0042o21_419	2B	200.9
IWA1667	wsnp_Ex_c12675_20144479	2B	201.6
IWA3773	wsnp_Ex_c41300_48154348	2B	201.6
IWB4120	BobWhite_c62684_270	2B	201.6
IWB6010	BS00007384_51	2B	201.6
IWB9733	BS00066148_51	2B	201.6
IWB22135	Excalibur_c12675_1789	2B	201.6
IWB28691	Excalibur_c73791_215	2B	201.6
IWB29265	Excalibur_c8919_2133	2B	201.6
IWB29266	Excalibur_c8919_345	2B	201.6
IWB44797	Kukri_c38413_121	2B	201.6
IWB54390	RAC875_c16993_444	2B	201.6
IWB73793	Tdurum_contig92425_1673	2B	201.6
IWB32335	GENE-1258_171	2B	201.9
IWA3206	wsnp_Ex_c29008_38081173	2B	202.3
IWA4619	wsnp_Ex_c707_1391630	2B	202.3
IWB6956	BS00022185_51	2B	202.3
IWB12118	BS00100118_51	2B	202.3
IWB28692	Excalibur_c73791_296	2B	202.3
IWB75041	tplb0053o16_915	2B	202.3
IWB4319	BobWhite_c7274_333	2B	203.3
IWB5733	BS00000012_51	2B	203.3
IWB10610	BS00072349_51	2B	203.3
IWB27094	Excalibur_c49875_479	2B	203.3
IWB3062	BobWhite_c39489_116	2B	204.4
IWB32380	GENE-1320_141	2B	206.5
IWB34642	IAAV298	2D	0.0
IWB62903	RAC875_rep_c72743_51	2D	8.6
IWB44405	Kukri_c3507_158	2D	10.8
IWB15863	D_contig17313_245	2D	12.6
IWB8564	BS00049876_51	2D	19.0
IWA965	wsnp_CAP12_c455_248396	2D	22.9
IWA4354	wsnp_Ex_c58019_59494143	2D	22.9
IWA4746	wsnp_Ex_c7908_13430703	2D	22.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB740	BobWhite_c15073_502	2D	22.9
IWB15804	D_contig16084_234	2D	22.9
IWB40288	Kukri_c102346_668	2D	22.9
IWB42132	Kukri_c19434_936	2D	22.9
IWB7706	BS00029208_51	2D	23.3
IWB10124	BS00067698_51	2D	23.3
IWB40677	Kukri_c11809_824	2D	23.3
IWB40159	Ku_c941_3020	2D	26.2
IWB8481	BS00047901_51	2D	27.2
IWB9432	BS00065034_51	2D	30.1
IWB9943	BS00067046_51	2D	30.8
IWB11668	BS00090678_51	2D	30.8
IWB16321	D_contig27429_284	2D	30.8
IWA6301	wsnp_JD_rep_c63957_40798083	2D	31.4
IWA6302	wsnp_JD_rep_c63957_40798121	2D	31.4
IWB49600	Kukri_rep_c113120_104	2D	31.4
IWB50861	Ra_c108690_556	2D	31.8
IWB49203	Kukri_rep_c106786_230	2D	32.8
IWA1939	wsnp_Ex_c14779_22892053	2D	33.2
IWB46206	Kukri_c51992_290	2D	33.2
IWA989	wsnp_CAP12_c812_428290	2D	49.4
IWA927	wsnp_CAP12_c1503_764765	2D	53.3
IWA6897	wsnp_Ku_c3107_5818628	2D	69.4
IWA2414	wsnp_Ex_c1944_3663988	2D	69.8
IWA2415	wsnp_Ex_c1944_3664205	2D	69.8
IWB22544	Excalibur_c15048_488	2D	69.8
IWB59246	RAC875_c57_1178	2D	69.8
IWB59950	RAC875_c65419_229	2D	69.8
IWA4496	wsnp_Ex_c6400_11123059	2D	72.6
IWB49647	Kukri_rep_c114322_506	2D	72.9
IWB44554	Kukri_c36316_190	2D	73.3
IWB3556	BobWhite_c47086_539	2D	73.9
IWA4012	wsnp_Ex_c4817_8598511	2D	74.3
IWA7435	wsnp_Ku_rep_c68228_67133195	2D	74.3
IWB1425	BobWhite_c20687_252	2D	74.3
IWB10425	BS00069899_51	2D	74.3
IWB10652	BS00073229_51	2D	74.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB13053	CAP11_c784_408	2D	74.3
IWB16499	D_contig31797_313	2D	74.3
IWB19256	D_GDRF1KQ02JH49B_255	2D	74.3
IWB20902	Ex_c54373_394	2D	74.3
IWA609	wsnp_BM140538D_Ta_2_1	2D	74.6
IWB24243	Excalibur_c2496_1752	2D	75.3
IWA1858	wsnp_Ex_c14107_22021215	2D	81.7
IWA6520	wsnp_Ku_c14251_22503965	2D	81.7
IWB49478	Kukri_rep_c110868_147	2D	81.7
IWB35441	IAAV8184	2D	82.3
IWB24333	Excalibur_c2553_894	2D	83.0
IWB66107	TA012840-0369	2D	87.3
IWB6649	BS00018028_51	2D	90.7
IWA8544	wsnp_RFL_Contig3960_4401914	2D	93.6
IWB17710	D_GA8KES401AVZF3_380	2D	93.6
IWB32128	GENE-0875_506	2D	93.6
IWB32130	GENE-0875_620	2D	93.6
IWB32133	GENE-0875_887	2D	93.6
IWB49853	Kukri_rep_c69087_153	2D	93.6
IWB46550	Kukri_c5579_466	2D	97.2
IWA5542	wsnp_Ex_rep_c68555_67394261	2D	99.3
IWB18886	D_GCE8AKX02HFCFH_165	2D	101.3
IWB6349	BS00011109_51	2D	106.3
IWB44201	Kukri_c3344_401	2D	106.7
IWB43326	Kukri_c26676_225	2D	108.9
IWB55091	RAC875_c2092_1020	2D	119.7
IWB15987	D_contig19931_275	2D	129.9
IWB47275	Kukri_c65988_297	2D	134.7
IWB58937	RAC875_c53390_252	2D	135.0
IWB52332	Ra_c6118_350	3A	0.0
IWB52333	Ra_c6118_450	3A	0.0
IWB31307	Excalibur_rep_c80735_81	3A	4.0
IWA3939	wsnp_Ex_c4548_8166555	3A	9.6
IWA8105	wsnp_Ra_c9738_16173810	3A	9.6
IWA8106	wsnp_Ra_c9738_16174002	3A	9.6
IWB4588	BobWhite_c9249_564	3A	9.6
IWB26667	Excalibur_c4548_2505	3A	9.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB26668	Excalibur_c4548_2697	3A	9.6
IWB34361	IAAV1328	3A	9.6
IWA4804	wsnp_Ex_c8409_14170476	3A	11.0
IWB11649	BS00090225_51	3A	11.0
IWB23480	Excalibur_c20448_318	3A	11.0
IWB14875	CAP8_c665_242	3A	11.7
IWA4257	wsnp_Ex_c55051_57706127	3A	12.0
IWB5723	BobWhite_s67516_159	3A	12.4
IWB8523	BS00049032_51	3A	12.4
IWB29612	Excalibur_c98205_83	3A	12.7
IWB54315	RAC875_c16583_1259	3A	21.7
IWB27598	Excalibur_c55759_282	3A	22.7
IWA2047	wsnp_Ex_c15674_24004513	3A	23.1
IWA7086	wsnp_Ku_c4568_8243775	3A	23.1
IWB7571	BS00025191_51	3A	23.1
IWB26833	Excalibur_c47078_512	3A	23.1
IWB43842	Kukri_c30370_79	3A	23.1
IWB45555	Kukri_c4568_1708	3A	23.1
IWB45556	Kukri_c4568_958	3A	23.1
IWB2275	BobWhite_c29419_116	3A	23.4
IWB8516	BS00048757_51	3A	23.4
IWB9531	BS00065382_51	3A	23.4
IWB9681	BS00065956_51	3A	23.4
IWB24284	Excalibur_c25239_283	3A	23.4
IWB5655	BobWhite_rep_c67729_312	3A	24.4
IWB32388	GENE-1332_230	3A	25.1
IWB38640	Ku_c181_790	3A	29.9
IWB38639	Ku_c18096_552	3A	31.3
IWB50154	Kukri_rep_c71916_1548	3A	31.3
IWA5641	wsnp_Ex_rep_c69816_68774416	3A	32.3
IWB32527	GENE-1533_226	3A	32.3
IWB6586	BS00013584_51	3A	37.3
IWB59873	RAC875_c6445_275	3A	37.3
IWB65671	TA003281-2379	3A	37.3
IWB69125	Tdurum_contig25520_363	3A	37.3
IWA4333	wsnp_Ex_c57322_59083238	3A	37.7
IWA4334	wsnp_Ex_c57322_59084809	3A	37.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4335	wsnp_Ex_c57322_59084950	3A	37.7
IWB9676	BS00065932_51	3A	37.7
IWB58700	RAC875_c50864_1921	3A	37.7
IWB59109	RAC875_c55313_89	3A	37.7
IWB53051	RAC875_c10430_672	3A	40.1
IWB20076	Ex_c20039_301	3A	41.2
IWA443	wsnp_BF292295A-Ta_2_1	3A	42.3
IWB7185	BS00022624_51	3A	42.3
IWA1972	wsnp_Ex_c15036_23203474	3A	42.6
IWB35588	IAAV9068	3A	42.6
IWB38093	Ku_c103671_362	3A	42.6
IWB2733	BobWhite_c34866_232	3A	43.0
IWB35968	IACX464	3A	43.0
IWB70304	Tdurum_contig31898_53	3A	45.4
IWB6043	BS00009326_51	3A	46.6
IWB49635	Kukri_rep_c114028_94	3A	47.3
IWA4451	wsnp_Ex_c6217_10848574	3A	48.7
IWA5399	wsnp_Ex_rep_c67460_66057400	3A	48.7
IWA8526	wsnp_RFL_Contig3866_4228783	3A	48.7
IWB3613	BobWhite_c47722_613	3A	48.7
IWB11008	BS00078430_51	3A	48.7
IWB12478	BS00110129_51	3A	48.7
IWB34987	IAAV5207	3A	48.7
IWB35281	IAAV6974	3A	48.7
IWA1308	wsnp_Ex_c10272_16842803	3A	49.3
IWA7501	wsnp_Ku_rep_c71761_71496470	3A	49.3
IWB2017	BobWhite_c26555_74	3A	49.3
IWB6835	BS00021976_51	3A	49.3
IWB24112	Excalibur_c2419_531	3A	49.3
IWB30707	Excalibur_rep_c116073_259	3A	49.3
IWB64668	RFL_Contig4403_1034	3A	49.3
IWA4009	wsnp_Ex_c48136_53140385	3A	49.7
IWB19997	Ex_c17586_108	3A	50.7
IWB26160	Excalibur_c40694_473	3A	50.7
IWB41742	Kukri_c17313_667	3A	50.7
IWA5387	wsnp_Ex_rep_c67349_65914945	3A	51.4
IWA1894	wsnp_Ex_c14420_22402673	3A	51.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2095	wsnp_Ex_c16079_24507688	3A	52.1
IWA2763	wsnp_Ex_c22888_32105519	3A	52.1
IWB2241	BobWhite_c28950_147	3A	52.1
IWB5126	BobWhite_rep_c55551_53	3A	52.1
IWB8105	BS00037400_51	3A	52.1
IWB9840	BS00066585_51	3A	52.1
IWB9886	BS00066800_51	3A	52.1
IWB11609	BS00089400_51	3A	52.1
IWB41095	Kukri_c13793_1152	3A	52.1
IWB72601	Tdurum_contig57753_138	3A	52.1
IWB72895	Tdurum_contig62502_90	3A	52.1
IWB73154	Tdurum_contig697_73	3A	52.1
IWA6229	wsnp_JD_c9434_10274598	3A	52.8
IWA6306	wsnp_JD_rep_c64325_41024646	3A	53.1
IWA720	wsnp_CAP11_c2438_1258747	3A	53.4
IWB6861	BS00022016_51	3A	53.4
IWB9817	BS00066475_51	3A	53.8
IWA3498	wsnp_Ex_c3478_6369892	3A	54.1
IWB3287	BobWhite_c43213_184	3A	54.1
IWB6187	BS00010204_51	3A	54.1
IWB8878	BS00062645_51	3A	54.1
IWB45706	Kukri_c46833_105	3A	54.1
IWB46450	Kukri_c54729_181	3A	54.1
IWB68344	Tdurum_contig15074_284	3A	54.9
IWB8930	BS00062808_51	3A	56.0
IWB2801	BobWhite_c35789_281	3A	57.3
IWA4381	wsnp_Ex_c5929_10402147	3A	58.4
IWA5005	wsnp_Ex_rep_c101340_86719115	3A	58.4
IWA5006	wsnp_Ex_rep_c101340_86719239	3A	58.4
IWA7941	wsnp_Ra_c44141_50623811	3A	58.4
IWB6240	BS00010531_51	3A	58.4
IWB6870	BS00022029_51	3A	58.4
IWB8262	BS00041121_51	3A	58.4
IWB11929	BS00095423_51	3A	58.4
IWB35205	IAAV6474	3A	58.4
IWB36921	JD_c1187_1398	3A	58.4
IWB38609	Ku_c17569_905	3A	58.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB56053	RAC875_c27323_867	3A	58.4
IWA7319	wsnp_Ku_c8334_14181247	3A	59.4
IWB53805	RAC875_c13895_763	3A	59.4
IWA1614	wsnp_Ex_c12354_19711297	3A	60.4
IWA5786	wsnp_JD_c1187_1731186	3A	60.4
IWB42869	Kukri_c23833_181	3A	60.4
IWB16112	D_contig22865_78	3A	61.1
IWB28286	Excalibur_c64302_103	3A	62.1
IWA4172	wsnp_Ex_c53364_56625806	3A	62.8
IWB42984	Kukri_c2454_59	3A	63.5
IWA143	wsnp_BE443995B_Ta_2_2	3A	64.2
IWA899	wsnp_CAP11_rep_c8750_3780311	3A	64.2
IWA1422	wsnp_Ex_c11039_17902115	3A	64.2
IWA2156	wsnp_Ex_c16615_25147492	3A	64.2
IWA4912	wsnp_Ex_c943_1808232	3A	64.2
IWA5617	wsnp_Ex_rep_c69577_68526990	3A	64.2
IWA5782	wsnp_JD_c11273_11770307	3A	64.2
IWB7860	BS00031903_51	3A	64.2
IWB12541	BS00110452_51	3A	64.2
IWB14495	CAP8_c1093_136	3A	64.2
IWB26251	Excalibur_c41557_147	3A	64.2
IWB32585	GENE-1657_48	3A	64.2
IWB36078	IACX5968	3A	64.2
IWB49444	Kukri_rep_c110312_376	3A	64.2
IWB49539	Kukri_rep_c112061_617	3A	64.2
IWB51117	Ra_c14565_1056	3A	64.2
IWB11732	BS00091769_51	3A	64.5
IWA1699	wsnp_Ex_c12850_20377830	3A	65.9
IWA1435	wsnp_Ex_c11085_17973016	3A	66.2
IWB63579	RFL_Contig1175_354	3A	68.3
IWA4075	wsnp_Ex_c5047_8963671	3A	69.7
IWA5124	wsnp_Ex_rep_c104884_89459472	3A	69.7
IWB72652	Tdurum_contig59531_892	3A	69.7
IWA1507	wsnp_Ex_c1149_2206471	3A	70.7
IWA1604	wsnp_Ex_c12269_19597341	3A	70.7
IWA1605	wsnp_Ex_c12269_19597415	3A	70.7
IWA1982	wsnp_Ex_c15100_23284023	3A	70.7



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA2925	wsnp_Ex_c24731_33983680	3A	70.7
IWA3600	wsnp_Ex_c37208_45002588	3A	70.7
IWA3772	wsnp_Ex_c41283_48141201	3A	70.7
IWA4930	wsnp_Ex_c9510_15761235	3A	70.7
IWA6907	wsnp_Ku_c32404_42016343	3A	70.7
IWA6914	wsnp_Ku_c3286_6111360	3A	70.7
IWA7440	wsnp_Ku_rep_c68484_67499824	3A	70.7
IWA7564	wsnp_Ra_c11291_18338838	3A	70.7
IWA7817	wsnp_Ra_c27831_37346894	3A	70.7
IWA7891	wsnp_Ra_c35889_44345459	3A	70.7
IWA7970	wsnp_Ra_c4858_8709000	3A	70.7
IWB6301	BS00010854_51	3A	70.7
IWB6449	BS00011612_51	3A	70.7
IWB7381	BS00023026_51	3A	70.7
IWB8115	BS00037537_51	3A	70.7
IWB10468	BS00070511_51	3A	70.7
IWB12173	BS00101401_51	3A	70.7
IWB19612	Ex_c104581_457	3A	70.7
IWB26728	Excalibur_c46082_440	3A	70.7
IWB26905	Excalibur_c47907_517	3A	70.7
IWB33344	GENE-3343_183	3A	70.7
IWB34172	GENE-4795_75	3A	70.7
IWB34362	IAAV1334	3A	70.7
IWB34546	IAAV2383	3A	70.7
IWB34963	IAAV5030	3A	70.7
IWB35184	IAAV6317	3A	70.7
IWB39592	Ku_c53625_627	3A	70.7
IWB42389	Kukri_c20889_526	3A	70.7
IWB51985	Ra_c38505_544	3A	70.7
IWB51986	Ra_c38505_555	3A	70.7
IWB52004	Ra_c39556_524	3A	70.7
IWB60602	RAC875_c8010_155	3A	70.7
IWA7441	wsnp_Ku_rep_c68484_67500021	3A	71.1
IWB66003	TA005679-0546	3A	71.8
IWA5285	wsnp_Ex_rep_c66685_65003254	3A	72.1
IWB9177	BS00064039_51	3A	72.1
IWB35578	IAAV902	3A	72.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB60351	RAC875_c744_1935	3A	72.1
IWB22387	Excalibur_c14216_692	3A	73.2
IWA7073	wsnp_Ku_c44716_51926415	3A	75.2
IWB1051	BobWhite_c1749_406	3A	76.0
IWB72074	Tdurum_contig50389_317	3A	76.3
IWA2291	wsnp_Ex_c18223_27035083	3A	79.8
IWB6177	BS00010136_51	3A	79.8
IWB1698	BobWhite_c23344_457	3A	80.5
IWB72994	Tdurum_contig64606_1106	3A	81.6
IWA7132	wsnp_Ku_c50833_56310208	3A	82.6
IWB6603	BS00014695_51	3A	83.0
IWB58656	RAC875_c5056_220	3A	83.0
IWB72993	Tdurum_contig64606_1104	3A	83.7
IWB72995	Tdurum_contig64606_1309	3A	83.7
IWB73364	Tdurum_contig76296_461	3A	83.7
IWA6996	wsnp_Ku_c38911_47455674	3A	85.2
IWA6997	wsnp_Ku_c38911_47455924	3A	85.2
IWB6793	BS00021909_51	3A	85.2
IWB30159	Excalibur_rep_c105978_544	3A	85.2
IWB60142	RAC875_c67998_96	3A	85.2
IWB27980	Excalibur_c60581_62	3A	85.8
IWB32569	GENE-1634_405	3A	85.8
IWA2348	wsnp_Ex_c18747_27625264	3A	86.5
IWA5114	wsnp_Ex_rep_c104327_89077792	3A	86.5
IWA5601	wsnp_Ex_rep_c69342_68276235	3A	86.5
IWA5602	wsnp_Ex_rep_c69342_68276256	3A	86.5
IWB4301	BobWhite_c716_644	3A	86.5
IWB20567	Ex_c35861_1382	3A	86.5
IWB24674	Excalibur_c28180_367	3A	86.5
IWB59654	RAC875_c62012_382	3A	86.5
IWB61104	RAC875_c947_383	3A	86.5
IWB72458	Tdurum_contig55560_972	3A	86.5
IWB72584	Tdurum_contig57552_327	3A	86.5
IWB74012	Tdurum_contig97800_262	3A	86.5
IWB44225	Kukri_c33640_640	3A	87.5
IWA5657	wsnp_Ex_rep_c69919_68881108	3A	88.5
IWB4503	BobWhite_c8674_595	3A	88.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB23189	Excalibur_c18747_1292	3A	88.5
IWB53914	RAC875_c14370_1319	3A	88.5
IWB40964	Kukri_c1308_2236	3A	92.3
IWB49970	Kukri_rep_c69970_717	3A	92.6
IWB26279	Excalibur_c41857_814	3A	94.0
IWB40965	Kukri_c1308_2782	3A	95.7
IWB64060	RFL_Contig2787_634	3A	99.0
IWB10228	BS00068094_51	3A	100.4
IWB11684	BS00091002_51	3A	100.4
IWB43989	Kukri_c31546_66	3A	100.4
IWB47055	Kukri_c63259_151	3A	100.4
IWB60569	RAC875_c79551_167	3A	100.4
IWB5352	BobWhite_rep_c63229_98	3A	101.1
IWB6009	BS00006822_51	3A	101.4
IWB64845	RFL_Contig497_1114	3A	101.4
IWA799	wsnp_CAP11_c68_106078	3A	111.4
IWA926	wsnp_CAP12_c15_9559	3A	111.4
IWA2028	wsnp_Ex_c15475_23756906	3A	111.4
IWA2029	wsnp_Ex_c15475_23757972	3A	111.4
IWB6678	BS00020459_51	3A	111.4
IWB8579	BS00049977_51	3A	111.4
IWB8580	BS00049978_51	3A	111.4
IWB35344	IAAV7454	3A	111.4
IWB40418	Kukri_c10751_1031	3A	111.4
IWB40419	Kukri_c10751_158	3A	111.4
IWB40420	Kukri_c10751_264	3A	111.4
IWB40422	Kukri_c10751_860	3A	111.4
IWB54057	RAC875_c15109_106	3A	111.4
IWB64637	RFL_Contig4282_1420	3A	111.4
IWA2008	wsnp_Ex_c1533_2930233	3A	112.1
IWB899	BobWhite_c1627_567	3A	115.0
IWB5927	BS00003935_51	3A	115.0
IWB11738	BS00091887_51	3A	115.0
IWB20736	Ex_c4465_1641	3A	115.0
IWB20737	Ex_c4465_882	3A	115.0
IWB36105	IACX6065	3A	115.0
IWB38323	Ku_c1255_1107	3A	115.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB38325	Ku_c1255_627	3A	115.0
IWB38326	Ku_c1255_862	3A	115.0
IWB40381	Kukri_c106254_386	3A	115.0
IWB12563	BS00110550_51	3A	117.5
IWB6988	BS00022245_51	3A	117.8
IWB7097	BS00022459_51	3A	117.8
IWB46039	Kukri_c49927_151	3A	117.8
IWB7306	BS00022884_51	3A	118.2
IWB12516	BS00110350_51	3A	118.2
IWB26072	Excalibur_c3969_713	3A	136.4
IWB26070	Excalibur_c3969_1208	3A	137.4
IWB43795	Kukri_c29993_593	3A	142.9
IWA7297	w SNP_Ku_c7811_13387117	3A	144.6
IWB71198	Tdurum_contig42495_389	3A	144.6
IWA1207	w SNP_CAP8_c6939_3242530	3A	146.7
IWB12651	CAP11_c1022_117	3A	146.7
IWB12652	CAP11_c1022_66	3A	146.7
IWB41929	Kukri_c18258_440	3A	147.0
IWB2639	BobWhite_c3356_442	3A	149.2
IWB44003	Kukri_c3164_633	3A	156.7
IWB72476	Tdurum_contig55841_351	3A	156.7
IWB366	BobWhite_c12428_371	3A	157.0
IWB8288	BS00041742_51	3A	157.0
IWB7383	BS00023028_51	3A	158.1
IWB43198	Kukri_c25871_124	3A	158.4
IWB9606	BS00065673_51	3A	158.8
IWB24224	Excalibur_c24829_189	3A	158.8
IWB10961	BS00077819_51	3A	159.8
IWA1366	w SNP_Ex_c10630_17338703	3A	160.1
IWB7790	BS00030652_51	3A	160.1
IWB50452	Kukri_rep_c86903_184	3A	160.1
IWB61868	RAC875_rep_c109228_400	3A	165.2
IWB8509	BS00048633_51	3A	165.9
IWB10817	BS00075598_51	3A	166.3
IWB40771	Kukri_c12212_182	3A	167.6
IWB34789	IAAV3851	3A	171.2
IWB6826	BS00021967_51	3A	176.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB814	BobWhite_c15582_253	3A	178.8
IWB3508	BobWhite_c46361_331	3A	178.8
IWA5111	wsnp_Ex_rep_c104125_88923836	3A	179.5
IWB7071	BS00022419_51	3A	179.5
IWB12017	BS00097939_51	3A	179.9
IWB66063	TA006156-0624	3A	180.5
IWA3560	wsnp_Ex_c361_708712	3A	181.6
IWB7734	BS00029569_51	3A	181.6
IWA2949	wsnp_Ex_c25082_34346512	3A	182.6
IWB45815	Kukri_c47887_111	3A	183.2
IWA7835	wsnp_Ra_c29624_38979654	3A	183.6
IWB4391	BobWhite_c7851_202	3A	183.9
IWB14956	CAP8_c8360_186	3A	185.3
IWB11	BobWhite_c10098_535	3A	186.0
IWB45816	Kukri_c47887_183	3A	186.0
IWB37804	JD_c7528_325	3A	186.3
IWB478	BobWhite_c13293_107	3A	186.7
IWB10331	BS00068508_51	3A	186.7
IWB35035	IAAV5507	3A	186.7
IWB35582	IAAV9044	3A	186.7
IWB56532	RAC875_c3084_415	3A	186.7
IWA5112	wsnp_Ex_rep_c104141_88935451	3A	187.0
IWB59641	RAC875_c61934_186	3A	187.0
IWB61557	RAC875_rep_c106170_204	3A	187.0
IWA4258	wsnp_Ex_c55096_57733841	3A	187.7
IWB14312	CAP7_c915_121	3A	188.0
IWA5190	wsnp_Ex_rep_c66274_64426834	3A	189.7
IWA5191	wsnp_Ex_rep_c66274_64426901	3A	189.7
IWB38307	Ku_c12191_1123	3A	189.7
IWB38308	Ku_c12191_1202	3A	189.7
IWB68041	Tdurum_contig13646_225	3A	189.7
IWB33232	GENE-3102_149	3A	190.4
IWB25613	Excalibur_c3556_520	3A	190.7
IWA2396	wsnp_Ex_c19309_28242774	3A	191.0
IWA6716	wsnp_Ku_c217_430915	3A	191.0
IWA7999	wsnp_Ra_c5454_9660102	3A	191.0
IWB20558	Ex_c3556_2319	3A	191.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB42541	Kukri_c217_2282	3A	191.0
IWB2753	BobWhite_c35093_176	3A	191.4
IWB5755	BS00000523_51	3A	191.4
IWB11435	BS00086050_51	3A	191.4
IWB65706	TA003550-0145	3A	191.4
IWB67817	Tdurum_contig13011_381	3A	191.4
IWB72092	Tdurum_contig50577_620	3A	191.4
IWB1505	BobWhite_c21540_63	3A	193.5
IWA4407	wsnp_Ex_c60462_60905848	3A	198.6
IWB36083	IACX5980	3A	198.9
IWB58222	RAC875_c46236_214	3A	202.8
IWB57469	RAC875_c38975_411	3A	206.7
IWB41710	Kukri_c17082_519	3B	0.0
IWB30660	Excalibur_rep_c114249_187	3B	2.1
IWA3271	wsnp_Ex_c30368_39293103	3B	6.1
IWA6587	wsnp_Ku_c1629_3206989	3B	6.1
IWB5790	BS00001335_51	3B	6.1
IWB31170	Excalibur_rep_c71060_78	3B	6.1
IWB38903	Ku_c24488_313	3B	6.1
IWB64175	RFL_Contig3008_1342	3B	6.1
IWB73672	Tdurum_contig84762_189	3B	6.1
IWB23457	Excalibur_c20277_483	3B	8.5
IWB64989	RFL_Contig5360_1282	3B	8.5
IWB67389	Tdurum_contig12008_803	3B	8.5
IWB8755	BS00058860_51	3B	8.9
IWB8756	BS00058861_51	3B	8.9
IWB14549	CAP8_c1614_529	3B	8.9
IWB66970	Tdurum_contig11192_373	3B	8.9
IWB1836	BobWhite_c2453_253	3B	9.2
IWB1837	BobWhite_c2453_282	3B	9.2
IWB29466	Excalibur_c94546_61	3B	9.2
IWB62488	RAC875_rep_c118986_60	3B	9.2
IWB7595	BS00025838_51	3B	9.5
IWB8745	BS00058654_51	3B	9.5
IWB11105	BS00079989_51	3B	9.5
IWB23179	Excalibur_c18645_857	3B	9.5
IWB29792	Excalibur_rep_c102055_320	3B	9.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB63732	RFL_Contig1801_1473	3B	9.5
IWB64711	RFL_Contig4531_1195	3B	9.5
IWB8037	BS00036089_51	3B	10.6
IWB9061	BS00063445_51	3B	10.6
IWA5299	w SNP_ Ex_ rep_ c66766_65123941	3B	13.1
IWB67376	Tdurum_contig11988_459	3B	13.4
IWA5347	w SNP_ Ex_ rep_ c67033_65490126	3B	13.8
IWB1561	BobWhite_c22126_94	3B	13.8
IWB7919	BS00033209_51	3B	13.8
IWB54322	RAC875_c16609_1134	3B	13.8
IWB62455	RAC875_rep_c118229_56	3B	13.8
IWB66936	Tdurum_contig11115_99	3B	13.8
IWB70625	Tdurum_contig402_129	3B	13.8
IWB19063	D_GDEEGVY02FU4W8_119	3B	14.8
IWB12639	BS00111294_51	3B	15.8
IWB37219	JD_c23336_253	3B	16.1
IWB51846	Ra_c327_1696	3B	16.1
IWB51847	Ra_c327_599	3B	16.1
IWB71460	Tdurum_contig43938_291	3B	16.5
IWB36538	Jagger_c342_119	3B	22.3
IWB2094	BobWhite_c27352_145	3B	23.4
IWB9212	BS00064177_51	3B	23.4
IWB28657	Excalibur_c7321_741	3B	23.4
IWB24336	Excalibur_c25566_1000	3B	23.7
IWB74707	tplb0041e10_1230	3B	24.1
IWB6660	BS00018764_51	3B	24.4
IWB30037	Excalibur_rep_c104532_80	3B	24.4
IWB30862	Excalibur_rep_c67448_528	3B	24.4
IWB49248	Kukri_rep_c107316_393	3B	24.4
IWB65723	TA003677-1077	3B	24.4
IWB7055	BS00022387_51	3B	24.7
IWB24337	Excalibur_c25566_423	3B	24.7
IWB30032	Excalibur_rep_c104498_168	3B	24.7
IWB32543	GENE-1579_18	3B	24.7
IWB48628	Kukri_rep_c101341_425	3B	24.7
IWB60938	RAC875_c8885_74	3B	24.7
IWB10462	BS00070455_51	3B	40.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB10463	BS00070456_51	3B	40.4
IWA4340	wsnp_Ex_c57450_59156677	3B	40.8
IWB5363	BobWhite_rep_c63300_279	3B	44.8
IWB5601	BobWhite_rep_c66224_103	3B	44.8
IWB5714	BobWhite_s67322_122	3B	44.8
IWB9884	BS00066798_51	3B	44.8
IWB49268	Kukri_rep_c107494_369	3B	44.8
IWB54838	RAC875_c19475_61	3B	44.8
IWB24150	Excalibur_c24391_321	3B	45.6
IWB2741	BobWhite_c34987_301	3B	45.9
IWB6207	BS00010332_51	3B	45.9
IWB9677	BS00065934_51	3B	45.9
IWB57897	RAC875_c43028_62	3B	45.9
IWB59331	RAC875_c5799_224	3B	45.9
IWB64118	RFL_Contig29_1062	3B	50.7
IWA3983	wsnp_Ex_c47078_52393295	3B	53.1
IWB59476	RAC875_c59977_598	3B	55.4
IWB6373	BS00011243_51	3B	55.7
IWB64356	RFL_Contig3442_106	3B	59.3
IWB69999	Tdurum_contig30304_151	3B	75.3
IWA1863	wsnp_Ex_c14147_22077948	3B	82.6
IWB3668	BobWhite_c48504_480	3B	83.0
IWB9734	BS00066149_51	3B	83.0
IWB11650	BS00090227_51	3B	83.0
IWB14946	CAP8_c8016_120	3B	83.0
IWB36039	IACX5844	3B	83.0
IWB60637	RAC875_c81076_317	3B	83.0
IWB71405	Tdurum_contig43263_243	3B	83.0
IWB30268	Excalibur_rep_c107483_324	3B	84.7
IWB44131	Kukri_c32802_706	3B	84.7
IWB68368	Tdurum_contig15181_67	3B	85.0
IWB69288	Tdurum_contig26727_267	3B	85.0
IWA292	wsnp_BE497469B_Ta_2_1	3B	85.3
IWB22396	Excalibur_c14273_1407	3B	85.3
IWB23272	Excalibur_c19240_109	3B	85.3
IWB41155	Kukri_c14113_98	3B	85.3
IWB45768	Kukri_c4747_330	3B	85.3



