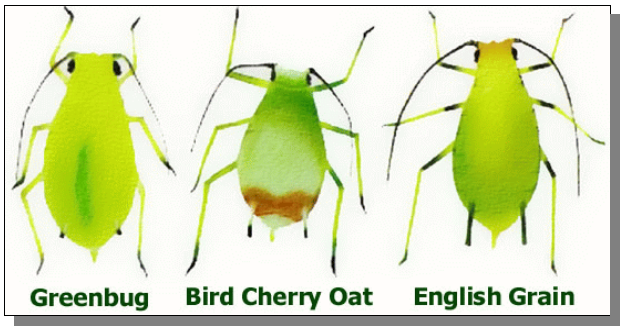
WHEAT INSECTS

Other Resources Available Through NDSU Extension Service:

Publications	E493	Aphid Management in Small Grains, Corn and Sorghum (1993)
	E830	The Armyworm and the Army Cutworm (2000)
	E1230	Cereal Leaf Beetle Management (2002)
	PP680	Wheat Stem Infesting Insects in North Dakota (1989)
	E1007	Biology and Management of Barley Thrips (1991)
	E272	Grasshopper Management (1997)
	E188	Wireworm Control (2001)
	E1330	Integrated Pest Management of the Wheat Midge in North Dakota (2008)

APHID

Wheat aphid descriptions:



Greenbug - pale green with darker stripe down back.

Bird Cherry Oat Aphid - olive green, brownish patch at the base of cornicles.

English Grain Aphid - bright green with long black cornicles.

The greenbug, English grain aphid and bird cherry oat aphids are the principle species that cause problems in North Dakota small grains. None of these aphids are known to overwinter in North Dakota; they migrate to the region from the South in late spring. The greenbug is the most injurious because it injects a toxin with its saliva during feeding. The English grain aphid is the most common aphid seen in small grains. Its populations grow rapidly when feeding on wheat heads. The bird cherry oat aphid feeds primarily on leaves in the lower part of the small grain plant. These aphids transmit barley yellow dwarf virus. When aphid populations are high, the disease can spread through small grain fields. At greatest risk are later planted fields which attract migrating aphids that are moving from more mature fields.

Thresholds for Wheat: ***English Grain, Bird Cherry Oat, Greenbug***

To protect small grains from yield loss due to aphid feeding, the treatment threshold is 85% stems with more than one aphid present or 12-15 aphid per stem, prior to complete heading. 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.

The greatest risk of yield loss from aphids feeding on grains is in the vegetative to boot stages. Significant yield reductions after the onset of flowering could not be demonstrated in research published from South Dakota in 1997 (Voss et al., 1997. J of Economic Entomology 90: 1346-1350). Reasons for these conclusions were that: after heading the only major yield component aphids can affect is seed weight; aphids are unable to sustain the very large populations necessary to achieve significant impact on this factor. Other components of yield are determined earlier (number of spikelets - determined at jointing; number of seeds - determined at flowering).

Russian Wheat Aphid (RWA):

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 southwest North Dakota during late summer; no economic damage has been reported. No RWA have been reported in North Dakota since the early '90s. Occasionally, RWA have overwintered during mild winters in Montana.**

Natural Controls:

Lady beetles, aphid lions, syrphid fly larvae, and parasitoid 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
beta-cyfluthrin Baythroid XL *RUP*	0.014 - 0.019	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
chlorpyrifos + gamma-cyhalothrin Cobalt *RUP*	0.14 - 0.25 + 0.003 - 0.004	7 - 13 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Chlorpyrifos 4E AG Lorsban 4E Lorsban Advanced Warhawk Yuma 4E *RUP*	0.25 - 0.5	0.5 - 1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre.
cyfluthrin Tombstone Tombstone Helios *RUP*	0.028 - 0.038	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 7 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
dimethoate Digon 400, Dimethoate 400	0.25 - 0.5	0.5 - 0.75 pt	PHI = 35 days, or graze within 14 days of last application. Do not make more than two applications per season.
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Senator 600		0.8 - 2.4 fl oz per cwt of seed	Apply as a seed treatment or for end-use at agricultural establishments (total slurry treater, farmer applied seed treater). Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
imidacloprid Enhance AW	refer to recommended label rate	4 oz per 100 lbs of seed	Apply as an on-farm seed treatment at planting time. Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz	
malathion Malathion 57EC	0.9 - 1.25	1.5 - 2 pts	PHI = 7 days. Do not apply below 60° F.
methomyl Lannate LV *RUP*	0.225 - 0.45	12 - 24 fl oz	PHI = 7 days or feed treated forage within 10 days of application.
methyl parathion *RUP*	0.25 - 1.5	0.5 - 1.5 pt	PHI = 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.
methyl parathion Penncap-M *RUP*	0.5 - 0.75	2 - 3 pts	

