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2012 Field Crop Insect Management Guide

For Use in 2012 Only

compiled by

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This is your reference copy of the 2012 edition of the North Dakota Insect Management Guide. The recommendations conform to the current federal and state laws and regulations relating to pesticidal chemicals at the time of printing. However, because pesticide recommendations frequently are subject to change, and inasmuch as this publication is revised only once each year, keeping in contact with North Dakota State University for up-to-date information on possible changes in insecticide registrations and use patterns is extremely important.

Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, using any pesticides in a manner inconsistent with the label is illegal. Therefore, **reading**, **understanding** and **following** all label directions and precautions is of the utmost importance for insecticide users.

Trade names have been used in some cases for simplicity, and their usage does not imply endorsement of one product over another nor discrimination against any product by the North Dakota State University Extension Service. Some compounds have been omitted because they are not available, present unnecessary hazards to the user, or there is a lack of efficacy when compared with other available products.

CAUTION!!!

The Extension Entomology staff at North Dakota State University believes that the recommendations in the guide are essentially accurate. However, since we do not exercise control over their use and the manner or conditions under which they are used, we assume no responsibility for personal injury, property damage or other types of loss resulting from the handling or use of the pesticides listed herein. PLEASE DISCARD ALL EARLIER EDITIONS OF THE NORTH DAKOTA FIELD CROP INSECT MANAGEMENT GUIDE.

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GENERAL INSECTICIDE INFORMATION

The following recommendations include only the application of chemicals for the control of some of the important and mite pests for each crop. Keep in mind that the most effective and economial controls for many of these pests involve a complete program including cultural, mechanical and chemical operations.

For more complete information on any particular pest, consult reference material, such as textbooks, bulletins, circulars and leaflets covering the specific problem. North Dakota State University Extension Entomology staff can help you find the most up to date information for a given pest.

Insecticides usually are available as emulsifiable concentrates, wettable powders, dusts, granules or solutions. Each is designed for a specific method of application. For example, dusts are formulated to be applied dry; wettable powders are designed mainly for high gallonage pressure sprayers as used for spraying livestock; emulsifiable concentrates, when diluted with water, form emulsions which may be used in low gallonage, low pressure sprayers. The job to be done and the equipment to be used will govern the type of formulation to recommend.

Amount of Active Ingredient per Acre

Most applications to field crops are made with granular, soluble powder or liquid formulations. The labels for most products listed in this guide give application rates in amount of product per acre or per 1,000 row-feet (for variable row spacings). Seed treatments rates are generally given as amount of product per hundredweight (cwt) or a standard seed unit, such as an 80,000 seed unit for corn, but may also be given in amount of active ingredient (AI) per seed. In addition to total product rates, most insecticide labels also indicate the amount of AI applied for a given total product rate. All insecticide labels list percent AI in the product, as well as the AI amount per unit weight or volume of product, depending on the formulation. This information can be found at the beginning of the product label.

Many insecticides have restrictions on the amount of AI that can be used per acre per season. Different insecticide brands can have different total product application rates (based on different AI concentrations) *even though they have the same AI*. These restrictions are often given in amount of AI per acre per season. Therefore, it is extremely important to understand exactly how much AI is being applied. For example, if a product containing 2 lbs imidacloprid per gallon is applied at a rate of 6 fl oz of product per acre, the amount of AI applied is 0.078 lbs imidacloprid per acre

(2 lbs/gal x 1 gal/128 fl oz x 6 fl oz/acre).

If a product containing 4 lbs imidacloprid per gallon is applied at a rate of 3 fl oz per acre, *the same amount of AI is applied as with the 2 lb per gallon product at 6 fl oz per acre*. Some products contain more than one AI, but the same restrictions on use for each AI per acre per season still apply.

Understanding product composition and the relationship between AI concentration in a product and total product application rate also assists growers and applicators in deciding which products are of optimum safety and benefit in their farming operations.

Pesticide Residue Tolerance

Pesticide residue limits in feed, food and food products are set by the Environmental Protection Agency (EPA), as required by the Federal Food, Drug, and Cosmetic Act amended to include the Food Quality Protection Act. These limits are known as tolerances, and are set to protect the nation's food supply and its consumers from harmful levels of pesticide residues. For more information on tolerances, please visit www.epa.gov/pesticides

Preharvest Intervals

A preharvest interval is the time required between applications and harvest which will ensure conformance with with tolerance limits. Preharvest intervals vary among products. Also, restrictions are often placed on grazing, foraging, and harvesting hay and straw. In some instances, a product cannot be used simply because it is not possible to adhere to the preharvest interval. In this guide, preharvest intervals for all products are given for each crop. Where applicaple, grazing, forage, hay and straw harvest intervals and restrictions are also given. **Be sure to consult the product label you are using at the time of application for all preharvest and grazing restrictions.**

INSECTICIDE FORMULATION ABBREVIATIONS

CF	capsule suspension for seed treatment	EW	emulsion, oil in water	ULV	ultra-low volume
CG	encapsulated granule	F	flowable	WDG	water dispersable granules
CS	capsule suspension	FL	flowable	WP	wettable powder
D	dry	FS	flowable concentrate for seed treatment	WSP	water dispersable powder
DC	dispersible concentrate	GR	granule	XL	other liquid formulation
DF	dry flowable	L	liquid	XX	others
DP	dustable powder	LS	solution for seed treatment	ZC	mixed formulation of CS and SC
DS	dry seed treatment	ME	microemulsion		
E	emulsifiable	OD	oil dispersion		
EC	emulsifiable concentrate	OS	oil-based suspension concentrate		
EG	emulsifiable granule	SC	suspension concentrate		
EP	emulsifiable powder	SL	soluble concentrate		
ES	emulsion for seed treatment	SP	soluble powder		

INSECTICIDE CLASSES AND RESISTANCE MANAGEMENT

Insecticides can be classified in a number of ways. The following table provides a listing of insecticides included in the crop sections of this guide registered for use in North Dakota. Be sure to consult the North Dakota Department of Agriculture for current product registration. Product labels and material safety data sheets (MSDS) in electronic form can be searched, viewed and printed from the Kelly Registration Systems website: www.kellysolutions.com/nd This website can also be accessed from the Pesticide Registration Program webpage in the North Dakota Department of Agriculture website: www.nd.gov/ndda/program/pesticide-registration-program Product cancellations and/or new product registrations will be updated in the on-line version of this guide.

Alternating the class of insecticide used for controlling insects can delay or even prevent insects becoming resistant to those chemicals. Reliance on a single chemical or a group of chemicals in the same insecticide class can lead to development of resistance at a faster rate. Resistance develops when exposed survivors of a chemical application are able to reproduce and pass on to their offspring the genetic traits responsible for their survival. If control failure occurs and cannot be attributed to equipment malfunction, human error or environmental conditions, do not use that chemical or another chemical in the same class in a follow-up treatment.

Even when control failure does not occur, rotation of insecticide classes should be observed within a season, and from year to year if possible. This is particularly true for foliar applications following use of seed treatments. Many seed treatments, such as imidacloprid and thiamethoxam, are from the neonicotinoid class of insecticides. These same chemicals are also the AIs in products labeled for foliar application in the same crops. Many labels contain Resistance Management language in the labels. Recently, many product labels include the Insecticide Resistance Action Committee (IRAC) Groups number in the upper right corner of the label. This number indicates the chemical class to which the product belongs, and its mode of action. For more information, please visit the IRAC website at: www.irac-online.org

Trade Name	Active Ingredient	Class	IRAC Group
ABBA 0.15EC	abamectin	A	6
Acephate 75WSP	acephate	OP	1B
Acephate 90 Prill	acephate	OP	1B
Acephate 90WDG	acephate	OP	1B
Acephate 97	acephate	OP	1B
Acephate 97UP	acephate	OP	1B
Actara	thiamethoxam	N	4A
Adjourn	esfenvalerate	P	3A
Admire Pro	imidacloprid	N	4A
Advise 2FL	imidacloprid	N	4A
Agri-Mek 0.15EC	abamectin	A	6
Ambush	permethrin	P	3A
Ambush 25W	permethrin	P	3A
AmTide Imidacloprid 2F	imidacloprid	N	4A
Arctic 3.2EC	permethrin	P	3A
Asana XL	esfenvalerate	P	3A
Assail 30SG	acetamiprid	N	4A
Assail 70WP	acetamiprid	N	4A
Athena	abamectin bifenthrin	A+P	6 3A
Attendant 600	imidacloprid	N	4A
Avaunt	indoxacarb	O	22A
Avicta Duo Corn	abamectin thiamethoxam	A+N	6 4A
Aztec 2.1G	cyfluthrin tebupirimiphos	P+OP	3A 1B
Aztec 4.67G	cyfluthrin tebupirimiphos	P+OP	3A 1B
Battalion 0.2EC	deltamethrin	P	3A
Baythoid XL	beta-cyfluthrin	P	3A
Belay	clothianidin	N	4A
Belay 50WDG	clothianidin	N	4A
Beleaf 50G	flonicamid	PC	9C
Belt SC	flubendiamide	D	28
Bifenthrin 2EC	bifenthrin	P	3A
Bifenture EC	bifenthrin	P	3A
Biobit HP	Bt	M	11
Blackhawk	spinosad	S	5
Brigade 2EC	bifenthrin	P	3A

