
Hard Red Spring Wheat and Durum Wheat Production Guide (continued)

A-1050, May 1998

Insect Management

Aphid

Greenbug, English grain, and others

Thresholds for small grains: English grain, bird cherry oat, greenbug:

Recent research with cereal grain aphids has provided scouting guidelines that use different thresholds based on the value of wheat. The thresholds are 9, 13, and 17 aphids per stem when wheat prices are > \$5, > \$4, and < \$4 per bushel, respectively. Sampling plans designed to save time during field scouting are available. These plans require as few as 25 wheat stems to a maximum of 100 stems to make a treatment decision. Field scouting should begin at stem elongation and continue up to the heading stage of wheat. Aphid populations, at or above the thresholds, during these growth stages will result in economic injury to plants.

Russian Wheat Aphid (RWA):

Threshold is 15 to 20% of tillers infested up to flowering 20+% infested tillers from flowering to early milk stage. (Note: A tiller is infested whether it has one or several RWA present. RWA have only been found in southwestern North Dakota during late summer; no economic damage has been reported.)

Natural Controls:

Lady beetles, aphid lions, Syrphid fly, and parasitic wasps play a major role in reducing aphid populations. When natural enemies are present in large numbers, and the crop is well developed, farmers are discouraged from spraying fields.

Insecticide	Dosage in LB AI/Acre	Product Per Acre	Restrictions on Use
Dimethoate (Digon 400, Dimethoate 400)	0.25-0.5 lb/acre	0.5-0.75 pt	Do not apply within 14 days of grazing immature wheat plants. Do not harvest grain within 35 days (Digon 400) or 60 days (Dimethoate 400) of last application. Do not make more than two applications per season. Do not enter treated fields without protective clothing until sprays have dried.
Di-Syston*	0.5 - 1 lb/acre	0.5 - 1 pt	Aerial application only. Do not apply within 30 days of grain harvest. Use lower rate on plants up to tillering and higher rate after tillering.
Ethyl parathion 8EC*	0.5 lb/acre	8 fl oz	Aerial application only. Do not apply within 15 days of small grains harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
Malathion 57EC	0.9 - 1.25 lb/acre	1.5 - 2 pts	Do not apply within 7 days of harvest on wheat, oats, rye and barley. Do not apply below 60°F.
Lannate LV*	0.225 - 0.45 lb/acre	12-24 fl/oz	Do not harvest within 7 days or feed treated forage within 10 days of application. Field re-entry interval is 1 day.
Methyl parathion EC*	0.5 lb/acre	8 fl oz	Aerial application only. Do not use within 15 days of small grains harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
Penncap-M*	0.5 - 0.75 lb/acre	2 - 3 pts	Do not apply within 15 days of harvest or grazing. To avoid injury to bees, do not apply during pollen shed if

bees are visiting the areas to be treated during foraging hours. Do not enter treated fields within 48 hours after application. Fields must be posted.

Armyworms

Armyworm outbreaks in North Dakota can occur when large migrations of moths from southern states occur in late spring and early summer. Moths prefer to lay eggs in moist, shady areas where small grains or grasses have lodged or been damaged by hail or wind. Armyworms feed at night and hide under vegetation or in loose soil during the day. To scout for armyworms in grains, part the plants and inspect the soil for fecal pellets. If pellets or feeding damage are found, look for larvae under plant trash, soil clods or in soil cracks.

Threshold for small grains:

Treat when four to five or more worms per square foot are present.

Migrating Armyworms:

Treat a couple of swaths ahead of the infestation in the direction of movement to form a barrier strip.

Insecticide	Dosage in Lb AI/Acre	Product Per Acre	Restrictions on Use
carbaryl (Sevin)	1 - 1.5 lb/acre	rate varies with formulation	Do not apply within 21 days of harvest. Do not make more than two applications after the boot stage.
Ethyl parathion 8EC*	0.5 lb/acre	8 fl oz	Aerial application only. Do not apply within 15 days of small grains harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
Lannate LV*	0.225 - 0.45 lb/acre	12-24 fl oz	Do not harvest within 7 days or feed treated forage within 10 days of application. Field re-entry

interval is 1 day.