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	0.020 - 0.025	3.2 - 4 fl oz	PHI = 14 days for grain, forage or hay. Do not apply more than 0.125 lb AI per acre per season. Do not make applications less than 14 days apart. Apply by air or by ground using sufficient water to obtain full coverage. Use a minimum of 2 gals per acre by air and 10 gals per acre by ground. Aphid control may be variable depending on species present.

RUP - Restricted use pesticide

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 is found, look for larvae under plant trash, soil clods or in soil cracks.

Threshold for Wheat:

Treat when 4 to 5 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
beta-cyfluthrin Baythroid XL *RUP*	0.014 - 0.019	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
carbaryl Sevin	1 - 1.5	rate varies by formulation	PHI = 21 days. Do not make more than 2 applications after the boot stage.
chlorpyrifos + **gamma- cyhalothrin** Cobalt *RUP*	0.25 - 0.49 + 0.004 - 0.009	13 - 25 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Lorsban 4E Lorsban Advanced *RUP*	0.5	1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre.
cyfluthrin Tombstone Tombstone Helios *RUP*	0.028 - 0.038	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 7 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
gamma-cyhalothrin Proaxis *RUP*	0.01 - 0.015	2.56 - 3.84 fl oz	PHI = 30 days. When applying by air, apply in a minimum of 2 gals of water per acre.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz	
malathion Malathion 57EC	1.25	2 pts	PHI = 7 days.
methomyl Lannate LV *RUP*	0.225 - 0.45	12 - 24 fl oz	PHI = 7 days or feed treated forage within 10 days of application.
methyl parathion Methyl parathion 8EC *RUP*	0.5	8 fl oz	PHI = 15 days. Do not enter treated fields within 48 hours of application.
methyl parathion Penncap-M *RUP*	0.5 - 0.75	2 - 3 pts	
spinosad (microbial) Entrust (suppression only)	0.05 - 0.1	1 - 2 oz	Do not apply more than 5.6 oz (0.28 lb a.i.) per acre per season. PHI = 21 days for grain and straw harvest or within 3 days of forage or hay harvest.
spinosad (microbial) Success	0.047 - 0.094	3 - 6 fl oz	PHI = 21 days of grain or straw harvest or within 14 days of forage or hay harvest. Do not apply more than a total of 19 fl oz per acre per season.. Treat when pests appear, targeting eggs at hatch or small larvae. Use a higher rate in the rate range for larger larvae or moderate to severe infestations.
spinosad (microbial) Tracer	0.031 - 0.094	1 - 3 fl oz	PHI = 21 days of grain or straw harvest or within 14 days of forage or hay harvest.
spinetoram Radiant SC	0.023 - 0.047	3 - 6 fl oz	PHI = 21 days for grain or straw harvest or within 3 days of forage, fodder or hay harvest. Do not apply more than 18 fl oz (0.141 lb ai spinetoram) per acre per year. Do not make more than 3 applications in one calendar year. Do not make applications less than 4 days apart.
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	0.011 - 0.025	1.76 - 4 fl oz	PHI = 14 days for grain, forage or hay. Do not apply more than 0.125 lb AI per acre per season. Do not make applications less than 14 days apart. Apply by air or by ground using sufficient water to obtain full coverage. Use a minimum of 2 gals per acre by air and 10 gals per acre by ground.

RUP - Restricted use pesticide

CEREAL LEAF BEETLE

The cereal leaf beetle is an imported insect pest from Europe. This insect has just been found in **Williams and McKenzie counties of North Dakota**. It was first detected in Michigan in 1962, Utah in 1984, and Montana in 1989. The cereal leaf beetle is a serious pest of barley and wheat in Montana. Both adults and larvae of the cereal leaf beetle damage grain crops through their foliar feeding. The larvae are the most damaging stage and the target of control measures. Generally, the newer plant tissue is preferred with feeding occurring on the upper leaf surface causing characteristic elongated slits.

