Variety, Planting Date, and Planting Rate Effects on Buckwheat Yield in Northeastern North Dakota

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Buckwheat *(Fagopyrum esculentum* Moench) is a short-season speciality crop adapted to all regions of North Dakota. Annual acreages of buckwheat production are not officially recorded, but local estimates (10) indicate an increase in statewide acreage from 20,000 acres in 1980-1982 to 70,000 acres in 1988. This represents approximately two-thirds of the buckwheat grown in the United States.

Buckwheat is very sensitive to spring and fall frosts and high temperatures during anthesis (2,8,9). High temperature greatly increases the level of flower abortion. Proper planting date is, therefore, important to ensure maximum yields. Marshall (8) indicated that planting buckwheat 10-12 weeks before the first expected fall frost would help ensure plant maturity in Pennsylvania. This timing would also increase the probability that periods of high temperatures would occur during the vegetative growth period rather than during the peak blossoming period. Gubbels (5) studied two varieties with early, mid and late June planting dates at Morden, Manitoba over a three-year period. Averaged across years, reductions in yield from the early June planting date were 18 percent and 43 percent for mid and late June plantings, respectively. Date-of-planting studies conducted in central and southern Minnesota (9) indicated large differences in yield among planting dates which were attributed to escape from hot, dry weather and frost rather than planting date per se. Three months prior to the first killing frost was considered the optimum time for planting, although two months was enough time to obtain satisfactory yields.

Several studies have been conducted on planting rates of buckwheat. Ali-Khan (1) and Gubbels (5) examined planting rate effects on small seeded buckwheat varieties. Ali-Khan reported no real differences among plant populations ranging between 250,000 to 675,000 plants per acre. Gubbels studied planting rates of 8, 15, 30, and 61 pounds per acre. He concluded that a planting rate of 30 pounds per acre would ensure optimum yields each year. Gubbels and Campbell (7) studied the large seeded varieties Mancan and Manor at planting rates of 13, 27, 40, and 53 pounds per acre. They concluded that a planting rate between 27 and 40 pounds per acre would ensure optimum yields most years. Robinson (9) suggested 700,00 seeds per acre or 16 plants per square foot as an optimum planting rate. This would require approximately 50 to 55 pounds per acre of large seeded varieties and 40 pounds per acre of small seeded varieties.

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Campbell (unpublished date) (3) indicated that large seeded buckwheat varieties set the majority of their seed during the latter part of the growing season while the smaller seeded varieties generally have maximum seed set in the mid-growth period. Those results suggest a need for fine tuning information on planting dates to match regional climatic conditions. Further work is also needed on the relationship, for different regions, between actual plant populations and yield. The objective of this study was to examine the interrelationship between variety, planting date, and planting rate on buckwheat yield in Northeastern North Dakota.

METHODS AND MATERIALS

Two large seeded varieties, Manor and Mancan, and one small seeded variety, Tokyo, were sown at the Landgon Research Station in 1984, 1985, and 1986.

Planting rates of 525,000, 700,000, and 875,000 pure live seeds per acre were used. Planting rates in pounds per acre for the three-year study are given in Table 1. Stand counts from each plot were taken after emergence to determine actual plant population. Two random one-yard lengths were counted in each plot. Planting dates for 1984-1986 were approximately May 25, June 8, and June 22. Harvest plots consisted of seven 6-inch rows, 16 feet long. Trials were fertilized adequately for yield goals of 2,400, 2,160, and 1,440 pounds per acre for the years 1984-1986, respectively (4). The soil was classified a Svea fine-loamy, mixed Pachic Udic Haploborolls. Trials were kept weed free by the use of hand weeding. Harvest plots were cut and allowed to dry when flowering was almost finished and approximately 75 percent of the seeds had turned brown (6), or immediately after the first frost. The plots were threshed with a small plot combine. Samples were dried, cleaned and weighed for yield and test weight.

RESULTS AND DISCUSSION

The summary of weather data for 1984, 1985, and 1986 is presented in Table 2. The first year of the study was characterized by near normal temperatures and rainfall in June and July and above normal temperatures and below normal rainfall in August. All research plots, except those from the June 22 planting of Mancan and Manor, were harvested before first fall frost. The 1985 growing season had below normal temperatures June through September while precipitation was 4.90 inches above normal. The 1986 growing season had above normal temperatures in May and June and below normal the remainder of the growing season. Precipitation amounts May through September was 1.54 inches above normal. All varieties planted on June 22

Table 1. Buckwheat planting rates of three varieties at three plant populations during the 1984, 1985, and 1986 growing seasons at Langdon, North Dakota.