Trade Name	Active Ingredient	Class	IRAC Group
Brigadier	bifenthrin imidacloprid	P+N	3A 4A
Capture 1.15G	bifenthrin	P	3A
Capture LFR	bifenthrin	P	3A
Cheminova Malathion 57%	malathion	OP	1B
Cheminova Methyl 4EC	methyl parathion	OP	1B
Chloryrifos 4E AG	chlorpyrifos	OP	1B
Cobalt Advanced	chlorpyrifos lambda-cyhalothrin	OP+P	1B 3A
Concur	imidacloprid	N	4A
Coragen	chlorantraniliprole	D	28
Counter 15G Lock n' Load	terbufos	OP	1B
Counter 20G SmartBox	terbufos	OP	1B
Couraze 2F	imidacloprid	N	4A
Couraze 4F	imidacloprid	N	4A
Cruiser 5FS	thiamethoxam	N	4A
Cruiser MAXX	thiamethoxam	N	4A
Cruiser MAXX Cereals	thiamethoxam	N	4A
Cruiser MAXX Potato	thiamethoxam	N	4A
Declare	gamma-cyhalothrin	P	3A
Delta Gold	deltamethrin	P	3A
Diacon-D	methoprene	JH	7A
Diacon II	methoprene	JH	7A
Dibrom 8 Emulsive	naled	OP	1B
Digon 400	dimethoate	OP	1B
Dimate 4E	dimethoate	OP	1B
Dimethoate 400	dimethoate	OP	1B
Dimethoate 4E	dimethoate	OP	1B
Dimethoate 4EC	dimethoate	OP	1B
Dimilin 2L	diflubenzuron	B	15
DiPel DF	Bt	M	11
DiPel ES	Bt	M	11
Discipline 2EC	bifenthrin	P	3A
Dyna-Shield Imidacloprid 5	imidacloprid	N	4A

Trade Name	Active Ingredient	Class	IRAC Group
Endigo ZC	lambda-cyhalothrin thiamethoxam	P+N	3A 4A
Enhance AW	imidacloprid	N	4A
Entrust	spinosad	S	5
Epi-Mek 0.15EC	abamectin	A	6
Fanfare 2EC	bifenthrin	P	3A
Foothold Extra	imidacloprid	N	4A
Force 3G	tefluthrin	P	3A
Force 3G SmartBox	tefluthrin	P	3A
Force CS	tefluthrin	P	3A
Fortress 2.5G	chlorethoxyfos	OP	1B
Fortress 5G	chlorethoxyfos	OP	1B
Fulfill	pymetrozine	PA	9B
Fyfanon ULV	malathion	OP	1B
Gaucho 600	imidacloprid	N	4A
Govern 4E	chlorpyrifos	OP	1B
Grizzly Z	lambda-cyhalothrin	P	3A
Hatchet	chlorpyrifos	OP	1B
Helix	thiamethoxam	N	4A
Helix Lite	thiamethoxam	N	4A
Helix XTra	thiamethoxam	N	4A
Hero	bifenthrin zeta-cypermethrin	P	3A 3A
Imidan 70W	phosmet	OP	1B
Impulse 1.6F	imidacloprid	N	4A
Intrepid 2F	methoxyfenozide	DH	18
Kernel-Guard Supreme	permethrin	P	3A
Lambda-Cy EC	lambda-cyhalothrin	P	3A
LambdaStar	lambda-cyhalothrin	P	3A
Lambda-T	lambda-cyhalothrin	P	3A
Lamcap	lambda-cyhalothrin	P	3A
Lannate LV	methomyl	C	1A
Lannate SP	methomyl	C	1A
Larvin 3.2	thiodicarb	C	1A
Latitude	imidacloprid	N	4A
Leverage 360	beta-cyfluthrin imidacloprid	P+N	3A 4A
Lorsban 15G	chorpyrifos	OP	1B
Lorsban 15G SmartBox	chorpyrifos	OP	1B
Lorsban 4E	chlorpyrifos	OP	1B
Lorsban 50WSP	chlorpyrifos	OP	1B
Lorsban Advanced	chlorpyrifos	OP	1B
Macho 2FL	imidacloprid	N	4A
Malathion 5	malathion	OP	1B
Malathion 57EC	malathion	OP	1B
Malathion ULV	malathion	OP	1B
Malice 75WSP	imidacloprid	N	4A
MANA Alias 2F	imidacloprid	N	4A
MANA Alias 4F	imidacloprid	N	4A
Montana 2F	imidacloprid	N	4A
Montana 4F	imidacloprid	N	4A
Movento	spirotetramat	TA	23
Mustang Max	zeta-cypermethrin	P	3A
Mustang Max EC	zeta-cypermethrin	P	3A
NipsIt Inside	clothianidin	N	4A
NipsIt SUITE Cereals OF	clothianidin	N	4A
NipsIt SUITE Cereals VCR	clothianidin	N	4A

Trade Name	Active Ingredient	Class	IRAC Group
NipsIt SUITE Sugar Beets	clothianidin	N	4A
Nufarm Abamectin 0.15EC	abamectin	A	6
Nufarm Lambda-Cyhalothrin 1EC	lambda-cyhalothrin	P	3A
Nufos 4E	chlorpyrifos	OP	1B
Nuprid 1.6F	imidacloprid	N	4A
Nuprid 2F	imidacloprid	N	4A
Nuprid 2SC	imidacloprid	N	4A
Nuprid 4.6F Pro	imidacloprid	N	4A
Nuprid 4F Max	imidacloprid	N	4A
Oberon 2SC	spiromesifen	TA	23
Orthene 90S	acephate	OP	1B
Orthene 97	acephate	OP	1B
Pasada 1.6F	imidacloprid	N	4A
Penncap-M	methyl parathion	OP	1B
PermaStar AG	permethrin	P	3A
Permethrin 3.2EC	permethrin	P	3A
Perm-UP	permethrin	P	3A
Phorate 20G	phorate	OP	1B
Platinum	thiamethoxam	N	4A
Platinum 75SG	thiamethoxam	N	4A
Poncho 600	clothianidin	N	4A
Poncho Beta	clothianidin beta-cyfluthrin	N+P	4A 3A
Poncho Votivo	clothianidin *Bacillus firmus*	N+M	4A
Pounce 1.5G	permethrin	P	3A
Pounce 3.2EC	permethrin	P	3A
Prey 1.6F	imidacloprid	N	4A
Proaxis	gamma-cyhalothrin	P	3A
Prosper Flowable	clothianidin	N	4A
Prosper FX	clothianidin	N	4A
Province	lambda-cyhalothrin	P	3A
Radiant SC	spinetoram	S	5
Rancona Crest	imidacloprid	N	4A
Rancona Crest WR	imidacloprid	N	4A
Raxil MD-W	imidacloprid	N	4A
Reaper 0.15EC	abamectin	A	6
Regent 4SC	fipronil	PP	2B
Renounce 20WP	cyfluthrin	P	3A
Respect	zeta-cypermethrin	P	3A
Respect EC	zeta-cypermethrin	P	3A
Rimon 0.83EC	novaluron	B	15
Sativa IM Max	imidacloprid	N	4A
Saurus	chorpyrifos	OP	1B
Scorpion 35SL	dinotefuran	N	4A
Senator 600FS	imidacloprid	N	4A
Sevin 4F	carbaryl	C	1A
Sevin 80 WSP	carbaryl	C	1A
Sevin 80S	carbaryl	C	1A
Sevin SL	carbaryl	C	1A
Sevin XLR Plus	carbaryl	C	1A
Sherpa	imidacloprid	N	4A
Silencer	lambda-cyhalothrin	P	3A
Silencer VC	lambda-cyhalothrin	P	3A
SmartChoice 5G Lock n' Load	bifenthrin chlorethoxyfos	P+OP	3A 1B
Sniper	bifenthrin	P	3A
Spintor 2SC	spinosad	S	5

Trade Name	Active Ingredient	Class	IRAC Group
Stallion	chlorpyrifos zeta-cypermethrin	OP+P	1B 3A
Steward EC	indoxacarb	O	22A
Success	spinosad	S	5
Swagger	bifenthrin imidacloprid	P+N	3A 4A
Taiga Z	lambda-cyhalothrin	P	3A
Temprano	abamectin	A	6
Thimet 20G	phorate	OP	1B
Thimet 20G Lock n' Load	phorate	OP	1B
Thimet 20G SmartBox	phorate	OP	1B
Timectin 0.15EC	abamectin	A	6
Tombstone	cyfluthrin	P	3A
Tombstone Helios	cyfluthrin	P	3A

Trade Name	Active Ingredient	Class	IRAC Group
Tracer	spinosad	S	5
Tundra EC	bifenthrin	P	3A
Venom	dinotefuran	N	4A
Venom 20SG	dinotefuran	N	4A
Voliam Xpress	chlorantraniliprole lambda-cyhalothrin	D+P	28 3A
Vydate C-LV	oxamyl	C	1A
Vydate L	oxamyl	C	1A
Warhawk	chlorpyrifos	OP	1B
Warrior II	lambda-cyhalothrin	P	3A
Whirlwind	chlorpyrifos	OP	1B
Widow	imidacloprid	N	4A
Wrangler	imidacloprid	N	4A
Xentari DF	Bt	M	11
Yuma 4E	chlorpyrifos	OP	1B