Monitoring and Treatment Threshold:

The first sign of CLB activity in the spring is adult feeding damage on the plant foliage. While this is the first sign of adult activity, adults are not the target of control. Eggs and larvae are monitored by plant inspection since thresholds are expressed as egg and larvae numbers per plant or per stem. Examine 10 plants per location and select 1 location for every 10 acres of field. Count number of eggs and larvae per plant (small plants) or per stem (larger plants) and get an average number of eggs and larvae, based on the samples you have taken.

Boot stage is a critical point in plant development and impact of cereal leaf beetle feeding damage can be felt on both yield and grain quality. ***Before boot stage***, the threshold is: three 3 eggs and larvae or more per plant (including all the tillers present before the emergence of the flag leaf). Larvae feeding in early growth stages can have a general impact on plant vigor. When the flag leaf emerges, feeding is generally restricted to the flag leaf which can significantly impact grain yield and quality. The threshold is decreased ***at the boot stage*** to: 1 larvae or more per flag leaf.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
beta-cyfluthrin Baythroid XL *RUP*	0.008 - 0.014	1.0 - 1.8 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
carbaryl Sevin (XLR Plus,4F, 4-Oil)	1.0	2 pt	PHI = 21 days for grain or within 7 days of grazing.
Sevin 80S	1.0	1.25 pt	
chlorpyrifos + gamma-cyhalothrin Cobalt *RUP*	0.25 - 0.49 + 0.004 - 0.009	13 - 25 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Chlorpyrifos 4E AG Lorsban 4E Lorsban Advanced *RUP*	0.5	1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre.
cyfluthrin Tombstone Tombstone Helios *RUP*	0.016 - 0.028	1.0 - 1.8 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 7 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
diflubenzuron Dimilin 2L *RUP*	0.031	2 fl oz	PHI = 50 days for grain or straw, 15 days for hay, or 3 days for forage. Apply at egg laying. For use only west of US highway 281. Do not apply within 25 feet by ground or 150 feet by air of bodies of water. Applications must include a 25 foot vegetative buffer strip to limit runoff. Use 5 to 15 GPA total volume by ground, 3 to 5 GPA total volume by air. Do not exceed 4 fl oz per acre per season. Do not make more than 1 application per season.
gamma-cyhalothrin Proaxis *RUP*	0.01 - 0.015	2.56 - 3.84 fl oz	PHI = 30 days. Do not apply more than 0.03 lb ai (7.7 oz) per season.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz	
malathion Malathion ULV	0.3-0.6	4 - 8 oz	PHI = 7 days. Treatment is most effective at temperatures over 70° F.
methomyl Lannate LV *RUP*	0.225-0.45	0.75 - 1.5 pt 0.25 - 0.5 lbs	PHI = 7 days, or 10 day to graze. There is a 24-hour re-entry interval.
spinosad (microbial) Tracer	0.031 - 0.094	1 - 3 fl oz	PHI = 21 days of grain or straw harvest or within 14 days of forage or hay harvest.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
spinosad (microbial) Success	0.031 - 0.094	2 - 6 fl oz	PHI = 21 days of grain or straw harvest or within 14 days of forage or hay harvest. Do not apply more than a total of 19 fl oz per acre per season.. Treat when pests appear, targeting eggs at hatch or small larvae. Use a higher rate in the rate range for larger larvae or moderate to severe infestations.
spinetoram Radiant SC	0.016 - 0.047	2 - 6 fl oz	PHI = 21 days for grain or straw harvest or within 3 days of forage, fodder or hay harvest. Do not apply more than 18 fl oz (0.141 lb ai spinetoram) per acre per year. Do not make more than 3 applications in one calendar year. Do not make applications less than 4 days apart.
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	0.011 - 0.025	1.76 - 4 fl oz	PHI = 14 days for grain, forage or hay. Do not apply more than 0.125 lb AI per acre per season. Do not make applications less than 14 days apart. Apply by air or by ground using sufficient water to obtain full coverage. Use a minimum of 2 gals per acre by air and 10 gals per acre by ground.