Plant Population	Plants /Ft²	1984 Tokyo	1984 Manor	1984 Mancan	1985 Tokyo	1985 Manor	1985 Mancan	1986 Tokyo	1986 Manor	1986 Mancan
Pure live seeds per acre						pounds/acre				
525,000	12	28	26	33	27	36	32	28	38	33
700,000	16	38	35	44	36	48	42	37	50	44
875,000	20	47	44	55	45	60	52	47	63	54

Table 2. Climatological data for the 1984, 1985, and 1986 growing seasons at Langdon, North Dakota.

Month	1984 Temp Avg*	1984 Temp Dev	1984 Precip Total	1984 Precip Dev	1985 Temp Avg	1985 Temp Dev	1985 Precip Total	1985 Precip Dev	1986 Temp Avg	1986 Temp Dev	1986 Precip Total	1986 Precip Dev
	°F		in.		°F		in.		°F		in.	
May	48.4	−3.0	0.79	−1.35	55.9	+4.5	2.80	+0.69	54.0	+2.5	1.83	−0.29
June	60.8	−0.1	3.39	+0.36	60.9	−5.3	4.75	+1.71	62.3	+1.5	3.89	+0.83
July	66.3	−0.1	3.31	+0.65	64.2	−2.2	1.55	−1.12	65.7	−0.7	5.44	+2.78
August	68.7	+4.3	0.50	−2.17	58.8	−5.7	7.11	+4.47	61.5	−2.9	1.13	−1.57
September	48.8	−5.8	0.77	−1.28	49.0	−5.6	1.19	−0.85	51.5	−3.0	1.82	−0.21

	1984		1985		1986	
Last Spring Frost	May 27	32°F	May 20	30°F	May 18	30°F
First Fall Frost	September 15	30°F	September 23	31°F	September 13	26°F
Frost Free Days	110		123		122	

Average Last Spring Frost	May 30	32°F
Average First Fall Frost	September 10	32°F
Average Frost Days	102	

* Average data from the period 1896-1985

in 1985 and 1986 were immature at first frost which occurred on September 23 and 16, respectively.

Planting date effects on yield of the three varieties are indicated in Figure 1. The large seeded varieties of Mancan and Manor had no significant yield differences between the May 25 and June 8 planting dates for the three years studied. Yields from the June 22 planting date were significantly lower than from the May 25 and June 8 planting dates for both Mancan and Manor in 1984 to 1986. Yield reductions for the June 22 planting date, when compared to the average of the May 25 and June 8 planting dates, were 35 percent and 29 percent over the three-year study for Mancan and Manor, respectively.

Yield of the smaller seeded variety Tokyo at the May 25 planting date was significantly higher than the June 8 and 22 planting dates in 1984. Yields of Tokyo decreased significantly with each delay of planting in 1985, while only the June 22 planting date was significantly lower than the May 25 and June 8 planting date in 1986.

This study indicated that planting buckwheat 13 to 15 weeks before the average first killing frost would result in optimum yields most years in northeastern North Dakota. This is earlier than other studies in Pennsylvania and central and southern Minnesota have suggested (8,9) and is likely due to the cooler and shorter growing seasons in this region. The June 22 planting date in 1985 and 1986 did not allow the large seeded varieties of Mancan and Manor, which put on the majority of their yield in the latter part of the growing season, to reach full maturity before the first killing frost and resulted in large yield reductions. The smaller seeded variety Tokyo is generally expected to have a wider latitude in planting dates because its maximum seed set occurs in the midgrowth period of plant development. This study, however, indicated that in two of the three years examined the earliest planting date resulted in significantly higher yields.

Planting date effects on test weight for the three buckwheat varieties are shown in Figure 2. The warmer 1984 growing season resulted in stable test weights across all planting dates and varieties. Test weights for Mancan and Manor were reduced by 0.8 and 1.0 pound per bushel from the May 25 to June 8 planting date, respectively. Test weights for the June 8 and June 22 planting dates were similar to one another. Tokyo, which typically has higher test weights than the larger seeded Mancan and Manor, had a 0.7 pound per bushel reduction in test weight from the May 25 to the June 22 planting date in 1984.