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB55125	RAC875_c21086_130	3B	85.3
IWB60904	RAC875_c8755_314	3B	85.3
IWB65440	TA001691-0675	3B	85.3
IWB36433	Jagger_c1219_603	3B	86.4
IWB65362	TA001218-0519	3B	87.8
IWB10723	BS00074287_51	3B	88.8
IWB54463	RAC875_c17404_1160	3B	88.8
IWB22499	Excalibur_c14803_1088	3B	89.2
IWA210	wsnp_BE489326B-Ta_2_1	3B	89.5
IWA5638	wsnp_Ex_rep_c69783_68742690	3B	89.5
IWA6698	wsnp_Ku_c210_413608	3B	89.5
IWB27477	Excalibur_c54388_193	3B	89.5
IWB35464	IAAV8368	3B	89.5
IWB36923	JD_c119_119	3B	89.5
IWB49980	Kukri_rep_c70097_286	3B	89.5
IWB65427	TA001646-1356	3B	89.5
IWA7388	wsnp_Ku_rep_c102135_89174746	3B	95.6
IWB1014	BobWhite_c17191_297	3B	95.6
IWB39502	Ku_c47648_1403	3B	95.6
IWB49644	Kukri_rep_c114274_112	3B	95.9
IWB32559	GENE-1617_188	3B	96.2
IWA4847	wsnp_Ex_c8825_14757625	3B	96.6
IWB74291	tplb0026h15_986	3B	96.6
IWB58297	RAC875_c46966_193	3B	97.3
IWB24992	Excalibur_c30627_263	3D1	0.0
IWA6092	wsnp_JD_c5170_6293946	3D1	3.9
IWA8004	wsnp_Ra_c5532_9788185	3D1	3.9
IWB5892	BS00003774_51	3D1	3.9
IWB9168	BS00063985_51	3D1	3.9
IWB9543	BS00065422_51	3D1	3.9
IWB14792	CAP8_c5043_351	3D1	3.9
IWB23511	Excalibur_c20559_98	3D1	3.9
IWB26096	Excalibur_c39985_677	3D1	3.9
IWB32711	GENE-1897_552	3D1	3.9
IWB34431	IAAV1708	3D1	3.9
IWB35481	IAAV8465	3D1	3.9
IWB56971	RAC875_c34624_305	3D1	3.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB57532	RAC875_c3956_659	3D1	3.9
IWB57908	RAC875_c43163_189	3D1	3.9
IWB59180	RAC875_c5633_1748	3D1	3.9
IWB59200	RAC875_c56484_249	3D1	3.9
IWB63437	RAC875_s113853_61	3D1	3.9
IWB63525	RAC875_s120635_196	3D1	3.9
IWB65366	TA001247-0573	3D1	3.9
IWB68188	Tdurum_contig14350_431	3D1	3.9
IWB69146	Tdurum_contig25619_350	3D1	3.9
IWB72099	Tdurum_contig50596_708	3D1	3.9
IWB64177	RFL_Contig3008_1870	3D1	4.7
IWB1428	BobWhite_c2069_1096	3D1	5.1
IWB62299	RAC875_rep_c115090_51	3D1	5.8
IWB6715	BS00021687_51	3D1	6.8
IWB44215	Kukri_c33561_564	3D1	6.8
IWB46078	Kukri_c50527_241	3D1	6.8
IWB58493	RAC875_c48906_80	3D1	6.8
IWB63461	RAC875_s117035_123	3D1	7.1
IWA4725	wsnp_Ex_c7780_13254349	3D1	7.5
IWA8099	wsnp_Ra_c9185_15386027	3D1	7.5
IWB1876	BobWhite_c25110_98	3D1	7.5
IWB2424	BobWhite_c3111_636	3D1	7.5
IWB4057	BobWhite_c6016_214	3D1	7.5
IWB4106	BobWhite_c621_1218	3D1	7.5
IWB4467	BobWhite_c839_2021	3D1	7.5
IWB5970	BS00004358_51	3D1	7.5
IWB9960	BS00067117_51	3D1	7.5
IWB11113	BS00080151_51	3D1	7.5
IWB16928	D_contig59199_227	3D1	7.5
IWB21797	Excalibur_c11079_101	3D1	7.5
IWB26693	Excalibur_c45695_153	3D1	7.5
IWB29062	Excalibur_c83177_99	3D1	7.5
IWB29480	Excalibur_c9485_351	3D1	7.5
IWB31017	Excalibur_rep_c69004_1653	3D1	7.5
IWB33645	GENE-3869_1488	3D1	7.5
IWB34406	IAAV1578	3D1	7.5
IWB34643	IAAV2980	3D1	7.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB36735	Jagger_c728_225	3D1	7.5
IWB40683	Kukri_c1183_250	3D1	7.5
IWB49729	Kukri_rep_c117022_97	3D1	7.5
IWB53476	RAC875_c12071_413	3D1	7.5
IWB53477	RAC875_c12071_998	3D1	7.5
IWB56282	RAC875_c29099_540	3D1	7.5
IWB58245	RAC875_c46403_277	3D1	7.5
IWB58249	RAC875_c46415_638	3D1	7.5
IWB58492	RAC875_c48906_281	3D1	7.5
IWB61607	RAC875_rep_c106565_185	3D1	7.5
IWB64174	RFL_Contig3008_1177	3D1	7.5
IWB64735	RFL_Contig4591_1759	3D1	7.5
IWB75016	tplb0053a24_1247	3D1	7.5
IWB75329	tplb0062k24_584	3D1	7.5
IWB52061	Ra_c4231_465	3D2	0.0
IWB65183	RFL_Contig5953_1298	3D2	2.1
IWB50128	Kukri_rep_c71523_81	3D2	2.4
IWB34348	IAAV1270	3D2	8.3
IWB44854	Kukri_c38868_427	3D2	11.5
IWB58554	RAC875_c494_436	3D2	18.4
IWB39711	Ku_c6080_1667	3D2	26.1
IWB40511	Kukri_c11075_356	3D2	26.1
IWB64499	RFL_Contig383_1347	3D2	26.1
IWB48172	Kukri_c8913_385	3D2	26.8
IWB37176	JD_c2086_1242	3D3	0.0
IWA643	wsnp_CAP11_c1051_622082	3D3	1.8
IWA4081	wsnp_Ex_c5061_8986366	3D3	1.8
IWB7538	BS00024440_51	3D3	1.8
IWB9864	BS00066691_51	3D3	1.8
IWB10661	BS00073376_51	3D3	1.8
IWB11519	BS00087693_51	3D3	1.8
IWB12656	CAP11_c1051_121	3D3	1.8
IWB13275	CAP12_c2073_98	3D3	1.8
IWB18449	D_GBF1XID02HLMWB_65	3D3	1.8
IWB22531	Excalibur_c15009_1129	3D3	1.8
IWB32721	GENE-1910_113	3D3	1.8
IWB39678	Ku_c594_1198	3D3	1.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB40720	Kukri_c12013_90	3D3	1.8
IWB41228	Kukri_c1458_1705	3D3	1.8
IWB42149	Kukri_c19514_1602	3D3	1.8
IWB50460	Kukri_rep_c87658_1436	3D3	1.8
IWB50461	Kukri_rep_c87658_1542	3D3	1.8
IWB57983	RAC875_c43838_146	3D3	1.8
IWB58760	RAC875_c51595_177	3D3	1.8
IWB63941	RFL_Contig2432_953	3D3	1.8
IWB64548	RFL_Contig3966_1511	3D3	1.8
IWA1796	wsnp_Ex_c13629_21411429	3D3	4.3
IWB5027	BobWhite_rep_c52911_146	3D3	4.3
IWB14020	CAP7_c3438_196	3D3	4.3
IWB25922	Excalibur_c3821_1355	3D3	4.3
IWB58813	RAC875_c5222_59	3D3	4.3
IWB63653	RFL_Contig148_359	3D3	4.3
IWB5762	BS00000660_51	3D3	5.3
IWA6777	wsnp_Ku_c25527_35493338	3D3	6.4
IWB7555	BS00024812_51	3D3	6.4
IWB10689	BS00073760_51	3D3	6.4
IWB35284	IAAV7013	3D3	6.4
IWB26400	Excalibur_c4302_2208	3D3	6.7
IWB15088	CAP8_rep_c9749_292	3D3	7.0
IWA6485	wsnp_Ku_c13204_21105694	3D3	15.4
IWB8827	BS00061125_51	3D3	15.4
IWB4163	BobWhite_c6420_284	3D3	15.7
IWB14088	CAP7_c4219_359	3D3	15.7
IWB59163	RAC875_c5606_501	3D3	15.7
IWB25072	Excalibur_c31175_162	4A	0.0
IWA1766	wsnp_Ex_c13354_21047873	4A	0.7
IWB23404	Excalibur_c19984_1072	4A	0.7
IWB52137	Ra_c4614_1114	4A	5.0
IWB10389	BS00069271_51	4A	6.7
IWB34516	IAAV2216	4A	6.7
IWB5921	BS00003914_51	4A	12.6
IWB21392	Ex_c864_653	4A	15.1
IWB68921	Tdurum_contig21233_82	4A	16.4
IWB8337	BS00043286_51	4A	16.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB70645	Tdurum_contig41185_259	4A	19.3
IWB27620	Excalibur_c56041_728	4A	21.4
IWA54	wsnp_BE405275A_Ta_1_1	4A	23.9
IWA8389	wsnp_RFL_Contig2771_2524880	4A	23.9
IWB6948	BS00022177_51	4A	23.9
IWB9651	BS00065863_51	4A	23.9
IWB11749	BS00092244_51	4A	24.2
IWA3161	wsnp_Ex_c28429_37553452	4A	28.7
IWB38828	Ku_c22706_1527	4A	30.8
IWB53771	RAC875_c1377_428	4A	30.8
IWA3993	wsnp_Ex_c4752_8482625	4A	31.2
IWB5893	BS00003776_51	4A	31.8
IWB42619	Kukri_c22231_87	4A	46.1
IWA4232	wsnp_Ex_c54453_57331510	4A	46.4
IWB6335	BS00011060_51	4A	46.8
IWA603	wsnp_BM138178A_Ta_2_1	4A	47.8
IWA4321	wsnp_Ex_c5690_9994334	4A	49.2
IWA4260	wsnp_Ex_c55245_57821389	4A	51.2
IWA4261	wsnp_Ex_c55245_57821568	4A	51.2
IWB4310	BobWhite_c7235_365	4A	51.2
IWB4316	BobWhite_c7260_197	4A	51.2
IWB6362	BS00011173_51	4A	51.2
IWB47864	Kukri_c80869_122	4A	51.2
IWA4479	wsnp_Ex_c6320_11003498	4A	51.6
IWA1992	wsnp_Ex_c1520_2906995	4A	51.9
IWA4252	wsnp_Ex_c5487_9686018	4A	51.9
IWB22778	Excalibur_c16353_264	4A	53.0
IWB42248	Kukri_c2005_1312	4A	54.0
IWB1726	BobWhite_c23619_138	4A	55.0
IWB43873	Kukri_c30613_122	4A	56.2
IWA3584	wsnp_Ex_c36701_44603531	4A	57.3
IWB26062	Excalibur_c39621_358	4A	57.3
IWB45543	Kukri_c4559_278	4A	57.3
IWB65359	TA001195-0515	4A	57.3
IWA7521	wsnp_Ku_rep_c76865_75281903	4A	57.6
IWB46973	Kukri_c6199_1183	4A	57.6
IWB56556	RAC875_c31051_490	4A	57.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB67877	Tdurum_contig13140_69	4A	57.6
IWB32882	GENE-2331_126	4A	57.9
IWB50371	Kukri_rep_c79597_513	4A	58.3
IWB48136	Kukri_c8815_531	4A	59.3
IWB48137	Kukri_c8815_619	4A	59.3
IWA1320	wsnp_Ex_c10390_17007929	4A	60.0
IWB21625	Excalibur_c10390_104	4A	60.0
IWA5457	wsnp_Ex_rep_c67799_66488792	4A	60.6
IWB63549	RFL_Contig1053_65	4A	61.6
IWB54030	RAC875_c14911_1282	4A	62.0
IWB57437	RAC875_c38663_2179	4A	62.6
IWB34665	IAAV3115	4A	63.0
IWA110	wsnp_BE442776A-Ta_2_2	4A	63.3
IWA826	wsnp_CAP11_c992_593615	4A	63.3
IWA2781	wsnp_Ex_c23130_32358433	4A	63.3
IWA4230	wsnp_Ex_c54395_57291841	4A	63.3
IWA4406	wsnp_Ex_c6044_10590322	4A	63.3
IWA4560	wsnp_Ex_c6644_11508418	4A	63.3
IWA5069	wsnp_Ex_rep_c102623_87746777	4A	63.3
IWA5652	wsnp_Ex_rep_c69890_68851948	4A	63.3
IWA6531	wsnp_Ku_c14515_22860258	4A	63.3
IWA6597	wsnp_Ku_c16481_25377573	4A	63.3
IWA6873	wsnp_Ku_c30381_40208899	4A	63.3
IWA6944	wsnp_Ku_c34883_44172415	4A	63.3
IWA7216	wsnp_Ku_c61953_63254478	4A	63.3
IWA7271	wsnp_Ku_c7197_12439730	4A	63.3
IWA7859	wsnp_Ra_c31915_40982091	4A	63.3
IWB3065	BobWhite_c39599_82	4A	63.3
IWB30780	Excalibur_rep_c66815_273	4A	63.3
IWB33053	GENE-2768_352	4A	63.3
IWB40915	Kukri_c12878_659	4A	63.3
IWB42417	Kukri_c21014_1472	4A	63.3
IWB42611	Kukri_c22186_502	4A	63.3
IWB46684	Kukri_c57687_182	4A	63.3
IWB48340	Kukri_c93635_290	4A	63.3
IWB50522	Kukri_rep_c94281_83	4A	63.3
IWB59437	RAC875_c59416_158	4A	63.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB60593	RAC875_c79934_95	4A	63.3
IWB62547	RAC875_rep_c69241_454	4A	63.3
IWB65778	TA004056-0809	4A	63.3
IWB5392	BobWhite_rep_c63668_187	4A	63.7
IWB37681	JD_c6255_1092	4A	64.3
IWB34799	IAAV3906	4A	65.0
IWB45611	Kukri_c46057_646	4A	65.3
IWA109	wsnp_BE442776A_Ta_2_1	4A	65.7
IWA115	wsnp_BE442961A_Ta_2_1	4A	65.7
IWA172	wsnp_BE445427A_Ta_2_1	4A	65.7
IWA296	wsnp_BE497618A_Ta_1_1	4A	65.7
IWA1178	wsnp_CAP8_c296_283066	4A	65.7
IWA1341	wsnp_Ex_c10527_17198865	4A	65.7
IWA1693	wsnp_Ex_c12818_20334501	4A	65.7
IWA1824	wsnp_Ex_c1387_2659020	4A	65.7
IWA1919	wsnp_Ex_c14641_22698595	4A	65.7
IWA3027	wsnp_Ex_c2617_4864218	4A	65.7
IWA3028	wsnp_Ex_c2617_4864441	4A	65.7
IWA3029	wsnp_Ex_c2617_4864955	4A	65.7
IWA3088	wsnp_Ex_c27088_36309449	4A	65.7
IWA3311	wsnp_Ex_c31006_39850673	4A	65.7
IWA3326	wsnp_Ex_c31249_40066886	4A	65.7
IWA3361	wsnp_Ex_c3178_5868813	4A	65.7
IWA3541	wsnp_Ex_c35839_43909163	4A	65.7
IWA3542	wsnp_Ex_c35839_43909849	4A	65.7
IWA3565	wsnp_Ex_c36141_44153175	4A	65.7
IWA3845	wsnp_Ex_c4286_7734046	4A	65.7
IWA4405	wsnp_Ex_c6044_10590220	4A	65.7
IWA4700	wsnp_Ex_c7550_12907422	4A	65.7
IWA4771	wsnp_Ex_c8131_13753986	4A	65.7
IWA4772	wsnp_Ex_c8131_13754852	4A	65.7
IWA5851	wsnp_JD_c14769_14413046	4A	65.7
IWA5865	wsnp_JD_c15643_15039462	4A	65.7
IWA5897	wsnp_JD_c19109_17348071	4A	65.7
IWA5975	wsnp_JD_c27944_22630918	4A	65.7
IWA6540	wsnp_Ku_c14803_23225628	4A	65.7
IWA7092	wsnp_Ku_c46057_52907637	4A	65.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7133	wsnp_Ku_c50991_56423564	4A	65.7
IWA7134	wsnp_Ku_c50991_56423610	4A	65.7
IWA7270	wsnp_Ku_c7197_12439299	4A	65.7
IWA8220	wsnp_RFL_Contig1073_101625	4A	65.7
IWB2155	BobWhite_c27944_234	4A	65.7
IWB2614	BobWhite_c3325_613	4A	65.7
IWB12779	CAP11_c2377_62	4A	65.7
IWB14818	CAP8_c541_362	4A	65.7
IWB25984	Excalibur_c38886_129	4A	65.7
IWB28444	Excalibur_c6644_1461	4A	65.7
IWB32953	GENE-2491_309	4A	65.7
IWB35812	IACX1896	4A	65.7
IWB38110	Ku_c104619_404	4A	65.7
IWB45848	Kukri_c48155_158	4A	65.7
IWB47483	Kukri_c6954_320	4A	65.7
IWB54697	RAC875_c18564_222	4A	65.7
IWB55368	RAC875_c22562_429	4A	65.7
IWB61774	RAC875_rep_c108287_212	4A	65.7
IWB62659	RAC875_rep_c70191_89	4A	65.7
IWB62767	RAC875_rep_c71185_473	4A	65.7
IWA112	wsnp_BE442869A_Ta_2_1	4A	66.0
IWA5729	wsnp_Ex_rep_c71305_70087742	4A	66.0
IWB35538	IAAV8784	4A	66.0
IWB56922	RAC875_c34232_184	4A	66.0
IWB74553	tplb0035b22_184	4A	66.0
IWB74987	tplb0051g20_452	4A	66.0
IWA3582	wsnp_Ex_c3666_6687919	4A	66.3
IWB35060	IAAV562	4A	66.6
IWB32815	GENE-2127_235	4A	67.0
IWB45447	Kukri_c44469_1240	4A	67.3
IWA1060	wsnp_CAP7_c2243_1090229	4A	67.6
IWA2334	wsnp_Ex_c1865_3515470	4A	67.6
IWA4079	wsnp_Ex_c50586_54818545	4A	67.6
IWA6046	wsnp_JD_c4217_5322858	4A	67.6
IWA7522	wsnp_Ku_rep_c77171_75478137	4A	67.6
IWB32816	GENE-2127_317	4A	67.6
IWB32896	GENE-2354_155	4A	67.6



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB55905	RAC875_c26184_273	4A	67.6
IWB70517	Tdurum_contig34920_104	4A	67.6
IWA4608	wsnp_Ex_c7011_12080274	4A	69.0
IWA1074	wsnp_CAP7_c2931_1395666	4A	69.3
IWA1295	wsnp_Ex_c10186_16720660	4A	69.3
IWA3324	wsnp_Ex_c31173_39999624	4A	69.3
IWA4395	wsnp_Ex_c5979_10480527	4A	69.3
IWA4876	wsnp_Ex_c9094_15139750	4A	69.3
IWA5335	wsnp_Ex_rep_c66930_65358529	4A	69.3
IWA5687	wsnp_Ex_rep_c70327_69270561	4A	69.3
IWA6103	wsnp_JD_c5620_6774675	4A	69.3
IWB3495	BobWhite_c46071_74	4A	69.3
IWB4844	BobWhite_rep_c50115_136	4A	69.3
IWB20983	Ex_c5979_1449	4A	69.3
IWB26384	Excalibur_c4283_201	4A	69.3
IWB32991	GENE-2637_396	4A	69.3
IWB41622	Kukri_c16665_595	4A	69.3
IWB51260	Ra_c17211_876	4A	69.3
IWB61120	RAC875_c9526_88	4A	69.3
IWB62986	RAC875_rep_c73827_306	4A	69.3
IWB63037	RAC875_rep_c74695_101	4A	69.3
IWB63118	RAC875_rep_c77874_269	4A	69.3
IWB65188	RFL_Contig5998_745	4A	69.3
IWB74979	tplb0051b16_1324	4A	69.3
IWB4429	BobWhite_c8146_612	4A	70.0
IWA1327	wsnp_Ex_c10463_17113256	4A	70.7
IWA3826	wsnp_Ex_c42406_48991013	4A	70.7
IWA6443	wsnp_Ku_c11945_19406789	4A	70.7
IWA8495	wsnp_RFL_Contig3634_3841260	4A	70.7
IWB1119	BobWhite_c17999_112	4A	70.7
IWB1356	BobWhite_c20163_456	4A	70.7
IWB46934	Kukri_c61419_550	4A	70.7
IWB62690	RAC875_rep_c70416_332	4A	70.7
IWA3877	wsnp_Ex_c43734_49968808	4A	71.1
IWB61332	RAC875_rep_c102042_172	4A	72.1
IWA8	wsnp_BE398523A-Ta_2_1	4A	72.5
IWA1527	wsnp_Ex_c11663_18779609	4A	72.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1795	wsnp_Ex_c13623_21404172	4A	72.5
IWA3489	wsnp_Ex_c3463_6348659	4A	72.5
IWA3490	wsnp_Ex_c3463_6348808	4A	72.5
IWA5036	wsnp_Ex_rep_c101826_87124211	4A	72.5
IWA7072	wsnp_Ku_c44600_51841068	4A	72.5
IWB51756	Ra_c30013_483	4A	72.5
IWA4254	wsnp_Ex_c5492_9691880	4A	72.8
IWA7203	wsnp_Ku_c5979_10559245	4A	72.8
IWA7875	wsnp_Ra_c33762_42584098	4A	72.8
IWB35371	IAAV7636	4A	72.8
IWB48418	Kukri_c9578_2045	4A	72.8
IWA1400	wsnp_Ex_c10886_17694220	4A	73.1
IWB34345	IAAV125	4A	73.1
IWA4319	wsnp_Ex_c56880_58824784	4A	73.5
IWB43280	Kukri_c2634_487	4A	73.5
IWB74191	tplb0024j12_840	4A	73.5
IWA2734	wsnp_Ex_c2266_4247520	4A	73.8
IWA4253	wsnp_Ex_c5492_9691241	4A	73.8
IWA4768	wsnp_Ex_c8092_13695482	4A	73.8
IWA6377	wsnp_Ku_c10224_16965872	4A	73.8
IWB3663	BobWhite_c48455_818	4A	73.8
IWB12211	BS00103813_51	4A	73.8
IWB23168	Excalibur_c18575_310	4A	73.8
IWB34384	IAAV1461	4A	73.8
IWB35330	IAAV7376	4A	73.8
IWB41129	Kukri_c13991_279	4A	73.8
IWB41131	Kukri_c13991_655	4A	73.8
IWB44966	Kukri_c39882_203	4A	73.8
IWB58994	RAC875_c5394_1052	4A	73.8
IWB35170	IAAV6223	4A	74.2
IWB43370	Kukri_c27037_112	4A	74.5
IWB25199	Excalibur_c32366_122	4A	74.8
IWB45853	Kukri_c48199_102	4A	75.5
IWA1804	wsnp_Ex_c1373_2628597	4A	77.6
IWA1792	wsnp_Ex_c13615_21393511	4A	77.9
IWA4698	wsnp_Ex_c7528_12868250	4A	77.9
IWA4867	wsnp_Ex_c9035_15054913	4A	77.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7448	wsnp_Ku_rep_c68861_68030775	4A	77.9
IWB9	BobWhite_c10082_241	4A	77.9
IWB7960	BS00034174_51	4A	77.9
IWB12834	CAP11_c315_247	4A	77.9
IWB33127	GENE-2947_175	4A	77.9
IWB33128	GENE-2947_357	4A	77.9
IWB61674	RAC875_rep_c107210_217	4A	77.9
IWA5699	wsnp_Ex_rep_c70578_69495303	4A	78.9
IWB1360	BobWhite_c20183_318	4A	79.3
IWB31143	Excalibur_rep_c70578_299	4A	79.3
IWA2211	wsnp_Ex_c17361_26054611	4A	80.3
IWB485	BobWhite_c13322_215	4A	80.3
IWB63363	RAC875_rep_c97967_340	4A	80.3
IWA4657	wsnp_Ex_c7335_12579818	4A	80.7
IWB48193	Kukri_c89772_150	4A	81.0
IWB21125	Ex_c67622_392	4A	81.7
IWA2864	wsnp_Ex_c2403_4502745	4A	82.0
IWA53	wsnp_BE404977A_Ta_1_1	4A	82.4
IWA101	wsnp_BE442666A_Ta_2_1	4A	82.4
IWA568	wsnp_BG604678A_Ta_1_2	4A	82.4
IWA3664	wsnp_Ex_c39021_46412977	4A	82.4
IWA4201	wsnp_Ex_c53906_56983357	4A	82.4
IWA4784	wsnp_Ex_c829_1620518	4A	82.4
IWA4787	wsnp_Ex_c829_1621908	4A	82.4
IWA7346	wsnp_Ku_c9208_15488367	4A	82.4
IWA8269	wsnp_RFL_Contig1910_1074716	4A	82.4
IWB3705	BobWhite_c4931_170	4A	82.4
IWB18669	D_GBUVHFX01EZR9Q_294	4A	82.4
IWB20890	Ex_c53906_569	4A	82.4
IWB36333	IACX8919	4A	82.4
IWB57347	RAC875_c37840_704	4A	82.7
IWB3123	BobWhite_c4048_247	4A	83.0
IWB42278	Kukri_c20202_223	4A	83.4
IWA483	wsnp_BF474615A_Ta_1_4	4A	83.7
IWA4431	wsnp_Ex_c6139_10739829	4A	83.7
IWA4512	wsnp_Ex_c64593_63334637	4A	83.7
IWA4742	wsnp_Ex_c7899_13416350	4A	83.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA4785	wsnp_Ex_c829_1620563	4A	83.7
IWA4786	wsnp_Ex_c829_1620740	4A	83.7
IWA6501	wsnp_Ku_c13640_21686670	4A	83.7
IWB851	BobWhite_c1593_539	4A	83.7
IWB2566	BobWhite_c3266_501	4A	83.7
IWB3142	BobWhite_c4089_73	4A	83.7
IWB3706	BobWhite_c4931_62	4A	83.7
IWB6208	BS00010339_51	4A	83.7
IWB21367	Ex_c829_634	4A	83.7
IWB28352	Excalibur_c65185_665	4A	83.7
IWB36471	Jagger_c2057_97	4A	83.7
IWB43463	Kukri_c2760_804	4A	83.7
IWB43750	Kukri_c29625_198	4A	83.7
IWB56169	RAC875_c28145_553	4A	83.7
IWA5269	wsnp_Ex_rep_c66600_64897324	4A	84.4
IWA5291	wsnp_Ex_rep_c66706_65037564	4A	84.4
IWB7495	BS00023522_51	4A	84.4
IWB33174	GENE-3043_279	4A	84.4
IWB33175	GENE-3043_289	4A	84.4
IWB74969	tplb0050j22_569	4A	85.4
IWA2794	wsnp_Ex_c23248_32488251	4A	86.4
IWB20891	Ex_c53906_571	4A	87.1
IWB29546	Excalibur_c96303_224	4A	87.4
IWB65999	TA005643-0627	4A	88.5
IWA2606	wsnp_Ex_c21383_30513824	4A	88.8
IWA6193	wsnp_JD_c8309_9321723	4A	88.8
IWB63874	RFL_Contig2226_1048	4A	88.8
IWA4023	wsnp_Ex_c48449_53350799	4A	89.1
IWA7442	wsnp_Ku_rep_c68565_67614479	4A	89.5
IWB4910	BobWhite_rep_c50869_1676	4A	89.5
IWA7077	wsnp_Ku_c45197_52288542	4A	90.2
IWB34865	IAAV4351	4A	90.8
IWB8287	BS00041735_51	4A	91.2
IWB6070	BS00009492_51	4A	93.0
IWB8569	BS00049911_51	4A	93.0
IWB51795	Ra_c3111_1623	4A	93.0
IWB65970	TA005380-0966	4A	93.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7386	BS00023031_51	4A	94.0
IWB2676	BobWhite_c3417_424	4A	96.1
IWB11778	BS00092859_51	4A	98.5
IWB11779	BS00092860_51	4A	98.5
IWB1450	BobWhite_c20909_243	4A	98.8
IWB4642	BobWhite_c9660_938	4A	98.8
IWB5911	BS00003866_51	4A	98.8
IWB10950	BS00077716_51	4A	98.8
IWB23666	Excalibur_c21616_254	4A	98.8
IWB27434	Excalibur_c539_1253	4A	98.8
IWB27435	Excalibur_c539_567	4A	98.8
IWB32858	GENE-2267_428	4A	98.8
IWB34445	IAAV1775	4A	98.8
IWB43375	Kukri_c2706_1424	4A	98.8
IWB58408	RAC875_c48107_65	4A	98.8
IWB41721	Kukri_c17144_678	4A	100.2
IWB1322	BobWhite_c19919_572	4A	104.8
IWB6734	BS00021715_51	4A	106.1
IWB10266	BS00068243_51	4A	106.5
IWB55747	RAC875_c25124_182	4A	111.3
IWA7118	w SNP_Ku_c4924_8816643	4A	113.1
IWB35298	IAAV7132	4A	114.6
IWB59546	RAC875_c6075_214	4A	114.6
IWB22749	Excalibur_c16188_531	4A	120.3
IWB24962	Excalibur_c30378_673	4A	121.8
IWA1521	w SNP_Ex_c11619_18714738	4A	122.1
IWB56921	RAC875_c34231_812	4A	122.1
IWB12388	BS00108849_51	4A	125.3
IWB9549	BS00065444_51	4A	130.0
IWB30671	Excalibur_rep_c114451_411	4A	130.0
IWB46985	Kukri_c6224_492	4A	130.0
IWB46819	Kukri_c59705_167	4A	131.8
IWB1375	BobWhite_c20282_164	4A	132.1
IWB43191	Kukri_c25832_687	4A	132.1
IWB37469	JD_c4438_839	4A	132.4
IWB42362	Kukri_c20719_949	4A	132.8
IWB43192	Kukri_c25832_794	4A	133.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB31239	Excalibur_rep_c74900_73	4A	135.1
IWB71854	Tdurum_contig47858_908	4A	135.5
IWB47707	Kukri_c77040_87	4A	137.9
IWB64647	RFL_Contig4336_184	4A	140.0
IWB42242	Kukri_c20012_1362	4A	140.6
IWB12737	CAP11_c1989_183	4A	141.0
IWA2505	wsnp_Ex_c20041_29076295	4A	141.3
IWA7653	wsnp_Ra_c16476_25132652	4A	141.3
IWB2658	BobWhite_c33898_150	4A	141.3
IWB44184	Kukri_c33315_159	4A	141.3
IWB57472	RAC875_c390_1494	4A	141.3
IWB58550	RAC875_c49370_172	4A	141.3
IWB58552	RAC875_c49370_327	4A	141.3
IWB60934	RAC875_c88582_131	4A	142.3
IWA3774	wsnp_Ex_c41313_48161689	4A	143.0
IWB2846	BobWhite_c3656_1155	4A	143.7
IWB29781	Excalibur_rep_c102020_253	4A	143.7
IWB43187	Kukri_c25823_443	4A	143.7
IWB47582	Kukri_c7419_401	4A	143.7
IWB54425	RAC875_c17197_603	4A	143.7
IWB1669	BobWhite_c23141_92	4A	144.7
IWB5606	BobWhite_rep_c66326_95	4A	144.7
IWB60269	RAC875_c7016_2039	4A	144.7
IWB8782	BS00059503_51	4A	145.7
IWA2816	wsnp_Ex_c2352_4405961	4A	146.8
IWB8154	BS00039147_51	4A	146.8
IWB8155	BS00039148_51	4A	146.8
IWB87	BobWhite_c10610_1096	4A	147.1
IWB61118	RAC875_c95150_286	4A	147.4
IWB48435	Kukri_c96159_197	4A	148.1
IWB45924	Kukri_c48943_1149	4A	148.5
IWB4308	BobWhite_c7217_317	4A	148.8
IWB12722	CAP11_c18_238	4A	148.8
IWB26428	Excalibur_c4325_1150	4A	148.8
IWB26429	Excalibur_c4325_1440	4A	148.8
IWB26431	Excalibur_c4325_910	4A	148.8
IWB68425	Tdurum_contig15586_563	4A	149.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB59450	RAC875_c59673_188	4A	149.8
IWB59451	RAC875_c59673_500	4A	149.8
IWA811	wsnp_CAP11_c8366_3622210	4A	153.0
IWB14501	CAP8_c1180_342	4A	153.0
IWB44902	Kukri_c39261_561	4A	153.0
IWB68289	Tdurum_contig14728_113	4A	153.0
IWB1284	BobWhite_c19497_606	4A	153.3
IWB75315	tplb0062c24_1758	4A	153.6
IWB57145	RAC875_c35979_263	4A	154.0
IWB22203	Excalibur_c13054_1564	4A	154.3
IWB42841	Kukri_c23629_120	4A	154.3
IWB14913	CAP8_c714_128	4A	155.0
IWB2355	BobWhite_c30317_140	4A	155.3
IWB3325	BobWhite_c43728_100	4A	157.5
IWB12180	BS00101512_51	4A	157.5
IWB23058	Excalibur_c17992_1071	4A	157.5
IWB27364	Excalibur_c53103_113	4A	157.5
IWB28551	Excalibur_c7034_234	4A	157.5
IWB56310	RAC875_c29282_187	4A	157.5
IWB56311	RAC875_c29282_216	4A	157.5
IWB56313	RAC875_c29282_566	4A	157.5
IWB61041	RAC875_c917_442	4A	157.5
IWB34056	GENE-4618_110	4A	157.8
IWB12181	BS00101513_51	4A	158.1
IWB34057	GENE-4618_413	4A	158.5
IWB6566	BS00012482_51	4A	160.9
IWB65650	TA003110-1046	4A	161.6
IWB74680	tplb0040d24_613	4A	162.3
IWB74847	tplb0046a02_804	4A	162.6
IWB11714	BS00091561_51	4A	185.1
IWB73845	Tdurum_contig93100_77	4A	185.1
IWA1505	wsnp_Ex_c11474_18507872	4A	196.0
IWB63979	RFL_Contig2531_987	4A	196.0
IWB24691	Excalibur_c2827_227	4A	196.4
IWB27971	Excalibur_c6050_323	4A	196.4
IWB6186	BS00010202_51	4A	196.7
IWA2756	wsnp_Ex_c22830_32035900	4A	197.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB3188	BobWhite_c41628_83	4B	0.0
IWB67500	Tdurum_contig12204_384	4B	3.9
IWB37519	JD_c48945_490	4B	4.9
IWB6635	BS00016834_51	4B	5.3
IWB32456	GENE-1407_467	4B	5.3
IWB34322	IAAV1091	4B	5.3
IWB34734	IAAV3549	4B	5.3
IWB66861	Tdurum_contig10978_1074	4B	5.3
IWB9483	BS00065222_51	4B	5.9
IWB24458	Excalibur_c26571_370	4B	5.9
IWB24459	Excalibur_c26571_507	4B	5.9
IWB3256	BobWhite_c42663_70	4B	6.3
IWB5799	BS00001953_51	4B	6.3
IWB21233	Ex_c7059_1198	4B	6.3
IWB22876	Excalibur_c1692_1225	4B	6.3
IWB47765	Kukri_c7838_1343	4B	6.3
IWB73234	Tdurum_contig74813_560	4B	6.3
IWB12723	CAP11_c181_202	4B	6.6
IWB36199	IACX7457	4B	7.0
IWB5736	BS00000054_51	4B	7.3
IWB6035	BS00009274_51	4B	7.3
IWB33016	GENE-2673_2387	4B	7.3
IWB35845	IACX2226	4B	7.3
IWB42467	Kukri_c21281_202	4B	7.3
IWB63198	RAC875_rep_c82932_407	4B	8.4
IWB63199	RAC875_rep_c82932_428	4B	8.4
IWB67498	Tdurum_contig12204_1131	4B	9.4
IWB67499	Tdurum_contig12204_1182	4B	10.4
IWB3567	BobWhite_c47144_153	4B	16.1
IWB75120	tplb0056o05_409	4B	17.6
IWB35486	IAAV8499	4B	18.6
IWB3246	BobWhite_c4256_213	4B	28.4
IWB51352	Ra_c19259_1799	4B	28.8
IWB51353	Ra_c19259_1814	4B	28.8
IWB4447	BobWhite_c8266_510	4B	29.5
IWA564	wsnp_BG604404B-Ta_2_1	4B	29.8
IWB4448	BobWhite_c8266_582	4B	29.8