Chemical Class Abbreviations: A = avermectins; B = benzoylureas; C = carbamates; D = diamides; DH = diacylhydrazines; JH = juvenile hormone analogues; M = microbial; N = neonicotinoid; O = oxadiazines; OP = organophosphates; P = pyrethroids; PA = pyridine azomethines; PC = pyridine carboxamides; PP = phenylpyrazoles; S = spinosyns; TA = tetronic acid derivatives

IRAC Group Modes of Action: 1A, 1B = acetyl cholinesterase inihibitors; 2B = GABA-gated chloride channel antagonists; 3A = sodium channel modulators; 4A = nicotinic acetylocholine receptor agonists; 5 = nicotinic acetylcholine receptor allosteric activators; 6 = chlorine channel activators; 7A = juvenile hormone mimics; 9B, 9C = selective homopteran feeding blockers; 11 = microbial disruptors of insect midgut membranes (includes Bt transgenic crops); 15 = Inhibitors of chitin biosynthesis; 18 = ecdysone agonists / moulting disruptors; 22A = voltage-dependent sodium channel blockers; 23 = inhibitors of acetyl CoA carboxylase (lipid synthesis and growth regulation); 28 = ryanodine receptor modulators

INSECTICIDE TOXICITY

All insecticides are classified as poisons, although there is considerable variation in their degrees of toxicity to warm-blooded animals and fish. Toxicity refers to the degree to which a specific chemical is poisonous to animals. Toxicity is classified as **acute** (severe, immediate toxicity) or **chronic** (long-term).

Poisoning from insecticides can occur through the eyes, ears, mouth and nose (oral), lungs (inhalation) and/or skin (dermal). Storing, handling, mixing, loading and applying insecticides and working in treated areas inherently poses occupational hazards from poisoning, especially poisoning via inhalation and skin contamination. All insecticide labels have language relating to worker safety, specifically the Worker Protection Standard, 40 CFR part 170. This information can be found in the **AGRICULTURAL USE REQUIREMENTS** section at the beginning of the label. The language in this section contains the restricted entry interval (REI), posting requirements for treated areas and the minimum personal protective equipment (PPE) required for permitted early entry into treated areas. For more information on the Worker Protection Standard, please visit the EPA website at:

http://www.epa.gov/agriculture/twor.html

Additionally, labels carry **PRECAUTIONARY STATEMENTS** language that must be followed regarding PPE when handling, mixing, loading and/or applying pesticides. Labels also carry an **ENVIRONMENTAL HAZARDS** section, which contains language relating to application to or near surface water and other environmentally sensitive areas, spray drift and runoff language, and bee exposure language. **DIRECTIONS FOR USE, PHYSICAL AND CHEMICAL HAZARDS,** and **STORAGE AND DISPOSAL** sections provide additional safety language. Labels also carry a **FIRST AID** section describing what steps need to be taken in case of exposure.

Insecticide labels carry signal words indicating human toxicity. Tests used to determine insecticide toxicity involve laboratory animals. Toxicity is most commonly expressed as LD_{50}, which means the lethal dose required to kill 50 percent of the test animal population. The amount of material needed to produce a lethal dose is expressed as milligrams of toxicant per kilogram of live animal weight (mg/kg). LD_{50} values are determined for oral, inhalation, and dermal poisoning Specific toxicological information for a pesticide is given in its **Material Safety Data Sheet (MSDS)**. The table below gives the EPA toxicity categories, signal words and acute oral LD_{50} values for each toxicity catergory.

Category	Toxicity	Signal Word	Acute Oral LD_{50}
1	Highly toxic	Danger-Poison (accompanied by skull and crossbones)	< 50 mg/kg
2	Moderately toxic	Warning	50 to 500 mg/kg
3	Slightly toxic	Caution	501 to 5,000 mg/kg
4	Low toxicity	Caution	> 5,000 mg/kg

Pesticide Poison Information
Toll-Free Number (800) 222-1222

THE EFFECT OF WATER PH ON INSECTICIDES

An important consideration in the application of insectides is the pH of the water to be used for spraying. This is particularly important for carbamate and organophosphate insecticides. When mixed with water, the active ingredients undergo a process called alkaline hydrolysis. If left in the solution too long, including while in the spray tank and in spray droplets, these chemicals will degrade and become ineffective. For these chemicals, a buffering agent should be added to the water to adjust the pH to the proper level. Buffering effects occur until the water in the applied spray droplets has evaporated.

Values for pH are given on a scale from 1 to 14, with 1 being most acidic and 14 being most basic. A pH of 7 is considered neutral. Water pH values in the Red River Valley are slightly basic (pH around 8 - 8.2). The pH of the water being used for spraying should be tested with an electronic pH meter. Do not use paper testing strips, as these can be inaccurate.

The table below gives the optimum pH values for the spray tank water to be used for common insecticide active ingredients, as well as the half-life for each at different pH levels and whether a buffering agent should be used. Buffering agents can be obtained from your chemical supplier. Another important consideration is whether the insecticide will be tank-mixed with an herbicide or fungicide. Herbicides and fungicides also have optimum pH values, and some of these may be incompatible with some insecticides. Fixed copper fungicides and lime or lime sulfur should not be buffered, as plant injury can result.

Half-life of Some Commonly Used Insecticides at Different Water pH

				Half-life for Given pH at 25°C in Pure Water				
Insecticide Active Ingredient	**Example Trade Name**	**Buffering Advised**	**Optimum pH**	**9.0**	**8.0**	**7.0**	**5.0**	**4.0**
abamectin	Epi-Mek 0.15EC		7.0	Stable		Stable	Stable	
acephate	Acephate 97UP		7.0	16 d		46 d	40 d	
acetamiprid	Assail 70WP		7.0	Stable		Stable	Stable	
beta-cyfluthrin	Baythroid XL		7.0	17 h		Stable	Stable	Stable
bifenthrin	Bifenture EC		7.0	Stable		Stable	Stable	
carbaryl	Sevin 4F	●	7.0	3.2 h		12 d	Stable	
chlorantraniliprole	Coragen		7.0	< 10 d		Stable	Stable	
chlorpyrifos	Lorsban 4E		7.0	16 d		35 d	63 d	
clothianidin	Belay		7.0	Stable		Stable	Stable	
cyfluthrin	Tombstone		7.0	2 d	4 d	Stable	Stable	
deltamethrin	Delta Gold		7.0	2.5 d	31 d	Stable	Stable	
dimethoate	Dimate 4E	●	7.0	4 d		68 d	156 d	
esfenvalerate	Asana XL		7.0	Stable		Stable	Stable	
gamma-cyhalothrin	Proaxis		7.0	9 d		Stable	Stable	
imidacloprid	Admire Pro		7.0	Stable		Stable	Stable	
indoxacarb	Steward EC		7.0	1 day		38 d	30 d	
lambda-cyhalothrin	Warrior II		7.0	9 d		Stable	Stable	
malathion	Malathion 57EC	●	5.0	5 h	19 h	3 d	150 d	
methomyl	Lannate LV		7.0	Stable		Stable	Stable	
methyl parathion	Methyl 4EC		7.0	33 d		40 d	68 d	
naled	Dibrom	●	5.0	1.6 h		15.4 h	4 d	
oxamyl	Vydate	●	5.0	3 hrs		8 d	Stable	
permethrin	Arctic 3.2EC		7.0	242 d		Stable	Stable	
phosmet	Imidan 70W	●	5.0	4 h		18 h	9 d	
spinosad	Success	●	7.0	Stable		Stable	12 h	
thiamethoxam	Actara		7.0	2 d		29 d		14 d
zeta-cypermethrin	Mustang Max		7.0	2 d		Stable	Stable	

d = days, h = hours

MANAGING INSECTICIDES TO PREVENT GROUNDWATER CONTAMINATION

The potential for insecticide movement into groundwater exists wherever insecticides are used, but the extent varies with the chemical nature of the insecticide, physical soil characteristics and other factors such as volatilization (with subsequent loss to the atmosphere), decomposition, soil retention and transport by water. Volatilization, decomposition and soil retention reduce the total amounts of insecticides available for downward movement. Transport by water relates to the movement of insecticides with soil water.

The amount of insecticide applied affects the potential for groundwater contamination. The potential movement to groundwater of relatively mobile water-soluble insecticides may be much increased where large amounts have entered the soild, such as areas used for tank filling, rinsing and equipment washing. These practices should be carried out on concrete or other impermeable pads, and the liquid should be collected for disposal.

Organophosphorous, carbamate, pyrethroid and neonicotinoid insecticides present a wide spectrum of physiochemical properties and agricultural uses. Breakdown of insecticides in soil is caused by hydrolysis from water and microbes, and by reaction with light (photolysis). Soil half-life is greatly affected by physical properties of the soil, such as soil type, the amount of organic matter

in the soil, the amount of water in the soil column, and soil pH. For example, the half-life of chlorpyrifos in soil typically ranges from 60 to 120 days, but can be as low as two weeks or as long as one year.