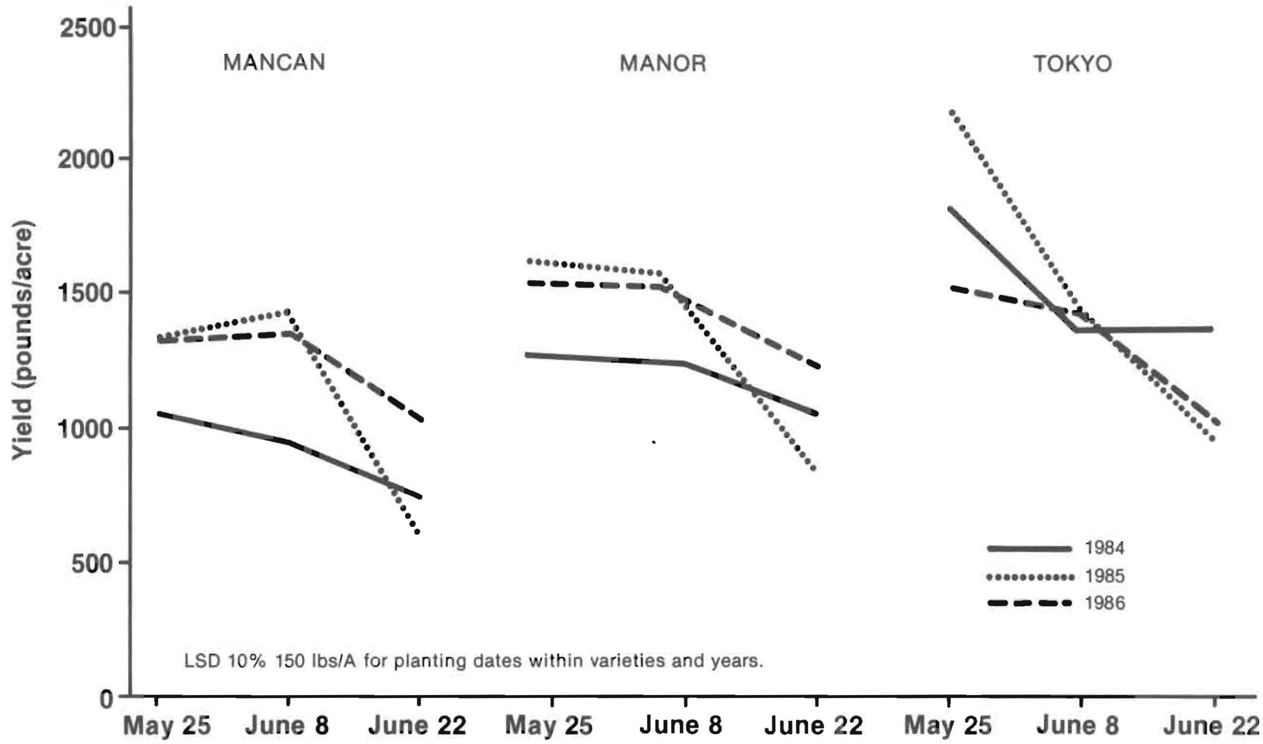

Figure 1. Planting date effect on yield of three buckwheat varieties during the 1984, 1985, and 1986 growing seasons at Langdon, North Dakota.

The cooler growing seasons of 1985 and 1986 probably did not allow maximum seed fill to occur before the first frost. This resulted in a large decrease in test weight for all varieties at the June 22 planting date when compared to other planting dates. Significantly lower test weights for Mancan, Manor and Tokyo resulted from the June 8 planting date compared to the May 25 planting date with the exception of Tokyo in 1985 and Manor in 1986, which had higher and equal test weights compared to the May 25 planting date, respectively. Reduced test weights resulting from later plantings are an important consideration for producers, as the grading system for buckwheat is based mainly on test weight and lower test weights are discounted (10).

Planting rate effects on yield and test weight for the three-year period were nonsignificant for all varieties and planting dates studied.

Buckwheat growers may often need to make replanting decisions as crusting soils may result in an unsatisfactory stand because of poor seedling emergence. The linear and quadratic relationships between actual plant populations and yield were analyzed in this study to help determine criteria for replanting in reduced stand situations. Stand counts from each plot of each variety, recorded in plants per square foot, were plotted as a percent mean for each variety over the three year period. The June 22 planting date data were not used because yield results were influenced by frost. No significant differences in yield were found between the low and high plant populations of six and 24 plants per square foot (261,000 and 1,045,000 plants per acre) for the three varieties studied. The buckwheat plant showed a remarkable ability to compensate for yield under good growing conditions. Other researchers have also reported these findings (1,5,8,9) and attributed the increased yield to the development of additional branches per plant and seeds per raceme (8,9).

Although no significant differences in yield were noted among planting rates in this study, a planting rate of 700,000 seeds per acre (16 plants per square foot) should produce satisfactory yields in most years. This agrees with earlier work done by Robinson (9). A lower planting rate may be undesirable in situations where weeds may become a problem. Buckwheat is a poor early season competitor with weeds, so a higher plant population will allow the crop to cover the ground more quickly for shading out weeds. No herbicides are presently cleared for use in buckwheat in the United States.