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB44213	Kukri_c33550_601	4B	30.5
IWB7473	BS00023204_51	4B	32.5
IWB57254	RAC875_c37166_408	4B	32.5
IWA5358	wsnp_Ex_rep_c67136_65617520	4B	32.9
IWB3641	BobWhite_c4818_173	4B	32.9
IWB13162	CAP11_s8679_211	4B	32.9
IWB50138	Kukri_rep_c71670_163	4B	32.9
IWB12411	BS00109456_51	4B	33.2
IWA1100	wsnp_CAP7_c599_312057	4B	34.9
IWB7266	BS00022808_51	4B	34.9
IWB38327	Ku_c12557_1183	4B	34.9
IWB39417	Ku_c4260_441	4B	34.9
IWB45261	Kukri_c4260_1139	4B	34.9
IWB47460	Kukri_c6879_252	4B	34.9
IWB74189	tplb0024i19_791	4B	34.9
IWA2595	wsnp_Ex_c21293_30421496	4B	35.2
IWA4490	wsnp_Ex_c6381_11093111	4B	35.2
IWA5408	wsnp_Ex_rep_c67510_66116823	4B	35.2
IWA6397	wsnp_Ku_c10515_17368422	4B	35.2
IWB2141	BobWhite_c27801_429	4B	35.2
IWB6882	BS00022055_51	4B	35.2
IWB11859	BS00094252_51	4B	35.2
IWB30656	Excalibur_rep_c114140_567	4B	35.2
IWB40627	Kukri_c11570_1218	4B	35.2
IWB43626	Kukri_c29008_195	4B	35.2
IWB58738	RAC875_c51375_238	4B	35.2
IWB58740	RAC875_c51375_394	4B	35.2
IWB74054	Tdurum_contig9893_492	4B	35.2
IWB74188	tplb0024i19_322	4B	35.2
IWA4055	wsnp_Ex_c49319_53953814	4B	69.1
IWB6961	BS00022194_51	4B	69.1
IWB72211	Tdurum_contig51818_145	4B	69.1
IWB65023	RFL_Contig5498_1000	4B	69.8
IWB11963	BS00096604_51	4B	70.1
IWA3400	wsnp_Ex_c32540_41180493	4B	71.9
IWB20500	Ex_c32540_659	4B	71.9
IWB34975	IAAV5117	4B	71.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3874	wsnp_Ex_c4358_7854194	4B	72.5
IWB51936	Ra_c36562_708	4B	72.5
IWB26339	Excalibur_c42450_727	4B	73.2
IWA7711	wsnp_Ra_c1992_3876325	4B	73.9
IWB20998	Ex_c61318_629	4B	74.6
IWB1339	BobWhite_c20051_53	4B	74.9
IWA3325	wsnp_Ex_c3119_5763762	4B	75.3
IWB34414	IAAV1630	4B	76.0
IWA5679	wsnp_Ex_rep_c70265_69211592	4B	77.0
IWA7641	wsnp_Ra_c15715_24192817	4B	77.0
IWB2965	BobWhite_c38340_243	4B	77.0
IWB3636	BobWhite_c4810_190	4B	77.0
IWB9134	BS00063804_51	4B	77.0
IWB9406	BS00064935_51	4B	77.0
IWB9582	BS00065555_51	4B	77.0
IWB20396	Ex_c28329_716	4B	77.0
IWB33082	GENE-2847_1060	4B	77.0
IWB34629	IAAV2880	4B	77.0
IWB34873	IAAV4437	4B	77.0
IWB34895	IAAV4595	4B	77.0
IWB35352	IAAV7491	4B	77.0
IWB35513	IAAV8654	4B	77.0
IWB42464	Kukri_c21270_1870	4B	77.0
IWB47207	Kukri_c65146_460	4B	77.0
IWB52318	Ra_c59822_1439	4B	77.0
IWB54160	RAC875_c15835_454	4B	77.0
IWB65720	TA003665-0980	4B	77.0
IWB65829	TA004394-0527	4B	77.0
IWB74037	Tdurum_contig98255_84	4B	77.0
IWB17848	D_GA8KES402G72JE_129	4B	77.8
IWB9392	BS00064884_51	4B	78.5
IWB21302	Ex_c7593_754	4B	78.5
IWB1249	BobWhite_c1907_124	4B	81.3
IWB5248	BobWhite_rep_c60452_158	4B	81.3
IWB24800	Excalibur_c29141_864	4B	81.3
IWB6136	BS00009915_51	4B	82.0
IWB11569	BS00088579_51	4B	82.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB27326	Excalibur_c52517_464	4B	83.6
IWB7799	BS00030842_51	4B	84.3
IWB42379	Kukri_c20822_1029	4B	84.7
IWB7267	BS00022809_51	4B	85.0
IWB21502	Excalibur_c100336_106	4B	85.4
IWB8217	BS00040305_51	4B	86.4
IWB10865	BS00076259_51	4B	86.4
IWB2398	BobWhite_c30756_256	4B	86.8
IWB3394	BobWhite_c44691_648	4B	86.8
IWB6994	BS00022258_51	4B	86.8
IWB7491	BS00023431_51	4B	86.8
IWB35104	IAAV585	4B	86.8
IWB37325	JD_c30756_562	4B	86.8
IWB43485	Kukri_c27737_912	4B	86.8
IWB73532	Tdurum_contig81797_369	4B	86.8
IWB33161	GENE-3024_59	4B	90.5
IWB27991	Excalibur_c60791_1196	4B	96.7
IWB23074	Excalibur_c18078_453	4B	97.4
IWB73887	Tdurum_contig93615_540	4B	97.4
IWB8837	BS00061358_51	4B	97.8
IWB69708	Tdurum_contig29104_533	4B	98.1
IWB72527	Tdurum_contig56675_78	4B	98.4
IWB72442	Tdurum_contig55414_154	4B	98.8
IWB7078	BS00022431_51	4B	99.1
IWB11201	BS00081631_51	4B	99.1
IWB70672	Tdurum_contig41902_1524	4B	99.1
IWB7142	BS00022534_51	4B	99.5
IWB49875	Kukri_rep_c69273_148	4B	99.5
IWB73888	Tdurum_contig93615_735	4B	99.5
IWA645	wsnp_CAP11_c1103_647926	4B	99.8
IWB37930	JG_c1844_303	4B	100.5
IWB46249	Kukri_c52413_282	4B	100.5
IWB46997	Kukri_c6242_147	4B	100.5
IWB72973	Tdurum_contig64187_347	4B	100.8
IWA7311	wsnp_Ku_c8075_13785546	4B	102.2
IWB47213	Kukri_c65194_256	4B	105.4
IWB24622	Excalibur_c27766_497	4B	106.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB2333	BobWhite_c30050_125	4B	106.4
IWB47849	Kukri_c80544_61	4B	106.4
IWB73117	Tdurum_contig68677_480	4B	106.4
IWB73227	Tdurum_contig74720_572	4B	106.4
IWB66869	Tdurum_contig10984_210	4B	106.8
IWB66870	Tdurum_contig10984_316	4B	106.8
IWB73226	Tdurum_contig74720_539	4B	106.8
IWA4569	wsnp_Ex_c6739_11646407	4B	107.8
IWB34526	IAAV2271	4B	107.8
IWB41837	Kukri_c17900_887	4B	107.8
IWB58319	RAC875_c47145_80	4B	107.8
IWB41836	Kukri_c17900_446	4B	108.1
IWB53624	RAC875_c12959_869	4B	108.1
IWB6422	BS00011510_51	4B	110.3
IWB49195	Kukri_rep_c106598_51	4B	110.3
IWB65475	TA001911-0254-w	4B	110.3
IWB44459	Kukri_c35562_207	4B	111.3
IWB65858	TA004596-0276	4B	112.3
IWA3615	wsnp_Ex_c37502_45236634	4B	114.0
IWB74821	tplb0045c06_1675	4B	123.3
IWB28293	Excalibur_c64418_447	4B	125.4
IWB66459	Tdurum_contig10322_1908	4B	125.4
IWB10339	BS00068537_51	4B	130.5
IWB28041	Excalibur_c6132_917	4B	130.5
IWB49180	Kukri_rep_c106474_293	4B	132.8
IWB932	BobWhite_c1656_845	4B	135.3
IWB59457	RAC875_c5969_173	4B	135.3
IWB71210	Tdurum_contig42498_637	4B	135.3
IWB3541	BobWhite_c46938_314	4B	135.7
IWB48970	Kukri_rep_c104277_1326	4B	135.7
IWB55304	RAC875_c22142_333	4B	135.7
IWB8794	BS00060041_51	4B	136.0
IWB39480	Ku_c4580_535	4B	141.4
IWB11911	BS00095028_51	4B	142.0
IWB1847	BobWhite_c24745_419	4B	142.4
IWB8981	BS00063011_51	4B	142.4
IWB6329	BS00011038_51	4B	143.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB6954	BS00022183_51	4B	143.8
IWB35311	IAAV7221	4B	143.8
IWB8207	BS00040127_51	4B	144.1
IWB8693	BS00056493_51	4B	144.1
IWB8694	BS00056495_51	4B	144.1
IWB60835	RAC875_c86104_111	4B	144.1
IWB65491	TA002019-0994	4B	144.1
IWB67263	Tdurum_contig11733_825	4B	144.1
IWB71796	Tdurum_contig47429_149	4B	144.1
IWB71797	Tdurum_contig47429_248	4B	144.1
IWB19222	D_GDRF1KQ02H66WD_341	4D	0.0
IWA2395	wsnp_Ex_c193_379727	4D	2.8
IWB45037	Kukri_c40437_66	4D	2.8
IWB35058	IAAV5607	4D	22.4
IWB28897	Excalibur_c79009_131	4D	27.9
IWB3336	BobWhite_c43880_73	4D	42.1
IWA161	wsnp_BE444858D_Ta_1_1	4D	50.8
IWA430	wsnp_BF202706D_Ta_1_1	4D	50.8
IWB59507	RAC875_c60218_63	4D	50.8
IWB62719	RAC875_rep_c70720_775	4D	50.8
IWA5381	wsnp_Ex_rep_c67296_65839761	4D	56.1
IWB30733	Excalibur_rep_c66353_598	4D	65.2
IWA752	wsnp_CAP11_c356_280910	4D	69.5
IWB15038	CAP8_rep_c5023_658	4D	69.5
IWB49801	Kukri_rep_c68594_530	4D	78.2
IWB34400	IAAV1538	5A1	0.0
IWB10092	BS00067606_51	5A1	0.7
IWB10110	BS00067647_51	5A1	0.7
IWB25463	Excalibur_c34451_370	5A1	4.9
IWB26906	Excalibur_c47920_249	5A1	5.3
IWB30060	Excalibur_rep_c104815_1181	5A1	8.2
IWB34611	IAAV2776	5A1	21.8
IWB64849	RFL_Contig4979_4240	5A1	21.8
IWB66053	TA006089-0703	5A1	23.6
IWB7371	BS00023008_51	5A1	25.3
IWB12158	BS00101071_51	5A1	25.3
IWB21806	Excalibur_c1110_978	5A1	26.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB9795	BS00066403_51	5A1	26.8
IWB21804	Excalibur_c1110_328	5A1	26.8
IWB40165	Ku_c9559_737	5A1	27.5
IWB41715	Kukri_c17126_1211	5A1	27.5
IWA4534	wsnp_Ex_c65569_63926293	5A1	27.8
IWA2991	wsnp_Ex_c25707_34968426	5A1	28.5
IWA7360	wsnp_Ku_c9559_15999945	5A1	28.5
IWA7361	wsnp_Ku_c9559_16000086	5A1	28.5
IWB7817	BS00031073_51	5A1	28.5
IWB25728	Excalibur_c36501_188	5A1	28.5
IWB50844	Ra_c10762_1137	5A1	28.5
IWA5053	wsnp_Ex_rep_c102143_87374435	5A1	28.9
IWB4171	BobWhite_c6468_104	5A1	28.9
IWA3196	wsnp_Ex_c28908_37989067	5A1	29.2
IWA3197	wsnp_Ex_c28908_37989320	5A1	29.2
IWA6463	wsnp_Ku_c1254_2498515	5A1	29.2
IWB5245	BobWhite_rep_c60372_388	5A1	29.2
IWB11440	BS00086096_51	5A1	29.2
IWB27798	Excalibur_c58300_564	5A1	29.2
IWB50392	Kukri_rep_c80571_265	5A1	29.2
IWB29632	Excalibur_c98513_226	5A1	29.9
IWA1569	wsnp_Ex_c11992_19213872	5A1	34.0
IWB64310	RFL_Contig3352_463	5A1	34.0
IWB17875	D_GA8KES402H1C3J_143	5A1	34.7
IWB12124	BS00100186_51	5A1	37.9
IWB34910	IAAV468	5A1	38.2
IWA4970	wsnp_Ex_c9842_16228523	5A1	38.5
IWB11068	BS00079189_51	5A1	38.5
IWB12123	BS00100185_51	5A1	38.5
IWB33288	GENE-3207_174	5A1	38.5
IWA4069	wsnp_Ex_c5013_8914160	5A1	42.3
IWB12627	BS00111119_51	5A1	42.3
IWB64449	RFL_Contig3674_847	5A1	42.3
IWB59582	RAC875_c61186_150	5A1	42.6
IWA419	wsnp_BF201102A-Ta_2_1	5A1	43.0
IWB12085	BS00099701_51	5A1	43.7
IWA3811	wsnp_Ex_c4211_7606269	5A1	44.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB48152	Kukri_c8835_579	5A1	44.7
IWA1062	wsnp_CAP7_c2282_1107112	5A1	45.0
IWA2378	wsnp_Ex_c19134_28056012	5A1	45.0
IWA5615	wsnp_Ex_rep_c69526_68472787	5A1	45.0
IWB3728	BobWhite_c51109_415	5A1	45.0
IWB40035	Ku_c7910_1651	5A1	45.0
IWB41931	Kukri_c18268_79	5A1	45.0
IWB48151	Kukri_c8835_112	5A1	45.0
IWB52605	Ra_c7322_2294	5A1	45.0
IWA5728	wsnp_Ex_rep_c71219_70023450	5A1	46.0
IWB4848	BobWhite_rep_c50145_387	5A1	46.0
IWB8252	BS00040933_51	5A1	46.4
IWB11853	BS00094095_51	5A1	46.4
IWB33331	GENE-3321_201	5A1	46.4
IWB602	BobWhite_c14172_113	5A1	47.7
IWA3876	wsnp_Ex_c43642_49901192	5A1	49.3
IWB14353	CAP7_rep_c10325_143	5A1	49.3
IWB62151	RAC875_rep_c112531_360	5A1	49.3
IWB9025	BS00063242_51	5A1	49.9
IWB43006	Kukri_c24642_426	5A1	50.3
IWB68312	Tdurum_contig14863_916	5A1	50.3
IWA825	wsnp_CAP11_c951_572693	5A1	51.3
IWA1973	wsnp_Ex_c15046_23216392	5A1	53.7
IWA7061	wsnp_Ku_c4389_7970859	5A1	55.1
IWB48691	Kukri_rep_c101800_175	5A2	0.0
IWA5002	wsnp_Ex_rep_c101323_86702413	5A2	0.7
IWB38700	Ku_c19516_384	5A2	1.0
IWB48690	Kukri_rep_c101800_131	5A2	1.0
IWB50947	Ra_c11529_647	5A2	1.7
IWA648	wsnp_CAP11_c1116_654940	5A2	2.7
IWB13571	CAP12_c956_61	5A2	2.7
IWB1070	BobWhite_c1763_558	5A2	3.0
IWB8070	BS00036851_51	5A2	3.4
IWB74351	tplb0029a15_1300	5A2	3.4
IWB9802	BS00066434_51	5A2	3.7
IWA649	wsnp_CAP11_c1116_654975	5A2	4.0
IWB34800	IAAV3916	5A2	4.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3391	wsnp_Ex_c32414_41076471	5A2	4.4
IWA7789	wsnp_Ra_c25624_35192195	5A2	4.4
IWB6828	BS00021969_51	5A2	4.4
IWB11229	BS00082063_51	5A2	4.4
IWB25201	Excalibur_c32414_705	5A2	4.4
IWB43734	Kukri_c29521_123	5A2	4.4
IWB59054	RAC875_c54693_298	5A2	4.4
IWA3083	wsnp_Ex_c26968_36188964	5A2	5.4
IWB4543	BobWhite_c8906_83	5A2	5.4
IWB23336	Excalibur_c1954_930	5A2	5.4
IWB64432	RFL_Contig3629_1465	5A2	7.1
IWB7282	BS00022838_51	5A2	7.5
IWA2802	wsnp_Ex_c2332_437192	5A2	7.8
IWB5368	BobWhite_rep_c63332_67	5A2	7.8
IWB6827	BS00021968_51	5A2	7.8
IWB7299	BS00022867_51	5A2	7.8
IWB11221	BS00081951_51	5A2	7.8
IWB12799	CAP11_c2623_196	5A2	7.8
IWB14661	CAP8_c3064_95	5A2	7.8
IWB20198	Ex_c2332_275	5A2	7.8
IWA2828	wsnp_Ex_c23689_32927141	5A2	10.4
IWA7162	wsnp_Ku_c5445_9668131	5A2	10.4
IWB10313	BS00068435_51	5A2	10.8
IWB58342	RAC875_c47328_483	5A2	10.8
IWA1670	wsnp_Ex_c12684_20157261	5A2	11.1
IWA7845	wsnp_Ra_c3095_5835193	5A2	11.4
IWB41874	Kukri_c18023_553	5A2	11.4
IWA6641	wsnp_Ku_c18023_27232712	5A2	11.8
IWB9669	BS00065915_51	5A2	11.8
IWB8656	BS00055102_51	5A2	12.1
IWB8015	BS00035526_51	5A2	12.5
IWB9130	BS00063793_51	5A2	12.8
IWB10029	BS00067351_51	5A2	12.8
IWB11590	BS00089076_51	5A2	14.2
IWB2919	BobWhite_c37652_272	5A2	14.9
IWB7528	BS00024230_51	5A2	14.9
IWB60231	RAC875_c68969_492	5A2	15.3



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB990	BobWhite_c17045_186	5A2	15.6
IWB16262	D_contig26179_372	5A2	15.6
IWB59300	RAC875_c57603_144	5A2	15.9
IWB5821	BS00003088_51	5A2	16.3
IWB7052	BS00022378_51	5A2	16.3
IWB8349	BS00043676_51	5A2	16.3
IWB10909	BS00076948_51	5A2	16.3
IWB11676	BS00090847_51	5A2	16.3
IWB66080	TA006296-0731	5A2	16.3
IWB33038	GENE-2725_217	5A2	16.6
IWB9252	BS00064336_51	5A2	17.3
IWB3232	BobWhite_c42349_99	5A2	18.4
IWB28033	Excalibur_c61241_109	5A2	21.9
IWB41168	Kukri_c14187_243	5A2	21.9
IWB61151	RAC875_c9617_373	5A2	21.9
IWB61152	RAC875_c9617_395	5A2	21.9
IWA821	wsnp_CAP11_c923_558715	5A2	22.9
IWA2114	wsnp_Ex_c16295_24772702	5A2	22.9
IWA2857	wsnp_Ex_c23968_33209733	5A2	22.9
IWA2859	wsnp_Ex_c23968_33210344	5A2	22.9
IWA4239	wsnp_Ex_c54655_57455562	5A2	22.9
IWA7009	wsnp_Ku_c3953_7233359	5A2	22.9
IWB59148	RAC875_c55872_149	5A2	22.9
IWB65730	TA003720-0955	5A2	22.9
IWB34731	IAAV3527	5A2	24.0
IWB2189	BobWhite_c2830_327	5A2	25.7
IWA2113	wsnp_Ex_c16295_24772663	5A2	28.2
IWA2856	wsnp_Ex_c23968_33209660	5A2	28.2
IWB15035	CAP8_rep_c4852_130	5A2	28.5
IWB59439	RAC875_c59520_130	5A2	28.5
IWB3299	BobWhite_c43389_1243	5A2	28.8
IWB11420	BS00085711_51	5A2	28.8
IWA6049	wsnp_JD_c43389_30288993	5A2	29.2
IWB48788	Kukri_rep_c102608_599	5A2	42.3
IWA2282	wsnp_Ex_c18107_26909127	5A2	43.0
IWB43581	Kukri_c28555_114	5A2	43.3
IWA3211	wsnp_Ex_c29051_38120784	5B	0.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6946	wsnp_Ku_c35090_44349446	5B	0.0
IWB7932	BS00033612_51	5B	0.0
IWB47615	Kukri_c74960_427	5B	0.0
IWB22465	Excalibur_c14594_182	5B	3.2
IWB72021	Tdurum_contig49841_618	5B	3.2
IWA2609	wsnp_Ex_c214_421541	5B	3.9
IWA2610	wsnp_Ex_c214_422365	5B	3.9
IWB8792	BS00060015_51	5B	3.9
IWB10350	BS00068592_51	5B	3.9
IWB41568	Kukri_c16387_186	5B	3.9
IWB7411	BS00023072_51	5B	5.3
IWB9125	BS00063769_51	5B	5.3
IWB9485	BS00065228_51	5B	5.3
IWB57445	RAC875_c3871_229	5B	5.3
IWB35827	IACX20330	5B	6.4
IWB5977	BS00004406_51	5B	6.7
IWA7300	wsnp_Ku_c7872_13484038	5B	7.1
IWA2992	wsnp_Ex_c2571_4784380	5B	7.4
IWA4282	wsnp_Ex_c5598_9855436	5B	7.4
IWB587	BobWhite_c14092_485	5B	7.4
IWB20310	Ex_c2571_842	5B	7.4
IWB47775	Kukri_c7872_96	5B	7.4
IWB51376	Ra_c19837_1031	5B	7.4
IWB58421	RAC875_c4828_268	5B	7.4
IWB32093	GENE-0782_747	5B	7.8
IWB56578	RAC875_c31197_62	5B	8.1
IWA1084	wsnp_CAP7_c3665_1701376	5B	8.4
IWA1176	wsnp_CAP8_c2693_1401039	5B	8.4
IWA1394	wsnp_Ex_c10842_17637744	5B	8.4
IWA1779	wsnp_Ex_c13468_21202450	5B	8.4
IWA1965	wsnp_Ex_c1498_2868339	5B	8.4
IWA4378	wsnp_Ex_c5915_10378807	5B	8.4
IWA5079	wsnp_Ex_rep_c103024_88075650	5B	8.4
IWA5494	wsnp_Ex_rep_c68091_66846454	5B	8.4
IWA6816	wsnp_Ku_c27243_37190781	5B	8.4
IWA7217	wsnp_Ku_c61976_63270478	5B	8.4
IWA7608	wsnp_Ra_c13424_21239985	5B	8.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB9938	BS00067028_51	5B	8.4
IWB10225	BS00068082_51	5B	8.4
IWB29856	Excalibur_rep_c102702_495	5B	8.4
IWB34854	IAAV4252	5B	8.4
IWB46117	Kukri_c51_98	5B	8.4
IWB49199	Kukri_rep_c106665_549	5B	8.4
IWB50091	Kukri_rep_c71114_838	5B	8.4
IWB66052	TA006084-0922	5B	8.4
IWB72886	Tdurum_contig62320_141	5B	8.4
IWA279	wsnp_BE496976B-Ta_2_1	5B	8.8
IWA1461	wsnp_Ex_c11275_18229524	5B	8.8
IWA1781	wsnp_Ex_c13496_21243167	5B	8.8
IWA3101	wsnp_Ex_c27219_36436025	5B	8.8
IWA7857	wsnp_Ra_c31894_40964279	5B	8.8
IWB1854	BobWhite_c2479_214	5B	8.8
IWB9949	BS00067072_51	5B	8.8
IWB13805	CAP7_c1403_70	5B	8.8
IWB34515	IAAV2194	5B	8.8
IWB39434	Ku_c4349_1791	5B	8.8
IWB39435	Ku_c4349_1890	5B	8.8
IWB40999	Kukri_c13224_551	5B	8.8
IWB42018	Kukri_c18702_132	5B	8.8
IWB47570	Kukri_c73901_100	5B	8.8
IWB53995	RAC875_c14769_1918	5B	8.8
IWB58756	RAC875_c51548_403	5B	8.8
IWB59100	RAC875_c5518_1401	5B	8.8
IWB63922	RFL_Contig2368_1958	5B	8.8
IWB72267	Tdurum_contig52439_196	5B	8.8
IWB74580	tplb0035o24_635	5B	8.8
IWA6909	wsnp_Ku_c32477_42086760	5B	9.1
IWB3193	BobWhite_c41725_430	5B	9.1
IWB3670	BobWhite_c4852_323	5B	9.1
IWB10187	BS00067938_51	5B	9.1
IWB20171	Ex_c226_499	5B	9.1
IWB22696	Excalibur_c15838_305	5B	9.1
IWB23028	Excalibur_c17843_812	5B	9.1
IWB25964	Excalibur_c38701_537	5B	9.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB27562	Excalibur_c5540_1197	5B	9.1
IWB34566	IAAV2507	5B	9.1
IWB69037	Tdurum_contig25068_259	5B	9.1
IWA620	wsnp_BQ166999B-Ta_2_1	5B	9.5
IWA894	wsnp_CAP11_rep_c8668_3741698	5B	9.5
IWA1626	wsnp_Ex_c12431_19823475	5B	9.5
IWA2910	wsnp_Ex_c24577_33826666	5B	9.5
IWA4708	wsnp_Ex_c765_1506774	5B	9.5
IWA6429	wsnp_Ku_c11721_19085513	5B	9.5
IWA6447	wsnp_Ku_c11980_19464222	5B	9.5
IWA6567	wsnp_Ku_c15630_24304828	5B	9.5
IWB28646	Excalibur_c7286_975	5B	9.5
IWB56824	RAC875_c33248_246	5B	9.5
IWB58751	RAC875_c51478_173	5B	9.5
IWB62125	RAC875_rep_c112125_305	5B	9.5
IWB62791	RAC875_rep_c71474_66	5B	9.5
IWB65769	TA004005-0934	5B	9.5
IWB71447	Tdurum_contig43677_338	5B	9.5
IWB73859	Tdurum_contig93270_1008	5B	9.5
IWA3870	wsnp_Ex_c43518_49814933	5B	9.8
IWB65963	TA005344-0744	5B	9.8
IWB34894	IAAV4590	5B	10.1
IWB35575	IAAV8999	5B	10.1
IWA2320	wsnp_Ex_c18519_27369737	5B	10.8
IWA6030	wsnp_JD_c38123_27754848	5B	10.8
IWB4808	BobWhite_rep_c49783_60	5B	10.8
IWB42192	Kukri_c19760_2091	5B	10.8
IWB61149	RAC875_c96137_101	5B	10.8
IWB70539	Tdurum_contig354_149	5B	10.8
IWA1057	wsnp_CAP7_c2086_1018815	5B	11.1
IWB12740	CAP11_c2008_278	5B	11.1
IWB57208	RAC875_c36684_56	5B	11.5
IWB64789	RFL_Contig4770_1618	5B	13.6
IWA2563	wsnp_Ex_c20988_30107609	5B	15.3
IWA4686	wsnp_Ex_c7483_12800686	5B	15.3
IWA6568	wsnp_Ku_c15630_24304954	5B	15.3
IWB5119	BobWhite_rep_c55336_265	5B	15.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB40832	Kukri_c12490_766	5B	15.3
IWB63425	RAC875_s112028_80	5B	15.3
IWB68623	Tdurum_contig17230_619	5B	15.3
IWB69058	Tdurum_contig25393_218	5B	15.3
IWA6521	wsnp_Ku_c14252_22506286	5B	15.7
IWA6908	wsnp_Ku_c32477_42086402	5B	15.7
IWB816	BobWhite_c15585_87	5B	15.7
IWB1196	BobWhite_c18554_76	5B	15.7
IWB9675	BS00065930_51	5B	15.7
IWB34841	IAAV4162	5B	15.7
IWB55651	RAC875_c2440_755	5B	15.7
IWA4353	wsnp_Ex_c58012_59490259	5B	16.0
IWB45308	Kukri_c43113_136	5B	16.3
IWB20311	Ex_c2571_987	5B	16.7
IWB58506	RAC875_c49044_335	5B	16.7
IWA5108	wsnp_Ex_rep_c104041_88855253	5B	17.0
IWA3209	wsnp_Ex_c2904_5355509	5B	17.3
IWA5078	wsnp_Ex_rep_c103024_88075347	5B	17.3
IWA6555	wsnp_Ku_c1535_3032561	5B	17.3
IWA6910	wsnp_Ku_c32477_42087329	5B	17.3
IWB7549	BS00024717_51	5B	17.3
IWB8592	BS00050709_51	5B	17.3
IWB10728	BS00074315_51	5B	17.3
IWB21704	Excalibur_c10669_997	5B	17.3
IWB37078	JD_c16284_736	5B	17.3
IWB39446	Ku_c439_1308	5B	17.3
IWB53062	RAC875_c104514_534	5B	17.3
IWB59668	RAC875_c62202_161	5B	17.3
IWB63300	RAC875_rep_c91778_96	5B	17.3
IWA4158	wsnp_Ex_c53011_56395185	5B	19.5
IWA8005	wsnp_Ra_c5634_9952011	5B	19.5
IWB14580	CAP8_c1968_64	5B	19.5
IWA1994	wsnp_Ex_c15262_23482284	5B	19.8
IWA2596	wsnp_Ex_c2132_4004831	5B	19.8
IWA2597	wsnp_Ex_c2132_4006417	5B	19.8
IWA3706	wsnp_Ex_c40022_47169698	5B	19.8
IWA7272	wsnp_Ku_c7199_12444840	5B	19.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB4516	BobWhite_c8764_219	5B	19.8
IWB8397	BS00045446_51	5B	19.8
IWB8398	BS00045447_51	5B	19.8
IWB21106	Ex_c67244_1093	5B	19.8
IWB22578	Excalibur_c15207_994	5B	19.8
IWB41816	Kukri_c17783_58	5B	19.8
IWB42745	Kukri_c23070_350	5B	19.8
IWB44611	Kukri_c36789_230	5B	19.8
IWB49093	Kukri_rep_c105540_177	5B	19.8
IWB57849	RAC875_c42518_57	5B	19.8
IWB58307	RAC875_c47060_61	5B	19.8
IWB64551	RFL_Contig398_51	5B	19.8
IWB66019	TA005820-0277	5B	19.8
IWB66093	TA008675-0589	5B	19.8
IWA2032	wsnp_Ex_c15524_23819269	5B	20.5
IWA2742	wsnp_Ex_c22726_31932096	5B	20.5
IWA5497	wsnp_Ex_rep_c68119_66884852	5B	20.5
IWB35198	IAAV6416	5B	20.5
IWB38284	Ku_c1191_2004	5B	20.5
IWA5764	wsnp_Ex_rep_c95506_83475785	5B	21.9
IWB48803	Kukri_rep_c102790_398	5B	21.9
IWA4758	wsnp_Ex_c7988_13555376	5B	22.2
IWA396	wsnp_BE606403B-Ta_2_1	5B	22.6
IWA1705	wsnp_Ex_c12909_20457407	5B	22.6
IWB9536	BS00065390_51	5B	22.6
IWB22592	Excalibur_c15262_2304	5B	22.6
IWB56615	RAC875_c31482_513	5B	22.6
IWB74241	tplb0025i03_2004	5B	23.3
IWA3707	wsnp_Ex_c40022_47169752	5B	24.0
IWA4300	wsnp_Ex_c5632_9904112	5B	24.0
IWA4862	wsnp_Ex_c8985_14979134	5B	24.0
IWB5805	BS00002191_51	5B	24.0
IWB6899	BS00022086_51	5B	24.0
IWB7200	BS00022662_51	5B	24.0
IWB7509	BS00023803_51	5B	24.0
IWB10495	BS00070771_51	5B	24.0
IWB20644	Ex_c40022_873	5B	24.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB26887	Excalibur_c4765_1557	5B	24.0
IWB34568	IAAV2526	5B	24.0
IWA4414	wsnp_Ex_c60683_61038062	5B	25.0
IWB5806	BS00002208_51	5B	27.0
IWB7194	BS00022652_51	5B	27.0
IWB73671	Tdurum_contig84745_267	5B	27.0
IWB8684	BS00056147_51	5B	28.4
IWB35222	IAAV6616	5B	28.8
IWB10299	BS00068390_51	5B	29.5
IWB11782	BS00092953_51	5B	29.5
IWB2326	BobWhite_c29999_82	5B	29.8
IWB48515	Kukri_c98694_120	5B	30.2
IWB1103	BobWhite_c17862_276	5B	30.5
IWB12463	BS00110064_51	5B	31.2
IWB12348	BS00108062_51	5B	31.5
IWB24957	Excalibur_c30346_54	5B	31.9
IWB43451	Kukri_c27568_1763	5B	31.9
IWB71672	Tdurum_contig46366_913	5B	31.9
IWA2003	wsnp_Ex_c15304_23532301	5B	32.9
IWA1777	wsnp_Ex_c13440_21171391	5B	33.9
IWA1588	wsnp_Ex_c12127_19394952	5B	34.2
IWB70171	Tdurum_contig31131_198	5B	34.2
IWB74498	tplb0033f11_1381	5B	34.2
IWA301	wsnp_BE497820B_Ta_2_1	5B	34.6
IWA1584	wsnp_Ex_c12119_19382764	5B	34.6
IWA1585	wsnp_Ex_c12119_19382820	5B	34.6
IWA5279	wsnp_Ex_rep_c66651_64962429	5B	34.6
IWA5280	wsnp_Ex_rep_c66651_64963120	5B	34.6
IWA5289	wsnp_Ex_rep_c66696_65023462	5B	34.6
IWA6344	wsnp_JG_c402_268605	5B	34.6
IWA7227	wsnp_Ku_c6464_11320381	5B	34.6
IWB6112	BS00009789_51	5B	34.6
IWB11100	BS00079914_51	5B	34.6
IWB11638	BS00089969_51	5B	34.6
IWB61438	RAC875_rep_c105322_99	5B	34.6
IWB64495	RFL_Contig3811_3709	5B	34.9
IWA1776	wsnp_Ex_c13440_21170884	5B	35.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB8558	BS00049793_51	5B	35.2
IWB34458	IAAV1835	5B	35.2
IWB62611	RAC875_rep_c69785_196	5B	35.2
IWB36269	IACX8091	5B	35.6
IWB61296	RAC875_c99618_116	5B	35.9
IWA8603	wsnp_RFL_Contig4565_5399994	5B	38.0
IWB9055	BS00063423_51	5B	38.0
IWB46693	Kukri_c57830_63	5B	38.7
IWB33231	GENE-3101_854	5B	39.4
IWB64262	RFL_Contig3192_1291	5B	39.4
IWB20366	Ex_c2735_955	5B	41.1
IWB40550	Kukri_c11240_332	5B	41.8
IWB50394	Kukri_rep_c80794_53	5B	41.8
IWA5742	wsnp_Ex_rep_c75281_72691359	5B	42.8
IWB7678	BS00028183_51	5B	42.8
IWB35030	IAAV5469	5B	42.8
IWB12344	BS00108020_51	5B	43.1
IWB25222	Excalibur_c32630_104	5B	43.1
IWA6979	wsnp_Ku_c3826_7020810	5B	43.5
IWA6992	wsnp_Ku_c3869_7094615	5B	43.5
IWB10467	BS00070507_51	5B	43.5
IWB12343	BS00108019_51	5B	43.5
IWB55844	RAC875_c25756_279	5B	43.5
IWB9128	BS00063785_51	5B	43.8
IWA1471	wsnp_Ex_c113235_94249366	5B	44.5
IWA7123	wsnp_Ku_c49907_55670146	5B	44.5
IWA7944	wsnp_Ra_c44756_51084202	5B	44.5
IWB9364	BS00064767_51	5B	44.5
IWB52109	Ra_c44756_929	5B	44.5
IWB58079	RAC875_c44756_381	5B	44.5
IWB36033	IACX5818	5B	47.3
IWB43018	Kukri_c24676_79	5B	48.3
IWB33353	GENE-3363_271	5B	49.1
IWB67658	Tdurum_contig12567_833	5B	50.6
IWB21608	Excalibur_c10336_335	5B	50.9
IWB51175	Ra_c15623_1791	5B	54.1
IWB34521	IAAV2240	5B	54.4