RUP - Restricted use pesticide

CUTWORMS

Several cutworm species affect regional crops. In western North Dakota, the pale western cutworm and the army cutworm 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. In eastern North Dakota, the Dingy cutworm, *Feltia jaculifera*, overwinters as a partially grown larva and is one of the first cutworm species to cause problems during crop emergence from early to mid-May. The moth of the dingy cutworm is known to lay her eggs on sunflower heads from mid-July through September. Crops following sunflowers in rotation are at greatest risk of injury by this cutworm. Other cutworms, the red-backed, *Exoa ochregaster*, and the darksided, *Exoa messoria*, overwinter as eggs which hatch in mid to late May. Eggs are laid in the fall and survive in weedy, wet, and reduced-tillage areas. Feeding injury by these cutworms normally occurs in late May to early June.

Management and Thresholds in Wheat:

Treatment is recommended when cutworms number 4 to 5 per square foot.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
beta-cyfluthrin Baythroid XL *RUP*	0.008 - 0.014	1.0 - 1.8 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Maximum number of applications per season = 2. Minimum application volume is 10 GPA by ground and 2 GPA by air.
chlorpyrifos + gamma-cyhalothrin Cobalt *RUP*	0.25 - 0.49 + 0.004 - 0.009	13 - 25 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Chlorpyrifos 4E AG Lorsban 4E Lorsban Advanced Warhawk Yuma 4E *RUP*	0.5	1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre. Control may be reduced under high temperatures and dry soil conditions, or if larvae are more than ½ inch long. Suppression only.
cyfluthrin Tombstone Tombstone Helios *RUP*	0.016 - 0.028	1.0 - 1.8 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 7 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Maximum number of applications per season = 2. Minimum application volume is 10 GPA by ground and 2 GPA by air.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
gamma-cyhalothrin Proaxis *RUP*	0.0075 - 0.0125	1.92 - 3.2 fl oz	PHI = 30 days. When applying by air, apply in a minimum of 2 gal water/A.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	
lambda-cyhalothrin Warrior II *RUP*	0.015 - 0.025	0.96 - 1.60 fl oz	
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	0.008 - 0.025	1.28 - 4 fl oz	PHI = 14 days for grain, forage or hay. Do not apply more than 0.125 lb AI per acre per season. Do not make applications less than 14 days apart. Apply by air or by ground using sufficient water to obtain full coverage. Use a minimum of 2 gals per acre by air and 10 gals per acre by ground.

RUP - Restricted use pesticide

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 Threshold:

The threatening rating is considered the action threshold for grasshoppers. For example, grasshopper control is advised whenever 50 or more small nymphs per square yard can be found in adjacent, non-crop areas, or when 30 or more nymphs per square yard can be found within the field. When 20 or more adults per square yard are found in field margins or 8 to 14 adults per square yard are occurring in the crop, treatment would be justified. Since it is difficult to estimate the number of grasshoppers per square yard when population densities are high, pest managers can use four 180-degree sweeps with a 15-inch sweep net, which is equivalent to the number of adult (or nymph) grasshoppers per square yard.

	Nymphs (young hoppers) per square yard		Adults per square yard	
Rating	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+