Malathion 57EC	1.25 lb/acre	2 pts	Do not harvest for 7 days.
Methyl parathion 8EC*	0.5 lb/acre	8 fl oz	Aerial application only. Do not apply within 15 days of small grains harvest. Do not enter treated fields within 48 hours of application. Fields must be posted.
Pennacap-M*	0.5 - 0.75 lb/acre	2 - 3 pts	Do not apply within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
Warrior*	0.02 - 0.03 lb/acre	2.56 - 3.84 fl oz	Do not apply within 21 days of wheat harvest. When applying by air, apply in a minimum of 2 gallons of water per acre.

Cutworms

Some criteria that may help predict cutworm problems are: 1) field history of cutworm damage; 2) surface crop residue from reduced or minimum tillage; 3) bottom land or low spots in field; 4) fair to poor drainage; 5) near shelterbelts with grassy ground cover. Eggs of the important cutworms are laid during late summer in North Dakota. Soil moisture at this time is important for survival. Growers should be cautious when planting corn following pasture, alfalfa, or clover sites where survival may be greater.

Management in small grains:

In western North Dakota, the pale western and the army cutworms are important pests of small grains. Eggs of pale western hatch in the spring and larvae feed underground. Eggs of the army cutworm hatch in the fall and spring feeding is above ground.

Thresholds for small grains:

Treatment is recommended when cutworms number four to five per square foot.

Insecticide	Dosage in Lb AI/Acre	Product Per Acre	Restrictions on Use
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Warrior*	0.015 - 0.025 lb/acre	1.92 - 3.2 fl oz	Do not apply within 30 days of harvest. When applying by air, apply in a minimum of 2 gallons of water per acre.
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Wireworms

Wireworms are most likely to be a problem when corn follows pasture or grassland. Continuous corn has developed problems in the past also. Infestations often are found in coarse textured soils (sandy loam) where moisture is abundant, perhaps in low spots of fields.

Currently the only insecticide registered for wireworm control that will provide effective suppression is lindane. This insecticide can be purchased as a dry automatic drill box treatment in combination with fungicides (Maneb or Captan) and is also available in liquid (flowable) formulation to be applied alone or with fungicides such as Vitavax, Captan or Thiram.

Caution: Do not use treated seed for feed or food purposes. Prevent the contamination of commercial grain by thoroughly cleaning bins, grain augers and trucks that have been used to store, handle and/or home treat seed.

Grasshoppers

In the northern plains, grasshopper egg hatch normally begins in late April to early May. Peak hatch occurs about mid June. Heavy infestations typically occur in areas of low rainfall or during drought years. Outbreaks are usually preceded by several years of hot, dry summers and warm falls. Cool, wet weather increases disease occurrence and delays development of grasshoppers, reducing the overall population.

Cultural Control Methods:

Early seeding – allows for early establishment and vigorous growth of plants.

Crop rotation – avoid planting in areas of high egg deposits. Fields with late maturing crops or green plant cover attract adults which then lay eggs.

Tillage – Summer fallow will act as a trap crop, attracting females for egg laying. Spring tillage of these sites will reduce successful emergence of nymphs.

Grasshopper Thresholds: Infestation Ratings

Rating	Nymphs (young hoppers) per square yard		Adults per square yard	
	Margin	Field	Margin	Field
Light	25-35	15-23	10-20	3-7
Threatening	50-75	30-45	21-40	8-14
Severe	100-150	60-90	41-80	15-28
Very severe	200+	120	80+	28+