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB34523	IAAV2246	5B	54.4
IWA1401	wsnp_Ex_c10902_17715268	5B	56.1
IWB9663	BS00065895_51	5B	57.2
IWA1380	wsnp_Ex_c10674_17400603	5B	57.5
IWB44988	Kukri_c40046_237	5B	57.5
IWB65250	RFL_Contig697_1463	5B	57.5
IWA2536	wsnp_Ex_c20440_29511162	5B	58.2
IWB27524	Excalibur_c54941_571	5B	58.2
IWB30453	Excalibur_rep_c110067_199	5B	58.5
IWB17929	D_GA8KES402JRBN7_105	5B	59.5
IWB51911	Ra_c35412_494	5B	59.9
IWB11879	BS00094480_51	5B	60.2
IWB24353	Excalibur_c25661_1177	5B	60.2
IWB40107	Ku_c8733_458	5B	60.6
IWA4622	wsnp_Ex_c709_1395347	5B	61.6
IWB17587	D_F5XZDLF01ELZ49_220	5B	61.6
IWB38085	Ku_c1031_670	5B	61.6
IWB42557	Kukri_c2181_291	5B	61.6
IWA6291	wsnp_JD_rep_c63013_40187485	5B	62.0
IWB34729	IAAV3515	5B	62.0
IWB47848	Kukri_c805_325	5B	62.0
IWB51909	Ra_c35412_1057	5B	62.0
IWB1659	BobWhite_c23037_241	5B	64.2
IWB70658	Tdurum_contig41335_181	5B	64.5
IWA6383	wsnp_Ku_c10296_17072695	5B	64.9
IWB72937	Tdurum_contig63161_121	5B	64.9
IWA4074	wsnp_Ex_c50413_54706626	5B	65.2
IWA5283	wsnp_Ex_rep_c66667_64981526	5B	65.2
IWB40681	Kukri_c11815_706	5B	65.2
IWB57415	RAC875_c38511_91	5B	65.2
IWB65086	RFL_Contig570_515	5B	65.5
IWB73106	Tdurum_contig68343_339	5B	65.5
IWB40845	Kukri_c12562_453	5B	65.9
IWA1374	wsnp_Ex_c10644_17356566	5B	68.0
IWB40314	Kukri_c10296_1074	5B	69.1
IWB49648	Kukri_rep_c114331_346	5B	70.1
IWB56759	RAC875_c32768_440	5B	70.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB52780	Ra_c8939_653	5B	70.8
IWA6468	wsnp_Ku_c12562_20256747	5B	71.5
IWA987	wsnp_CAP12_c7952_3403722	5B	75.9
IWA2694	wsnp_Ex_c222_436432	5B	75.9
IWA2695	wsnp_Ex_c222_436779	5B	75.9
IWA3964	wsnp_Ex_c46217_51790399	5B	75.9
IWA4632	wsnp_Ex_c718_1411957	5B	75.9
IWB8176	BS00039492_51	5B	75.9
IWB55404	RAC875_c22760_258	5B	75.9
IWA5139	wsnp_Ex_rep_c105478_89891634	5B	76.3
IWA337	wsnp_BE517711B-Ta_2_1	5B	76.6
IWB13599	CAP12_rep_c4520_171	5B	76.6
IWB33379	GENE-3397_535	5B	76.6
IWB6704	BS00021673_51	5B	76.9
IWB33391	GENE-3437_68	5B	76.9
IWB35318	IAAV7267	5B	76.9
IWB36579	Jagger_c3991_101	5B	76.9
IWB52934	RAC875_c10174_268	5B	76.9
IWB54035	RAC875_c14963_1579	5B	80.5
IWB266	BobWhite_c11861_557	5B	81.5
IWB12049	BS00098821_51	5B	81.5
IWB14185	CAP7_c6223_318	5B	81.5
IWB14193	CAP7_c6363_226	5B	81.5
IWB35462	IAAV8350	5B	81.5
IWB36070	IACX5939	5B	81.5
IWB75167	tplb0058c02_1053	5B	81.5
IWB30866	Excalibur_rep_c67473_264	5B	82.2
IWA4641	wsnp_Ex_c7244_12439355	5B	82.5
IWB23703	Excalibur_c21846_709	5B	82.5
IWB29181	Excalibur_c8675_1550	5B	82.5
IWB35031	IAAV547	5B	82.9
IWA2373	wsnp_Ex_c19041_27955460	5B	87.6
IWB12924	CAP11_c506_72	5B	87.6
IWB6211	BS00010366_51	5B	90.1
IWB6302	BS00010863_51	5B	90.1
IWB6612	BS00015205_51	5B	90.1
IWB7132	BS00022520_51	5B	90.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7809	BS00031016_51	5B	90.1
IWB9523	BS00065352_51	5B	90.1
IWB10903	BS00076833_51	5B	90.1
IWB11306	BS00083511_51	5B	90.1
IWB20926	Ex_c5594_2818	5B	90.1
IWB26666	Excalibur_c45471_81	5B	90.1
IWB34284	GENE-4974_9	5B	90.1
IWB42881	Kukri_c23894_464	5B	90.1
IWB43973	Kukri_c31419_399	5B	90.1
IWB44452	Kukri_c35480_647	5B	90.1
IWB59471	RAC875_c5995_94	5B	90.1
IWB65583	TA002629-0202	5B	90.1
IWB66282	Tdurum_contig10124_967	5B	90.1
IWB69283	Tdurum_contig26711_77	5B	90.1
IWB70860	Tdurum_contig42109_483	5B	90.1
IWB58072	RAC875_c44706_164	5B	90.5
IWB10904	BS00076835_51	5B	90.8
IWA7815	w SNP_Ra_c27733_37249132	5B	92.6
IWB982	BobWhite_c16987_106	5B	92.6
IWB3615	BobWhite_c4773_85	5B	92.6
IWB3630	BobWhite_c47964_969	5B	92.6
IWB4203	BobWhite_c6633_179	5B	92.6
IWB4204	BobWhite_c6633_240	5B	92.6
IWB4205	BobWhite_c6633_288	5B	92.6
IWB4207	BobWhite_c6633_476	5B	92.6
IWB5567	BobWhite_rep_c65835_277	5B	92.6
IWB10596	BS00072185_51	5B	92.6
IWB22494	Excalibur_c14753_899	5B	92.6
IWB34364	IAAV1358	5B	92.6
IWB36091	IACX6009	5B	92.6
IWB41225	Kukri_c14564_1108	5B	92.6
IWB47164	Kukri_c64573_443	5B	92.6
IWB56499	RAC875_c30584_75	5B	92.6
IWB68488	Tdurum_contig16032_330	5B	92.6
IWB36827	Jagger_c9788_248	5B	93.3
IWB60155	RAC875_c68097_62	5B	94.0
IWB28925	Excalibur_c7968_2218	5B	94.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB69282	Tdurum_contig26711_578	5B	108.3
IWA6894	w SNP_Ku_c3102_5810751	5B	132.9
IWB1762	BobWhite_c23903_443	5B	138.5
IWB2079	BobWhite_c27244_211	5B	138.5
IWB5758	BS00000592_51	5B	138.5
IWB8368	BS00044388_51	5B	138.5
IWB11074	BS00079316_51	5B	138.5
IWB11477	BS00087043_51	5B	138.5
IWB12092	BS00099782_51	5B	138.5
IWB24695	Excalibur_c28285_1188	5B	138.5
IWB27651	Excalibur_c56310_57	5B	138.5
IWB30236	Excalibur_rep_c106979_146	5B	138.5
IWB35873	IACX2796	5B	138.5
IWB36772	Jagger_c8122_111	5B	138.5
IWB44431	Kukri_c35352_483	5B	138.5
IWB48396	Kukri_c94990_140	5B	138.5
IWB52918	RAC875_c10139_92	5B	138.5
IWB57828	RAC875_c42281_112	5B	138.5
IWB6687	BS00020982_51	5B	138.8
IWB11522	BS00087696_51	5B	138.8
IWB25366	Excalibur_c33675_201	5B	138.8
IWB33372	GENE-3383_710	5B	138.8
IWB37428	JD_c4068_449	5B	138.8
IWB43978	Kukri_c31479_147	5B	138.8
IWB56720	RAC875_c32320_88	5B	138.8
IWA2306	w SNP_Ex_c1838_3461594	5B	139.1
IWB13523	CAP12_c703_150	5B	139.1
IWB61049	RAC875_c91986_410	5B	139.1
IWB66356	Tdurum_contig10210_428	5B	139.1
IWB70159	Tdurum_contig31075_260	5B	139.1
IWA4793	w SNP_Ex_c8322_14030310	5B	140.1
IWB46909	Kukri_c6113_189	5B	140.5
IWB43876	Kukri_c30643_112	5B	140.8
IWA3002	w SNP_Ex_c2582_4804223	5B	141.2
IWA7735	w SNP_Ra_c2105_4092507	5B	141.2
IWB7745	BS00029869_51	5B	141.2
IWB10167	BS00067841_51	5B	141.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB10635	BS00073015_51	5B	141.2
IWB38237	Ku_c11429_519	5B	141.2
IWB49876	Kukri_rep_c69276_59	5B	141.2
IWB53035	RAC875_c103988_92	5B	141.2
IWB61245	RAC875_c985_387	5B	141.2
IWB71533	Tdurum_contig44635_759	5B	141.2
IWA4103	wsnp_Ex_c5155_9140608	5B	141.5
IWA8508	wsnp_RFL_Contig3739_3996324	5B	141.5
IWB2723	BobWhite_c34759_227	5B	141.5
IWB5476	BobWhite_rep_c64527_134	5B	141.5
IWB10356	BS00068710_51	5B	141.5
IWB45849	Kukri_c4818_332	5B	141.5
IWB65641	TA003058-0693	5B	141.5
IWB68594	Tdurum_contig16866_148	5B	141.5
IWB69474	Tdurum_contig28268_91	5B	141.5
IWB69760	Tdurum_contig29319_475	5B	141.5
IWB73983	Tdurum_contig97342_274	5B	141.5
IWB66975	Tdurum_contig11228_274	5B	141.8
IWA1780	wsnp_Ex_c13485_21225504	5B	142.2
IWB10018	BS00067328_51	5B	142.2
IWB29205	Excalibur_c874_1479	5B	142.2
IWB34530	IAAV2296	5B	142.2
IWB50957	Ra_c11667_324	5B	142.2
IWB55063	RAC875_c20785_1219	5B	142.5
IWB47298	Kukri_c66357_357	5B	143.2
IWA2565	wsnp_Ex_c210_411604	5B	143.5
IWA3479	wsnp_Ex_c34474_42777857	5B	143.5
IWB23151	Excalibur_c18492_249	5B	143.5
IWB43483	Kukri_c27720_274	5B	143.5
IWB11813	BS00093522_51	5B	143.9
IWB61584	RAC875_rep_c106365_360	5B	143.9
IWB71503	Tdurum_contig44181_593	5B	144.2
IWB69317	Tdurum_contig27797_1114	5B	144.9
IWB75248	tplb0060e05_1182	5B	145.6
IWB6424	BS00011514_51	5B	145.9
IWB14973	CAP8_c890_220	5B	145.9
IWA3226	wsnp_Ex_c29304_38355434	5B	146.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB10135	BS00067744_51	5B	146.2
IWB24822	Excalibur_c29304_176	5B	146.2
IWB36098	IACX6034	5B	146.2
IWB40925	Kukri_c12910_214	5B	146.6
IWA6671	wsnp_Ku_c19334_28808006	5B	146.9
IWB6023	BS00008767_51	5B	146.9
IWB8052	BS00036434_51	5B	146.9
IWB39412	Ku_c4240_216	5B	147.3
IWA6718	wsnp_Ku_c21770_31551190	5B	148.3
IWB25936	Excalibur_c38433_291	5B	149.3
IWA8395	wsnp_RFL_Contig2809_2587619	5B	149.7
IWB69318	Tdurum_contig27797_654	5B	150.0
IWB45948	Kukri_c49101_731	5B	151.0
IWB34511	IAAV2160	5B	152.4
IWB34518	IAAV2219	5B	152.4
IWB51408	Ra_c20970_500	5B	152.4
IWB58682	RAC875_c50755_244	5B	152.4
IWA1577	wsnp_Ex_c12048_19288999	5B	152.7
IWA7732	wsnp_Ra_c20970_30293078	5B	152.7
IWA7733	wsnp_Ra_c20970_30293227	5B	152.7
IWB2786	BobWhite_c3552_1303	5B	152.7
IWB2787	BobWhite_c3552_1588	5B	152.7
IWB21097	Ex_c67086_584	5B	152.7
IWB32852	GENE-2239_795	5B	152.7
IWB35480	IAAV8463	5B	152.7
IWB56628	RAC875_c31614_450	5B	152.7
IWB12087	BS00099719_51	5B	153.4
IWB9939	BS00067029_51	5B	154.4
IWB65012	RFL_Contig5461_683	5B	154.4
IWA7910	wsnp_Ra_c39562_47242455	5B	154.8
IWB7415	BS00023077_51	5B	154.8
IWB29442	Excalibur_c9391_1016	5B	154.8
IWB68996	Tdurum_contig23273_426	5B	155.1
IWB9459	BS00065128_51	5B	155.8
IWB61173	RAC875_c96862_121	5B	156.2
IWB43739	Kukri_c2955_281	5B	156.8
IWB64098	RFL_Contig2832_2410	5B	157.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB56534	RAC875_c30867_515	5B	158.5
IWB40222	Kukri_c100408_598	5B	159.2
IWB8532	BS00049213_51	5B	161.4
IWB11131	BS00080474_51	5B	161.4
IWB13279	CAP12_c2189_159	5B	161.4
IWB62248	RAC875_rep_c114200_428	5B	161.4
IWB74045	Tdurum_contig98569_290	5B	161.4
IWB61387	RAC875_rep_c104919_902	5B	162.8
IWB30646	Excalibur_rep_c113786_110	5B	164.9
IWB7405	BS00023064_51	5B	165.2
IWB8537	BS00049403_51	5B	165.2
IWB48107	Kukri_c87104_125	5B	165.2
IWB68074	Tdurum_contig13773_321	5B	165.2
IWB7633	BS00026678_51	5B	165.9
IWB47857	Kukri_c8073_1068	5B	165.9
IWB52998	RAC875_c10323_90	5B	165.9
IWB54574	RAC875_c1792_3536	5B	165.9
IWB15938	D_contig18780_204	5B	167.0
IWB7634	BS00026679_51	5B	168.0
IWB7930	BS00033486_51	5B	168.0
IWB7931	BS00033487_51	5B	168.0
IWB54573	RAC875_c1792_3457	5B	168.0
IWB55316	RAC875_c2223_625	5B	168.0
IWB25600	Excalibur_c35398_114	5B	168.4
IWA1590	wsnp_Ex_c12152_19428078	5B	169.1
IWA1591	wsnp_Ex_c12152_19429932	5B	169.1
IWA7635	wsnp_Ra_c15069_23407152	5B	169.1
IWB8204	BS00040084_51	5B	169.1
IWB34578	IAAV2593	5B	169.1
IWB38809	Ku_c2209_641	5B	169.1
IWB68185	Tdurum_contig14326_495	5B	169.1
IWB12065	BS00099367_51	5B	169.4
IWB61759	RAC875_rep_c108082_333	5B	169.4
IWB29397	Excalibur_c9258_1222	5B	169.8
IWB27106	Excalibur_c50033_144	5B	170.1
IWB71849	Tdurum_contig47833_484	5B	170.1
IWA1592	wsnp_Ex_c12152_19431363	5B	170.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3266	wsnp_Ex_c3019_5578884	5B	170.4
IWA4539	wsnp_Ex_c6571_11387527	5B	170.4
IWB5242	BobWhite_rep_c60245_107	5B	170.4
IWB6889	BS00022065_51	5B	170.4
IWB6903	BS00022098_51	5B	170.4
IWB7291	BS00022852_51	5B	170.4
IWB11915	BS00095092_51	5B	170.4
IWB21051	Ex_c6571_224	5B	170.4
IWB29042	Excalibur_c82693_359	5B	170.4
IWB36568	Jagger_c3819_70	5B	170.4
IWB44945	Kukri_c3973_101	5B	170.4
IWB63594	RFL_Contig1265_515	5B	170.4
IWB64048	RFL_Contig2772_1693	5B	170.4
IWB68186	Tdurum_contig14326_597	5B	170.4
IWB71390	Tdurum_contig43078_437	5B	170.4
IWB73546	Tdurum_contig82077_129	5B	170.4
IWB73547	Tdurum_contig82077_336	5B	170.4
IWB73702	Tdurum_contig85945_281	5B	170.4
IWB5858	BS00003655_51	5B	170.8
IWB36025	IACX5792	5B	170.8
IWB1546	BobWhite_c22036_399	5B	173.7
IWB7946	BS00033768_51	5B	173.7
IWB8926	BS00062786_51	5B	173.7
IWB40362	Kukri_c10508_438	5B	173.7
IWB40363	Kukri_c10508_755	5B	173.7
IWB48671	Kukri_rep_c101622_604	5B	173.7
IWB56221	RAC875_c28645_455	5B	173.7
IWB65729	TA003709-0269	5B	173.7
IWB71881	Tdurum_contig48335_209	5B	173.7
IWB72592	Tdurum_contig57696_133	5B	173.7
IWA3414	wsnp_Ex_c32872_41456586	5B	174.4
IWA6148	wsnp_JD_c6562_7716133	5B	174.4
IWA6779	wsnp_Ku_c25613_35580381	5B	174.4
IWB1605	BobWhite_c22572_782	5B	174.4
IWB25344	Excalibur_c3350_265	5B	174.4
IWB34630	IAAV2883	5B	174.4
IWB43149	Kukri_c25613_1347	5B	174.4