Neonicotinoids are a relatively new class of insecticides, and may be applied as foliar sprays and/or seed treatments. Generally, neonicotinoids are highly mobile and relatively persistent in soil. However, plant uptake of neonicotinoids used as seed treatments and foliar sprays reduces the potential for groundwater contamination.

The following table gives the relative persistence and mobility of some insecticides commonly used in North Dakota. Bear in mind that the persistence and mobility classification assigned to each insecticide is approximate because environmental variation will influence persistence and mobility. Whenever several insecticide options exist for the pest/site to be treated, this information will help pesticide users and advisors select the insecticide that presents the least potential for groundwater contamination. More information on the environmental fate of insecticides can be found at:

FAO specifications and evaluations for plant protection products: http://www.fao.org
California Department of Pesticide Regulation, Environmental Monitoring and Pest Management Branch: http://www.pc.ucr.edu
Extension Toxicology Network: http://pmep.cce.cornell.edu/profiles/extoxnet

Relative Persistence and Mobility of Insecticides in Soils

AI	Persistence[1]	Mobility[2]
abamectin	L	NI
acephate	M	VM
acetamiprid	L	MM
beta-cyfluthrin	L	NI
bifenthrin	M	NI
carbaryl	L	NI
chlorantraniliprole	M	VM
chlorpyrifos	L	NI
clothianidin	M	VM
cyfluthrin	L	NI
deltamethrin	L	NI
dimethoate	L	MM
esfenvalerate	M	I
fipronil	M	SM
gamma-cyhalothrin	M	NI
imidacloprid	M	MM
indoxacarb	M	NI
lambda-cyhalothrin	M	NI
malathion	L	NI
methomyl	L	SM
methyl parathion	L	I
naled	L	SM
oxamyl	L	VM
permethrin	L	I
phorate	L	NI
phosmet	L	NI
spinosad	L	I
tefluthrin	L	NI
terbufos	M	SM
thiamethoxam	M	VM
zeta-cypermethrin	M	NI

[1] L = low persistence; M = moderate persistence
[2] I = immobile; NI = nearly immobile; SM = slightly mobile; MM = moderately mobile; VM = very mobile

Summary of Groundwater Contamination Potential as Influenced by Pesticide, Water and Soil Characteristics

	Low Risk	High Risk
Pesticide Characteristics		
water solubility	low	high
soil adsorption	high	low
persistence	low	moderate to high
Soil Characteristics		
texture	fine clay	coarse sand
organic matter	high	low
macropores	few, small	many, large
water table	deep (20+ ft)	shallow (< 10 ft)
Water Volume		
rain/irrigation	small volumes at infrequent intervals	large volumes at frequent intervals

Measures to protect groundwater from pesticides generally involve the following:

- Reduce the quantity of pesticide used
- Use pesticides with low soil leaching potential
- Use pesticides that have low persistence
- Avoid application if conditions favor leaching
- Prevent spills which can leach to groundwater
- Prevent back-siphoning to water source

Protecting Your Groundwater Through Farmstead Assessment: There are numberous NDSU Extension circulars which address the issue of protecting groundwater from agricultural pesticides. A listing of and access to these circulars can be found at:
http://www.ext.nodak.edu/extpubs/watgrnd.html

NORTH DAKOTA FIELD POSTING REQUIREMENTS

Effective July 1, 2004, North Dakota no longer has additional posting requirements for pesticides that are more demanding than federal labeling requirements. However, all pesticides that require posting on the label under the Worker Protection Standard must be posted according to the Worker Protection Standard.

REPORTING DAMAGE DUE TO PESTICIDE APPLICATIONS

Effective April 3, 2007

AN ACT to create and enact a new section to chapter 4-35 of the North Dakota Century Code, rleating to notification of alleged pesticide damage; to repeal sections 4-35-21, 4-35-21.1, and 4-35-21.2 of the North Dakota Century Code, relating to reports of loss resulting from pesticide application; and to declare an emergency.

A new section to chapter 4-35 of the North Dakota Century Code is created an enacted as follows:

Pesticide Application, Alleged Property Damage, Notification of Applicator.

1. a. Before a person may file a civil action seeking reimbursement for property damage allegedly stemming from the application of a pesticide, the person shall notify by certified mail the pesticide applicator of the alleged damage within the earlier of:
(1) Twenty-eight days from the date the person first knew or should have known of the alleged damage; or
(2) Before twenty percent of the crop or field allegedly damaged is harvested or destroyed.
1. b. Subdivision (a) does not apply if the person seeking reimbursement for property damage was the applicator of the pesticide.

2. Upon notifying the applicator as required under subsection 1, the person seeking reimbursement for the alleged property damage shall permit the applicator and up to four representatives of the applicator to enter the person's property for the purpose of observing and examining the alleged damage. If the person fails to allow entry, the person is barred from asserting a claim against the applicator.

SECTION 2. REPEAL. Sections 4-35-21, 4-35-21.1, and 4-35-21.2 of the North Dakota Century Code are repealed.
SECTION 3. EMERGENCY. This Act is declared to be an emergency measure.

Further inquiries shoud be directed to:

Department fo Agriculture
State Capitol Building
Bismarck, North Dakota 58505
Phone: 1-800-242-7535

North Dakota Department of Agriculturel

http://www.agdepartment.com

INSECTICIDE SEED TREATMENTS

Seed and planter box treatments are used on a wide variety of North Dakota crops for protection from a variety of soil and foliage feeding insects. The following table lists seed treatments and indicates labeled crops. Consult individual crop sections in this guide for active ingredients, product rates, commercial and on-farm use and restrictions on use. Always follow label directions. Protective clothing and equipment for mixing and handling are specified of the label. Mix thoroughly to ensure adequate coverage and protection. Treat only enough seed needed for immediate use. Do not store treated seed near feed or foodstuffs. Do not feed treated seed to livestock. Dispose of excess treated seed as specified on the label.

Slurry Seed Treatment: Seed treatments may be applied as slurry as seed is being augered into a drill, planter or truck. The treating equipment meters chemical into an auger conveyor where it is mixed with seed. The equipment is designed to mount to a truck be, bin or transport augers and drill fill augers. Treaters consist of a metered pump, hoses and tank. The equipment is commonly used in bulk seed operations, providing uniform application of chemical to seed which enhances seed treatment performance.

Planter Box Treatment: Seed treatments should be thoroughly mixed with seed to ensure sufficient coverage. Recommendations for maximizing the effectiveness of planter box seed treatments are as follows:

1. Fill planter box half full of seed
2. Add half of required amount of product and mix thoroughly with a paddle
3. Add remainder of seed and product to the planter box
4. Mix well. Thorough coverage is essential
5. At end of day, clean planter population monitors

Inoculants in Combination with Seed Treatments: Do not confuse seed inoculation with chemical seed treatment. Most seed disinfectants, including fungicides are toxic to *Rhizobium* bacteria. Do not apply inoculum to seeds that are treated with a bactericide, such as streptomycin, unsless you use a resistant strain of *Rhizobium*. Although some *Rhizobium* species are slightly tolerant to certain chemical compounds, inoculating chemically treated legume seed requires special precautions. Check with the inoculum manufacturer regarding compatibility when considering combining products.

The following are some general guidelines when using seed treatments and inoculants:

- Insecticides are more toxic than fungicides, which are more toxic than herbicides
- In-furrow inoculant applications are preferred when seed treatments have been used
- If a seed treatment and inoculant are combined on the seed, minimize exposure time; less than 4 hours is best. Some *Rhizobium* may be killed immediately; check compatibility prior to use.
- If liquid pesticides are used, apply first and allow to dry before inoculant is applied
- Powder-based inoculants protect *Rhizobium* better than liquid-based inoculants
- When using pre-treated seed, check with the inoculant manufacturer for comments on compatibility

REGISTERED SEED TREATMENTS APPROVED BY CROP

Seed Treatment	Barley	Dry Beans	Canola	Carrot	Chickpea	Corn	Field Pea	Flax	Lentil	Mustard	Oats	Potato	Safflower	Soybean	Sugarbeet	Sunflower	Wheat
Planter Box Treaments																	
Concur						●											
Kernel Guard Supreme						●								●			
Commercial and On-Farm Seed Treatments[1]																	
Admire Pro												●					
Advise 2FL												●					
AmTide Imidacloprid 2F												●					
Attendant 600	●	●		●	●	●	●		●	●	●			●			●
Avicta Complete Beans														●			
Avicta Complete Corn						●											
Couraze 2F												●					
Couraze 4F												●					
Cruiser 5FS	●	●			●	●	●	●	●	●		●	●	●	●	●	●
Cruiser MAXX		●			●		●		●					●			
Cruiser MAXX Cereals	●																●
Cruiser MAXX Potato												●					
Cruiser MAXX Sugar Beets															●		
Dyna-Shield Imidacloprid 5	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Enhance AW	●	●			●		●		●		●			●			●
Foothold Extra	●																●
Gaucho 600 Flowable	●		●	●	●	●	●	●	●	●	●		●	●	●	●	●
Helix			●														
Helix Lite			●														
Helix XTra			●														
Inovate System														●			
Latitude														●			
Lorsban 50WSP		●															
Macho 2FL												●					
MANA Alias 2F												●					
MANA Alias 4F												●					
Montana 2F												●					
Montana 4F												●					
NipsIt Inside			●												●		
Nipsit SUITE Cereals CVR	●																●
NipsIt SUITE Cereals OF	●																●
NipsIt SUITE Sugar Beets															●		
Nuprid 2F												●					
Nuprid 2SC												●					
Nuprid 4.6F Pro												●					
Nuprid 4F Max												●					
Poncho 600			●			●											
Poncho Beta															●		
Poncho Votivo						●								●	●		
Prosper Flowable			●														
Prosper FX			●														
Rancona Crest	●										●						●
Rancona Crest WR	●										●						●
Raxil MD-W	●																
Sativa IM Max	●																●
Sativa IM RTU	●																●
Senator 600FS	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●