Insecticide	Dosage in Lb AI/Acre	Product Per Acre	Restrictions on Use
Dimethoate (Digon 400, Dimethoate 400)	0.38 lb/acre	0.75 pt	Do not apply within 14 days of grazing immature plants. Do not harvest grain within 35 days (Digon 400) or 60 days (Dimethoate 400) of last application. Do not make more than two applications per season. Do not enter treated fields without protective clothing until sprays have dried.
carbaryl (Sevin)	0.5 - 1.5 lb/acre	rate varies with formulation	Do not apply within 21 days of grain harvest. Do not make more than 2 applications after the boot stage. No limitations on forage. The lower rate (0.5 lb) is suggested for nymphs on small plants or sparse vegetation. The higher rate is suggested for mature grasshoppers or when material is applied to crops requiring greater coverage.
Ethyl	0.5 lb/acre	8 fl oz	Aerial application. Do not

parathion 8E*			apply within 15 days of small grains harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
Furadan 4F*	0.125 - 0.25 lb/acre	0.25-0.5 pt	Apply before heads emerge from the boot. Do not make more than 2 applications per season. Do not apply within 21 days of harvest. Use a minimum of 10 gal of finished spray/acre with ground equipment and 2 gal/acre with aerial equipment. Do not feed treated forage to livestock. Do not apply in proximity of waterfowl nesting or feeding areas.
Malathion 57EC	1.25 lb/acre	1.5 - 2 pt	Wait 7 days before grain harvest. No time limitation on grazing or straw for dairy or slaughter animals.
Malathion (ULV) (95% concentrate)	0.48 lb/acre	8 fl oz/acre	Commercial aerial applicators only. Do not harvest for 7 days.
Methyl parathion 8EC*	0.5 lb/acre	8 fl oz.	Aerial application only. Do not apply within 15 days of small grains harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
Pennacap-M*	0.5 - 0.75 lb/acre	2 - 3 pts	Do not apply within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
Warrior*	0.02 - 0.03 lb/acre	-3.84 fl oz	Do not apply within 21 days of harvest. When applying by air, apply in a minimum of 2 gallons of water per acre.

Grasshoppers Winter Wheat field border treatment

Insecticide	Dosage in Lb AI/Acre	Product per Acre	Restrictions on Use
Thimet 20 G*	0.24 oz AI/1,000 ft of row row	1.2 oz/1,000 ft of row – any spacing (minimum 8 inch spacing) at planting	Apply at planting time in seed furrow with granular applicator or grass seeder attachment. Do not graze or feed forage within 45 days of treatment.

Wheat Stem Sawfly

Sawfly damage occurs annually in North Dakota. This insect primarily affects wheat in the central and western areas of the state. The larvae tunnel in the stem, reducing grain yield by 10-14%. Additional loss occurs when infested stems lodge, rendering the grain unharvestable. Larvae overwinter in the wheat stubble making infested sites the source of next year's problems.

Managing wheat stem sawfly:

Harvesting – Swath the most heavily infested fields at 30-35% moisture before significant lodging occurs. This strategy requires field surveys to determine infestation levels. Infested stems have a reddish-brown spot below the second or third node. Examine 50 consecutive stems in a drill row from at least two sites (one near the margin of the field, another near the center). Determine the percent of stems infested at each site. If >6% of the stems are infested, swath to reduce lodging losses within infested sites.

Fall tillage – A shallow fall tillage to dislodge stubble and leave it on the soil surface can result in 90% mortality of overwintering larvae. Tillage can be limited to areas where surveys indicated infestations within the field or strip.

Crop rotation – Plant non-host crops such as oats, flax, sunflower, legumes, and to a lesser extent barley, rye, durum and winter wheat.

Resistant wheat varieties – Wheats with the solid stem trait are unsuitable for sawfly larvae to complete their development. Varieties with resistance to wheat stem sawfly include Ernest, Lew, Leader, AC Eatonia, Cutless, Rambo, and Glenman.

Chemical control – None is currently recommended.

Hessian Fly

The Hessian fly overwinters as a maggot or pupa in winter wheat, volunteer grain, and wheat stubble. Overwintered maggots pupate and emerge as adults from April to May, infesting winter and spring planted wheat. By June, maggots pupate (flaxseed stage), emerging as adults in August to lay eggs for the overwintering generation.

Managing Hessian fly:

Winter wheat planting date – Winter wheat will act as a bridge to get Hessian fly from one season to the next. Delaying planting should reduce infestations. Suggested planting dates for North Dakota are: North – August 25 to September 15; South – September 1 to 20.

Tillage – Burying stubble and destroying volunteer grain after the first killing frost or early in the spring before fly emergence helps suppress adult populations.