Many of the grasshopper infestations will be the heaviest on the field margins. Treating these areas may lessen the total numbers of grasshoppers successfully entering a field.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
beta-cyfluthrin Baythroid XL *RUP*	0.014 - 0.019	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
carbaryl Sevin	0.5 - 1.5	rate varies by formulation	PHI = 21 days. 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.
chlorpyrifos + gamma-cyhalothrin Cobalt *RUP*	0.14 - 0.25 + 0.003 - 0.004	7 - 13 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Chlorpyrifos 4E AG Lorsban 4E Lorsban Advanced Warhawk Yuma 4E *RUP*	0.25 - 0.5	0.5 - 1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre.
cyfluthrin Tombstone Tombstone Helios *RUP*	0.028 - 0.038	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 7 days of last application. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per acre between 3-day interval. Minimum application volume is 10 GPA by ground and 2 GPA by air.
diflubenzuron Dimilin 2L *RUP*	0.031	2 fl oz	PHI = 50 days for grain or straw, 15 days for hay, or 3 days for forage. For best results, apply when grasshoppers reach the 2nd to 3rd nymphal stage of development (not effective on adult grasshoppers). For use only west of US highway 281. Do not apply within 25 feet by ground or 150 feet by air of bodies of water. Applications must include a 25 foot vegetative buffer strip to limit runoff. Use 5 to 15 GPA total volume by ground, 3 to 5 GPA total volume by air. Do not exceed 4 fl oz per acre per season. Do not make more than 1 application per season.
dimethoate Digon 400M, Dimethoate 400	0.38	0.75 pt	PHI = 35 days. Do not allow graze within 14 days of last application. Do not make more than 2 applications per season.
gamma-cyhalothrin Proaxis *RUP*	0.01 - 0.015	2.56 - 3.84 fl oz	PHI = 30 days. Proaxis may be used in bordering, non-crop areas not hayed or grazed
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Senator 600	refer to recommended label rate	1.2 - 2.4 fl oz per cwt of seed	Apply as a seed treatment or for end-use at agricultural establishments (total slurry treater, farmer applied seed treater). Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz	
malathion Malathion (ULV)	0.48	8 fl oz/acre (95% concentrate	Commercial aerial applicators only. PHI = 7 days.
malathion Malathion 57EC	0.9 - 25	1.5 - 2 pts	PHI = 7 days. No time limitation on grazing or straw for dairy or slaughter animals.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
methyl parathion Penncap-M *RUP*	0.5 - 0.75	2 - 3 pts	PHI = 15 days. Do not enter treated fields within 48 hours after application.
methyl parathion *RUP*	0.375 - 0.5	0.75 - 1 pt	
spinetoram Radiant SC (suppression only)	0.023 - 0.047	3 - 6 fl oz	PHI = 21 days for grain or straw harvest or within 3 days of forage, fodder or hay harvest. Do not apply more than 18 fl oz (0.141 lb ai spinetoram) per acre per year. Do not make more than 3 applications in one calendar year. Do not make applications less than 4 days apart.
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	0.020 - 0.025	3.2 - 4 fl oz	PHI = 14 days for grain, forage or hay. Do not apply more than 0.125 lb AI per acre per season. Do not make applications less than 14 days apart. Apply by air or by ground using sufficient water to obtain full coverage. Use a minimum of 2 gals per acre by air and 10 gals per acre by ground.

RUP - Restricted use pesticide

HESSIAN FLY

The Hessian fly overwinters as a maggot or pupa in winter wheat, volunteer grain, and wheat stubble. Overwintering maggots pupate and emerge as adults from April to May, infesting fall 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 in the fall should reduce the risk of infestations. Suggested planting dates for ND are: north - September 1 - 15; south - September 15 to 30.

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 nonsusceptible crops (oats, corn, soybean, sunflower, flax).

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

Chemical control . . . Imidacloprid and thiamethoxam are registered as active ingredients for use at planting time treatment or as a seed treatment on wheat. Warrior II is also labeled as a foliar application when adults emerge. However, population levels of this pest would rarely warrant the need for such treatments in North Dakota.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
imidacloprid Gaucho 600	refer to recommended label rate	0.8 - 2.4 fl oz per cwt of seed	Follow all applicable directions, restrictions and precautions on the EPA registered label.
imidacloprid Dyna-Shield Imidacloprid 5 Senator 600	refer to recommended label rate	0.8 - 2.4 fl oz per cwt of seed	Apply as a seed treatment or for end-use at agricultural establishments (total slurry treater, farmer applied seed treater). Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
imidacloprid Enhance AW	refer to recommended label rate	4 oz per 100 lbs of seed	Apply as an on-farm seed treatment at planting time. Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season. Make foliar application when adults emerge.
thiamethoxam Cruiser Maxx Cereals	refer to recommended label rate	0.48 - 1.0 fl oz per cwt of seed	Follow all applicable directions, restrictions and precautions on the EPA registered label.

WHEAT MIDGE

Though infestation pressure from this insect has declined, it remains an economic concern in North Dakota. Since 1996, wheat midge has been 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. Any factor which results in having heading wheat present in the fields during midge emergence will put a wheat crop at risk to infestation.

The adult midge is active from late June to early August. Peak activity is from late June 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; however, control of the orange larvae, which feed on the developing kernels, has not been demonstrated due to protection within the glume.

Degree Days as a Tool for Wheat Midge Management

Based on data from Canada, the threshold temperature for wheat midge development is 40° F. Observations indicate the following DD accumulations for events in the midge population.