Seed Treatment	Barley	Dry Beans	Canola	Carrot	Chickpea	Corn	Field Pea	Flax	Lentil	Mustard	Oats	Potato	Safflower	Soybean	Sugarbeet	Sunflower	Wheat
Widow												•					
Wrangler												•					

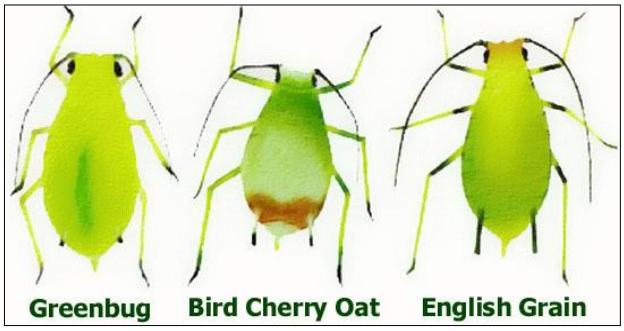
[1] Commercial and on-farm seed treatment uses indicated in individual crop sections of this guide.

BARLEY INSECTS

Other Resources Available Through NDSU Extension Service:

Publications	E1230	Cereal Leaf Beetle Management (2002)
	E188	Wireworm Control (2001)
	E830	The Armyworm and the Army Cutworm (2000)
	E272	Grasshopper Management (1997)
	E493	Aphid Management in Small Grains, Corn and Sorghum (1993)
	E1007	Biology and Management of Barley Thrips (1991)

APHIDS



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 principal 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 population grows 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: ***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, 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.

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: 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.

BARLEY THRIPS

Female barley thrips fly to barley from overwintering sites during mid to late May. Sampling for thrips should begin when the flag leaf is first visible and continue until the head is completely emerged from the boot. Sample at least 50 feet in from field margins. Most thrips can be found under the top two leaf sheaths. The dark brown to black thrips can be found by unrolling the leaf sheaths away from the stem. Insecticide treatments are only effective when applied before heading is complete.

Threshold For Thrips: *Treat when thrips are equal to or greater than the number calculated by*

$$\textit{Threshold (Thrips/stem)} = \frac{\textit{Cost of Control} \div \textit{Expected \$ value per bushel}}{0.4}$$

Sampling plans based on this number can be prepared with the help of E-1007, **Biology and Management of Barley Thrips.**

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 3 eggs and/or 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.

At the boot stage to 1 larvae or more per flag leaf.

CUTWORMS

Several cutworm species affect regional crops. 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. 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.

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

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.

Thresholds: Threatening is considered the action threshold for grasshoppers. 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.

Rating	Nymphs per square yard		Adults per square yard	
	Margin	Field	Margin	Field
Light	25-35	15-25	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+

WIREWORMS

Imidacloprid and thiamethoxam are now labeled as active ingredients for application to barley 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.

INSECTICIDES REGISTERED FOR USE IN BARLEY

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Barley Thrips	Cereal Leaf Beetle	Cutworms	Grasshoppers	Wireworms
Bacillus thuringiensis									
Biobit HP	0.5 - 1 lb	None		‡					
XenTari DF	0.5 - 2 lbs								
DiPel DF	1 - 2 lbs								
DiPel ES	2 - 4 pts								
beta-cyfluthrin									
Baythroid XL *RUP*	1.8 - 2.4 fl oz	30 days for grain 3 days for grazing or forage	●	●		●	●	●	
clothianidin									
NipsIt SUITE Cereals OF NipsIt SUITE Cereals CVR NipsIt Inside + fungicides **Product registration pending 2012**			*						●
diflubenzuron									
Dimilin 2L *RUP* **FOR USE WEST OF US HIGHWAY 281 ONLY**	2 - 4 fl oz	50 days for grain or straw 15 days for hay 3 days for forage				●		●	
imidacloprid									
Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	0.13 - 0.26 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days							†
imidacloprid									
Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	0.8 - 2.4 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*					*	
imidacloprid									
Enhance AW	4 oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*						●
imidacloprid									
Foothold Extra Sativa IM Max	3.4 - 5 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*						●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Barley Thrips	Cereal Leaf Beetle	Cutworms	Grasshoppers	Wireworms
imidacloprid Raxil MD-W	5 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days							†
imidacloprid Sativa IM RTU	5 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days							●
imidacloprid Rancona Crest	5 - 8.33 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*						†
imidacloprid Rancona Crest WR	5 - 8.33 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days							†
lambda-cyhalothrin Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Warrior II *RUP*	 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.28 - 1.92 fl oz	30 days for grain and straw 7 days for grazing and forage	●	●		●	●	●	
lambda-cyhalothrin + thiamethoxam Endigo ZC *RUP*	3.5 - 4.5 fl oz	30 days for grain, forage and straw	●	●		●	●	●	
malathion Malathion 5	1 - 2 pts	7 days	●	●		●			
malathion Malathion 57EC	1.5 - 2 pts	7 days	●	●				●	
malathion Cheminova Malathion 57%	1 - 2 pts	7 days	●			●		●	
malathion Fyfanon ULV Malathion ULV	4 - 8 oz	7 days				●		●	
methomyl Lannate LV *RUP*	12 - 24 fl oz	7 days	●	●		●			
methyl parathion Cheminova Methyl 4EC *RUP*	0.5 - 1.5 pt	15 days	●	●	●		●	●	
methyl parathion Penncap-M *RUP*	2 - 3 pt	15 days	●	●				●	
spinetoram Radiant SC	3 - 6 fl oz	21 days for grain and straw harvest 3 days for forage, fodder or hay harvest		●		●			
spinosad Blackhawk Entrust Spintor 2SC Success Tracer	1.1 - 3.3 oz 1 - 2 oz 2 - 6 fl oz 3 - 6 fl oz 1 - 3 fl oz	21 days for for grain and straw harvest 3 days for forage, fodder and hay		●		●		†	

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Barley Thrips	Cereal Leaf Beetle	Cutworms	Grasshoppers	Wireworms
thiamethoxam Actara	4 oz	21 days	●						
thiamethoxam Cruiser 5FS	0.75 - 1.33 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*						●
thiamethoxam Cruiser MAXX Cereals[1]	5 fl oz per cwt	Do not graze or feed livestock on treated areas for 45 days	*						●

RUP = Restricted Use Pesticide
● = Control
* = Seed treatments may not give control of grain aphids or grasshoppers
† = Suppression only
‡ = Control of first and second instar larvae only when populations are light
[1] = For protection against early season aphids and Hessian fly, CruiserMaxx Cereals must be mixed with 0.48 - 1 fl oz per cwt of Cruiser 5FS; consult each label for registered use rates and follow all label instructions

BEAN (DRY EDIBLE) INSECTS

Other resources available through NDSU Extension Service:

Publications	A602	Dry Bean Production Handbook
	E-1522	2010 Dry Bean Grower Survey of Pest Problems and Pesticide Use in Minnesota and North Dakota (2011)
	NCR Extension Pub #198	Recognition and Management of Dry Bean Production Problems

LEAFHOPPERS

Leafhopper Management

The adult is wedge-shaped and pale green in color. Adults are very active, jumping or flying when disturbed. Nymphs are wingless. Both adults and nymphs will run backwards or sideways rapidly. Large numbers of adults may appear early in the season. Nymphs usually complete their growth on the leaf where they hatched, feeding on the underside of the leaf. Damage by leafhoppers is referred to as hopper-burn. Foliage becomes dwarfed, crinkled, and curled. Small triangular brown areas appear at the tips of leaves, gradually spreading around the entire leaf margin.

Threshold: The threshold for basing spray decisions is when an average of one leafhopper per trifoliate leaf is found. Do not let infestations and damage progress to the point that yellowing of foliage is easily detected.

APHIDS

Aphid Management

The bean aphid has not been a major pest in North Dakota, though it can be found. It is nearly black in color and 1/8 inch long. They feed along stems and the underside of leaves. Infestations may result in a buildup of honeydew on leaf surfaces, promoting the growth of a black "sooty" fungus. No economic threshold guidelines for control have been established for North Dakota.

ARMYWORMS

Armyworms are more of a problem in small grains and corn. Damage to dry beans can occur when their usual host plants become depleted. They are inactive during the day, resting under plant trash, clumps of grass or lodged plants. They feed at night by crawling up on plants and consuming foliage.

Threshold: Control of armyworms is recommended when 25% to 30% of the foliage is destroyed or if significant injury to pods is evident.