Rotation – Rotate wheat with non-susceptible crops (oats, corn, soybean, sunflower, flax).

Resistant varieties – Two South Dakota releases, Guard and Shield, are hard red spring wheat. They are semi-dwarf varieties. Guard is reported to be prone to shattering.

Chemical control – Thimet is registered as a planting time treatment for wheat. Population levels of this pest rarely warrant such a treatment, however.

Wheat Midge or Orange Wheat Blossom Midge

This insect is currently an economic concern in North Dakota. In 1996, wheat midge was detected in all areas east and north of the Missouri River. A contributing factor to the recent outbreaks was delayed planting of wheat due to excessively wet soils in the spring.

The adult midge is active from late June to early August. Peak activity is from early to mid July. A model using daily temperatures to calculate degree day accumulations allows for a more accurate prediction of local adult emergence. Wheat is attractive for egg laying by midge from the time the head emerges from the boot through flowering. Insecticides for the control of midge are effective on the adult and impact the egg stage; however, control of the orange larvae, which feed on the developing kernels, has not been demonstrated due to protection within the glume.

Thresholds for wheat:

Examine wheat heads at dusk (9 pm and later when temperatures are above 60 F and wind speed less than 6 mph). The orange colored adult midge can be seen laying eggs on the wheat heads. Plants are susceptible as the head emerges from the boot. In general, if one or more midge are observed for every four or five heads, treatment is warranted. Treatments after 50% of the first heads have flowered are not recommended due to reduced levels of efficacy and for the protection of a parasitic wasp that attacks the midge eggs.

Detecting adult midge:

Sticky traps may be used to capture adult midges active in wheat fields. A simple trap design would be a white styrofoam plate, attached to the top and bottom of a surveyors flag. The trapping surface can be coated with Tanglefoot  or vegetable oil. The trap can alert an individual to the presence of midge and their identity, but it does not provide information about the need to treat.

Insecticide	Dosage in Lb AI/Acre	Product per Acre	Restrictions on Use
Lorsban 4E-SG	0.5 lb/acre	1 pt	Treat when 75% of the wheat heads have emerged from the boot. Apply product in the late afternoon in a minimum of 2 gallons of water per acre. Do not apply within 28 days of harvest. (Issued as Special Local Needs ND-950006)

Wheat Stem Maggot

The maggot tunnels in stems of wheat resulting in a white head that can be easily pulled out. This damage becomes evident after flowering. Infestations rarely exceed 2% and fail to become an economic concern. Crop rotation and destruction of volunteer grain are the most effective methods of reducing maggot populations.

No chemical control is recommended.

Grain Harvesting

Harvesting is one of the most important farming operations. Grain loss at harvest is a direct loss of income. Harvesting often is a compromise between getting the job done in a reasonable period of time and living with a reasonable seed loss. Studies have shown that losses can run as high as 20%, even with a properly adjusted machine when it is overloaded. A reasonable loss is considered to be three percent of the total crop or less. Total harvest losses are seldom if ever zero.

Usually over 60% of the grain left in the field is due to shattering of the crop before harvest and grain loss in getting it cut and into the combine header. Once the crop is in the combine, loss is very low with properly adjusted and operated equipment.

To keep harvest loss low, an operator must determine how much grain is being left in the field. A simple, accurate method to estimate losses requires the use of a one-foot square frame. Pick several typical areas in the field after the combine has passed and follow these steps:

[Graphic Illustration](#) (6KB b&w image)

1. Count the kernels left directly behind the rear of the combine. Count several separate square foot areas (A).
2. Count the kernels already in the field due to shatter and cutter bar (B).
3. Subtract (B) from (A).
4. Divide the results of Step 3 by the ratio:

Width of windrower / header cut (ft)

width of combine cylinder (ft)

5. Divide the result of Step 4 by the number of kernels for the particular crop from the table below for one bushel per acre loss. This is the approximate machinery loss in bushels per acre.

Number of kernels per square foot to equal one bushel per acre loss.