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB72182	Tdurum_contig51422_127	5B	174.4
IWB73678	Tdurum_contig85060_121	5B	174.4
IWB75169	tplb0058f13_242	5B	174.4
IWB69164	Tdurum_contig25692_435	5B	174.7
IWB4061	BobWhite_c6017_1096	5B	175.0
IWB8085	BS00037103_51	5B	175.0
IWB8581	BS00049997_51	5B	175.0
IWB73902	Tdurum_contig94033_717	5B	175.0
IWB9430	BS00065029_51	5B	175.4
IWB13788	CAP7_c1274_206	5B	175.4
IWB73572	Tdurum_contig82473_67	5B	175.4
IWB4062	BobWhite_c6017_1147	5B	175.7
IWB8086	BS00037104_51	5B	175.7
IWB42855	Kukri_c23743_112	5B	175.7
IWB45589	Kukri_c45951_367	5B	175.7
IWB67067	Tdurum_contig11399_221	5B	175.7
IWB69025	Tdurum_contig24416_284	5B	175.7
IWB73901	Tdurum_contig94033_487	5B	175.7
IWB6980	BS00022231_51	5B	181.4
IWB7105	BS00022477_51	5B	181.4
IWB7312	BS00022899_51	5B	181.4
IWB7338	BS00022956_51	5B	181.4
IWB7744	BS00029852_51	5B	181.4
IWB8083	BS00037023_51	5B	181.4
IWB12511	BS00110293_51	5B	181.4
IWB34462	IAAV1852	5B	181.4
IWB36134	IACX6288	5B	181.4
IWB72667	Tdurum_contig59606_2411	5B	181.4
IWB75047	tplb0054b11_284	5B	181.4
IWB162	BobWhite_c11038_605	5B	181.7
IWB64600	RFL_Contig4167_1164	5B	182.0
IWB6532	BS00012140_51	5B	187.9
IWB8860	BS00062409_51	5B	187.9
IWB9190	BS00064085_51	5B	187.9
IWB10952	BS00077734_51	5B	187.9
IWB56589	RAC875_c31261_367	5B	187.9
IWB71624	Tdurum_contig45588_730	5B	187.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB75125	tplb0057b23_1134	5B	187.9
IWB10888	BS00076536_51	5B	188.6
IWB28782	Excalibur_c7613_327	5B	188.9
IWB28783	Excalibur_c7613_789	5B	188.9
IWB2823	BobWhite_c36154_81	5B	189.3
IWB5837	BS00003586_51	5B	189.3
IWB9962	BS00067122_51	5B	189.3
IWB21826	Excalibur_c112240_381	5B	189.3
IWB23813	Excalibur_c22518_1683	5B	189.3
IWB26748	Excalibur_c4623_876	5B	189.3
IWB33104	GENE-2890_50	5B	189.3
IWB33119	GENE-2932_119	5B	189.3
IWB46655	Kukri_c5739_276	5B	189.3
IWB56345	RAC875_c29488_56	5B	189.3
IWB70546	Tdurum_contig35470_227	5B	189.3
IWB46501	Kukri_c55317_179	5B	189.6
IWB8279	BS00041550_51	5B	190.3
IWB8870	BS00062618_51	5B	200.5
IWA6902	wsnp_Ku_c3151_5892200	5B	202.6
IWB764	BobWhite_c15241_604	5B	204.3
IWB34704	IAAV3369	5B	204.3
IWA7066	wsnp_Ku_c4427_8029592	5B	204.7
IWA22	wsnp_BE403214B-Ta_2_1	5B	205.4
IWB9279	BS00064423_51	5B	205.4
IWB12232	BS00104690_51	5B	205.4
IWB13050	CAP11_c7700_247	5B	205.4
IWB23725	Excalibur_c21971_522	5B	205.4
IWB10401	BS00069416_51	5B	210.6
IWB28883	Excalibur_c78724_434	5B	210.6
IWB41110	Kukri_c13870_154	5B	210.6
IWB47364	Kukri_c67054_123	5B	210.6
IWB1968	BobWhite_c26082_239	5B	210.9
IWB27209	Excalibur_c5120_938	5B	213.0
IWB63871	RFL_Contig2219_1304	5B	213.6
IWB47950	Kukri_c83168_89	5B	215.0
IWB24361	Excalibur_c25699_244	5B	216.4
IWB55548	RAC875_c23687_320	5B	218.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3658	wsnp_Ex_c3874_7036132	5B	219.6
IWB37564	JD_c5065_1012	5B	219.6
IWB8786	BS00059847_51	5B	220.0
IWB40759	Kukri_c1214_948	5B	220.7
IWB24501	Excalibur_c26895_128	5B	221.4
IWB40751	Kukri_c1214_2316	5B	222.1
IWB5688	BobWhite_s66049_223	5B	223.4
IWB29462	Excalibur_c94390_60	5B	223.8
IWB10359	BS00068775_51	5B	224.1
IWB27150	Excalibur_c5055_1160	5B	224.1
IWB36771	Jagger_c8121_167	5B	224.1
IWB41962	Kukri_c18410_409	5B	224.1
IWB72714	Tdurum_contig60189_310	5B	224.1
IWB8808	BS00060460_51	5B	224.8
IWB35835	IACX20775	5B	226.1
IWB74020	Tdurum_contig97942_163	5B	227.5
IWB74021	Tdurum_contig97942_51	5B	227.5
IWB9951	BS00067074_51	5B	228.2
IWB60703	RAC875_c82589_246	5B	228.2
IWB2575	BobWhite_c32785_874	5B	228.5
IWA2093	wsnp_Ex_c16045_24471413	5B	228.9
IWA4726	wsnp_Ex_c7781_13255634	5B	228.9
IWB142	BobWhite_c10956_71	5B	228.9
IWB45587	Kukri_c4594_825	5B	228.9
IWB53989	RAC875_c14732_461	5B	228.9
IWB72711	Tdurum_contig60165_722	5B	228.9
IWB72715	Tdurum_contig60189_855	5B	228.9
IWB14290	CAP7_c8713_356	5B	229.6
IWB41961	Kukri_c18410_349	5B	229.9
IWB7835	BS00031338_51	5B	230.2
IWB3512	BobWhite_c46416_247	5B	230.9
IWB56719	RAC875_c3231_339	5B	230.9
IWB61890	RAC875_rep_c109540_64	5B	231.3
IWB41960	Kukri_c18410_193	5B	232.0
IWB53008	RAC875_c1035_65	5B	232.0
IWB18224	D_GBB4FNX01DY1EU_58	5B	232.3
IWA1390	wsnp_Ex_c10818_17605541	5B	232.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB66257	Tdurum_contig10100_523	5B	232.7
IWB72434	Tdurum_contig5522_455	5B	233.7
IWB263	BobWhite_c11811_327	5B	236.2
IWB6672	BS00019894_51	5B	238.8
IWA7314	wsnp_Ku_c815_1682284	5B	244.5
IWB2415	BobWhite_c31_2478	5B	246.4
IWB2417	BobWhite_c31_3667	5B	246.4
IWB61615	RAC875_rep_c106589_784	5B	246.4
IWB69551	Tdurum_contig28552_211	5B	246.4
IWB69552	Tdurum_contig28552_88	5B	246.4
IWB73829	Tdurum_contig92922_58	5B	246.4
IWB62591	RAC875_rep_c69613_547	5B	246.7
IWB71515	Tdurum_contig44271_1220	5B	247.0
IWA2681	wsnp_Ex_c2207_4135530	5B	248.4
IWB29548	Excalibur_c96435_216	5B	248.4
IWB46557	Kukri_c55885_139	5B	248.4
IWB47085	Kukri_c637_1679	5B	248.4
IWB47087	Kukri_c637_517	5B	248.4
IWB46556	Kukri_c55885_110	5B	249.4
IWA2682	wsnp_Ex_c2207_4136036	5B	250.1
IWA6578	wsnp_Ku_c16116_24914991	5B	250.1
IWB20541	Ex_c34486_581	5B	250.1
IWB28597	Excalibur_c71602_420	5B	250.1
IWB42485	Kukri_c21384_1758	5B	250.1
IWB44679	Kukri_c3734_400	5B	250.1
IWB44680	Kukri_c3734_438	5B	250.1
IWB45643	Kukri_c46310_84	5B	250.1
IWB47090	Kukri_c637_827	5B	250.1
IWB59314	RAC875_c57840_107	5B	250.1
IWB61527	RAC875_rep_c105927_650	5B	250.1
IWB47091	Kukri_c637_974	5B	250.8
IWB52508	Ra_c70331_779	5D1	0.0
IWA6268	wsnp_JD_rep_c50025_34123405	5D1	0.7
IWA8102	wsnp_Ra_c9233_15459255	5D1	0.7
IWB21506	Excalibur_c10046_579	5D1	0.7
IWB35167	IAAV6217	5D1	0.7
IWA7243	wsnp_Ku_c6762_11762520	5D1	1.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB17310	D_F1BEJMU01DNFXS_203	5D1	1.0
IWB48935	Kukri_rep_c103997_238	5D1	1.0
IWB62708	RAC875_rep_c70595_321	5D1	1.0
IWB63251	RAC875_rep_c86919_52	5D1	1.0
IWA1172	wsnp_CAP8_c2589_1356390	5D1	1.3
IWB34503	IAAV2115	5D1	1.3
IWB54278	RAC875_c16354_606	5D1	5.7
IWB35889	IACX2960	5D1	12.0
IWB50747	Ra_c10336_666	5D1	33.0
IWB4317	BobWhite_c7263_337	5D1	33.4
IWB107	BobWhite_c10764_251	5D1	43.4
IWB44733	Kukri_c37793_135	5D1	50.2
IWB6178	BS00010144_51	5D2	0.0
IWA6189	wsnp_JD_c825_1223424	5D2	1.4
IWA6190	wsnp_JD_c825_1223454	5D2	1.4
IWA6191	wsnp_JD_c825_1223506	5D2	1.4
IWB14252	CAP7_c756_531	5D2	1.4
IWB22168	Excalibur_c1289_927	5D2	1.4
IWB26695	Excalibur_c4570_451	5D2	1.4
IWB37841	JD_c825_1450	5D2	1.4
IWB44404	Kukri_c35049_357	5D2	1.4
IWB57677	RAC875_c41114_390	5D2	1.4
IWB74390	tplb0030a05_2386	5D2	1.4
IWB56960	RAC875_c34515_86	5D2	1.7
IWB24735	Excalibur_c28592_377	5D2	2.4
IWB46497	Kukri_c5528_603	5D2	2.4
IWB52946	RAC875_c102066_254	5D2	2.7
IWA701	wsnp_CAP11_c209_198671	5D2	3.0
IWA6060	wsnp_JD_c4438_5567972	5D2	3.0
IWA6061	wsnp_JD_c4438_5568170	5D2	3.0
IWB3368	BobWhite_c4438_162	5D2	3.0
IWB12263	BS00105939_51	5D2	3.0
IWB14533	CAP8_c145_89	5D2	3.0
IWB17701	D_GA8KES401AL4GG_122	5D2	3.0
IWB40790	Kukri_c12301_227	5D2	3.8
IWA700	wsnp_CAP11_c209_198467	5D2	4.5
IWA6059	wsnp_JD_c4438_5567834	5D2	4.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB443	BobWhite_c13030_406	5D2	4.5
IWB6413	BS00011469_51	5D2	4.5
IWB6473	BS00011794_51	5D2	4.5
IWB6872	BS00022036_51	5D2	4.5
IWB10013	BS00067308_51	5D2	4.5
IWB10643	BS00073116_51	5D2	4.5
IWB11094	BS00079676_51	5D2	4.5
IWB11570	BS00088587_51	5D2	4.5
IWB11571	BS00088592_51	5D2	4.5
IWB13223	CAP12_c1612_327	5D2	4.5
IWB13474	CAP12_c5949_104	5D2	4.5
IWB14381	CAP7_rep_c12715_390	5D2	4.5
IWB19299	D_GDS7LZN01CBWNE_99	5D2	4.5
IWB23845	Excalibur_c22724_85	5D2	4.5
IWB24734	Excalibur_c28592_173	5D2	4.5
IWB26308	Excalibur_c42190_383	5D2	4.5
IWB28284	Excalibur_c64287_145	5D2	4.5
IWB28510	Excalibur_c687_886	5D2	4.5
IWB28511	Excalibur_c687_907	5D2	4.5
IWB28512	Excalibur_c687_961	5D2	4.5
IWB35632	IACX10520	5D2	4.5
IWB40408	Kukri_c1073_91	5D2	4.5
IWB42723	Kukri_c22934_453	5D2	4.5
IWB42724	Kukri_c22934_766	5D2	4.5
IWB43020	Kukri_c24695_273	5D2	4.5
IWB47729	Kukri_c7786_81	5D2	4.5
IWB50293	Kukri_rep_c74522_96	5D2	4.5
IWB53671	RAC875_c13169_459	5D2	4.5
IWB16037	D_contig21184_313	5D2	5.2
IWB36118	IACX6176	5D2	5.2
IWB40526	Kukri_c11140_323	5D2	5.2
IWB18013	D_GB5Y7FA01DGNQR_235	5D2	5.5
IWA2276	w SNP_Ex_c17928_26697183	5D2	6.2
IWA6872	w SNP_Ku_c3022_5674299	5D2	6.2
IWA7095	w SNP_Ku_c46270_53051831	5D2	6.2
IWA7147	w SNP_Ku_c5228_9318604	5D2	6.2
IWB6593	BS00013935_51	5D2	6.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7212	BS00022688_51	5D2	6.2
IWB30055	Excalibur_rep_c104791_725	5D2	6.2
IWB58681	RAC875_c50750_234	5D2	6.2
IWB64602	RFL_Contig4176_605	5D2	6.2
IWB638	BobWhite_c14409_206	5D2	6.5
IWB2413	BobWhite_c30990_228	5D2	6.5
IWB27155	Excalibur_c50584_358	5D2	6.5
IWB10732	BS00074353_51	5D2	7.2
IWB16947	D_contig61362_644	5D2	7.2
IWB66110	TA013009-0365	5D2	7.2
IWB6934	BS00022157_51	5D2	7.5
IWB57210	RAC875_c3672_705	5D2	7.9
IWA7914	wsnp_Ra_c40111_47657505	5D2	8.2
IWA7915	wsnp_Ra_c40111_47657589	5D2	8.2
IWB4362	BobWhite_c7604_254	5D2	8.2
IWB6038	BS00009287_51	5D2	8.2
IWB6998	BS00022267_51	5D2	8.2
IWB7143	BS00022537_51	5D2	8.2
IWB7302	BS00022876_51	5D2	8.2
IWB7566	BS00025017_51	5D2	8.2
IWB9398	BS00064893_51	5D2	8.2
IWB10288	BS00068331_51	5D2	8.2
IWB10799	BS00075368_51	5D2	8.2
IWB11346	BS00084133_51	5D2	8.2
IWB24961	Excalibur_c30378_344	5D2	8.2
IWB27909	Excalibur_c59832_58	5D2	8.2
IWB34439	IAAV1744	5D2	8.2
IWB48688	Kukri_rep_c101796_71	5D2	8.2
IWB56420	RAC875_c30052_548	5D2	8.2
IWB66035	TA005986-0607	5D2	8.2
IWB6498	BS00011935_51	5D2	21.3
IWB11863	BS00094333_51	5D2	21.3
IWB19357	D_GDS7LZN02F4FP5_176	5D2	21.3
IWB22809	Excalibur_c16573_197	5D2	21.3
IWB61079	RAC875_c93365_200	5D2	21.3
IWB74430	tplb0031c19_721	5D2	21.3
IWB74431	tplb0031c19_924	5D2	21.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB6466	BS00011762_51	5D2	21.6
IWB42481	Kukri_c21384_1333	5D2	21.6
IWB57018	RAC875_c34968_514	5D2	21.6
IWA2877	w SNP_Ex_c24145_3339456	5D2	22.0
IWB44516	Kukri_c36044_457	5D2	22.3
IWB1633	BobWhite_c22752_182	5D2	22.6
IWB3568	BobWhite_c47158_89	5D2	22.6
IWB6435	BS00011561_51	5D2	22.6
IWB11400	BS00085191_51	5D2	22.6
IWB30174	Excalibur_rep_c106082_272	5D2	22.6
IWB47755	Kukri_c7827_1309	5D2	22.6
IWB48264	Kukri_c91538_610	5D2	22.6
IWB65232	RFL_Contig617_1357	5D2	22.6
IWB74263	tplb0026a09_1444	5D2	22.6
IWA4561	w SNP_Ex_c6657_11523455	5D2	23.0
IWB22653	Excalibur_c1559_913	5D2	23.3
IWB6844	BS00021991_51	5D2	23.6
IWB6110	BS00009777_51	5D2	24.0
IWB8973	BS00062990_51	5D2	24.0
IWB46742	Kukri_c5848_318	5D2	24.0
IWB49046	Kukri_rep_c104865_57	5D2	24.0
IWB1289	BobWhite_c19606_374	5D2	24.3
IWB5872	BS00003711_51	5D2	24.6
IWB7713	BS00029317_51	5D2	24.6
IWB10494	BS00070751_51	5D2	24.6
IWB25292	Excalibur_c33062_305	5D2	24.6
IWB35098	IAAV5825	5D2	24.6
IWB36040	IACX5847	5D2	24.6
IWB47754	Kukri_c7827_1168	5D2	24.6
IWB53716	RAC875_c13410_2221	5D2	24.6
IWB55430	RAC875_c2296_872	5D2	24.6
IWB63126	RAC875_rep_c78258_214	5D2	24.6
IWA2878	w SNP_Ex_c24145_3339464	5D2	25.0
IWB6523	BS00012069_51	5D2	25.0
IWB11093	BS00079664_51	5D2	25.0
IWB18008	D_GB5Y7FA01D4CBK_54	5D2	25.0
IWB21790	Excalibur_c11055_2629	5D2	25.0



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB24107	Excalibur_c24145_1643	5D2	25.0
IWB42483	Kukri_c21384_1475	5D2	25.0
IWB50764	Ra_c105060_1855	5D2	25.0
IWB60636	RAC875_c8100_245	5D2	25.3
IWA2635	wsnp_Ex_c21633_30782312	6A	0.0
IWB47842	Kukri_c80373_786	6A	0.0
IWB71998	Tdurum_contig49707_674	6A	0.0
IWB71875	Tdurum_contig48187_691	6A	0.7
IWA5416	wsnp_Ex_rep_c67563_66193104	6A	1.4
IWA8160	wsnp_Ra_rep_c69602_67107375	6A	1.4
IWB11199	BS00081603_51	6A	1.4
IWB26904	Excalibur_c4789_2748	6A	1.4
IWB47513	Kukri_c7146_870	6A	1.4
IWB64080	RFL_Contig2815_1110	6A	1.7
IWA2413	wsnp_Ex_c19430_28378386	6A	2.1
IWA6711	wsnp_Ku_c21405_31157318	6A	2.1
IWA6937	wsnp_Ku_c34036_43438136	6A	2.1
IWB843	BobWhite_c15849_189	6A	2.1
IWB1655	BobWhite_c2297_1853	6A	2.1
IWB2212	BobWhite_c28547_208	6A	2.1
IWB5557	BobWhite_rep_c65669_295	6A	2.1
IWB5558	BobWhite_rep_c65669_525	6A	2.1
IWB5563	BobWhite_rep_c65775_338	6A	2.1
IWB11274	BS00082812_51	6A	2.1
IWB40670	Kukri_c11737_1241	6A	2.1
IWB49719	Kukri_rep_c116677_306	6A	2.1
IWB54332	RAC875_c16649_322	6A	2.1
IWB69382	Tdurum_contig27939_357	6A	2.1
IWB1848	BobWhite_c24750_122	6A	2.4
IWA5781	wsnp_JD_c1119_1642176	6A	2.8
IWB23071	Excalibur_c18072_214	6A	2.8
IWB48022	Kukri_c8500_728	6A	2.8
IWB64082	RFL_Contig2815_1305	6A	2.8
IWB11785	BS00093036_51	6A	4.5
IWB14763	CAP8_c4805_295	6A	4.5
IWB882	BobWhite_c16182_53	6A	5.2
IWB5029	BobWhite_rep_c52979_181	6A	5.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB8077	BS00037002_51	6A	5.2
IWB8078	BS00037003_51	6A	5.2
IWB10105	BS00067630_51	6A	5.2
IWB22036	Excalibur_c12085_276	6A	5.2
IWB22702	Excalibur_c15851_590	6A	5.2
IWB23519	Excalibur_c20597_509	6A	5.2
IWB25143	Excalibur_c31801_752	6A	5.2
IWB26592	Excalibur_c4483_1053	6A	5.2
IWB44965	Kukri_c39873_66	6A	5.2
IWB49090	Kukri_rep_c105406_308	6A	5.2
IWB58271	RAC875_c4668_771	6A	5.2
IWB60249	RAC875_c6916_860	6A	5.2
IWB67415	Tdurum_contig12045_613	6A	5.2
IWB72956	Tdurum_contig63703_1143	6A	5.2
IWB72958	Tdurum_contig63703_1305	6A	5.2
IWB72429	Tdurum_contig55193_347	6A	6.2
IWA7007	wsnp_Ku_c39334_47795461	6A	6.9
IWB2392	BobWhite_c3073_1156	6A	6.9
IWB26414	Excalibur_c431_1130	6A	6.9
IWB2598	BobWhite_c32973_167	6A	7.2
IWB7815	BS00031062_51	6A	7.2
IWB11315	BS00083630_51	6A	7.2
IWB35595	IAAV9150	6A	7.2
IWB43805	Kukri_c3009_1374	6A	7.2
IWB43808	Kukri_c3009_1702	6A	7.2
IWB64918	RFL_Contig5170_330	6A	7.2
IWB67412	Tdurum_contig12045_1230	6A	7.2
IWB67413	Tdurum_contig12045_246	6A	7.2
IWB72957	Tdurum_contig63703_1237	6A	7.2
IWB35219	IAAV661	6A	7.5
IWB23521	Excalibur_c20597_569	6A	7.9
IWB66015	TA005787-0140	6A	8.2
IWB60233	RAC875_c68978_220	6A	8.9
IWB67416	Tdurum_contig12045_868	6A	8.9
IWA705	wsnp_CAP11_c2142_1128735	6A	13.8
IWB72414	Tdurum_contig54957_624	6A	15.5
IWB74005	Tdurum_contig97611_150	6A	16.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA6601	wsnp_Ku_c16572_25480808	6A	25.3
IWB841	BobWhite_c15802_72	6A	25.3
IWB842	BobWhite_c15802_720	6A	25.3
IWB10335	BS00068515_51	6A	25.3
IWB20433	Ex_c2978_643	6A	25.3
IWB28338	Excalibur_c64989_250	6A	25.3
IWB28340	Excalibur_c64989_610	6A	25.3
IWB40111	Ku_c8779_606	6A	25.3
IWB40299	Kukri_c102502_261	6A	25.3
IWB53140	RAC875_c106584_1077	6A	25.3
IWB53141	RAC875_c106584_747	6A	25.3
IWB54801	RAC875_c19250_188	6A	25.3
IWB69896	Tdurum_contig29823_203	6A	25.7
IWB22191	Excalibur_c13_1928	6A	26.0
IWB7466	BS00023192_51	6A	27.4
IWB21168	Ex_c68796_2057	6A	31.0
IWB10743	BS00074487_51	6A	32.0
IWB29888	Excalibur_rep_c102991_619	6A	32.0
IWB30282	Excalibur_rep_c107577_250	6A	33.1
IWB13344	CAP12_c2970_177	6A	34.1
IWB9848	BS00066615_51	6A	34.8
IWB10710	BS00074131_51	6A	34.8
IWB14573	CAP8_c1881_215	6A	34.8
IWB38095	Ku_c10377_335	6A	34.8
IWB47853	Kukri_c80594_361	6A	34.8
IWB75263	tplb0060j17_450	6A	34.8
IWB1857	BobWhite_c24848_219	6A	35.2
IWB3478	BobWhite_c4580_669	6A	35.2
IWB6401	BS00011436_51	6A	35.2
IWB7199	BS00022660_51	6A	35.2
IWB7337	BS00022951_51	6A	35.2
IWB7568	BS00025084_51	6A	35.2
IWB72039	Tdurum_contig50062_934	6A	35.2
IWA1283	wsnp_Ex_c1011_1931956	6A	35.5
IWA1523	wsnp_Ex_c11621_18716254	6A	35.8
IWB12604	BS00110902_51	6A	36.9
IWB43021	Kukri_c24705_248	6A	38.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA51	wsnp_BE404947A_Ta_2_1	6A	38.6
IWA1282	wsnp_Ex_c1011_1931797	6A	38.6
IWA1748	wsnp_Ex_c13223_20866191	6A	38.6
IWA2137	wsnp_Ex_c16491_24996576	6A	38.6
IWA7286	wsnp_Ku_c7458_12842353	6A	38.6
IWA8608	wsnp_RFL_Contig4601_5473822	6A	38.6
IWB552	BobWhite_c13839_135	6A	38.6
IWB553	BobWhite_c13839_78	6A	38.6
IWB2817	BobWhite_c36070_89	6A	38.6
IWB6044	BS00009331_51	6A	38.6
IWB6082	BS00009584_51	6A	38.6
IWB6327	BS00011010_51	6A	38.6
IWB6440	BS00011591_51	6A	38.6
IWB6509	BS00012023_51	6A	38.6
IWB7009	BS00022292_51	6A	38.6
IWB8366	BS00044360_51	6A	38.6
IWB8876	BS00062642_51	6A	38.6
IWB8946	BS00062894_51	6A	38.6
IWB9442	BS00065076_51	6A	38.6
IWB10227	BS00068092_51	6A	38.6
IWB10775	BS00074991_51	6A	38.6
IWB10776	BS00074992_51	6A	38.6
IWB11433	BS00085980_51	6A	38.6
IWB11794	BS00093145_51	6A	38.6
IWB12224	BS00104366_51	6A	38.6
IWB13333	CAP12_c2800_262	6A	38.6
IWB13400	CAP12_c4447_280	6A	38.6
IWB19789	Ex_c13223_1847	6A	38.6
IWB24036	Excalibur_c23748_1233	6A	38.6
IWB29014	Excalibur_c8197_381	6A	38.6
IWB29622	Excalibur_c98315_309	6A	38.6
IWB33864	GENE-4235_196	6A	38.6
IWB36020	IACX5772	6A	38.6
IWB36242	IACX7801	6A	38.6
IWB36255	IACX7895	6A	38.6
IWB36961	JD_c12887_157	6A	38.6
IWB40519	Kukri_c11106_439	6A	38.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB40703	Kukri_c1192_825	6A	38.6
IWB41785	Kukri_c17618_874	6A	38.6
IWB44425	Kukri_c35255_1312	6A	38.6
IWB44659	Kukri_c37241_513	6A	38.6
IWB44960	Kukri_c3986_94	6A	38.6
IWB51731	Ra_c29107_289	6A	38.6
IWB53462	RAC875_c12015_576	6A	38.6
IWB54384	RAC875_c16962_288	6A	38.6
IWB55849	RAC875_c25800_836	6A	38.6
IWB57376	RAC875_c38136_199	6A	38.6
IWB58142	RAC875_c45444_883	6A	38.6
IWB59564	RAC875_c6094_675	6A	38.6
IWB61585	RAC875_rep_c106371_205	6A	38.6
IWB65082	RFL_Contig5693_646	6A	38.6
IWB66606	Tdurum_contig10572_840	6A	38.6
IWB67933	Tdurum_contig13287_203	6A	38.6
IWB71361	Tdurum_contig42823_1811	6A	38.6
IWB71874	Tdurum_contig48179_1197	6A	38.6
IWB73285	Tdurum_contig75595_1072	6A	38.6
IWB73286	Tdurum_contig75595_586	6A	38.6
IWB73287	Tdurum_contig75595_643	6A	38.6
IWB73288	Tdurum_contig75595_886	6A	38.6
IWB73954	Tdurum_contig9612_80	6A	38.6
IWB58843	RAC875_c52504_215	6A	38.9
IWA647	wsnp_CAP11_c1114_653767	6A	39.3
IWA1335	wsnp_Ex_c1050_2008559	6A	39.3
IWA1336	wsnp_Ex_c1050_2008598	6A	39.3
IWA1338	wsnp_Ex_c1050_2009301	6A	39.3
IWB18727	D_GBUIVHFX02I5C26_339	6A	39.3
IWB22389	Excalibur_c14222_179	6A	39.3
IWB32435	GENE-1388_21	6A	39.3
IWB58955	RAC875_c53520_103	6A	39.3
IWB9743	BS00066207_51	6A	39.6
IWB6231	BS00010467_51	6A	40.6
IWB2542	BobWhite_c32377_278	6A	43.0
IWA6013	wsnp_JD_c3441_4455541	6A	44.4
IWB5910	BS00003861_51	6A	44.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB11844	BS00093964_51	6A	44.4
IWB12491	BS00110201_51	6A	44.4
IWB36957	JD_c12608_191	6A	44.4
IWB56496	RAC875_c30571_189	6A	44.4
IWB61283	RAC875_c99286_60	6A	44.4
IWB62193	RAC875_rep_c113205_124	6A	44.4
IWB40242	Kukri_c100884_175	6A	50.3
IWA7443	wsnp_Ku_rep_c68790_67933679	6A	51.3
IWA2849	wsnp_Ex_c2389_4477621	6A	54.3
IWB39003	Ku_c26804_497	6A	56.8
IWB39323	Ku_c37893_495	6A	58.5
IWB49012	Kukri_rep_c104648_106	6A	58.5
IWB56842	RAC875_c33488_549	6A	59.5
IWB73400	Tdurum_contig76911_950	6A	61.6
IWB1414	BobWhite_c20611_403	6A	66.1
IWB7500	BS00023627_51	6A	66.1
IWB12244	BS00105466_51	6A	66.1
IWB23736	Excalibur_c22012_68	6A	66.1
IWB63050	RAC875_rep_c75189_110	6A	66.1
IWB40829	Kukri_c12478_628	6A	66.4
IWB48600	Kukri_rep_c101121_477	6A	66.4
IWA1086	wsnp_CAP7_c399_215824	6A	67.5
IWB7827	BS00031178_51	6A	67.5
IWB34957	IAAV4950	6A	67.5
IWB35365	IAAV7556	6A	67.5
IWB36506	Jagger_c2853_75	6A	67.5
IWB73817	Tdurum_contig92819_647	6A	67.5
IWB3692	BobWhite_c4872_97	6A	67.8
IWB21588	Excalibur_c10263_218	6A	67.8
IWA6806	wsnp_Ku_c26784_36747712	6A	68.2
IWA6807	wsnp_Ku_c26784_36748247	6A	68.2
IWB34778	IAAV3806	6A	68.2
IWB10644	BS00073124_51	6A	70.2
IWB68523	Tdurum_contig16290_156	6A	71.2
IWB58592	RAC875_c49875_405	6A	71.6
IWA1589	wsnp_Ex_c12141_19415226	6A	71.9
IWB26966	Excalibur_c48569_78	6A	71.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB37867	JD_c8888_741	6A	71.9
IWB56218	RAC875_c28637_1004	6A	71.9
IWB62987	RAC875_rep_c73850_589	6A	71.9
IWB68613	Tdurum_contig17126_1477	6A	71.9
IWB56139	RAC875_c27962_61	6A	72.2
IWB9036	BS00063296_51	6A	72.9
IWB13025	CAP11_c6962_208	6A	72.9
IWA1928	wsnp_Ex_c14692_22766127	6A	73.3
IWA1048	wsnp_CAP7_c1839_907899	6A	73.9
IWA1874	wsnp_Ex_c14192_22135363	6A	73.9
IWA5238	wsnp_Ex_rep_c66433_64661643	6A	73.9
IWA5239	wsnp_Ex_rep_c66433_64662690	6A	73.9
IWB7511	BS00023847_51	6A	73.9
IWB13089	CAP11_c989_113	6A	73.9
IWB42115	Kukri_c19338_413	6A	73.9
IWB44573	Kukri_c36476_559	6A	73.9
IWB45584	Kukri_c45898_147	6A	73.9
IWB49782	Kukri_rep_c68344_627	6A	73.9
IWB56845	RAC875_c33523_648	6A	73.9
IWB72426	Tdurum_contig55124_310	6A	73.9
IWB73616	Tdurum_contig83190_441	6A	73.9
IWB74998	tplb0052b07_577	6A	73.9
IWA1875	wsnp_Ex_c14192_22135384	6A	74.3
IWA902	wsnp_CAP11_rep_c8811_3803397	6A	74.6
IWA1276	wsnp_Ex_c10087_16579529	6A	74.6
IWB11102	BS00079942_51	6A	74.6
IWB14307	CAP7_c900_114	6A	74.6
IWB35501	IAAV8577	6A	74.6
IWB63176	RAC875_rep_c81239_73	6A	74.6
IWB1120	BobWhite_c18017_209	6A	74.9
IWB6752	BS00021747_51	6A	74.9
IWB31327	Excalibur_rep_c82397_137	6A	74.9
IWB33626	GENE-3854_620	6A	74.9
IWB42599	Kukri_c22149_276	6A	74.9
IWB59541	RAC875_c60695_112	6A	74.9
IWB71935	Tdurum_contig48870_249	6A	74.9
IWA731	wsnp_CAP11_c2817_1415793	6A	76.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB12868	CAP11_c3827_198	6A	76.0
IWA2201	wsnp_Ex_c1728_3271657	6A	76.3
IWA3207	wsnp_Ex_c29025_38097560	6A	76.3
IWB38287	Ku_c11950_931	6A	76.3
IWB65184	RFL_Contig5958_1142	6A	78.0
IWB33545	GENE-3659_162	6A	79.4
IWA5619	wsnp_Ex_rep_c69627_68580121	6A	80.4
IWB61742	RAC875_rep_c107922_295	6A	80.4
IWB10321	BS00068469_51	6A	80.7
IWA5898	wsnp_JD_c19278_17450072	6A	81.4
IWA5899	wsnp_JD_c19278_17450210	6A	81.4
IWA8348	wsnp_RFL_Contig2523_2130662	6A	81.4
IWA3527	wsnp_Ex_c35545_43677576	6A	81.7
IWA6820	wsnp_Ku_c27273_37219950	6A	82.1
IWA2660	wsnp_Ex_c2192_4108709	6A	82.4
IWA8110	wsnp_Ra_rep_c100410_86374467	6A	82.4
IWB3738	BobWhite_c5154_466	6A	82.4
IWB8932	BS00062823_51	6A	82.4
IWB25702	Excalibur_c36332_449	6A	82.4
IWB35526	IAAV8707	6A	82.4
IWB38402	Ku_c13637_545	6A	82.4
IWB62878	RAC875_rep_c72499_697	6A	82.4
IWB5437	BobWhite_rep_c64054_499	6A	82.7
IWB9385	BS00064873_51	6A	83.4
IWA3782	wsnp_Ex_c41551_48349585	6A	84.1
IWA5057	wsnp_Ex_rep_c102173_87395725	6A	84.1
IWB4193	BobWhite_c6597_641	6A	84.1
IWB6351	BS00011122_51	6A	84.1
IWB7067	BS00022412_51	6A	84.1
IWB34522	IAAV2245	6A	84.1
IWB34811	IAAV3994	6A	84.1
IWB35040	IAAV5536	6A	84.1
IWB52665	Ra_c77116_279	6A	84.1
IWB56100	RAC875_c27728_298	6A	84.1
IWB59037	RAC875_c54465_101	6A	84.1
IWA2295	wsnp_Ex_c1827_3442984	6A	84.4
IWA2421	wsnp_Ex_c19476_28434084	6A	84.4