BEAN LEAF BEETLE

This beetle can vary in color from yellow to reddish-brown, and may have three to four black spots and a black border on the wing covers. Adults emerge from overwintering, moving into bean fields as the seedlings emerge. The white larvae develop in the soil, feeding on the roots and nodules. New adults emerging in July feed on foliage and pods. The injury to pods results in secondary infections by fungi and bacteria, causing rotting and discoloration.

Threshold: Due to low incidence of this insect in North Dakota, no local control guidelines have been developed. University of Missouri entomologists suggest treatment when 40% to 70% of the bean plants show feeding injury on one or more of the pods/plant.

CUTWORMS

Most damage by cutworms occurs when bean plants are in the early stage of development. Damage consists of young plants being chewed off slightly below or at ground level. Some cutworm feeding injury may occur on foliage. Cutworms primarily feed at night. When checking bean fields for cutworms during the day, dig down into soil an inch or two around recently damaged plants; there you can find the gray to gray-brown larva.

Threshold: Treatment is warranted when one cutworm or more is found per 3 feet of row and the larvae are small (<3/4 inch long).

FOLIAGE FEEDING CATERPILLARS

Green Cloverworm, Cabbage Looper, Velvetbean Caterpillar, Thistle Caterpillar, and Alfalfa webworm

Populations of these caterpillars have been negligible in North Dakota and little treatment to control them has been required. The exception was the 2001 growing season when many of these caterpillars affected bean fields. Sampling for these insects is accomplished through the use of a drop cloth or a vertical beat sheet, placed between two rows of plants. The larvae are dislodged from the plants and counted on the cloth or collection tray to arrive at an estimate of the number per row feet.

Green cloverworm: These caterpillars are green with two narrow, white stripes down the side. When mature, the worms are 1 ¼ inches long. These caterpillars have only three pairs of fleshy prolegs on the abdomen, plus the pair on the back tip. When moving, the worms move by arching the middle of the body, or “looping.” Young worms scrape leaf tissue, creating a transparent skin, or "window," on the leaf surface. Older clover worms eat holes in the leaves.

Cabbage looper: These caterpillars are light to dark green with lighter colored stripes, along the side and on the top, running the length of the body. When mature, the worms are 1 ½ inches long. These caterpillars have only two pairs of fleshy prolegs on the abdomen, plus the pair on the back tip. When moving, the caterpillars move by arching the middle of the body, or "looping." These worms feed on leaves on the interior and lower portion of the plant. As defoliation occurs, worms feed higher in the plant. Feeding injury is similar to the cloverworm.

Velvetbean caterpillar: This insect does not overwinter in the region, instead, moths migrate from Southern locations. These caterpillars have dark lines bordered by lighter colored, narrower lines running the length of the body. The background color ranges from a pale yellow-green to brown or black. These larvae have four pairs of fleshy prolegs to distinguish them from the cloverworm and the looper. Young velvetbean caterpillars feed on the underside of leaves in the upper portion of the plant. Older larvae consume the entire leaf, except for the leaf veins.

Thistle caterpillar: This insect is the larva of the butterfly known as the Painted Lady. This butterfly does not overwinter in the region, but migrates from Southern locations each spring. These caterpillars are brown to black in color with yellow stripes along each side of the body. They are covered with spiny-hairs that give the caterpillar a prickly appearance. Full grown larvae are about 1 ½ inches long. The caterpillars feed on the leaves, webbing them together at the feeding site.

Alfalfa webworm: These larvae are 1inch when full grown. They are greenish to nearly black with a light stripe that runs down the middle of the back. There are three dark spots, each with hairs, on the side of each segment. These larvae feed for about 3+ weeks. Infestations are characterized by light webbing over the leaves. These larvae move very rapidly, forward or backward, when disturbed.

Threshold for foliage feeding caterpillars: Control of these different caterpillars is normally not warranted until greater than 30% of the foliage is destroyed. This usually requires an average infestation of 10 to 15 larvae per row foot.

GRASSHOPPERS

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Most grasshoppers emerge from eggs deposited in uncultivated ground. Bean growers should expect to find grasshoppers feeding first along bean field margins adjacent to these sites. Later infestations may develop when grasshopper adults migrate from harvested small grain fields. Grasshoppers will attack leaves and pods, creating holes. Due to these migrations, bean fields become sites for significant egg laying.

Thresholds: Threatening is considered the action threshold for grasshoppers. 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 per square yard		**Adults per square yard**	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

SEEDCORN MAGGOT

Seed corn maggot attack bean seed, preventing sprouting or weakening seedlings. The yellowish white maggot is found burrowing in the seed or emerging stem. The adult flies emerge in spring when soil temperatures reach 50^{o} F. They deposit eggs in soil where there is abundant organic matter and decaying crop residue, or on the seed or seedling. Seed corn maggots are usually most severe in wet, cold seasons and on high organic matter soils.

Threshold: When conditions are wet and cool or planting into high crop residue conditions, seed treatments will provide the best defense against injury. Please see the seed treatment section in the introduction for more information.

WIREWORMS

Wireworms are most likely to be problems when dry beans follows pasture or grassland. Infestations often are found in coarse textured soils (sandy loam) where moisture is abundant, perhaps in low spots of fields.

Thresholds: There is no easy way to estimate wireworm infestations. Two methods are currently used.

***Soil Sampling*:** Sample 20, well spaced, 1 square foot sites to a depth of 4 to 6 inches for every 40 acres being planted. If an average of 1 wireworm per square foot is found, treatment would be justified.

***Solar Baiting*:** In September, establish bait stations for 2 to 3 weeks before freeze. Place bait stations randomly through the field, but representing all areas of the field. There should be 10 - 12 stations per 40 acre field. Place one cup wheat and one cup shelled corn in a 4- to 6-inch deep hole. Cover grain with soil and then an 18-inch square piece of clear plastic. Dig up the grain. If an average of one or more wireworm larvae are found per station, treatment would be justified.