Crop	# of kernels ft ²
Hard Red Spring Wheat	20
Flax	100
Durum	16
Sunflower	3
Barley	14
Corn	2
Oats	10
Soybeans	4

6. To find total loss, add the count in (B) to the result in Step 4. This gives the total seed count from shatter, cutter bar and machine losses.
7. Divide the total seed count of Step 6 by the number of kernels for the particular crop for one bushel per acre loss (Table). This will give the approximate total loss in bushels per acre.
8. For a percentage loss, divide the loss in Step 7 (loss in bushels per acre) by the total yield (harvest yield plus loss) in bushels per acre for the field.

$$\frac{\text{Loss}}{\text{Harvest Yield Plus Loss}} * 100 = \% \text{ Loss}$$

Example: A 20 foot windrower is used in a wheat field yielding 26 bu/acre, and the combine has a cylinder 4 feet wide.

1. A = kernels per square foot counted directly behind the combine = 59 kernels per square foot.
2. B = kernels per square foot to the side of the windrow.
B = 4
3. A - B = 59 - 4 = 55 kernels per square foot.

4. Ratio:

$$\frac{\text{width of cut (ft)} \quad 20}{\text{width of cylinder} \quad 4} = \frac{\quad}{\quad} = 5$$

Divide 55 by 5 = 11 kernels per square foot.

5. Divide 11 by 20 (Table) = .55 bu/acre = machine loss.
6. Total loss = "B" plus answer in Step 4.
= 4 + 11
= 15 kernels/square foot
7. Divide 15 by 20 (Table) = .75 bu/acre = total loss.
8. % total loss = answer in Step 7 divided by harvest yield plus total loss.

$$\% \text{ loss} = \frac{\text{loss}}{\text{harvest yield plus loss}} * 100$$

Swathing Versus Straight Combining

Grain grading standards are almost sure to become more rigid; cracked or broken kernels will be discounted at market. Improving quality will require harvesting at optimum moisture levels, expert combine operation, natural air/low temperature drying, and minimizing rough handling.

Grain threshed at high moisture contents is subject to damage. Less damage occurs when grain moisture contents are near storage levels, but as standing grain dries in the field, shatter loss increases. Swathing should occur after grain has reached physiologically maturity. This occurs at about 35% moisture in wheat and durum. Swath grain at 20 to 30% moisture. If grain is left to stand at moisture levels under 20%, straight combining results in the least amount of loss. Swathing at this stage causes excessive shatter loss.

Straight combining is best done at 15 to 18% moisture and the grain dried to safe storage levels. Cylinder speeds should be as slow as possible to reduce damage to grain, but fast enough to thresh the grain out of the heads. Follow combine manufacturers recommendations. In wet grain, slightly faster speeds may be needed to get complete threshing. Reduce cylinder to concave spacing first, then increase cylinder speed as a last resort.

Grain Drying

Natural air/low temperature drying is energy efficient, economical and reduces drying bottle necks. Drying time is normally three to six weeks using airflow rates of 0.75 to 1.0 cubic foot per minute per bushel (cfm/bu). Generally a centrifugal fan of adequate size is needed to provide the airflow. The potential for grain spoilage is high until all the grain reaches the proper storage moisture content, so adequate airflow to dry the wheat within its allowable storage time is critical.

A grain kernel contacting air will either lose or gain moisture, depending on its moisture content and the air's temperature and relative humidity. Water moves from an area of high vapor pressure to areas of low vapor pressure. Eventually, the vapor pressure inside the kernel almost equals the air's vapor pressure. When this occurs, the grain has reached the equilibrium moisture content. Higher temperatures and lower relative humidity results in lower equilibrium moisture contents.

Adding supplemental heat to a natural air drying system will reduce the moisture content of the grain and may reduce the drying time slightly. Normally the air should be warmed no more than about 5 F. As a rule of thumb, one kilowatt of electric heat per fan motor horsepower will warm the air about 5 degrees. Adding more heat will result in over drying unless the grain is stirred. The air will normally be warmed 3-5 degrees by the fan operating at a static pressure of about 6 inches.