DD	Biological Event
450	the midge breaks the larval cocoon and moves close to soil surface to form the pupal cocoon
1300	10% of the females will have emerged
1475	about 50% of the females will have emerged
1600	about 90% of the females will have emerged

Identifying Wheat Fields at Risk for Midge Infestation

Based on North Dakota field observations, midge larval infestations were the greatest when heading occurred during peak female emergence (1475 DD). When using 40° F as a threshold for wheat development (*normally wheat development is monitored with 32 degrees*), heading occurs around 1000 - 1100 DD. Using this information, the following midge activity is expected based on degree day accumulations at time of wheat planting. There is a wheat growth and midge emergence model available through the North Dakota Agricultural Weather Network (NDAWN) Internet site and can be found at:

http://ndawn.ndsu.nodak.edu

Wheat Midge Degree Days Used as a Guideline for HRSW Risk Assessment
HRSW planted **PRIOR** to accumulating **200 DD** will head before wheat midge emerge.
HRSW planted FROM **200 to 600 DD** will be heading at the time wheat midge are emerging.
HRSW planted **AFTER 600 DD** will head after peak emergence and should be at low risk to midge infestation (higher risk of frost, however).

Thresholds for Wheat:
Examine wheat heads at dusk (9 p.m. 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, **Hard Red Spring Wheat** treatment is warranted when 1 or more midge are observed for every 4 or 5 heads. **Durum Wheat** treatment is warranted when 1 or more midge are observed for every 7 or 8 wheat

heads. 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:

Pheronome traps and 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
chlorpyrifos + gamma-cyhalothrin Cobalt *RUP*	0.25 - 0.49 + 0.004 - 0.009	13 - 25 fl oz	PHI = 14 days for forage and hay, 28 days for grain and straw. Do not make more than 2 applications or apply more than 25 fl oz in a single application. Do not feed straw from treated wheat within 30 days of application.
chlorpyrifos Chlorpyrifos 4E AG Lorsban 4E Lorsban Advanced Warhawk Yuma 4E *RUP*	0.5	1 pt	PHI = 28 days for grain and straw. PHI = 14 days before harvest for forage and hay. Do not allow livestock to graze within 14 days of application or feed straw from treated wheat within 28 days of application. Do not make more than 2 applications per season. Maximum single application rate is 0.47 lb ai per acre.
lambda-cyhalothrin Lambda-Cy Silencer Grizzly Z *RUP*	0.02 - 0.03 (suppression)	2.56 - 3.84 fl oz (suppression)	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.
lambda-cyhalothrin Kaiso 24 WG *RUP*	0.02 - 0.03	1.33 - 2.0 oz	
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	1.28 - 1.92 fl oz (suppression)	
methyl parathion Penncap-M *RUP*	0.5 - 0.75	2 - 3 pts	PHI = 15 days. Do not enter treated fields within 48 hours after application.

RUP - Restricted use pesticide

WHEAT STEM MAGGOT

The maggot tunnels in stems of wheat, resulting in a white head that can be easily pulled out of the boot. 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. Preliminary research data from NDSU suggests that tank mixing insecticides with the early season herbicides during 5-leaf to jointing wheat helped reduce the incidence of white heads and increased yields when large numbers of wheat stem maggot adults are present. Time insecticide application during peak adult activity and before larvae bore into stem. No economic threshold has been developed.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
beta-cyfluthrin Baythroid XL *RUP*	0.014 - 0.019	1.8 - 2.4 fl oz	PHI = 30 days. Pre-grazing or foraging interval = 3 days. Maximum of 4.8 fl oz per acre per season. Maximum of 2.4 fl oz per three-day interval.
lambda-cyhalothrin Warrior II *RUP*	0.02 - 0.03	2.56 - 3.84 fl oz	PHI = 30 days. Do not allow livestock to graze in treated areas or harvest treated wheat forage as feed for meat or dairy animals within 7 day after last treatment. Do not feed straw to meat or dairy animals within 30 days after last treatment. Do not apply more than 0.06 lb ai per acre per season.

RUP - Restricted use pesticide

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% to 25% or higher yield losses when infestations are severe. 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:

Chemical control. Insecticides have been found to be ineffective in controlling wheat stem sawfly.