***Seed Treatment*:** Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN DRY EDIBLE BEANS

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Bean Leaf Beetle	Caterpillars	Cutworms	Grasshoppers	Leafhoppers	Seed Corn Maggot	Wireworms
acephate											
Acephate 75WSP	0.33 - 1.33 lb	14 days Do not feed treated vines or hay	●	●	●	●	●	●	●		
Acephate 90 Prill	4.4 oz - 1.1 lb										
Acephate 90 WDG	4.4 oz - 1.1 lb										
Acephate 97	0.25 - 1 lb										
Acephate 97UP	0.25 - 1 lb										
Orthene 97	0.25 - 1 lb										
Bacillus thuringiensis* ssp. *kurstaki											
Biobit HP	0.5 - 2 lbs	None.		‡		●					
XenTari DF	0.5 - 2 lbs										
DiPel DF	1 - 2 lbs										
DiPel ES	1 - 4 pts										
beta-cyfluthrin											
Baythroid XL *RUP*	0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	‡	●	●	●	●	●		
beta-cyfluthrin + imidacloprid											
Leverage 360 *RUP*	2.4 - 2.8 fl oz	7 days Do not feed treated vines or hay	●	‡	●	●	●	●	●		
bifenthrin											
Bifenture EC	1.6 - 6.4 fl oz	14 days	●	●	●	●	●	●	●		
Brigade 2EC	1.6 - 6.4 fl oz										
Fanfare 2EC	1.6 - 6.4 fl oz										
Sniper	1.6 - 6.4 fl oz										
Tundra EC *RUP*	1.6 - 6.4 fl oz										
bifenthrin											
Capture LFR *RUP*	3.4 - 6.8 fl oz 0.2 - 0.39 fl oz per 1000 linear feet	14 days		●			●			●	●
bifenthrin + imidacloprid											
Brigadier	3.8 - 5.6 fl oz	14 days	●	●	●	●	●	●	●		
Swagger *RUP*	7.6 - 11.2 fl oz										
bifenthrin + zeta-cypermethrin											
Hero *RUP*	4.0 - 10.3 fl oz	21 days	●	●	●	●	●	●	●		
carbaryl											
Sevin 4F	0.5 - 1.5 qts	21 days		●	●	●	●	●	●		
Sevin XLR Plus	0.5 - 1.5 qts										
Sevin 80S	0.625 - 1.875 lbs										
chlorpyrifos											
Lorsban 50WSP *RUP*	**COMMERCIAL SEED TREATMENT ONLY**	None								●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Bean Leaf Beetle	Caterpillars	Cutworms	Grasshoppers	Leafhoppers	Seed Corn Maggot	Wireworms
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Yuma 4E *RUP*	Preplant broadcast: 2 pt At-plant T-band: 1.8 fl oz per 1000 linear feet at 30" row spacing	None								●	
chlorantraniliprole Coragen	3.5 - 5 fl oz	1 day		●							
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5.0 - 8.0 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	●	●	●		
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 4 oz 0.8 - 3.2 fl oz 0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	‡	●	●	●	●	●		
dimethoate Digon 400 Dimate 4E Dimethoate 400 Dimethoate 4E Dimethoate 4EC	0.5 - 1 pt 0.5 - 1 pt 0.5 - 1 pt 0.5 - 1 pt 0.5 - 1 pt	No PHI Do not feed vines	●		●			●	●		
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	21 days Do not feed or graze treated vines	●			●	●	●	●		
flubendiamide Belt SC	2 - 3 fl oz	14 days 3 days for forage and hay		●		●	●				
gamma-cyhalothrin Declare Proaxis *RUP*	1.02 - 1.54 fl oz 2.56 - 3.84 fl oz	21 days Do not graze or feed treated vines	●	●	●	●	●	●	●		
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	**COMMERCIAL SEED TREATMENT ONLY** 1.6 - 3.2 fl oz per cwt	None	●		●				●		●
imidacloprid Enhance AW	5 oz per cwt	Do not graze or feed livestock on treated area for 60 days after planting	●		●				●		●
imidacloprid Impulse 1.6F Nuprid 1.6F Pasada 1.6F Prey 1.6F Sherpa	Foliar application: 3.5 fl oz	7 days	●						●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Bean Leaf Beetle	Caterpillars	Cutworms	Grasshoppers	Leafhoppers	Seed Corn Maggot	Wireworms
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	Soil applications: 16.0 - 24.0 fl oz	21 days	●						●		
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL Nuprid 2SC	Foliar application: 2.8 fl oz	7 days	●						●		
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Soil applications: 8.0 - 12.0 fl oz	21 days	●						●		
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar application: 1.4 fl oz	7 days	●						●		
imidacloprid Admire Pro Nuprid 4.6F Pro	Soil applications: 7.0 - 10.5 fl oz	21 days	●						●		
imidacloprid Admire Pro	Foliar application: 1.2 fl oz	7 days	●						●		
imidacloprid Malice 75WSP	0.9 oz	7 days	●						●		
lambda-cyhalothrin Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z Warrior II *RUP*	1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.28 - 1.92 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	●	●	●		
malathion Fyfanon ULV Malathion ULV	8 fl oz	1 day Do not graze or feed vines, straw or hay	●			●			●		
methomyl Lannate LV *RUP*	0.75 - 3 pts	14 days	●	●			●		●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Bean Leaf Beetle	Caterpillars	Cutworms	Grasshoppers	Leafhoppers	Seed Corn Maggot	Wireworms
methyl parathion Penncap-M *RUP*	2 pts	15 days	●			●			●		
methoxyfenozide Intrepid 2F	4 - 8 fl oz (early season) 8 - 16 fl oz (late season)	7 days		●							
naled Dibrom 8 Emulsive *RUP*	1 - 1.5 pts	1 day	●			●			●		
novaluron Rimon 0.83EC	6 - 12 fl oz	1 day		‡	‡	‡					
phorate Phorate 20G Thimet 20G Thimet 20G SmartBox Thimet 20G Lock n Load *RUP*	4.5 - 7.0 oz/1,000 ft of row - minimum 30-inch spacing **Do not allow granules to contact seed**	60 days	●						●	●	
spinosad Blackhawk Entrust Spintor 2SC Success	2.2 - 3.3 oz 1.25 - 2 oz 4 - 6 fl oz 4 - 6 fl oz	28 days Do not feed forage or hay		●		●					
spinetoram Radiant SC	4 - 8 fl oz	28 days		●		●					
spirotetramat Movento	4 - 5 fl oz	7 days	●								
thiamethoxam Cruiser 5FS CruiserMAXX	1.28 fl oz per cwt 3 fl oz per cwt	None	●		●				●	●	●
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	At plant T-band or in-furrow application: 4 fl oz	None					●				●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.28 - 4 fl oz	21 days	●	●	●	●	●	●	●		

RUP = Restricted Use Pesticide
● = Control
† = Pea aphid suppression only
‡ = Control of early instar larvae only

CANOLA INSECTS

Other Resources Available Through NDSU Extension Service:

Publications	A1280	Canola Production Field Guide (2011)
	E1346	Diamondback Moth in Canola: Biology and Integrated Pest Management (2008)
	E1347	Bertha Armyworm in Canola: Biology and Integrated Pest Management (2008)
	E1234	Biology and Integrated Pest Management of the Crucifer Flea Beetle in Canola (2002)

BERTHA ARMYWORM

The Bertha armyworm attacks many kinds of broadleaf plants, including canola, flax and beans. Areas of North Dakota where this insect may be found include the north-central counties of Bottineau, Rollette, Towner, and neighboring areas. The larvae are pale green when they first hatch. These larvae feed on the leaves. Older larvae reach a length of 3/4 to 1 inch and will be velvety brown to black with a yellowish band along each side of the body. As leaves dry, these larvae begin feeding on seeds and flowers which are more succulent. The greatest risk of crop injury occurs in August as the worms approach full growth. In Canada, where this insect is a more frequent pest, early seeded canola often has been swathed prior to the occurrence of significant feeding injury.

Threshold: Thresholds would be 18 to 22 larvae per square yard, as long as leaf feeding is the extent of the damage observed. Thresholds may be adjusted lower if larvae are found feeding on maturing seed pods.

CUTWORMS

Most damage by cutworms occurs during seedling stage. Army cutworm feeding as early as late April has caused problems in recent years for canola growers in southwestern North Dakota. Cutworm damage consists of young plants being chewed off slightly below or at ground level. Some cutworm feeding injury may occur on foliage. Cutworms primarily feed at night. When checking canola fields for cutworms during the day, dig down into soil an inch or two around recently damaged plants; there you can find the gray to gray-brown larva.

Threshold: Treatment is warranted when one cutworm or more is found per 3 feet of row and the larvae are small (<3/4 inch long).

DIAMONDBACK MOTH

Diamondback moths move to canola, rapeseed and other mustard hosts in late spring and early summer. The first eggs are laid on the lower leaves. The small, greenish larvae make tiny, irregular holes in the leaves. Moths of later generations lay eggs higher on the plant. These hatching larvae feed first on leaves, moving later to buds, flowers and developing seedpods. Foliar damage by diamondback moth larvae looks bad, but significant yield losses are not common. Damage would be much worse when plants are under drought or heat stress.

Threshold: Treat when larval counts reach 25 to 30 per square foot, or 1 to 2 larvae per plant, and there is significant evidence of damage to flowers and/or pods.

FLEA BEETLES

Flea beetles are the most serious pest of canola in North Dakota. The adult beetles feed on the emerging cotyledon and first true leaves of the young plant. Feeding injury can result in plant death and significant stand loss, especially during hot, dry weather. Flea beetles overwinter as adults. They become active when temperatures reach 58^{o} F. The beetles fly to canola, rapeseed and other mustards, moving into fields just as the seedlings emerge. The feeding injury appears as holes or small pits in the cotyledons and leaves. Injury can range from a few shot holes to destruction of the entire plant. Flea beetles feed most actively when the weather is sunny, warm and dry. Beetle activity is less when weather conditions are cool and damp. When warm, dry conditions exist and feeding injury is occurring, the plant can be stressed quickly. Cool, damp conditions can reduce the feeding intensity of the beetles and aid plant growth to the point where they can withstand the feeding damage. Once the crop is beyond the seedling stage and the first true leaves are fully expanded, serious damage usually does not occur. By mid-June, adult beetles decrease in number.

Flea Beetle Management

***Early Planting*:** The early planting and establishment of canola can prevent significant injury to young plants by flea beetles migrating to fields after the first true leaves are fully expanded.

***Seed Treatment*:** Helix®, NipsIt INSIDE® Poncho® and Prosper® are for use by commercial seed treaters.

***Foliar Treatment*:** Fields should be checked daily for the presence of flea beetles while canola plants are at risk. The treatment threshold is when injury is approaching 25% and beetles are present. Foliar treatments must be made quickly. The weakness of foliar control strategies is the inability to cover large number of acres quickly when feeding pressure is high, and residual protection by the insecticides is short, allowing for reinfestation to occur.

GRASSHOPPERS

Thresholds: Grasshopper control is advised whenever 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. In the table, threatening is considered the action threshold for grasshoppers. 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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

LYGUS BUGS (TARNISHED PLANT BUGS)

Lygus bugs are comprised of several species belonging to the genus *Lygus*. The tarnished plant bug, *Lygus lineolaris*, is one of the more common species and is known to feed on over 200 host plants. Adult Lygus bugs are about ¼ inch in length, and pale green, light brown, or dark brown with a distinctive triangular marking on its back. Lygus bugs overwinter as adults in weedy areas and move into canola fields throughout the season. Adults lay eggs in the stems, leaves, and flowers of host plants, and then die. Immature nymphs hatch from these eggs. These nymphs are small, green, and sometimes confused with aphids; although Lygus nymphs are very active and move rapidly when disturbed, while aphids do not. Several generations occur each year with the second generation occurring in late July to early August. Hot dry weather favors the buildup of Lygus populations and increases the risk of damage to the canola crop. Both immature and adult Lygus bugs feed on growing points, buds, flowers, and green pods. Lygus bugs inject a toxic saliva with their piercing sucking mouthparts during feeding, causing blasting of flowers or buds and shriveled seeds. Blasted flowers turn white within 24 hours and quickly fall to the ground. The small seeds or damaged seeds are lost during harvest.