SUMMARY

Results from this study indicate that planting buckwheat 13 to 15 weeks before the first average date for fall frost is necessary to optimize yields in northeastern North Dakota. The larger seeded varieties Mancan and Manor had nearly equal yields at both the May 25 and June 8 planting dates. The smaller seeded variety Tokyo had the highest yields with the May 25 planting in two of the three years studied. Delayed planting to June 22 resulted in large yield reductions except in 1984 when August was 4.3 degrees Fahren-

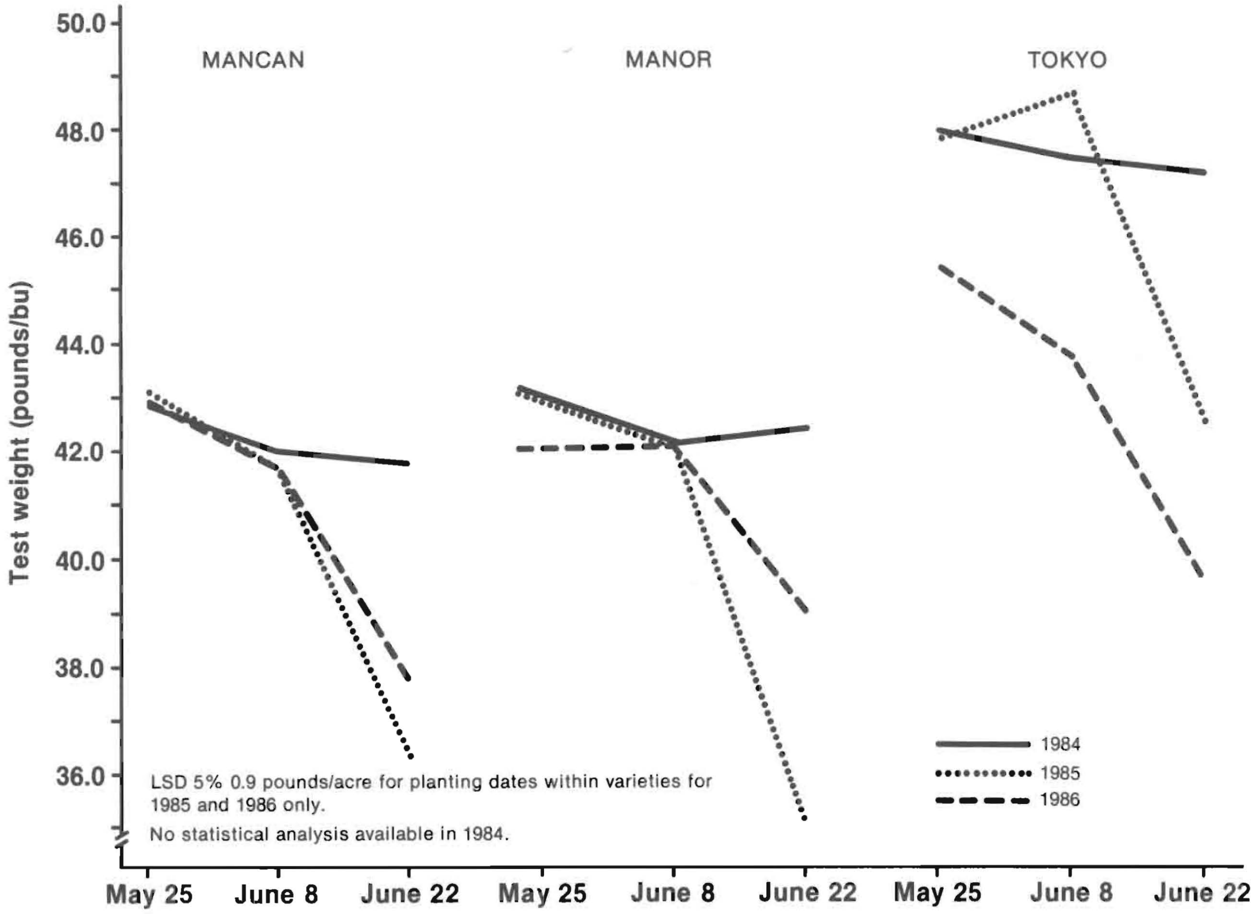

Figure 2. Planting date effects on test weight of three buckwheat varieties during the 1984, 1985, and 1986 growing seasons at Langdon, North Dakota.

heit warmer than normal. The effect of planting date on test weight paralleled yield results with large decreases occurring at the later planting date.

Although planting rate effects on yield and test weight were nonsignificant across all treatments, a planting rate of 700,000 seeds per acre (16 plants per square foot) should result in satisfactory yields in most years. Buckwheat has a remarkable ability to compensate for yield in reduced stands. Fields where plants are uniformly distributed and relatively weed free should produce near normal yields, in good growing conditions, even with stands as low as six plants per square foot.

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