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA3261	wsnp_Ex_c3016_5573603	6A	84.4
IWA3299	wsnp_Ex_c30823_39695268	6A	84.4
IWA6679	wsnp_Ku_c19799_29342935	6A	84.4
IWB1433	BobWhite_c20706_135	6A	84.4
IWB4299	BobWhite_c7156_643	6A	84.4
IWB7420	BS00023089_51	6A	84.4
IWB8871	BS00062619_51	6A	84.4
IWB9166	BS00063977_51	6A	84.4
IWB9221	BS00064203_51	6A	84.4
IWB9444	BS00065079_51	6A	84.4
IWB9507	BS00065309_51	6A	84.4
IWB11484	BS00087178_51	6A	84.4
IWB22623	Excalibur_c154_375	6A	84.4
IWB25298	Excalibur_c33110_52	6A	84.4
IWB31491	Excalibur_s105534_234	6A	84.4
IWB34375	IAAV1385	6A	84.4
IWB35282	IAAV6992	6A	84.4
IWB38665	Ku_c18654_689	6A	84.4
IWB39093	Ku_c2951_1724	6A	84.4
IWB39455	Ku_c44422_456	6A	84.4
IWB40145	Ku_c9204_918	6A	84.4
IWB51018	Ra_c12531_779	6A	84.4
IWB52666	Ra_c77116_338	6A	84.4
IWB52712	Ra_c8185_676	6A	84.4
IWB54052	RAC875_c15077_241	6A	84.4
IWB65773	TA004032-0298	6A	84.4
IWA7847	wsnp_Ra_c31062_40243185	6A	85.5
IWB12060	BS00099290_51	6A	85.5
IWB48650	Kukri_rep_c101477_475	6A	85.5
IWA3879	wsnp_Ex_c43887_50077773	6A	85.8
IWA6560	wsnp_Ku_c1549_3054996	6A	85.8
IWA7349	wsnp_Ku_c927_1905095	6A	85.8
IWA7483	wsnp_Ku_rep_c70860_70522328	6A	85.8
IWB26877	Excalibur_c47557_418	6A	85.8
IWB29660	Excalibur_c99271_71	6A	85.8
IWB56344	RAC875_c29487_369	6A	85.8
IWB60780	RAC875_c8481_2685	6A	85.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB63073	RAC875_rep_c76107_118	6A	85.8
IWB14059	CAP7_c3837_154	6A	86.2
IWB51005	Ra_c12362_422	6A	86.5
IWB30642	Excalibur_rep_c113748_62	6A	87.3
IWA1423	wsnp_Ex_c1104_2118684	6A	87.9
IWA1498	wsnp_Ex_c11446_18468102	6A	87.9
IWA1520	wsnp_Ex_c11604_18695170	6A	87.9
IWA1606	wsnp_Ex_c12288_19625413	6A	87.9
IWA1813	wsnp_Ex_c1381_2647144	6A	87.9
IWA2187	wsnp_Ex_c17089_25709028	6A	87.9
IWA2366	wsnp_Ex_c18965_27868480	6A	87.9
IWA3227	wsnp_Ex_c29350_38393488	6A	87.9
IWA3262	wsnp_Ex_c3016_5573835	6A	87.9
IWA3408	wsnp_Ex_c32624_41252144	6A	87.9
IWA4370	wsnp_Ex_c590_1176006	6A	87.9
IWA4371	wsnp_Ex_c590_1176609	6A	87.9
IWA5376	wsnp_Ex_rep_c67218_65729639	6A	87.9
IWA5421	wsnp_Ex_rep_c67605_66248628	6A	87.9
IWA5441	wsnp_Ex_rep_c67692_66357763	6A	87.9
IWA5713	wsnp_Ex_rep_c70831_69710886	6A	87.9
IWA6276	wsnp_JD_rep_c51547_35074931	6A	87.9
IWA6469	wsnp_Ku_c12588_20290369	6A	87.9
IWA6559	wsnp_Ku_c1549_3054872	6A	87.9
IWA6737	wsnp_Ku_c2329_4474766	6A	87.9
IWA7354	wsnp_Ku_c9388_15743434	6A	87.9
IWA7438	wsnp_Ku_rep_c68351_67302372	6A	87.9
IWA7492	wsnp_Ku_rep_c71238_70957970	6A	87.9
IWA7940	wsnp_Ra_c44015_50539749	6A	87.9
IWB2038	BobWhite_c26797_144	6A	87.9
IWB2480	BobWhite_c31673_617	6A	87.9
IWB3897	BobWhite_c556_926	6A	87.9
IWB6555	BS00012351_51	6A	87.9
IWB7175	BS00022605_51	6A	87.9
IWB7526	BS00024191_51	6A	87.9
IWB8045	BS00036211_51	6A	87.9
IWB9334	BS00064632_51	6A	87.9
IWB9704	BS00066047_51	6A	87.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB10629	BS00072945_51	6A	87.9
IWB10774	BS00074979_51	6A	87.9
IWB11029	BS00078715_51	6A	87.9
IWB11434	BS00086046_51	6A	87.9
IWB20443	Ex_c3016_944	6A	87.9
IWB20844	Ex_c50864_326	6A	87.9
IWB21378	Ex_c8482_488	6A	87.9
IWB21483	Ex_c9854_373	6A	87.9
IWB22512	Excalibur_c1492_1282	6A	87.9
IWB22862	Excalibur_c16840_3454	6A	87.9
IWB24555	Excalibur_c27187_438	6A	87.9
IWB25285	Excalibur_c33017_141	6A	87.9
IWB25286	Excalibur_c33017_392	6A	87.9
IWB28056	Excalibur_c61509_69	6A	87.9
IWB29260	Excalibur_c8900_354	6A	87.9
IWB34635	IAAV2924	6A	87.9
IWB35121	IAAV5967	6A	87.9
IWB35130	IAAV6004	6A	87.9
IWB35228	IAAV665	6A	87.9
IWB35256	IAAV6837	6A	87.9
IWB35453	IAAV8240	6A	87.9
IWB35565	IAAV894	6A	87.9
IWB37679	JD_c6195_347	6A	87.9
IWB38060	Ku_c1021_1642	6A	87.9
IWB38062	Ku_c1021_1971	6A	87.9
IWB38524	Ku_c16169_809	6A	87.9
IWB38557	Ku_c1672_301	6A	87.9
IWB38739	Ku_c20452_1414	6A	87.9
IWB38787	Ku_c21490_472	6A	87.9
IWB39584	Ku_c5312_1140	6A	87.9
IWB39881	Ku_c6998_485	6A	87.9
IWB39921	Ku_c71238_1537	6A	87.9
IWB40154	Ku_c935_3041	6A	87.9
IWB40285	Kukri_c10226_1815	6A	87.9
IWB40725	Kukri_c12035_517	6A	87.9
IWB40898	Kukri_c1281_515	6A	87.9
IWB43035	Kukri_c24790_253	6A	87.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB44856	Kukri_c38882_391	6A	87.9
IWB49068	Kukri_rep_c105113_334	6A	87.9
IWB51879	Ra_c33862_243	6A	87.9
IWB52050	Ra_c41794_1690	6A	87.9
IWB52105	Ra_c4452_3073	6A	87.9
IWB52222	Ra_c5250_567	6A	87.9
IWB52786	Ra_c90_3168	6A	87.9
IWB55210	RAC875_c21590_141	6A	87.9
IWB55581	RAC875_c24004_127	6A	87.9
IWB59351	RAC875_c58253_127	6A	87.9
IWB59402	RAC875_c58780_213	6A	87.9
IWB59409	RAC875_c58848_60	6A	87.9
IWB59505	RAC875_c60191_947	6A	87.9
IWB62532	RAC875_rep_c69147_1105	6A	87.9
IWB62533	RAC875_rep_c69147_1219	6A	87.9
IWB62534	RAC875_rep_c69147_184	6A	87.9
IWB62536	RAC875_rep_c69147_767	6A	87.9
IWB63261	RAC875_rep_c87765_69	6A	87.9
IWB65577	TA002574-0890	6A	87.9
IWB74895	tplb0047k12_1370	6A	87.9
IWB38113	Ku_c104762_377	6A	88.3
IWA6928	wsnp_Ku_c3354_6228863	6A	88.6
IWA7511	wsnp_Ku_rep_c72681_72356010	6A	88.6
IWB7951	BS00033795_51	6A	88.6
IWB25812	Excalibur_c37358_676	6A	88.6
IWB26704	Excalibur_c4579_979	6A	88.6
IWB27029	Excalibur_c49239_97	6A	88.6
IWB43983	Kukri_c31502_115	6A	89.7
IWA3356	wsnp_Ex_c31711_40468407	6A	91.1
IWB36276	IACX8190	6A	91.1
IWB2812	BobWhite_c35961_80	6A	91.4
IWA4029	wsnp_Ex_c4865_8679756	6A	91.8
IWA6927	wsnp_Ku_c3354_6228393	6A	91.8
IWB1421	BobWhite_c2068_385	6A	91.8
IWB7152	BS00022553_51	6A	91.8
IWB7319	BS00022913_51	6A	91.8
IWB34757	IAAV3686	6A	91.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB43142	Kukri_c25562_1826	6A	91.8
IWB52347	Ra_c6244_1331	6A	91.8
IWB54968	RAC875_c2020_3731	6A	91.8
IWB56692	RAC875_c32059_2463	6A	91.8
IWB65393	TA001414-0867	6A	91.8
IWB1442	BobWhite_c20782_697	6A	92.1
IWB8179	BS00039515_51	6A	92.1
IWB46863	Kukri_c60461_374	6A	92.1
IWA3231	wsnp_Ex_c29368_38408543	6A	92.5
IWA8027	wsnp_Ra_c61979_62214892	6A	92.5
IWA8028	wsnp_Ra_c61979_62215037	6A	92.5
IWB3245	BobWhite_c4255_127	6A	92.5
IWB4536	BobWhite_c8879_142	6A	92.5
IWB8364	BS00044311_51	6A	92.5
IWB60744	RAC875_c83532_305	6A	92.5
IWA2249	wsnp_Ex_c17692_26437459	6A	92.8
IWA5041	wsnp_Ex_rep_c102011_87270703	6A	92.8
IWA7659	wsnp_Ra_c16745_25482384	6A	92.8
IWB7989	BS00034886_51	6A	92.8
IWB27032	Excalibur_c49263_512	6A	92.8
IWB27051	Excalibur_c49419_202	6A	92.8
IWB39176	Ku_c32392_967	6A	92.8
IWB40054	Ku_c8125_1049	6A	92.8
IWB40405	Kukri_c10711_632	6A	92.8
IWB45982	Kukri_c49417_141	6A	92.8
IWB51108	Ra_c14408_576	6A	92.8
IWB55735	RAC875_c25029_554	6A	92.8
IWB59738	RAC875_c63051_372	6A	92.8
IWB60393	RAC875_c75884_249	6A	92.8
IWB74471	tplb0032i10_420	6A	92.8
IWB75254	tplb0060e19_614	6A	92.8
IWB35750	IACX14305	6A	93.1
IWB63034	RAC875_rep_c74600_377	6A	93.1
IWB69955	Tdurum_contig30082_197	6A	93.1
IWB33544	GENE-3659_104	6A	94.2
IWA2457	wsnp_Ex_c19770_28768859	6A	94.9
IWB65965	TA005366-0788	6A	95.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB6691	BS00021376_51	6A	95.6
IWB6717	BS00021689_51	6A	95.6
IWB8073	BS00036878_51	6A	95.6
IWB22320	Excalibur_c13746_178	6A	95.6
IWB35849	IACX2250	6A	95.6
IWB73438	Tdurum_contig78006_158	6A	95.9
IWB12269	BS00106028_51	6A	96.6
IWB7421	BS00023092_51	6A	96.9
IWB35333	IAAV7384	6A	96.9
IWB72306	Tdurum_contig53138_302	6A	96.9
IWA2416	wsnp_Ex_c19454_28409258	6A	97.3
IWB30696	Excalibur_rep_c115366_128	6A	97.6
IWB14704	CAP8_c381_190	6A	97.9
IWB45770	Kukri_c4750_452	6A	97.9
IWB47666	Kukri_c76003_183	6A	97.9
IWB51739	Ra_c29420_237	6A	97.9
IWB71835	Tdurum_contig47663_321	6A	97.9
IWB73396	Tdurum_contig76709_195	6A	97.9
IWA2136	wsnp_Ex_c16480_24986490	6A	98.6
IWB41283	Kukri_c14877_303	6A	98.6
IWB74245	tplb0025i05_1985	6A	99.0
IWB33680	GENE-3945_245	6A	99.7
IWB65813	TA004297-0876	6A	100.0
IWA2812	wsnp_Ex_c2350_4403690	6A	100.4
IWB33567	GENE-3709_393	6A	100.4
IWB59702	RAC875_c62614_191	6A	100.4
IWB74244	tplb0025i05_1836	6A	100.4
IWA6973	wsnp_Ku_c37942_46693718	6A	101.0
IWB57556	RAC875_c39852_592	6A	101.0
IWA3463	wsnp_Ex_c341_667884	6A	101.4
IWA3482	wsnp_Ex_c34545_42832894	6A	102.1
IWA3483	wsnp_Ex_c34545_42833327	6A	102.1
IWA8306	wsnp_RFL_Contig2182_1514692	6A	102.1
IWB31050	Excalibur_rep_c69275_346	6A	102.1
IWB33803	GENE-4154_365	6A	102.1
IWB35169	IAAV622	6A	102.1
IWB64457	RFL_Contig3687_972	6A	102.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB8079	BS00037006_51	6A	102.8
IWB717	BobWhite_c14915_156	6A	103.8
IWA7052	wsnp_Ku_c4296_7807837	6A	104.2
IWA664	wsnp_CAP11_c1244_714229	6A	104.5
IWB5996	BS00005019_51	6A	104.5
IWB8093	BS00037223_51	6A	104.5
IWB9844	BS00066605_51	6A	104.5
IWB10570	BS00071706_51	6A	104.5
IWB10571	BS00071708_51	6A	104.5
IWB10695	BS00073872_51	6A	104.5
IWB10758	BS00074752_51	6A	104.5
IWB11353	BS00084250_51	6A	104.5
IWB11354	BS00084251_51	6A	104.5
IWB33751	GENE-4052_338	6A	104.5
IWB33872	GENE-4249_885	6A	104.5
IWB34763	IAAV3734	6A	104.5
IWB39473	Ku_c45494_267	6A	104.5
IWB43118	Kukri_c25389_688	6A	104.5
IWA38	wsnp_BE403818A_Ta_2_1	6A	104.9
IWB65994	TA005615-0600	6A	104.9
IWA6596	wsnp_Ku_c16432_25320146	6A	105.2
IWB7281	BS00022836_51	6A	105.2
IWB7681	BS00028263_51	6A	105.2
IWB27445	Excalibur_c53981_77	6A	105.2
IWB34914	IAAV4703	6A	105.2
IWB42164	Kukri_c19612_514	6A	105.2
IWB43791	Kukri_c29966_1223	6A	105.2
IWA1997	wsnp_Ex_c15268_23489498	6A	105.5
IWB24402	Excalibur_c26057_1049	6A	105.5
IWB36100	IACX6046	6A	105.5
IWB36365	IACX9256	6A	105.5
IWB40151	Ku_c9262_902	6A	105.5
IWA1671	wsnp_Ex_c1269_2435294	6A	105.9
IWA5074	wsnp_Ex_rep_c102807_87894833	6A	105.9
IWA5757	wsnp_Ex_rep_c86110_78630016	6A	105.9
IWB110	BobWhite_c1082_134	6A	105.9
IWB1314	BobWhite_c19820_129	6A	105.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB1926	BobWhite_c2568_115	6A	105.9
IWB6286	BS00010780_51	6A	105.9
IWB10738	BS00074432_51	6A	105.9
IWB11506	BS00087447_51	6A	105.9
IWB51205	Ra_c16143_1157	6A	105.9
IWB60244	RAC875_c691_1486	6A	105.9
IWB30129	Excalibur_rep_c105491_144	6A	106.5
IWA6724	wsnp_Ku_c22358_32187765	6A	106.9
IWB35929	IACX3586	6A	106.9
IWA4036	wsnp_Ex_c48789_53586502	6A	107.6
IWB50963	Ra_c11721_631	6A	107.6
IWB71372	Tdurum_contig42858_1256	6A	107.6
IWA4035	wsnp_Ex_c48789_53586406	6A	107.9
IWB71373	Tdurum_contig42858_1352	6A	107.9
IWB9445	BS00065082_51	6A	108.6
IWB56339	RAC875_c29455_79	6A	109.6
IWB50964	Ra_c11721_766	6A	110.0
IWB74549	tplb0035a03_368	6A	110.0
IWB38780	Ku_c21399_772	6A	110.3
IWB29094	Excalibur_c840_1220	6A	118.4
IWB9616	BS00065700_51	6A	122.8
IWA259	wsnp_BE495143A_Ta_2_1	6A	123.5
IWA260	wsnp_BE495143A_Ta_2_2	6A	123.5
IWA5142	wsnp_Ex_rep_c105594_89968727	6A	123.5
IWB1033	BobWhite_c17385_55	6A	123.5
IWB2006	BobWhite_c26503_61	6A	123.5
IWB5711	BobWhite_s67148_324	6A	123.5
IWB8760	BS00058929_51	6A	123.5
IWB8924	BS00062781_51	6A	123.5
IWB9048	BS00063378_51	6A	123.5
IWB9468	BS00065152_51	6A	123.5
IWB60449	RAC875_c77113_57	6A	123.5
IWB63308	RAC875_rep_c92223_1022	6A	123.5
IWB21617	Excalibur_c10372_1256	6A	124.6
IWB33879	GENE-4268_101	6A	124.6
IWB39700	Ku_c604_705	6A	124.6
IWB40112	Ku_c87838_1055	6A	124.6



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB53303	RAC875_c11289_71	6A	124.9
IWA1497	wsnp_Ex_c11439_18459047	6A	125.2
IWA5479	wsnp_Ex_rep_c68010_66754171	6A	125.6
IWA5481	wsnp_Ex_rep_c68010_66754801	6A	125.6
IWB20965	Ex_c5868_1113	6A	125.6
IWB34744	IAAV3609	6A	127.4
IWB46185	Kukri_c5168_980	6A	137.9
IWB24870	Excalibur_c29639_65	6A	143.7
IWB31101	Excalibur_rep_c69981_75	6A	144.0
IWB5823	BS00003185_51	6A	144.7
IWB24222	Excalibur_c24825_539	6A	144.7
IWA7764	wsnp_Ra_c2270_4383252	6A	145.4
IWB12055	BS00099074_51	6A	145.7
IWB51908	Ra_c3533_880	6A	147.4
IWA5035	wsnp_Ex_rep_c101766_87073440	6A	147.8
IWB46659	Kukri_c57452_1040	6A	147.8
IWB12203	BS00103442_51	6A	149.1
IWA5398	wsnp_Ex_rep_c67436_66026057	6A	151.2
IWA2538	wsnp_Ex_c20457_29526260	6A	153.6
IWA2539	wsnp_Ex_c20457_29526403	6A	153.6
IWA4809	wsnp_Ex_c8510_14306239	6A	153.6
IWA2481	wsnp_Ex_c19928_28951983	6A	154.3
IWB50538	Kukri_rep_c95718_868	6A	155.8
IWB63000	RAC875_rep_c74051_276	6A	155.8
IWB2065	BobWhite_c27145_731	6A	159.1
IWB5984	BS00004466_51	6A	159.1
IWB73296	Tdurum_contig75700_411	6A	159.1
IWB11953	BS00096240_51	6A	162.1
IWB21222	Ex_c70144_671	6A	162.1
IWB33740	GENE-4028_111	6A	162.1
IWB33741	GENE-4028_152	6A	162.1
IWB34973	IAAV5088	6A	162.1
IWA928	wsnp_CAP12_c1663_836753	6A	165.0
IWB4933	BobWhite_rep_c51132_85	6A	165.0
IWB28230	Excalibur_c63713_871	6A	165.0
IWB29913	Excalibur_rep_c103170_504	6A	165.0
IWB33635	GENE-3863_132	6A	165.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB1815	BobWhite_c24258_496	6A	165.4
IWB4646	BobWhite_c9681_769	6A	165.4
IWB9213	BS00064182_51	6A	165.4
IWB10077	BS00067558_51	6A	165.4
IWB28030	Excalibur_c61218_269	6A	165.4
IWB45558	Kukri_c45702_439	6A	165.4
IWB56108	RAC875_c27781_591	6A	165.4
IWB57413	RAC875_c38488_164	6A	165.4
IWA2580	wsnp_Ex_c21129_30256617	6A	165.7
IWA6182	wsnp_JD_c7795_8868122	6A	165.7
IWA6316	wsnp_JD_rep_c65886_41872083	6A	165.7
IWA7747	wsnp_Ra_c21546_30949373	6A	165.7
IWB2929	BobWhite_c37804_181	6A	165.7
IWB3130	BobWhite_c40602_313	6A	165.7
IWB5829	BS00003485_51	6A	165.7
IWB6638	BS00017018_51	6A	165.7
IWB7041	BS00022362_51	6A	165.7
IWB10996	BS00078214_51	6A	165.7
IWB11712	BS00091539_51	6A	165.7
IWB11831	BS00093844_51	6A	165.7
IWB12100	BS00099879_51	6A	165.7
IWB14438	CAP7_rep_c6384_381	6A	165.7
IWB19087	D_GDEEGVY02GMZ4L_337	6A	165.7
IWB22815	Excalibur_c16590_1494	6A	165.7
IWB22816	Excalibur_c16590_1536	6A	165.7
IWB23266	Excalibur_c19182_226	6A	165.7
IWB29179	Excalibur_c8670_972	6A	165.7
IWB30119	Excalibur_rep_c105389_309	6A	165.7
IWB33624	GENE-3852_1100	6A	165.7
IWB33625	GENE-3852_857	6A	165.7
IWB33632	GENE-3862_103	6A	165.7
IWB33633	GENE-3862_178	6A	165.7
IWB33634	GENE-3862_349	6A	165.7
IWB33648	GENE-3871_109	6A	165.7
IWB33650	GENE-3871_337	6A	165.7
IWB35301	IAAV7160	6A	165.7
IWB43895	Kukri_c30754_229	6A	165.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB44539	Kukri_c36210_205	6A	165.7
IWB45148	Kukri_c41482_311	6A	165.7
IWB49132	Kukri_rep_c106022_483	6A	165.7
IWB50084	Kukri_rep_c70994_104	6A	165.7
IWB53746	RAC875_c13595_438	6A	165.7
IWB53748	RAC875_c13595_669	6A	165.7
IWB56187	RAC875_c28339_128	6A	165.7
IWB56812	RAC875_c3312_1715	6A	165.7
IWB60484	RAC875_c77791_840	6A	165.7
IWB60590	RAC875_c79898_255	6A	165.7
IWB66989	Tdurum_contig11275_461	6A	165.7
IWB70138	Tdurum_contig30953_159	6A	165.7
IWB71125	Tdurum_contig42418_957	6A	165.7
IWB7230	BS00022729_51	6A	166.0
IWB11554	BS00088274_51	6A	166.0
IWB11675	BS00090829_51	6A	166.0
IWB11920	BS00095206_51	6A	166.0
IWB24946	Excalibur_c30234_130	6A	166.0
IWB28231	Excalibur_c63713_892	6A	166.0
IWB29652	Excalibur_c99101_82	6A	166.0
IWB33846	GENE-4222_877	6A	166.0
IWB34392	IAAV1495	6A	166.0
IWB34813	IAAV40	6A	166.0
IWB35265	IAAV6895	6A	166.0
IWB64047	RFL_Contig2765_669	6A	166.0
IWB64259	RFL_Contig3175_482	6A	166.0
IWB71973	Tdurum_contig49511_330	6A	166.0
IWB74125	tplb0022c19_495	6A	166.0
IWB11639	BS00089973_51	6A	166.7
IWB64257	RFL_Contig3175_1271	6A	167.9
IWB43328	Kukri_c26693_158	6A	171.8
IWB21174	Ex_c69054_723	6A	172.5
IWB23484	Excalibur_c20459_1081	6A	173.2
IWB57610	RAC875_c4030_942	6A	173.9
IWB45089	Kukri_c40994_61	6A	174.9
IWB33807	GENE-4167_145	6A	175.9
IWB36445	Jagger_c1423_102	6A	175.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB74836	tplb0045108_298	6A	176.6
IWB74837	tplb0045108_703	6A	176.6
IWA5768	wsnp_Ex_rep_c98716_85135069	6A	176.9
IWA2632	wsnp_Ex_c2161_4059735	6A	177.3
IWA5172	wsnp_Ex_rep_c109274_92142043	6A	177.3
IWB6725	BS00021704_51	6A	177.3
IWB8323	BS00042710_51	6A	177.3
IWB26640	Excalibur_c4518_2931	6A	177.3
IWA3246	wsnp_Ex_c29648_38653281	6A	178.4
IWB3463	BobWhite_c45410_242	6A	178.4
IWA3202	wsnp_Ex_c28973_38050174	6A	178.7
IWB20413	Ex_c28973_947	6A	178.7
IWB36427	Jagger_c1134_353	6A	178.7
IWB42057	Kukri_c18955_73	6A	178.7
IWB46594	Kukri_c5631_968	6A	178.7
IWB68609	Tdurum_contig1706_272	6A	178.7
IWA4699	wsnp_Ex_c7546_12900094	6A	180.8
IWA7497	wsnp_Ku_rep_c71567_71302229	6A	180.8
IWA7908	wsnp_Ra_c39433_47141896	6A	180.8
IWB6503	BS00011962_51	6A	180.8
IWB11445	BS00086173_51	6A	180.8
IWB27178	Excalibur_c5082_158	6A	180.8
IWB31589	Excalibur_s115877_56	6A	180.8
IWB33599	GENE-3780_131	6A	180.8
IWB34398	IAAV1529	6A	180.8
IWB34589	IAAV2636	6A	180.8
IWB44476	Kukri_c3570_1817	6A	180.8
IWB45106	Kukri_c41157_315	6A	180.8
IWB45429	Kukri_c44291_138	6A	180.8
IWB45430	Kukri_c44291_192	6A	180.8
IWB45431	Kukri_c44291_223	6A	180.8
IWB45981	Kukri_c494_1479	6A	180.8
IWB47326	Kukri_c66671_183	6A	180.8
IWB48467	Kukri_c9731_578	6A	180.8
IWB50129	Kukri_rep_c71567_1037	6A	180.8
IWB50550	Kukri_rep_c96828_86	6A	180.8
IWB53601	RAC875_c12821_466	6A	180.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB53602	RAC875_c12821_550	6A	180.8
IWB56147	RAC875_c27997_250	6A	180.8
IWB73185	Tdurum_contig70819_393	6A	180.8
IWB38521	Ku_c16162_2453	6A	181.2
IWB11329	BS00083914_51	6A	181.5
IWB74644	tplb0038e08_1052	6A	181.8
IWB10711	BS00074151_51	6A	185.2
IWB52366	Ra_c6404_966	6B	0.0
IWB12201	BS00103275_51	6B	8.2
IWA3679	wsnp_Ex_c3940_7144946	6B	11.6
IWA5722	wsnp_Ex_rep_c71062_69901558	6B	11.6
IWB8012	BS00035381_51	6B	11.6
IWB21830	Excalibur_c11245_880	6B	11.6
IWB23657	Excalibur_c21568_1462	6B	11.6
IWB34510	IAAV2149	6B	11.6
IWB35399	IAAV7878	6B	11.6
IWB43172	Kukri_c25725_1921	6B	11.6
IWB51554	Ra_c23874_338	6B	11.6
IWB54739	RAC875_c18821_1272	6B	11.6
IWB54740	RAC875_c18821_137	6B	11.6
IWB56906	RAC875_c34089_249	6B	11.6
IWB57949	RAC875_c43536_193	6B	11.6
IWB65405	TA001478-0609	6B	11.6
IWA2062	wsnp_Ex_c15785_24157360	6B	11.9
IWB73418	Tdurum_contig77500_369	6B	12.3
IWA2039	wsnp_Ex_c15595_23910900	6B	12.6
IWB3587	BobWhite_c47347_420	6B	12.6
IWB21773	Excalibur_c110151_286	6B	12.6
IWB25328	Excalibur_c3336_1007	6B	12.6
IWB38798	Ku_c2173_206	6B	12.6
IWB68462	Tdurum_contig15762_139	6B	12.6
IWB72851	Tdurum_contig62005_185	6B	12.6
IWB65718	TA003659-1136	6B	12.9
IWA3354	wsnp_Ex_c31670_40433594	6B	13.3
IWB45958	Kukri_c49155_297	6B	13.3
IWB69230	Tdurum_contig26001_242	6B	13.3
IWA800	wsnp_CAP11_c681_443861	6B	13.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA1017	wsnp_CAP12_rep_c8688_3644383	6B	13.9
IWB28858	Excalibur_c7785_123	6B	13.9
IWB30825	Excalibur_rep_c67196_143	6B	13.9
IWB31427	Excalibur_rep_c94584_98	6B	13.9
IWB34839	IAAV4147	6B	13.9
IWB35401	IAAV7892	6B	13.9
IWB41602	Kukri_c16568_287	6B	13.9
IWB44505	Kukri_c35968_680	6B	13.9
IWB62422	RAC875_rep_c117576_74	6B	13.9
IWB64884	RFL_Contig5080_766	6B	14.3
IWA683	wsnp_CAP11_c166_172556	6B	14.9
IWA2927	wsnp_Ex_c24766_34017588	6B	14.9
IWA5197	wsnp_Ex_rep_c66315_64480362	6B	14.9
IWA5198	wsnp_Ex_rep_c66315_64480670	6B	14.9
IWA5530	wsnp_Ex_rep_c68452_67273676	6B	14.9
IWB21613	Excalibur_c10352_911	6B	14.9
IWB21680	Excalibur_c10568_826	6B	14.9
IWB23748	Excalibur_c22106_190	6B	14.9
IWB30657	Excalibur_rep_c114175_83	6B	14.9
IWB44917	Kukri_c39369_307	6B	14.9
IWB57917	RAC875_c432_237	6B	14.9
IWB62745	RAC875_rep_c70998_974	6B	14.9
IWB65508	TA002184-1372	6B	14.9
IWB71500	Tdurum_contig44173_572	6B	14.9
IWB71501	Tdurum_contig44173_792	6B	14.9
IWB71761	Tdurum_contig47140_554	6B	14.9
IWB73501	Tdurum_contig81414_256	6B	14.9
IWB29642	Excalibur_c98849_278	6B	15.3
IWA1434	wsnp_Ex_c11073_17956329	6B	15.6
IWA3699	wsnp_Ex_c3990_7223090	6B	15.6
IWA6440	wsnp_Ku_c11870_19296142	6B	15.6
IWB1549	BobWhite_c22075_85	6B	15.6
IWB13090	CAP11_c991_160	6B	15.6
IWB14915	CAP8_c7260_77	6B	15.6
IWB30643	Excalibur_rep_c113750_104	6B	15.6
IWB36405	Jagger_c1015_305	6B	15.6
IWB36565	Jagger_c3773_108	6B	15.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB38829	Ku_c22709_313	6B	15.6
IWB45911	Kukri_c48868_478	6B	15.6
IWB47029	Kukri_c62878_1033	6B	15.6
IWB47059	Kukri_c63314_962	6B	15.6
IWB48947	Kukri_rep_c104075_178	6B	15.6
IWB48961	Kukri_rep_c104217_79	6B	15.6
IWB51061	Ra_c13513_591	6B	15.6
IWB51161	Ra_c15317_1538	6B	15.6
IWB52315	Ra_c5942_955	6B	15.6
IWB63231	RAC875_rep_c85751_123	6B	15.6
IWB63232	RAC875_rep_c85751_268	6B	15.6
IWB63233	RAC875_rep_c85751_72	6B	15.6
IWB71763	Tdurum_contig47140_916	6B	15.6
IWB72871	Tdurum_contig62155_472	6B	15.6
IWB72946	Tdurum_contig63468_1413	6B	15.6
IWB73860	Tdurum_contig93283_513	6B	15.6
IWB38810	Ku_c2212_270	6B	16.0
IWB20641	Ex_c3990_102	6B	16.3
IWB24658	Excalibur_c28014_99	6B	16.3
IWA7111	wsnp_Ku_c4834_8676678	6B	16.6
IWA7954	wsnp_Ra_c46591_52408053	6B	16.6
IWB23062	Excalibur_c18036_53	6B	16.6
IWB45862	Kukri_c4834_1883	6B	16.6
IWB66073	TA006249-0396	6B	16.6
IWB26462	Excalibur_c43557_540	6B	17.0
IWB47265	Kukri_c65766_78	6B	17.0
IWB72451	Tdurum_contig55473_437	6B	17.0
IWA6534	wsnp_Ku_c14603_22966714	6B	18.0
IWB2501	BobWhite_c3194_125	6B	18.7
IWB2558	BobWhite_c32601_144	6B	19.0
IWB2201	BobWhite_c28409_462	6B	20.0
IWB14244	CAP7_c7415_267	6B	20.0
IWB23036	Excalibur_c17905_126	6B	20.0
IWB43074	Kukri_c25082_328	6B	20.0
IWB2200	BobWhite_c28409_271	6B	20.4
IWB28134	Excalibur_c6260_536	6B	20.4
IWB46923	Kukri_c6128_319	6B	20.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB48999	Kukri_rep_c104521_117	6B	20.4
IWB49000	Kukri_rep_c104521_601	6B	20.4
IWB49001	Kukri_rep_c104521_727	6B	20.4
IWB60573	RAC875_c7965_80	6B	20.4
IWB7480	BS00023217_51	6B	22.1
IWA634	wsnp_BQ171182B_Ta_1_1	6B	23.2
IWB7397	BS00023050_51	6B	24.6
IWB14228	CAP7_c7065_166	6B	24.6
IWB7171	BS00022599_51	6B	24.9
IWB12220	BS00104265_51	6B	24.9
IWB65825	TA004372-0730	6B	24.9
IWB73405	Tdurum_contig76997_462	6B	24.9
IWB73406	Tdurum_contig76997_664	6B	24.9
IWB60190	RAC875_c68525_284	6B	26.3
IWB73404	Tdurum_contig76997_244	6B	27.7
IWB46924	Kukri_c6128_373	6B	29.4
IWB42492	Kukri_c21404_527	6B	29.7
IWB33616	GENE-3807_45	6B	30.0
IWB53728	RAC875_c1349_270	6B	30.0
IWA2305	wsnp_Ex_c18372_27196625	6B	30.7
IWA723	wsnp_CAP11_c2485_1280612	6B	31.4
IWA3650	wsnp_Ex_c3854_7003399	6B	31.7
IWB23818	Excalibur_c22563_69	6B	31.7
IWB45909	Kukri_c48868_346	6B	31.7
IWB58318	RAC875_c47138_124	6B	31.7
IWB40397	Kukri_c10661_480	6B	32.8
IWB67340	Tdurum_contig11881_593	6B	34.5
IWA2173	wsnp_Ex_c16836_25401702	6B	34.8
IWA6660	wsnp_Ku_c1876_3666308	6B	34.8
IWB3753	BobWhite_c520_181	6B	34.8
IWB24238	Excalibur_c24932_199	6B	34.8
IWB24239	Excalibur_c24932_446	6B	34.8
IWB36423	Jagger_c1077_98	6B	34.8
IWB48793	Kukri_rep_c102659_221	6B	34.8
IWB70121	Tdurum_contig30863_137	6B	34.8
IWB72676	Tdurum_contig5968_1095	6B	34.8
IWB72677	Tdurum_contig5968_365	6B	34.8