Harvesting. Swath the most heavily infested fields at 30% to 35% moisture before significant lodging occurs. This 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 field margin, another near the center). Determine the percent of stems infested at each site. **If more than 15% of stems are infested by sawflies, producers should swath the wheat crop.** Producers should swath sawfly-infested wheat as soon as kernel moisture drops below 40% to save infested stems before they lodge. If producers decide to swath grain, use a high swathing height to conserve the parasitoids that attack wheat stem sawfly. Research from Montana State University has shown that taller residue (at least the lower ⅓ of the plant)is better for conserving the parasitoids. If 10 to 15% of the crop was cut by sawfly during the current field season, a solid-stemmed variety of wheat is recommended for the upcoming field season.

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. Non-host crops are oats, flax, sunflower, legumes, and to a lesser extent barley, rye, durum or winter wheat.

Resistant wheat varieties. Resistant wheats have a solid-stem trait which is unsuitable for sawfly development. Please note the 2009 release of the NDAES solid-stem hard red spring wheat release named 'Mott' which has good resistance to wheat stem sawfly and high yield.

Wheat Stem Sawfly Resistant Wheat Variety Descriptions

Variety	Type[1]	Height	Origin[2]	Year Released	Straw Strength	Maturity	Test Weight	Protein	Yield[3]
Older varieties that were released prior to 1990 (may be difficult to find):									
Cutless	HRS	semidwarf	NDAES	1986	med	med early	high	avg	med
Glenman	HRS	semidwarf	MAES	1985	strong	med	avg	low	high
Fortuna	HRS	standard	NDAES & MAES	1966	med	med	high	avg	high
Lew*	HRS	standard	MAES & ARS	1976	med	med	high	low	high
Leader	HRS	standard	AC	1981	med	med	high	high	med
Rambo	HRS	semidwarf	WPB	1986	very strong	med early	high	avg	high
Tioga	HRS	standard	NDAES & ARS	1974	med	med	high	avg	low
Newer varieties that were released after 1990:									
AC Abbey	HRS	standard	AC	1998	med	med	high	high	high
AC Eatonia	HRS	standard	AC	1996	med	med	high	high	high
AC Lilian	HRS	standard	AC	2006	med	med	high	high	high
Agawam	HWS	semidwarf	WPB	2005	strong	med	high	avg	high
Choteau	HRS	semidwarf	MAES	2003	strong	med	avg	avg	high
Ernest	HRS	standard	NDAES	1995	med	med	high	high	high
Explorer*	HWS	semidwarf	MAES	2002	strong	med	high	high	high
Genou	HRW	standard	MAES	2004	strong	med	high	high	high
Mott	HRS	standard	NDAES	2009	strong	med-late	high	high	high
Rampart	HRW	standard	MAES	1996	med	med	high	high	high
Vanguard	HRW	standard	MAES	1995	med	med	avg	high	high

*indicates semi-solid lines that provide partially resistance.[1]HRS = Hard Red Spring Wheat, HRW = Hard Red Winter Wheat, HWS = Hard White Spring Wheat..

[2]AC = Agriculture Canada, ARS = Agriculture Research Service (USDA), MAES = Montana Agricultural Experiment Station, NDAES = North Dakota Agricultural Experiment Station, WPB = Western Plant Breeders, Inc.

[3]Yields are relative to sawfly resistant varieties.

WIREWORMS

imidacloprid and Cruiser(thiamethoxam are labeled for application to wheat planting seed for wireworm management. Please refer to the seed treatment section in the introduction for more information.

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.

INSECTICIDE	DOSAGE IN LB AI/ACRE	PRODUCT PER ACRE	RESTRICTIONS ON USE
imidacloprid Gaucho 600	refer to recommended label rate	0.13 - 0.26 fl oz per cwt of seed	Follow all applicable directions, restrictions and precautions on the EPA registered label.
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Senator 600	refer to recommended label rate	0.13 - 0.26 fl oz per cwt of seed	Apply as a seed treatment or for end-use at agricultural establishments (total slurry treater, farmer applied seed treater). Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
imidacloprid Enhance AW	refer to recommended label rate	4 oz per 100 lbs of seed	Apply as an on-farm seed treatment at planting time. Do not graze or feed livestock on treated area for 45 days after planting. Follow all applicable directions, restrictions and precautions on the EPA registered label.
thiamethoxam Cruiser 5FS, Cruiser MAXX Cereals	refer to recommended label rate		Follow all applicable directions, restrictions and precautions on the EPA registered label.