Drying temperatures need to be limited when using a high temperature dryer to prevent damaging the quality of the wheat. Baking

quality diminishes when kernel temperatures approach about 150 degrees for continuous flow dryers and 135 degrees for batch dryers. Since milling quality is affected by a time and temperature relationship, the maximum recommended kernel temperature for drying milling wheat is 150 F for 16% moisture content and 130° F for 20% moisture wheat in a continuous-flow dryer.

A moisture variation develops in the kernel when wheat is dried in a high temperature dryer, with the outside being drier than the inside. This moisture variation causes electronic meters to give an erroneously low value, since they are more influenced by the outer surface of the kernel. If the outer surface is wetter than the inside of the kernel, the meter reading will be erroneously high.

For more information refer to circular AE-701, Grain Drying and EB-35, Natural Air/Low Temperature Crop Drying.

Equilibrium moisture content of wheat (wet basis) at varying temperatures and relative humidities.

Grain	Temperature (F)	Relative Humidity (%)			
		20	40	60	80

- Equilibrium Moisture Content -					
Hard Wheat	35	8.6	11.9	14.9	18.3
	50	8.2	11.3	14.2	17.4
	70	7.7	10.7	13.3	16.5
	80	7.5	10.4	13.0	16.0

Managing Stored Grain

Grain stores best if cool, dry and clean. The maximum recommended moisture content for wheat in storage is 13% for long term storage and 14% for just over winter. Grain that contains considerable foreign material or broken kernels will be more susceptible to mold and insects. The grain should be cleaned to reduce this hazard or be dried to a moisture content 1 to 2 percentage points lower than clean grain.

Begin aeration to reduce the grain temperature when the average outdoor temperature is about 10 to 15 F cooler than the grain temperature and the grain can be cooled below 70 F. Cool the grain to about 25 to 30 F for winter storage. Insect activity is stopped at temperatures below about 50 degrees, and insects can be killed if grain temperatures are maintained at or below 32 degrees for about two months. Moisture migration will cause a moisture accumulation in the top central part of a bin if about a 20-degree or

more temperature difference exists in the stored grain.

It takes about 150 hours to cool grain with an aeration airflow rate of 0.1 CFM/bu. Increasing the airflow rate reduces the aeration time. Make sure the fan runs long enough to cool all the grain. Little if any drying will occur during aeration. Also, very little rewetting will occur if the fan is run just long enough to cool the wheat during humid weather. The aeration fan or duct should be covered whenever the fan is not running.

Grain may be warmed in the spring if desired, but should only be warmed to about 40° F for summer storage. Research has not shown that it is better to warm the grain than to leave it at about 30 degrees. Moisture accumulation during summer due to moisture migration typically occurs at depths of two to four feet below the grain surface. The moisture increase will normally be less than one percentage point. Grain should not be aerated during the summer when outside air temperatures exceed 60° F. Warming the wheat to 70° F, for example, will add moisture to the grain and put the grain at a temperature conducive to mold growth and insect activity.

Check the stored grain at least every two weeks during the fall and at least monthly during the rest of the storage period. Search for small changes that are indicators of potential problems. Check and record the temperature and moisture content at several locations. Examine samples from several locations for insects. For more information refer to circular AE-791, Crop Storage Management, and EB-45, Insect Pest Management for Farm Stored Grain.

Pesticide Safety Rules

- Read label carefully before using product.
- Store chemicals under lock and key.
- Keep chemicals in original containers.
- Use chemicals only on crops specified and at correct rate and schedule.
- Do not eat or smoke while applying pesticides.
- Wear all of the protective clothing and equipment listed on the pesticide label.
- Wash clothing and skin immediately if chemicals should come in contact with same.
- Avoid chemical drift to sensitive crops.
- Apply pesticides properly to avoid harm to humans, livestock, fish, wildlife, and water supplies.
- Keep a record of pesticides applied, amounts used and date of application.
- Use returnable pesticide containers when possible. Rinse and recycle nonreturnable containers or dispose of properly.
- In case of accidental poisoning, call physician or take patient to a hospital immediately. Remember to the pesticide label with you.
- Follow the worker protection standard requirements and ensure workers are trained and protected while working with pesticides.

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