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB72740	Tdurum_contig60536_304	6B	34.8
IWB1000	BobWhite_c1712_293	6B	36.0
IWB404	BobWhite_c12770_158	6B	36.7
IWB47281	Kukri_c66051_320	6B	36.7
IWB49153	Kukri_rep_c106170_174	6B	36.7
IWB49077	Kukri_rep_c105243_341	6B	41.0
IWB36358	IACX9184	6B	41.6
IWB73193	Tdurum_contig71266_87	6B	42.3
IWA2653	wsnp_Ex_c21783_30945248	6B	44.5
IWA3825	wsnp_Ex_c42372_48966781	6B	44.5
IWA3963	wsnp_Ex_c46160_51746546	6B	44.5
IWA1545	wsnp_Ex_c11873_19047792	6B	44.8
IWA2451	wsnp_Ex_c19707_28702378	6B	44.8
IWA2652	wsnp_Ex_c21783_30944914	6B	44.8
IWA4065	wsnp_Ex_c50022_54446632	6B	44.8
IWA6293	wsnp_JD_rep_c63108_40258378	6B	44.8
IWA7783	wsnp_Ra_c24962_34524602	6B	44.8
IWB11133	BS00080544_51	6B	44.8
IWB14571	CAP8_c1851_62	6B	44.8
IWB42338	Kukri_c20529_1006	6B	44.8
IWB65505	TA002165-1178	6B	44.8
IWB66131	TA015451-0472	6B	44.8
IWA1742	wsnp_Ex_c1319_2522682	6B	45.1
IWA2244	wsnp_Ex_c17667_26408733	6B	45.1
IWA3168	wsnp_Ex_c2849_5262624	6B	45.1
IWA3878	wsnp_Ex_c43809_50018316	6B	45.1
IWA8129	wsnp_Ra_rep_c106754_90462550	6B	45.1
IWB1088	BobWhite_c17750_568	6B	45.1
IWB5090	BobWhite_rep_c54531_95	6B	45.1
IWB6165	BS00010093_51	6B	45.1
IWB8360	BS00044237_51	6B	45.1
IWB8414	BS00045761_51	6B	45.1
IWB9908	BS00066902_51	6B	45.1
IWB10108	BS00067644_51	6B	45.1
IWB22393	Excalibur_c14257_489	6B	45.1
IWB29940	Excalibur_rep_c103447_433	6B	45.1
IWB30546	Excalibur_rep_c111646_110	6B	45.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB35233	IAAV6675	6B	45.1
IWB36332	IACX8906	6B	45.1
IWB36646	Jagger_c555_287	6B	45.1
IWB40388	Kukri_c10641_584	6B	45.1
IWB43603	Kukri_c28823_142	6B	45.1
IWB45968	Kukri_c49233_594	6B	45.1
IWB46590	Kukri_c56292_194	6B	45.1
IWB50756	Ra_c10469_616	6B	45.1
IWB51876	Ra_c3381_1027	6B	45.1
IWB57956	RAC875_c43581_280	6B	45.1
IWB60447	RAC875_c77_1176	6B	45.1
IWB60487	RAC875_c7781_531	6B	45.1
IWB70018	Tdurum_contig30403_411	6B	45.1
IWB75217	tplb0059j12_800	6B	45.1
IWA2342	wsnp_Ex_c18669_27544717	6B	45.8
IWB1636	BobWhite_c22767_189	6B	45.8
IWB4249	BobWhite_c686_387	6B	45.8
IWB6452	BS00011624_51	6B	45.8
IWB8608	BS00051998_51	6B	45.8
IWB8710	BS00057297_51	6B	45.8
IWB8753	BS00058774_51	6B	45.8
IWB10878	BS00076397_51	6B	45.8
IWB12647	BS00111399_51	6B	45.8
IWB54423	RAC875_c17189_155	6B	45.8
IWB73966	Tdurum_contig97042_256	6B	46.2
IWB42809	Kukri_c23433_416	6B	46.5
IWB7618	BS00026280_51	6B	47.9
IWB10116	BS00067672_51	6B	47.9
IWB5586	BobWhite_rep_c65994_267	6B	48.6
IWB33858	GENE-4231_195	6B	49.3
IWA1640	wsnp_Ex_c1249_2399894	6B	49.7
IWA1663	wsnp_Ex_c1267_2431315	6B	49.7
IWA2418	wsnp_Ex_c19467_28423197	6B	49.7
IWA3501	wsnp_Ex_c34962_43193869	6B	49.7
IWA3923	wsnp_Ex_c45081_50974769	6B	49.7
IWA6467	wsnp_Ku_c12559_20252463	6B	49.7
IWA7937	wsnp_Ra_c4330_7871129	6B	49.7

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB1248	BobWhite_c1905_98	6B	49.7
IWB10400	BS00069412_51	6B	49.7
IWB25753	Excalibur_c36771_136	6B	49.7
IWB28975	Excalibur_c80941_665	6B	49.7
IWB43007	Kukri_c24643_1087	6B	49.7
IWB45920	Kukri_c4892_755	6B	49.7
IWB48572	Kukri_rep_c100676_151	6B	49.7
IWB59064	RAC875_c54818_1008	6B	49.7
IWB61962	RAC875_rep_c110391_565	6B	49.7
IWB72415	Tdurum_contig54967_581	6B	49.7
IWB73067	Tdurum_contig67567_93	6B	49.7
IWA5986	wsnp_JD_c2954_3925740	6B	50.0
IWB30523	Excalibur_rep_c111207_77	6B	50.0
IWA2307	wsnp_Ex_c18382_27210656	6B	50.3
IWA7897	wsnp_Ra_c3766_6948184	6B	50.3
IWB44834	Kukri_c38732_225	6B	50.3
IWB69643	Tdurum_contig28832_316	6B	50.3
IWB72416	Tdurum_contig54967_722	6B	50.3
IWB23124	Excalibur_c18382_760	6B	50.7
IWA206	wsnp_BE488206B-Ta_2_1	6B	51.0
IWA6032	wsnp_JD_c3834_4899033	6B	51.0
IWA6466	wsnp_Ku_c12559_20251082	6B	51.0
IWB5824	BS00003214_51	6B	51.0
IWB33618	GENE-3813_174	6B	51.0
IWB58704	RAC875_c50914_107	6B	51.0
IWB68944	Tdurum_contig21737_203	6B	51.0
IWB72496	Tdurum_contig56197_370	6B	51.0
IWA1657	wsnp_Ex_c12577_20022294	6B	52.8
IWB11556	BS00088307_51	6B	53.4
IWB7098	BS00022462_51	6B	53.8
IWB11233	BS00082086_51	6B	54.1
IWA1660	wsnp_Ex_c12618_20079758	6B	54.5
IWA3410	wsnp_Ex_c3267_6026545	6B	54.5
IWA3411	wsnp_Ex_c3267_6026676	6B	54.5
IWB34422	IAAV1673	6B	54.5
IWB35569	IAAV8967	6B	54.5
IWB53275	RAC875_c11183_2580	6B	54.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB56800	RAC875_c33034_408	6B	54.5
IWB58376	RAC875_c47717_388	6B	54.5
IWB63387	RAC875_rep_c99895_112	6B	54.5
IWA4408	wsnp_Ex_c6057_10611952	6B	54.8
IWA7753	wsnp_Ra_c22075_31509915	6B	54.8
IWA7809	wsnp_Ra_c2730_5190076	6B	55.1
IWB90	BobWhite_c10614_157	6B	55.1
IWB42574	Kukri_c21943_958	6B	55.1
IWB44892	Kukri_c39151_460	6B	55.1
IWB71394	Tdurum_contig43119_297	6B	55.1
IWA7807	wsnp_Ra_c2730_5189836	6B	55.5
IWA2219	wsnp_Ex_c17435_26144201	6B	56.2
IWA5888	wsnp_JD_c18284_16822042	6B	56.2
IWA7618	wsnp_Ra_c13949_21928888	6B	56.2
IWA7810	wsnp_Ra_c2730_5190365	6B	56.2
IWA8380	wsnp_RFL_Contig2738_2459768	6B	56.2
IWB11485	BS00087190_51	6B	56.2
IWB45887	Kukri_c48571_361	6B	56.2
IWB53823	RAC875_c13949_923	6B	56.2
IWB56050	RAC875_c2730_620	6B	56.2
IWB57021	RAC875_c34994_183	6B	56.2
IWB69518	Tdurum_contig28405_288	6B	56.2
IWB69799	Tdurum_contig29467_99	6B	56.2
IWB35555	IAAV8886	6B	56.5
IWB39117	Ku_c30637_1294	6B	56.5
IWB45612	Kukri_c4606_170	6B	56.5
IWB5440	BobWhite_rep_c64102_331	6B	58.2
IWB8057	BS00036521_51	6B	58.2
IWB9751	BS00066226_51	6B	58.2
IWB20486	Ex_c31970_673	6B	58.2
IWB49178	Kukri_rep_c106450_71	6B	58.2
IWB72912	Tdurum_contig62803_286	6B	58.2
IWB7274	BS00022823_51	6B	58.5
IWB9007	BS00063109_51	6B	58.5
IWB9928	BS00066990_51	6B	58.5
IWB55567	RAC875_c23812_187	6B	58.5
IWB31788	GENE-0293_154	6B	70.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB31789	GENE-0293_285	6B	70.8
IWB59636	RAC875_c6190_1173	6B	71.2
IWB3103	BobWhite_c4014_508	6B	72.2
IWB9362	BS00064761_51	6B	72.2
IWB33796	GENE-4142_630	6B	72.2
IWB49791	Kukri_rep_c68415_936	6B	72.2
IWB61390	RAC875_rep_c104937_1620	6B	72.5
IWB1708	BobWhite_c23416_168	6B	76.1
IWB59681	RAC875_c62325_320	6B	78.9
IWB21500	Excalibur_c100270_78	6B	79.6
IWB73576	Tdurum_contig82504_154	6B	84.7
IWB56156	RAC875_c2808_1394	6B	86.8
IWA4290	wsnp_Ex_c56091_58346859	6B	87.2
IWB60019	RAC875_c66376_395	6B	87.5
IWA7725	wsnp_Ra_c20409_29673950	6B	87.9
IWB22024	Excalibur_c12037_1241	6B	87.9
IWB30316	Excalibur_rep_c108023_321	6B	87.9
IWB60219	RAC875_c68849_153	6B	87.9
IWA1901	wsnp_Ex_c14481_22485922	6B	96.0
IWA3991	wsnp_Ex_c4728_8444212	6B	96.0
IWA4610	wsnp_Ex_c702_1382859	6B	96.0
IWA5943	wsnp_JD_c23373_19987039	6B	96.0
IWB6216	BS00010403_51	6B	96.0
IWB7778	BS00030457_51	6B	96.0
IWB61321	RAC875_rep_c101299_88	6B	96.0
IWB62692	RAC875_rep_c70449_63	6B	96.0
IWB69722	Tdurum_contig29162_378	6B	96.0
IWB44868	Kukri_c38982_86	6B	104.0
IWB54721	RAC875_c18689_1870	6B	107.5
IWB66298	Tdurum_contig10149_284	6B	108.9
IWA921	wsnp_CAP12_c1388_706924	6B	110.3
IWA1493	wsnp_Ex_c1143_2195442	6B	113.6
IWA1494	wsnp_Ex_c1143_2195598	6B	113.6
IWA6704	wsnp_Ku_c2119_4098330	6B	113.6
IWA6759	wsnp_Ku_c24391_34351602	6B	113.6
IWB415	BobWhite_c12846_196	6B	113.6
IWB8673	BS00055768_51	6B	113.6

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB8674	BS00055769_51	6B	113.6
IWB9057	BS00063429_51	6B	113.6
IWB10964	BS00077844_51	6B	113.6
IWB11777	BS00092845_51	6B	113.6
IWB23395	Excalibur_c1988_276	6B	113.6
IWB24996	Excalibur_c30648_868	6B	113.6
IWB24997	Excalibur_c30648_924	6B	113.6
IWB53647	RAC875_c1305_120	6B	113.6
IWB58009	RAC875_c44002_81	6B	113.6
IWB60232	RAC875_c68978_126	6B	113.6
IWA4997	wsnp_Ex_rep_c101133_86572194	6B	113.9
IWB3282	BobWhite_c43135_397	6B	113.9
IWB3283	BobWhite_c43135_430	6B	113.9
IWB6572	BS00012530_51	6B	113.9
IWB51476	Ra_c22493_190	6B	113.9
IWB56603	RAC875_c31381_313	6B	113.9
IWB56605	RAC875_c31381_820	6B	113.9
IWA2098	wsnp_Ex_c16090_24522660	6B	114.2
IWB6423	BS00011513_51	6B	114.2
IWB52483	Ra_c69836_515	6B	114.2
IWB63023	RAC875_rep_c74471_125	6B	114.2
IWB10358	BS00068735_51	6B	114.5
IWB14443	CAP7_rep_c6852_87	6B	114.5
IWB29541	Excalibur_c96134_152	6B	114.5
IWB39541	Ku_c5002_1541	6B	114.5
IWB71432	Tdurum_contig43538_1306	6B	114.5
IWB71434	Tdurum_contig43538_1687	6B	114.5
IWB71435	Tdurum_contig43538_1812	6B	114.5
IWB71436	Tdurum_contig43538_648	6B	114.5
IWB73489	Tdurum_contig81191_342	6B	114.5
IWB13715	CAP7_c10772_156	6B	116.6
IWB2246	BobWhite_c29001_89	6B	117.0
IWB69383	Tdurum_contig27939_98	6B	119.2
IWB505	BobWhite_c13435_700	6D1	0.0
IWB32150	GENE-0925_515	6D1	0.0
IWB41219	Kukri_c14511_217	6D1	0.0
IWB16727	D_contig37522_188	6D1	1.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7256	BS00022787_51	6D1	7.0
IWA3926	wsnp_Ex_c4518_8119503	6D1	8.3
IWA6631	wsnp_Ku_c1765_3452586	6D1	8.3
IWB4005	BobWhite_c5847_919	6D1	8.3
IWB4637	BobWhite_c9641_566	6D1	8.3
IWB12259	BS00105877_51	6D1	8.3
IWB33500	GENE-3609_447	6D1	8.3
IWB48855	Kukri_rep_c103186_166	6D1	8.3
IWB57502	RAC875_c3928_422	6D1	8.3
IWB62149	RAC875_rep_c112449_669	6D1	8.3
IWB35193	IAAV64	6D1	9.0
IWB11494	BS00087334_51	6D1	9.7
IWB11495	BS00087343_51	6D1	9.7
IWB12245	BS00105522_51	6D1	9.7
IWB12939	CAP11_c5372_271	6D1	9.7
IWB50622	Kukri_s109823_59	6D1	9.7
IWA2637	wsnp_Ex_c21688_30845705	6D1	10.0
IWA3909	wsnp_Ex_c4480_8054926	6D1	10.0
IWA3910	wsnp_Ex_c4480_8055163	6D1	10.0
IWA3913	wsnp_Ex_c4480_8056354	6D1	10.0
IWB40695	Kukri_c11902_580	6D1	10.0
IWB49920	Kukri_rep_c69637_318	6D1	10.0
IWB1134	BobWhite_c18136_441	6D1	10.4
IWA3912	wsnp_Ex_c4480_8056013	6D1	10.7
IWA3914	wsnp_Ex_c4480_8057184	6D1	10.7
IWB65984	TA005561-0543	6D1	10.7
IWA1741	wsnp_Ex_c13188_20825019	6D1	11.0
IWB53907	RAC875_c14354_907	6D1	12.8
IWA1925	wsnp_Ex_c14691_22763609	6D1	13.8
IWA5591	wsnp_Ex_rep_c69248_68171036	6D1	13.8
IWB2718	BobWhite_c34694_70	6D1	13.8
IWB21099	Ex_c67100_1172	6D1	13.8
IWB21244	Ex_c7086_154	6D1	13.8
IWB26363	Excalibur_c4261_1098	6D1	13.8
IWB27168	Excalibur_c50656_660	6D1	13.8
IWB27630	Excalibur_c5612_711	6D1	13.8
IWB33637	GENE-3864_207	6D1	13.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB34805	IAAV3944	6D1	13.8
IWB57427	RAC875_c38615_143	6D1	13.8
IWB59755	RAC875_c63262_67	6D1	13.8
IWB17777	D_GA8KES401DAG15_124	6D1	14.2
IWB19726	Ex_c12134_1160	6D1	14.2
IWB19727	Ex_c12134_939	6D1	14.2
IWB29594	Excalibur_c9754_1428	6D1	14.2
IWB35223	IAAV6637	6D1	14.2
IWB48604	Kukri_rep_c101126_881	6D1	14.2
IWB49305	Kukri_rep_c107983_607	6D1	14.2
IWB49747	Kukri_rep_c68091_971	6D1	14.2
IWB69844	Tdurum_contig29607_179	6D1	14.5
IWA1926	wsnp_Ex_c14691_22763753	6D1	15.5
IWA1927	wsnp_Ex_c14691_22765150	6D1	15.5
IWA4056	wsnp_Ex_c4942_8793029	6D1	15.5
IWA4455	wsnp_Ex_c62371_62036044	6D1	15.5
IWA5354	wsnp_Ex_rep_c67100_65576598	6D1	15.5
IWA6179	wsnp_JD_c7793_8866097	6D1	15.5
IWA6274	wsnp_JD_rep_c50999_34772439	6D1	15.5
IWB6366	BS00011192_51	6D1	15.5
IWB14891	CAP8_c6799_93	6D1	15.5
IWB15301	D_contig04313_517	6D1	15.5
IWB17781	D_GA8KES401DISTP_65	6D1	15.5
IWB20473	Ex_c31468_763	6D1	15.5
IWB20854	Ex_c5168_849	6D1	15.5
IWB21019	Ex_c6258_1094	6D1	15.5
IWB24795	Excalibur_c29102_933	6D1	15.5
IWB28990	Excalibur_c8134_1319	6D1	15.5
IWB33715	GENE-3993_284	6D1	15.5
IWB38169	Ku_c107983_831	6D1	15.5
IWB44754	Kukri_c38025_633	6D1	15.5
IWB49303	Kukri_rep_c107975_95	6D1	15.5
IWB55623	RAC875_c24285_1049	6D1	15.5
IWB56623	RAC875_c3156_630	6D1	15.5
IWB57428	RAC875_c38615_1540	6D1	15.5
IWB61355	RAC875_rep_c103556_427	6D1	15.5
IWB10159	BS00067819_51	6D1	15.9



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB53549	RAC875_c12542_1857	6D1	15.9
IWB53908	RAC875_c14354_934	6D1	15.9
IWB34507	IAAV2130	6D1	16.3
IWB15598	D_contig10996_530	6D1	16.6
IWB22598	Excalibur_c15309_646	6D1	16.6
IWB2727	BobWhite_c34798_184	6D1	16.9
IWB21245	Ex_c7086_187	6D1	16.9
IWB28132	Excalibur_c6258_692	6D1	16.9
IWB15884	D_contig17730_738	6D1	30.0
IWB6427	BS00011523_51	6D1	53.2
IWA4042	wsnp_Ex_c4894_8723248	6D1	59.5
IWB64086	RFL_Contig2815_1908	6D2	0.0
IWB13767	CAP7_c1208_150	6D2	1.7
IWB47157	Kukri_c64412_175	6D2	1.7
IWA2338	wsnp_Ex_c18664_27540364	6D2	2.1
IWA6673	wsnp_Ku_c19587_29102203	6D2	2.1
IWB21614	Excalibur_c10358_1800	6D2	2.1
IWB64081	RFL_Contig2815_1135	6D2	2.4
IWB1786	BobWhite_c23997_952	6D2	3.4
IWB28147	Excalibur_c62792_172	6D2	4.7
IWB46507	Kukri_c55362_75	6D2	5.8
IWB65608	TA002853-0110-w	6D2	5.8
IWA1896	wsnp_Ex_c14439_22426200	6D2	7.1
IWB49086	Kukri_rep_c105352_281	6D2	14.2
IWB49821	Kukri_rep_c68823_696	6D2	14.2
IWB61900	RAC875_rep_c109653_409	6D2	14.2
IWB63240	RAC875_rep_c85994_258	6D2	14.2
IWB7135	BS00022523_51	6D2	15.3
IWB262	BobWhite_c11808_975	6D2	16.6
IWB6902	BS00022094_51	6D2	17.0
IWB33108	GENE-2903_68	6D2	19.5
IWB57246	RAC875_c37085_317	7A1	0.0
IWA1424	wsnp_Ex_c11047_17915103	7A1	0.3
IWA1425	wsnp_Ex_c11047_17915225	7A1	0.3
IWB286	BobWhite_c1201_384	7A1	0.3
IWB713	BobWhite_c149_3064	7A1	0.3
IWB4998	BobWhite_rep_c52270_315	7A1	0.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB5019	BobWhite_rep_c52775_117	7A1	0.3
IWB21290	Ex_c7495_807	7A1	0.3
IWB37021	JD_c149_1700	7A1	0.3
IWB42963	Kukri_c24408_743	7A1	0.3
IWB47152	Kukri_c64387_218	7A1	0.3
IWA4911	wsnp_Ex_c9428_15641639	7A1	2.1
IWB7435	BS00023128_51	7A1	2.5
IWA4910	wsnp_Ex_c9428_15641609	7A1	2.8
IWB38282	Ku_c11884_1220	7A1	2.8
IWB5961	BS00004257_51	7A1	4.9
IWB25309	Excalibur_c33199_1430	7A1	4.9
IWA6670	wsnp_Ku_c19251_28705893	7A1	6.0
IWB22437	Excalibur_c14451_389	7A1	6.0
IWB74845	tplb0045p11_893	7A1	6.0
IWB39743	Ku_c62742_888	7A1	7.7
IWA4621	wsnp_Ex_c7071_12171619	7A1	8.4
IWB20381	Ex_c27898_414	7A1	8.4
IWB69898	Tdurum_contig29834_165	7A1	9.1
IWB35048	IAAV5578	7A1	9.4
IWA7406	wsnp_Ku_rep_c103889_90513052	7A1	10.1
IWB7382	BS00023027_51	7A1	10.4
IWB28649	Excalibur_c7298_165	7A1	10.8
IWB2231	BobWhite_c2878_64	7A1	11.5
IWB21365	Ex_c8261_2309	7A1	12.2
IWB41660	Kukri_c16852_314	7A1	12.9
IWB13518	CAP12_c6937_214	7A1	13.2
IWA7407	wsnp_Ku_rep_c103889_90513365	7A1	13.5
IWB35597	IAAV9161	7A1	13.5
IWB53096	RAC875_c105310_155	7A1	13.5
IWB65620	TA002938-0337	7A1	14.9
IWA8297	wsnp_RFL_Contig2136_1423367	7A1	15.6
IWA4626	wsnp_Ex_c7121_12243681	7A1	16.9
IWB27946	Excalibur_c60238_183	7A1	18.3
IWB27037	Excalibur_c49272_174	7A1	18.6
IWB27947	Excalibur_c60238_251	7A1	19.3
IWA7028	wsnp_Ku_c4035_7363089	7A1	21.1
IWA7709	wsnp_Ra_c19741_28965647	7A1	21.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA7074	wsnp_Ku_c44760_51961180	7A1	21.9
IWB21840	Excalibur_c113078_320	7A1	21.9
IWB9574	BS00065529_51	7A1	22.2
IWB50931	Ra_c114158_328	7A1	22.2
IWB25010	Excalibur_c30730_1503	7A1	22.5
IWB25011	Excalibur_c30730_253	7A1	22.5
IWB65087	RFL_Contig5701_169	7A1	22.5
IWB55540	RAC875_c2359_652	7A1	22.9
IWB25012	Excalibur_c30730_276	7A1	23.3
IWB45565	Kukri_c45763_319	7A1	23.6
IWB41336	Kukri_c15151_249	7A1	24.0
IWA4483	wsnp_Ex_c6354_11053460	7A1	24.6
IWB54820	RAC875_c19332_645	7A1	25.3
IWB25155	Excalibur_c3188_1352	7A1	26.4
IWA3367	wsnp_Ex_c3188_5889767	7A1	27.8
IWA7884	wsnp_Ra_c35321_43882919	7A1	27.8
IWB6221	BS00010435_51	7A1	27.8
IWB8627	BS00053365_51	7A1	27.8
IWB1277	BobWhite_c19346_434	7A1	28.1
IWB70291	Tdurum_contig31699_276	7A1	32.7
IWB70292	Tdurum_contig31699_300	7A1	32.7
IWB4932	BobWhite_rep_c51122_404	7A1	33.0
IWB34242	GENE-4921_156	7A1	33.0
IWB9043	BS00063363_51	7A1	33.4
IWB12039	BS00098483_51	7A1	33.7
IWB46674	Kukri_c57593_79	7A1	35.4
IWB28062	Excalibur_c61603_1052	7A1	35.7
IWB28064	Excalibur_c61603_1209	7A1	35.7
IWB29819	Excalibur_rep_c102327_102	7A1	35.7
IWB28063	Excalibur_c61603_1138	7A1	36.1
IWB72397	Tdurum_contig54832_139	7A1	36.1
IWA4925	wsnp_Ex_c9476_15710162	7A1	36.4
IWA8393	wsnp_RFL_Contig2805_2579582	7A1	36.4
IWB28967	Excalibur_c8066_791	7A1	36.4
IWB30790	Excalibur_rep_c66918_307	7A1	36.4
IWB50566	Kukri_rep_c98227_230	7A1	36.4
IWB50567	Kukri_rep_c98227_390	7A1	36.4

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB68610	Tdurum_contig17062_221	7A1	36.4
IWB74465	tplb0032g12_1241	7A1	36.4
IWB23295	Excalibur_c1935_1234	7A1	43.7
IWB34401	IAAV1543	7A1	43.7
IWB34760	IAAV3713	7A1	43.7
IWB40425	Kukri_c10757_183	7A1	43.7
IWB35099	IAAV5828	7A1	44.0
IWB1800	BobWhite_c24096_57	7A1	44.4
IWB23297	Excalibur_c1935_1885	7A1	44.4
IWB27289	Excalibur_c52115_233	7A1	44.4
IWB36973	JD_c1314_1184	7A1	44.4
IWB65153	RFL_Contig5898_2341	7A1	44.4
IWB10701	BS00073989_51	7A1	46.2
IWB14331	CAP7_c950_137	7A1	46.5
IWB14426	CAP7_rep_c5949_55	7A1	46.5
IWB34754	IAAV3676	7A1	46.5
IWA865	wsnp_CAP11_rep_c4346_2050918	7A1	46.9
IWA866	wsnp_CAP11_rep_c4346_2051052	7A1	46.9
IWB367	BobWhite_c12434_462	7A1	48.3
IWB3557	BobWhite_c47099_193	7A1	51.6
IWB50005	Kukri_rep_c70288_1087	7A1	51.6
IWB50006	Kukri_rep_c70288_1101	7A1	51.6
IWA7964	wsnp_Ra_c47942_53349897	7A1	51.9
IWB6248	BS00010578_51	7A1	51.9
IWB6450	BS00011622_51	7A1	51.9
IWB38709	Ku_c19745_1093	7A1	51.9
IWB25140	Excalibur_c31784_294	7A1	52.6
IWB38710	Ku_c19745_833	7A1	53.0
IWB69347	Tdurum_contig27856_230	7A1	53.0
IWB45030	Kukri_c40353_179	7A1	53.7
IWB35735	IACX13137	7A1	54.0
IWB63209	RAC875_rep_c83934_91	7A1	54.4
IWB72691	Tdurum_contig59836_250	7A1	54.4
IWB10807	BS00075425_51	7A1	55.1
IWA4176	wsnp_Ex_c53387_56640789	7A1	55.4
IWB9555	BS00065454_51	7A1	55.4
IWB1471	BobWhite_c21023_110	7A1	55.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB7611	BS00026122_51	7A1	56.1
IWB9275	BS00064413_51	7A1	56.4
IWA4887	wsnp_Ex_c916_1767286	7A1	56.8
IWB9554	BS00065453_51	7A1	56.8
IWB25264	Excalibur_c3286_103	7A1	56.8
IWB40294	Kukri_c10243_475	7A1	56.8
IWB43619	Kukri_c28968_130	7A1	56.8
IWB55778	RAC875_c2532_64	7A1	56.8
IWB60289	RAC875_c7112_816	7A1	56.8
IWB72648	Tdurum_contig59467_433	7A1	56.8
IWB72649	Tdurum_contig59467_534	7A1	56.8
IWB73997	Tdurum_contig97505_172	7A1	56.8
IWB14962	CAP8_c8600_130	7A1	57.1
IWB19694	Ex_c1159_616	7A1	57.1
IWA1517	wsnp_Ex_c1159_2224684	7A1	57.5
IWA4173	wsnp_Ex_c53387_56639804	7A1	57.5
IWB10852	BS00076120_51	7A1	57.5
IWB35043	IAAV5550	7A1	57.5
IWB40989	Kukri_c13171_474	7A1	57.5
IWB5812	BS00002510_51	7A1	57.8
IWB6268	BS00010677_51	7A1	57.8
IWB26780	Excalibur_c46453_144	7A1	57.8
IWB29946	Excalibur_rep_c103504_628	7A1	57.8
IWB67604	Tdurum_contig12454_585	7A1	57.8
IWB72673	Tdurum_contig59633_56	7A1	57.8
IWB73864	Tdurum_contig93328_869	7A1	57.8
IWB64099	RFL_Contig2834_890	7A1	60.3
IWB8847	BS00061911_51	7A1	60.6
IWB49784	Kukri_rep_c68371_1242	7A1	60.6
IWA737	wsnp_CAP11_c298_250917	7A1	61.0
IWA179	wsnp_BE445506A-Ta_2_2	7A1	63.4
IWA794	wsnp_CAP11_c639_424059	7A1	63.4
IWA795	wsnp_CAP11_c639_424134	7A1	63.4
IWB34223	GENE-4895_101	7A1	63.4
IWA7005	wsnp_Ku_c3929_7189422	7A1	70.2
IWA7592	wsnp_Ra_c12773_20367106	7A1	70.5
IWB4898	BobWhite_rep_c50659_205	7A1	70.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB9244	BS00064302_51	7A1	70.5
IWB12407	BS00109393_51	7A1	70.5
IWB40615	Kukri_c11530_60	7A1	70.5
IWB40616	Kukri_c11530_92	7A1	70.5
IWB41240	Kukri_c14620_362	7A1	70.5
IWB48282	Kukri_c92030_109	7A1	70.5
IWB52831	Ra_c956_2318	7A1	70.5
IWB55414	RAC875_c22831_356	7A1	70.5
IWB60899	RAC875_c8752_1079	7A1	70.5
IWB64078	RFL_Contig2814_604	7A1	70.5
IWB64079	RFL_Contig2814_859	7A1	70.5
IWB73420	Tdurum_contig77505_779	7A1	70.5
IWB63311	RAC875_rep_c92225_262	7A1	71.3
IWB6037	BS00009283_51	7A1	72.0
IWB9146	BS00063860_51	7A1	72.7
IWB6675	BS00020236_51	7A1	73.1
IWB36088	IACX5996	7A1	73.1
IWB40599	Kukri_c11451_1882	7A1	73.4
IWB6394	BS00011399_51	7A1	73.8
IWB74282	tplb0026f01_168	7A1	73.8
IWB2584	BobWhite_c32883_84	7A1	74.1
IWB6132	BS00009886_51	7A1	74.1
IWB10573	BS00071736_51	7A1	74.1
IWB65192	RFL_Contig602_627	7A1	74.1
IWB65821	TA004354-0356	7A1	74.1
IWB6271	BS00010689_51	7A1	75.2
IWB69811	Tdurum_contig29501_243	7A1	78.2
IWB5968	BS00004348_51	7A1	79.3
IWB7469	BS00023200_51	7A1	79.3
IWB10825	BS00075731_51	7A1	79.3
IWB11407	BS00085421_51	7A1	79.3
IWB36289	IACX8328	7A1	79.3
IWB40614	Kukri_c11530_168	7A1	79.3
IWB53576	RAC875_c12733_1509	7A1	79.3
IWB71711	Tdurum_contig46717_2021	7A1	79.3
IWB71625	Tdurum_contig45618_1089	7A1	83.2
IWB68872	Tdurum_contig20378_260	7A1	83.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA5798	wsnp_JD_c1219_1766330	7A1	84.6
IWB46195	Kukri_c51804_762	7A1	85.0
IWB69525	Tdurum_contig28435_107	7A1	85.0
IWB38593	Ku_c1738_2299	7A2	0.0
IWB9300	BS00064488_51	7A2	0.3
IWA1880	wsnp_Ex_c14219_22169892	7A2	0.7
IWA6989	wsnp_Ku_c38569_47177068	7A2	0.7
IWB2616	BobWhite_c33300_159	7A2	0.7
IWB6832	BS00021973_51	7A2	0.7
IWB11685	BS00091003_51	7A2	0.7
IWB28886	Excalibur_c78792_203	7A2	0.7
IWB60087	RAC875_c6736_336	7A2	0.7
IWB10367	BS00068863_51	7A2	1.0
IWB55483	RAC875_c23310_217	7A2	2.1
IWB8896	BS00062708_51	7A2	3.2
IWB10368	BS00068864_51	7A2	3.2
IWB12506	BS00110283_51	7A2	3.2
IWB29356	Excalibur_c9166_913	7A2	3.2
IWB55137	RAC875_c21165_1058	7A2	3.2
IWA7196	wsnp_Ku_c5874_10384659	7A2	4.5
IWB55312	RAC875_c22210_305	7A2	4.9
IWB33971	GENE-4466_79	7A2	5.2
IWB24479	Excalibur_c26682_394	7A2	5.5
IWB57684	RAC875_c41169_68	7A2	5.5
IWB19874	Ex_c14854_412	7A2	5.9
IWA2196	wsnp_Ex_c17230_25883590	7A2	6.6
IWA7978	wsnp_Ra_c5008_8947135	7A2	6.6
IWB624	BobWhite_c14303_240	7A2	6.9
IWB67909	Tdurum_contig13245_443	7A2	6.9
IWB68683	Tdurum_contig17756_518	7A2	6.9
IWB47400	Kukri_c67586_306	7A2	7.6
IWB74123	tplb0022c16_494	7A2	8.3
IWA1921	wsnp_Ex_c14654_22713620	7A2	8.6
IWB55317	RAC875_c22233_83	7A2	8.6
IWB67908	Tdurum_contig13245_119	7A2	8.6
IWB73135	Tdurum_contig69003_607	7A2	8.6
IWB50911	Ra_c1126_2463	7A2	11.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB2420	BobWhite_c31067_242	7A2	13.6
IWB19840	Ex_c1421_1813	7A2	13.6
IWB27193	Excalibur_c50999_236	7A2	13.6
IWB49213	Kukri_rep_c106900_130	7A2	13.6
IWA5337	wsnp_Ex_rep_c66939_65371026	7A2	13.9
IWB515	BobWhite_c13514_340	7A2	13.9
IWB52484	Ra_c69906_620	7A2	13.9
IWB59239	RAC875_c56907_274	7A2	13.9
IWB70303	Tdurum_contig31852_251	7A2	13.9
IWB24038	Excalibur_c23756_1461	7A2	14.2
IWB63942	RFL_Contig2435_3008	7A2	14.2
IWA6160	wsnp_JD_c7060_8169490	7A2	14.9
IWA6519	wsnp_Ku_c14220_22456923	7A2	15.3
IWB1522	BobWhite_c2179_1476	7A2	15.3
IWB24216	Excalibur_c24750_504	7A2	15.3
IWB28096	Excalibur_c62100_325	7A2	15.3
IWB33956	GENE-4440_719	7A2	15.3
IWB34248	GENE-4923_506	7A2	15.3
IWB42415	Kukri_c2101_2358	7A2	15.3
IWB48546	Kukri_c99396_111	7A2	15.3
IWB57393	RAC875_c38350_58	7A2	15.3
IWB59141	RAC875_c55774_126	7A2	15.3
IWB59369	RAC875_c5834_699	7A2	15.3
IWB21158	Ex_c6861_460	7A2	15.6
IWB29719	Excalibur_rep_c101421_191	7A2	15.6
IWB34436	IAAV174	7A2	15.6
IWB58575	RAC875_c4965_264	7A2	15.6
IWB11369	BS00084482_51	7A2	16.3
IWB24698	Excalibur_c28315_205	7A2	16.3
IWB35452	IAAV824	7A2	16.3
IWB1677	BobWhite_c232_563	7A2	20.0
IWB7636	BS00026702_51	7A2	20.0
IWB7997	BS00035083_51	7A2	20.0
IWB8042	BS00036144_51	7A2	20.0
IWB8106	BS00037421_51	7A2	20.0
IWB16832	D_contig50905_592	7A2	20.0
IWB23670	Excalibur_c21666_712	7A2	20.0



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB27732	Excalibur_c57544_174	7A2	20.0
IWB38729	Ku_c20100_2216	7A2	20.0
IWB38730	Ku_c20100_999	7A2	20.0
IWB40553	Kukri_c11260_559	7A2	20.0
IWB51440	Ra_c2171_1347	7A2	20.0
IWB54108	RAC875_c1553_667	7A2	20.0
IWB69539	Tdurum_contig28493_829	7A2	20.0
IWB75141	tplb0057f21_146	7A2	20.0
IWB3927	BobWhite_c5649_344	7A2	28.0
IWB4930	BobWhite_rep_c51103_654	7A2	28.0
IWB10274	BS00068258_51	7A2	28.0
IWB26797	Excalibur_c46601_57	7A2	28.0
IWB35535	IAAV877	7A2	28.0
IWB56760	RAC875_c32780_467	7A2	28.0
IWB61248	RAC875_c98675_226	7A2	28.0
IWB71785	Tdurum_contig47309_862	7A2	28.0
IWB72404	Tdurum_contig54860_525	7A2	28.0
IWB68597	Tdurum_contig16896_426	7A2	28.4
IWB2340	BobWhite_c30138_69	7A2	28.8
IWB53116	RAC875_c10609_1380	7A2	29.1
IWB27935	Excalibur_c60134_182	7A2	29.8
IWB35150	IAAV6131	7A2	30.5
IWB75034	tplb0053113_1225	7A2	30.5
IWB7352	BS00022978_51	7A2	31.1
IWB11150	BS00080831_51	7A2	31.1
IWB19538	Ex_c10105_526	7A2	31.1
IWB57105	RAC875_c35727_64	7A2	31.1
IWB5770	BS00000747_51	7A2	31.5
IWB12708	CAP11_c1661_59	7A2	31.5
IWB24232	Excalibur_c24882_848	7A2	31.5
IWB26720	Excalibur_c46018_271	7A2	31.5
IWB26795	Excalibur_c46601_212	7A2	31.5
IWB26796	Excalibur_c46601_265	7A2	31.5
IWB28718	Excalibur_c74403_580	7A2	31.5
IWB33884	GENE-4277_295	7A2	31.5
IWB41312	Kukri_c15008_1402	7A2	31.5
IWB54421	RAC875_c17185_90	7A2	31.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB54744	RAC875_c18845_104	7A2	31.5
IWB57925	RAC875_c4336_208	7A2	31.5
IWB68596	Tdurum_contig16896_287	7A2	31.5
IWB68639	Tdurum_contig17365_336	7A2	31.5
IWB55129	RAC875_c21119_305	7A2	31.8
IWB47685	Kukri_c76470_79	7A2	32.5
IWB61171	RAC875_c9677_212	7A2	32.5
IWB73823	Tdurum_contig92906_272	7A2	32.5
IWB61170	RAC875_c9677_131	7A2	32.8
IWB6149	BS00010006_51	7A2	33.5
IWA2880	wsnp_Ex_c24167_33417032	7A2	33.8
IWB11336	BS00084036_51	7A2	33.8
IWB73889	Tdurum_contig93663_457	7A2	33.8
IWB41942	Kukri_c1831_56	7A2	34.2
IWA2879	wsnp_Ex_c24167_33416760	7A2	34.5
IWA5245	wsnp_Ex_rep_c66476_64726880	7A2	34.5
IWA7013	wsnp_Ku_c3969_7256560	7A2	34.5
IWB2606	BobWhite_c33103_439	7A2	34.5
IWB2607	BobWhite_c33103_476	7A2	34.5
IWB6290	BS00010796_51	7A2	34.5
IWB7063	BS00022406_51	7A2	34.5
IWB11165	BS00081098_51	7A2	34.5
IWB35593	IAAV912	7A2	34.5
IWB54330	RAC875_c16644_1722	7A2	34.5
IWB54331	RAC875_c16644_491	7A2	34.5
IWB62296	RAC875_rep_c114991_62	7A2	34.5
IWB65964	TA005348-0816	7A2	34.5
IWB68390	Tdurum_contig15285_588	7A2	34.5
IWB11654	BS00090274_51	7A2	34.9
IWB43608	Kukri_c28866_183	7A2	34.9
IWB6597	BS00014126_51	7A2	35.5
IWB12319	BS00107552_51	7A2	35.5
IWB32052	GENE-0689_601	7A2	35.5
IWB33973	GENE-4469_430	7A2	35.5
IWB57019	RAC875_c34971_137	7A2	35.5
IWB71783	Tdurum_contig47309_600	7A2	35.5
IWA3267	wsnp_Ex_c30239_39179460	7A2	35.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWA8032	wsnp_Ra_c63822_63288359	7A2	36.2
IWB59812	RAC875_c63822_185	7A2	36.2
IWB73683	Tdurum_contig85217_286	7A2	41.3
IWB38907	Ku_c24644_599	7A2	42.4
IWB65343	TA001117-0895	7A2	43.0
IWB11004	BS00078400_51	7A2	43.7
IWB24300	Excalibur_c25335_306	7A2	43.7
IWB27825	Excalibur_c58596_321	7A2	43.7
IWB41259	Kukri_c14765_1655	7A2	43.7
IWB44377	Kukri_c34887_734	7A2	44.4
IWB3124	BobWhite_c40535_218	7A2	48.6
IWB10106	BS00067639_51	7A2	48.6
IWB8512	BS00048699_51	7A2	49.0
IWB22160	Excalibur_c12849_228	7A2	49.0
IWB26664	Excalibur_c45417_218	7A2	49.0
IWB28748	Excalibur_c7538_2718	7A2	49.0
IWB30693	Excalibur_rep_c115261_135	7A2	49.0
IWB3869	BobWhite_c55017_267	7A2	49.6
IWB3870	BobWhite_c55017_291	7A2	49.6
IWB36127	IACX6236	7A2	49.6
IWB6243	BS00010559_51	7A2	74.2
IWB6385	BS00011330_51	7A2	74.2
IWB6011	BS00007429_51	7A2	74.9
IWB8895	BS00062706_51	7A2	74.9
IWB33243	GENE-3129_436	7A2	74.9
IWB34476	IAAV1940	7A2	74.9
IWB40391	Kukri_c106476_350	7A2	74.9
IWB40392	Kukri_c106476_709	7A2	74.9
IWB64283	RFL_Contig3271_810	7A2	74.9
IWB67816	Tdurum_contig13011_241	7A2	74.9
IWB68133	Tdurum_contig14075_328	7A2	74.9
IWB68135	Tdurum_contig14075_630	7A2	74.9
IWB68859	Tdurum_contig20214_279	7A2	74.9
IWB58488	RAC875_c4889_1393	7A2	77.8
IWB47104	Kukri_c6386_2065	7A2	78.5
IWB60067	RAC875_c67063_703	7A2	100.2
IWB60068	RAC875_c67063_984	7A2	104.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB49084	Kukri_rep_c105330_552	7A2	112.9
IWB44949	Kukri_c39759_102	7B1	0.0
IWB225	BobWhite_c11480_1370	7B1	0.4
IWA3986	wsnp_Ex_c47153_52447514	7B1	0.7
IWA6386	wsnp_Ku_c10355_17149304	7B1	0.7
IWB39037	Ku_c27939_333	7B1	0.7
IWB47421	Kukri_c67810_105	7B1	1.1
IWB29286	Excalibur_c8994_1297	7B1	1.4
IWA6857	wsnp_Ku_c29256_39161320	7B1	1.8
IWB47535	Kukri_c722_1754	7B1	4.5
IWB69212	Tdurum_contig25895_484	7B1	4.5
IWB30564	Excalibur_rep_c111831_114	7B1	4.9
IWB40799	Kukri_c12317_336	7B1	4.9
IWB40800	Kukri_c12317_367	7B1	4.9
IWB73104	Tdurum_contig68339_168	7B1	4.9
IWB73395	Tdurum_contig76683_147	7B1	4.9
IWB73890	Tdurum_contig93706_108	7B1	4.9
IWB59338	RAC875_c58060_75	7B1	6.2
IWB73892	Tdurum_contig93706_517	7B1	6.2
IWB169	BobWhite_c11077_231	7B1	6.9
IWB13066	CAP11_c846_221	7B1	7.6
IWA355	wsnp_be518436B_Ta_2_3	7B1	7.9
IWB2834	BobWhite_c36268_275	7B1	8.9
IWB26677	Excalibur_c4556_113	7B1	8.9
IWB26679	Excalibur_c4556_776	7B1	8.9
IWB62673	RAC875_rep_c70325_76	7B1	8.9
IWB71339	Tdurum_contig42718_1576	7B1	8.9
IWB72166	Tdurum_contig51208_147	7B1	8.9
IWB72641	Tdurum_contig59440_1621	7B1	8.9
IWB72960	Tdurum_contig63792_549	7B1	8.9
IWB73208	Tdurum_contig71786_231	7B1	8.9
IWB73340	Tdurum_contig76013_605	7B1	8.9
IWB73341	Tdurum_contig76013_766	7B1	8.9
IWB451	BobWhite_c13098_526	7B1	9.3
IWB3274	BobWhite_c42974_184	7B1	9.3
IWB4794	BobWhite_rep_c49587_1290	7B1	9.3
IWB4816	BobWhite_rep_c49910_432	7B1	9.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB22837	Excalibur_c16687_380	7B1	9.3
IWB22838	Excalibur_c16687_476	7B1	9.3
IWB30869	Excalibur_rep_c67475_1759	7B1	9.3
IWB45912	Kukri_c48870_115	7B1	9.3
IWB73443	Tdurum_contig78772_317	7B1	9.6
IWB62671	RAC875_rep_c70325_264	7B1	10.3
IWB71496	Tdurum_contig44138_1546	7B1	10.3
IWB71582	Tdurum_contig45195_117	7B1	10.3
IWB72167	Tdurum_contig51208_286	7B1	10.3
IWB73338	Tdurum_contig76013_1230	7B1	10.3
IWB73339	Tdurum_contig76013_352	7B1	10.3
IWB71733	Tdurum_contig46922_814	7B1	10.6
IWB15008	CAP8_rep_c3680_203	7B1	11.0
IWB40798	Kukri_c12317_179	7B1	12.3
IWB61623	RAC875_rep_c106651_490	7B1	12.3
IWB61624	RAC875_rep_c106651_635	7B1	12.3
IWB68767	Tdurum_contig19022_1524	7B1	12.3
IWB68768	Tdurum_contig19022_1555	7B1	12.3
IWB73105	Tdurum_contig68339_71	7B1	12.3
IWB60181	RAC875_c68398_75	7B1	12.6
IWB66304	Tdurum_contig101572_103	7B1	12.6
IWB26274	Excalibur_c41771_990	7B1	13.0
IWA636	wsnp_BQ171683B-Ta_2_1	7B1	15.8
IWA1361	wsnp_Ex_c106_217340	7B1	15.8
IWA3987	wsnp_Ex_c47153_52447553	7B1	15.8
IWB44319	Kukri_c34355_722	7B1	15.8
IWB67554	Tdurum_contig12326_232	7B1	15.8
IWB72254	Tdurum_contig52239_120	7B1	15.8
IWB73035	Tdurum_contig65979_289	7B1	15.8
IWA6401	wsnp_Ku_c10572_17445600	7B1	16.2
IWB72504	Tdurum_contig56342_134	7B1	16.2
IWB72505	Tdurum_contig56342_259	7B1	16.2
IWB44978	Kukri_c39981_381	7B1	16.8
IWA3437	wsnp_Ex_c33461_41945399	7B1	17.2
IWB28152	Excalibur_c62837_164	7B1	17.2
IWA8469	wsnp_RFL_Contig3405_3533915	7B1	17.5
IWB22830	Excalibur_c16661_122	7B1	17.5

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB56478	RAC875_c30453_93	7B1	17.5
IWA3691	wsnp_Ex_c3974_7194320	7B1	17.8
IWA3853	wsnp_Ex_c43096_49510056	7B1	17.8
IWA4151	wsnp_Ex_c5270_9324025	7B1	17.8
IWB19721	Ex_c12057_797	7B1	17.8
IWB25947	Excalibur_c38547_118	7B1	17.8
IWB25969	Excalibur_c38719_496	7B1	17.8
IWB26968	Excalibur_c48577_543	7B1	17.8
IWB26969	Excalibur_c48577_577	7B1	17.8
IWB38733	Ku_c20136_198	7B1	17.8
IWB43515	Kukri_c2796_1436	7B1	17.8
IWB46152	Kukri_c51296_438	7B1	17.8
IWB47614	Kukri_c7495_824	7B1	17.8
IWB60564	RAC875_c7947_1288	7B1	17.8
IWB60941	RAC875_c8890_148	7B1	17.8
IWB60943	RAC875_c8890_244	7B1	17.8
IWB66386	Tdurum_contig102328_129	7B1	17.8
IWB70525	Tdurum_contig35073_183	7B1	19.6
IWB68838	Tdurum_contig19852_327	7B1	21.4
IWA306	wsnp_BE498323B_Ta_2_1	7B1	22.1
IWA3112	wsnp_Ex_c27323_36528037	7B1	22.1
IWA8021	wsnp_Ra_c60161_61164295	7B1	22.1
IWA8022	wsnp_Ra_c60161_61164325	7B1	22.1
IWB7147	BS00022542_51	7B1	22.1
IWB19722	Ex_c12057_798	7B1	22.1
IWB30611	Excalibur_rep_c113065_100	7B1	22.1
IWB41271	Kukri_c14804_352	7B1	22.1
IWB41272	Kukri_c14804_757	7B1	22.1
IWB41273	Kukri_c14804_876	7B1	22.1
IWB42505	Kukri_c21426_234	7B1	22.1
IWB47700	Kukri_c76860_181	7B1	22.1
IWB47917	Kukri_c82220_112	7B1	22.1
IWB52857	Ra_c9803_939	7B1	22.1
IWB55750	RAC875_c25143_110	7B1	22.1
IWB56477	RAC875_c30453_292	7B1	22.1
IWB59499	RAC875_c60161_448	7B1	22.1
IWB59552	RAC875_c60770_82	7B1	22.1

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB68451	Tdurum_contig15690_195	7B1	22.1
IWB70890	Tdurum_contig42140_871	7B1	22.1
IWB3949	BobWhite_c5704_517	7B1	22.4
IWB46070	Kukri_c50417_99	7B1	22.4
IWB59498	RAC875_c60161_281	7B1	22.4
IWB45709	Kukri_c469_366	7B1	23.9
IWB59495	RAC875_c60161_1223	7B1	24.6
IWB10200	BS00067984_51	7B1	25.0
IWB2732	BobWhite_c3484_538	7B1	26.4
IWB62985	RAC875_rep_c73821_223	7B1	27.4
IWB4191	BobWhite_c6580_361	7B1	28.1
IWB54467	RAC875_c1742_2710	7B1	28.5
IWB70613	Tdurum_contig3914_153	7B1	28.5
IWB714	BobWhite_c149_4419	7B1	28.8
IWB45202	Kukri_c42156_327	7B1	28.8
IWB4041	BobWhite_c5961_849	7B1	29.2
IWB35797	IACX1805	7B1	29.2
IWB44831	Kukri_c38676_251	7B1	29.2
IWB48253	Kukri_c91303_322	7B1	29.2
IWB59247	RAC875_c570_302	7B1	29.2
IWB71468	Tdurum_contig43966_1107	7B1	29.2
IWB40249	Kukri_c10108_115	7B1	29.5
IWB74657	tplb0039c07_334	7B1	29.8
IWB1660	BobWhite_c23044_279	7B1	30.2
IWB44832	Kukri_c38676_278	7B1	30.2
IWB74658	tplb0039c07_537	7B1	30.2
IWB30322	Excalibur_rep_c108075_472	7B1	30.5
IWB72089	Tdurum_contig50574_304	7B1	30.5
IWB63629	RFL_Contig1404_351	7B1	30.8
IWB45141	Kukri_c4143_1055	7B1	31.2
IWB45142	Kukri_c4143_869	7B1	31.2
IWB59198	RAC875_c5646_774	7B1	31.2
IWB68522	Tdurum_contig16275_277	7B1	31.2
IWA594	wsnp_BM134363B_Ta_2_7	7B1	31.8
IWB2777	BobWhite_c3541_152	7B1	31.8
IWB5727	BobWhite_s67603_103	7B1	31.8
IWB7447	BS00023150_51	7B1	31.8

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB14346	CAP7_c9776_62	7B1	31.8
IWB24749	Excalibur_c28715_447	7B1	31.8
IWB34138	GENE-4746_1032	7B1	31.8
IWB34139	GENE-4746_72	7B1	31.8
IWB34141	GENE-4746_978	7B1	31.8
IWB35732	IACX1302	7B1	31.8
IWB45276	Kukri_c42653_179	7B1	31.8
IWB45277	Kukri_c42653_248	7B1	31.8
IWB48044	Kukri_c8570_444	7B1	31.8
IWB54489	RAC875_c17510_356	7B1	31.8
IWB56260	RAC875_c29004_652	7B1	31.8
IWB56832	RAC875_c33333_266	7B1	31.8
IWB60292	RAC875_c7123_1703	7B1	31.8
IWB73232	Tdurum_contig74753_946	7B1	31.8
IWB74053	Tdurum_contig98926_227	7B1	31.8
IWB75085	tplb0055m05_1805	7B1	31.8
IWB27695	Excalibur_c5700_670	7B1	32.9
IWB27692	Excalibur_c5700_244	7B1	33.2
IWB42528	Kukri_c21628_1215	7B1	33.2
IWA437	wsnp_BF291608B_Ta_2_2	7B1	33.5
IWB5025	BobWhite_rep_c52876_72	7B1	33.5
IWB10797	BS00075332_51	7B1	33.5
IWB73136	Tdurum_contig69011_566	7B1	33.5
IWB73755	Tdurum_contig90495_232	7B1	33.5
IWB1506	BobWhite_c21560_163	7B1	34.9
IWB24845	Excalibur_c29455_308	7B1	34.9
IWB27694	Excalibur_c5700_527	7B1	35.2
IWB42656	Kukri_c22495_552	7B1	35.2
IWA436	wsnp_BF291608B_Ta_2_1	7B1	35.6
IWB3028	BobWhite_c39053_78	7B1	35.6
IWB24846	Excalibur_c29455_428	7B1	35.6
IWB24847	Excalibur_c29455_476	7B1	35.6
IWB5616	BobWhite_rep_c66630_331	7B1	38.0
IWB14408	CAP7_rep_c5216_143	7B1	38.0
IWB330	BobWhite_c12256_96	7B1	38.3
IWB39590	Ku_c5351_1820	7B1	38.7
IWB70715	Tdurum_contig41998_1213	7B1	38.7



**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB1294	BobWhite_c19633_233	7B1	39.8
IWA1345	wsnp_Ex_c10550_17231294	7B1	40.4
IWA1346	wsnp_Ex_c10550_17231658	7B1	40.4
IWA7207	wsnp_Ku_c60707_62509051	7B1	40.4
IWB11629	BS00089938_51	7B1	40.4
IWB56080	RAC875_c27548_234	7B1	40.4
IWB56081	RAC875_c27548_417	7B1	40.4
IWB69177	Tdurum_contig25773_144	7B1	40.8
IWB7572	BS00025278_51	7B1	41.5
IWB7573	BS00025286_51	7B1	41.5
IWB35974	IACX486	7B1	41.5
IWB36066	IACX5924	7B1	41.8
IWB44493	Kukri_c35918_164	7B1	41.8
IWB74015	Tdurum_contig97814_355	7B1	41.8
IWB21802	Excalibur_c11093_519	7B1	42.1
IWB2378	BobWhite_c30582_103	7B1	42.5
IWB4725	BobWhite_rep_c49050_1476	7B1	42.5
IWB4726	BobWhite_rep_c49050_1890	7B1	42.5
IWB6881	BS00022053_51	7B1	42.5
IWB7710	BS00029286_51	7B1	42.5
IWB7711	BS00029287_51	7B1	42.5
IWB9820	BS00066484_51	7B1	42.5
IWB15590	D_contig10891_118	7B1	42.5
IWB25804	Excalibur_c373_1347	7B1	42.5
IWB28758	Excalibur_c7552_1933	7B1	42.5
IWB57362	RAC875_c3794_849	7B1	42.5
IWB10498	BS00070791_51	7B1	42.8
IWB56854	RAC875_c3361_180	7B1	42.8
IWA1339	wsnp_Ex_c10500_17163855	7B1	43.2
IWA6588	wsnp_Ku_c16295_25148628	7B1	43.2
IWA6608	wsnp_Ku_c16895_25861847	7B1	43.2
IWB9120	BS00063744_51	7B1	43.2
IWB28513	Excalibur_c6871_217	7B1	43.2
IWB71473	Tdurum_contig43995_370	7B1	45.7
IWB5408	BobWhite_rep_c63859_127	7B1	47.1
IWB64170	RFL_Contig3005_1138	7B2	0.0
IWB64302	RFL_Contig3338_278	7B2	0.3

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB9137	BS00063821_51	7B2	0.7
IWB64077	RFL_Contig2814_385	7B2	1.0
IWB63221	RAC875_rep_c84729_461	7B2	1.7
IWB24666	Excalibur_c28086_173	7B2	2.0
IWB1688	BobWhite_c23287_57	7B2	2.4
IWB24507	Excalibur_c26939_1225	7B2	2.4
IWB47204	Kukri_c65047_76	7B2	2.4
IWB57016	RAC875_c34939_963	7B2	2.4
IWB61786	RAC875_rep_c108382_824	7B2	2.4
IWB64015	RFL_Contig2647_624	7B2	2.4
IWB64169	RFL_Contig3005_1031	7B2	2.4
IWB64301	RFL_Contig3338_1082	7B2	2.4
IWB64303	RFL_Contig3338_394	7B2	2.4
IWB71287	Tdurum_contig42584_1134	7B2	2.4
IWB71288	Tdurum_contig42584_1190	7B2	2.4
IWB73641	Tdurum_contig83564_600	7B2	2.4
IWB24667	Excalibur_c28086_450	7B2	2.7
IWB59287	RAC875_c5744_115	7B2	3.4
IWB34193	GENE-4848_348	7B2	3.7
IWB73667	Tdurum_contig8448_363	7B2	3.7
IWB25320	Excalibur_c33267_538	7B2	4.7
IWB50136	Kukri_rep_c71636_533	7B2	4.7
IWA182	wsnp_BE445506B-Ta_2_4	7B2	5.8
IWA2149	wsnp_Ex_c16577_25095267	7B2	5.8
IWA8324	wsnp_RFL_Contig2315_1788036	7B2	5.8
IWB9518	BS00065338_51	7B2	5.8
IWB34948	IAAV4890	7B2	5.8
IWB38489	Ku_c15539_433	7B2	5.8
IWB41905	Kukri_c18148_1177	7B2	5.8
IWB72248	Tdurum_contig52096_270	7B2	5.8
IWB6295	BS00010819_51	7B2	6.1
IWB27075	Excalibur_c49736_1148	7B2	6.1
IWB65432	TA001664-1167	7B2	6.1
IWB36193	IACX7421	7B2	6.4
IWB44507	Kukri_c35975_593	7B2	7.1
IWB13220	CAP12_c1587_70	7B2	11.0
IWB4483	BobWhite_c8454_782	7D1	0.0

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB35944	IACX4152	7D1	0.0
IWB7092	BS00022449_51	7D1	1.1
IWB9967	BS00067140_51	7D1	1.1
IWB12476	BS00110124_51	7D1	1.1
IWB12582	BS00110642_51	7D1	1.1
IWB15620	D_contig11494_202	7D1	1.1
IWB17499	D_F5XZDLF01ASSE2_190	7D1	1.1
IWB20013	Ex_c18266_680	7D1	1.1
IWB20272	Ex_c25027_535	7D1	1.1
IWB4469	BobWhite_c8415_728	7D1	2.1
IWB62490	RAC875_rep_c118995_572	7D1	2.5
IWB29066	Excalibur_c833_1405	7D1	2.8
IWB10326	BS00068485_51	7D1	3.2
IWB18120	D_GB5Y7FA02IDDA9_183	7D1	3.2
IWB28637	Excalibur_c7255_697	7D1	3.2
IWB35715	IACX11794	7D1	3.2
IWB48611	Kukri_rep_c101179_404	7D1	3.2
IWB48882	Kukri_rep_c103404_314	7D1	3.2
IWB65969	TA005377-1076	7D1	3.2
IWB63607	RFL_Contig1323_544	7D1	3.8
IWA3745	wsnp_Ex_c410_808465	7D1	4.2
IWA3746	wsnp_Ex_c410_808635	7D1	4.2
IWA3749	wsnp_Ex_c410_810250	7D1	4.2
IWA4131	wsnp_Ex_c5231_9256482	7D1	4.2
IWA4133	wsnp_Ex_c5231_9259463	7D1	4.2
IWB3933	BobWhite_c5654_231	7D1	4.2
IWB17630	D_F5XZDLF02H192C_184	7D1	4.2
IWB22849	Excalibur_c16775_1833	7D1	4.2
IWB24931	Excalibur_c30119_285	7D1	4.2
IWB25036	Excalibur_c30913_512	7D1	4.2
IWB35592	IAAV9104	7D1	4.2
IWB38758	Ku_c20948_1263	7D1	4.2
IWB43939	Kukri_c31100_311	7D1	4.2
IWB55455	RAC875_c23140_909	7D1	4.2
IWB61302	RAC875_c99892_81	7D1	4.2
IWB51788	Ra_c30952_531	7D1	5.5
IWB3214	BobWhite_c42170_144	7D1	5.9

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB12634	BS00111202_51	7D1	5.9
IWB23865	Excalibur_c22830_2010	7D1	5.9
IWB57735	RAC875_c41522_328	7D1	6.9
IWB56616	RAC875_c31483_117	7D1	7.2
IWB9595	BS00065623_51	7D1	7.6
IWB10503	BS00070821_51	7D1	7.6
IWB71561	Tdurum_contig44876_1626	7D1	7.6
IWB74313	tplb0027d07_1388	7D1	7.6
csLv34	csLv34	7D1	43.1
IWA1247	wsnp_CAP8_rep_c9647_4198594	7D2	0.0
IWB23802	Excalibur_c22419_460	7D2	7.4
IWB54644	RAC875_c1829_321	7D2	7.4
IWB3122	BobWhite_c40479_283	7D2	7.7
IWB19377	D_GDS7LZN02FSYZC_227	7D2	7.7
IWB33244	GENE-3129_828	7D2	7.7
IWB33245	GENE-3129_890	7D2	7.7
IWB44140	Kukri_c32845_116	7D2	7.7
IWB48288	Kukri_c92151_216	7D2	7.7
IWA1323	wsnp_Ex_c10430_17064001	7D2	27.9
IWB40232	Kukri_c100613_331	7D2	28.5
IWB14320	CAP7_c9278_185	7D2	36.2
IWB18130	D_GB5Y7FA02IRT85_195	7D2	39.7
IWB38905	Ku_c24562_206	7D2	39.7
IWA732	wsnp_CAP11_c2839_1425826	7D2	44.4
IWB15080	CAP8_rep_c9420_186	7D2	44.4
IWB22212	Excalibur_c13094_523	7D2	45.1
IWB35409	IAAV7925	7D2	45.4
IWA604	wsnp_bm138650D_Ta_2_2	7D2	45.8
IWB39156	Ku_c31629_1269	7D2	45.8
IWA1257	wsnp_cd454041D_Ta_2_1	7D2	46.1
IWB34836	IAAV4133	7D2	46.1
IWB67426	Tdurum_contig12069_385	7D2	46.1
IWB36226	IACX7714	7D2	46.5
IWA5249	wsnp_Ex_rep_c66483_64738995	7D2	46.8
IWA5557	wsnp_Ex_rep_c68671_67525179	7D2	46.8
IWB49398	Kukri_rep_c109239_223	7D2	46.8
IWA2208	wsnp_Ex_c17346_26030825	7D2	47.2

**Table C1.** The LMPG-6/PI 362698-1 Infinium iSelect SNP map of all 30 linkage groups (continued).

<b>Grain Genes Marker Name</b>	<b>Marker</b>	<b>Linkage Group</b>	<b>Position (cM)</b>
IWB39006	Ku_c26916_669	7D2	47.2
IWB6064	BS00009457_51	7D2	47.5
IWB46722	Kukri_c58234_519	7D2	51.4
IWA1537	wsnp_Ex_c11813_18968198	7D2	55.8
IWB21364	Ex_c8238_637	7D2	57.5
IWB41575	Kukri_c16416_647	7D2	58.5
IWA2273	wsnp_Ex_c17914_26681837	7D2	58.9
IWB8024	BS00035732_51	7D2	60.2
IWB34689	IAAV3265	7D2	60.6
IWB45846	Kukri_c48125_714	7D2	60.9
IWB53451	RAC875_c11933_885	7D2	60.9
IWB26628	Excalibur_c4508_1007	7D2	61.2
IWB26629	Excalibur_c4508_1959	7D2	61.2
IWB65357	TA001185-0966	7D2	61.2
IWB8604	BS00051607_51	7D2	62.6
IWB9724	BS00066128_51	7D2	62.6
IWB11300	BS00083421_51	7D2	62.6
IWB16883	D_contig55386_313	7D2	62.6
IWA1902	wsnp_Ex_c145_285194	7D2	62.9
IWA304	wsnp_BE497845D_Ta_1_1	7D2	64.6
IWB39179	Ku_c32426_324	7D2	68.6
IWB7177	BS00022610_51	7D2	69.6
IWB26912	Excalibur_c4799_338	7D2	69.6
IWB41457	Kukri_c15768_1383	7D2	69.6
IWB39510	Ku_c47803_245	7D2	70.0
IWB41458	Kukri_c15768_68	7D2	70.3
IWB8877	BS00062644_51	7D2	71.0
IWB10447	BS00070188_51	7D2	73.4
IWB15372	D_contig05962_325	7D2	73.4
IWB35552	IAAV8855	7D2	73.4
IWB35112	IAAV5907	7D2	84.8
IWB9744	BS00066209_51	7D2	113.7
IWB40337	Kukri_c10396_1588	7D2	116.2
IWB65383	TA001353-0349	7D2	127.6