Lygus Bug Thresholds: Scout for Lygus bugs from just prior to bud formation until seeds within the pod have become firm. Lygus populations can increase suddenly. For example, when an alfalfa (preferred host) is cut, Lygus will migrate quickly into nearby canola fields and often in high numbers. Use a 15-inch sweep net and make 10 180-degree sweeps at several sampling sites. The economic thresholds developed in Canada are: 15 Lygus bugs per 10 sweeps from bud stage through petal drop, and 20 Lygus bugs per 10 sweeps after petal drop. If soil moisture is good, canola plants usually can compensate for Lygus bug feeding injury to plants in the bud and flowering stages. However, if populations are high, control during the early pod ripening stage is usually the most economical.

INSECTICIDES REGISTERED FOR USE IN CANOLA

INSECTICIDE	PRODUCT PER ACRE	PHI	Bertha Armyworm	Cutworms	Diamondback Moth	Flea Beetles	Grasshoppers	Lygus Bugs
Bacillus thuringiensis DiPel DF, XenTari DF	0.5 - 2 lbs	None	†					
bifenthrin Bifenthrin 2EC, Bifenture EC, Brigade 2EC, Discipline 2EC, Fanfare 2EC, Sniper, Tundra EC *RUP*	2.1 - 2.6 fl oz	35 days	●	●	●	●	●	●
chlorantraniliprole Coragen	3.5 - 5 fl oz	21 days			●			
clothianidin NipsIt INSIDE	**COMMERCIAL SEED TREATMENT ONLY** 10.23 fl oz per cwt	Do not graze or feed livestock				●		
clothianidin Poncho 600	**COMMERCIAL SEED TREATMENT ONLY** 3.84 - 10.23 fl oz per cwt	None indicated				●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Bertha Armyworm	Cutworms	Diamondback Moth	Flea Beetles	Grasshoppers	Lygus Bugs
clothianidin Prosper FX	**COMMERCIAL SEED TREATMENT ONLY** 21.5 fl oz per cwt	None indicated				●		
clothianidin Prosper Flowable	**COMMERCIAL SEED TREATMENT ONLY** 19.2 - 25.6 fl oz per cwt	None indicated				●		
deltamethrin Delta Gold Battalion 0.2EC *RUP*	0.8 fl oz 5.8 fl oz	7 days	●	●	●	●	●	●
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 1.92 - 3.84 fl oz	7 days	●	●	●	●	●	●
imidacloprid Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600 FS	10.24 - 25.6 fl oz per cwt	None indicated				●		‡
lambda-cyhalothrin Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z Warrior II *RUP*	1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 0.96 - 1.92 fl oz	7 days	●	●	●	●	●	●
methyl parathion Cheminova Methyl 4EC *RUP*	1 pt	28 days			●	●		
thiamethoxam Helix Helix Lite Helix XTra	**COMMERCIAL SEED TREATMENT ONLY** 23 fl oz per cwt	None indicated				●		
zeta-cypermethrin Mustang Max Mustang Max EC *RUP*	4 fl oz 4 fl oz	7 days	●	●	●		●	●

RUP = Restricted Use Pesticide
● = Control
† = Control of first and second instar bertha armyworm only
‡ = Suppresion of second generation lygus bugs only

CARROT INSECTS

ASTER LEAFHOPPER

Aster leafhopper can be a serious pest of carrots, potatoes and other vegetables. Feeding injury by the aster leafhopper is usually not the concern. It is the insect's ability to transmit Aster Yellows, a mycoplasma-induced disease. Aster Yellows can also affect wheat (symptoms resemble barley yellow dwarf). The aster leafhopper is light green. The head is marked with black spots arranged in pairs (which accounts for the other common name of "six-spotted leafhopper"). The aster leafhopper overwinters as an egg in the northern states. These eggs hatch sometime in June. However, by late May and early June, adult leafhoppers are migrating into the region from areas to the south. In southern Minnesota and Wisconsin, the migrant adults are monitored for Aster Yellows infectivity levels. This information is useful for determining the population levels where growers need to control aster leafhopper to minimize infection and losses.

Thresholds: Sampling for leafhopper adults is done with a sweep net. When monitoring a field, estimate the population based on the average number of leafhoppers per 100 sweeps. In Wisconsin, based on a 2.5% infectivity level, control of aster leafhopper in carrots is currently recommended when sweep net sampling finds 20 leafhoppers per 100 sweeps for susceptible carrot varieties, or 40 per 100 sweeps for resistant carrot varieties.

WIREWORMS

Wireworms, although often serious pests of cereal grains in the seedling stage, seldom damage carrots. Cruiser and Gaucho are labeled as commercial seed treatment and use decisions must be made at time of seed purchase. Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN CARROT FOR ASTER LEAFHOPPER AND WIREWORMS

INSECTICIDE	PRODUCT PER ACRE	PHI	Aster Leafhopper	Wireworms
beta-cyfluthrin Baythroid XL *RUP*	1.6 - 2.8 fl oz	0 days	●	
beta-cyfluthrin + imicacloprid Leverage 360 *RUP*	2.4 - 2.8 fl oz	7 days	●	
carbaryl Sevin 4F Sevin XLR Plus Sevin 80S	1 - 2 qts 1 - 2 qts 1.25 - 2.5 lbs	7 days	●	
cyfluthrin Tombstone Tombstone Helios Renounce 20WP *RUP*	1.6 - 2.8 fl oz 1.6 - 2.8 fl oz 2 - 3.5 oz	0 days	●	
deltamethrin Battalion 0.2EC Delta Gold *RUP*	11.5 - 17.9 fl oz 1.5 - 2.4 fl oz	3 days	●	
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	7 days	●	
imidacloprid Attendant 600 Gaucho 600 Dyna-Shield Imidacloprid 5 Senator 600 FS	**COMMERCIAL SEED TREATMENT ONLY** 6.4 fl oz per cwt	None indicated		●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aster Leafhopper	Wireworms
imidacloprid Impulse 1.6FL Nuprid 1.6F Pasada 1.6F Prey 1.6 Sherpa	Foliar application: 3.5 fl oz	7 days	●	
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	Soil applications: 0.7 - 1.7 fl oz per 1,000 row-feet (10 - 24 fl oz per acre)	21 days	●	
imidacloprid Advise 2FL AmTide Imidacloprid 2F Macho 2FL Montana 2F Nuprid 2SC	Foliar application: 2.8 fl oz	7 days	●	
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Soil applications: 0.35 - 0.85 fl oz per 1,000 row-feet (5 - 12 fl oz per acre)	21 days	●	
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar application: 1.4 fl oz	7 days	●	
imidacloprid Admire Pro Nuprid 4.6F Pro	Soil application: 0.31 - 0.74 fl oz per 1,000 row-feet (4.4 - 10.5 fl oz per acre)	21 days	●	
imidacloprid Admire Pro	Foliar application: 1.2 fl oz	7 days	●	
imidacloprid Malice 75WSP	0.9 oz	7 days	●	
malathion Cheminova Malathion 57% Malathion 57 EC	1.5 - 2 pts 2.5 pts	7 days	●	
methomyl Lannate LV *RUP*	1.5 - 3 pts	1 day	●	
thiamethoxam Actara	1.5 - 3 oz	7 days	●	
thiamethoxam Platinum 75SG Platinum	1.7 - 4 oz 5 - 12 fl oz	None	●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Aster Leafhopper	Wireworms
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.76 - 4 fl oz	1 day	●	

RUP = Restricted Use Pesticide
● = Control

CHICKPEA/GARBANZO BEAN INSECTS

NDSU Pulse-info website: http://www.ndsu.edu/pubweb/pulse-info/index.html

Chickpea stems, leaves and seed pods are covered with small, hairlike glandular structures that secrete malic and oxalic acids. The secretions discourage insects from feeding on the plants. Therefore, insect problems on chickpeas have been minimal and insecticide applications generally have not been necessary. Several viral diseases that are transmitted by aphids have occasionally been reported in chickpea fields from the states of Washington and Idaho. Potential insect pests of chickpea include seedcorn maggots, armyworms, aphids, cutworms, grasshoppers, lygus bugs and wireworms.

INSECTICIDES REGISTERED FOR USE IN CHICKPEA

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cutworms	Grasshoppers	Lygus Bugs	Seed Corn Maggot	Wireworms
Bacillus thuringiensis* ssp. *kurstaki Biobit HP DiPel DF DiPel ES XenTari DF	 0.5 - 2 lbs 1 - 2 lbs 1 - 4 pts 0.5 - 2 lbs	None		‡					
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	‡	●	●	●		
beta-cyfluthrin + imidacloprid Leverage 360 *RUP*	2.4 - 2.8 fl oz	7 days Do not feed treated vines or hay	●	●	●	●			
bifenthrin Bifenture EC Brigade 2EC Fanfare 2EC Sniper Tundra EC *RUP*	2.1 - 6.4 fl oz	14 days	●	●	●	●	●		
bifenthrin Capture LFR *RUP*	3.4 - 6.8 fl oz 0.2 - 0.39 fl oz per 1000 linear feet	14 days		●	●			●	●
bifenthrin + imidacloprid Brigadier Swagger *RUP*	3.8 - 5.6 fl oz 7.6 - 11.2 fl oz	14 days	●	●	●	●	●		
bifenthrin + zeta-cypermethrin Hero *RUP*	4.0 - 10.3 fl oz	21 days	●	●	●	●	●		
carbaryl Sevin 4F Sevin XLR Plus	0.5 - 1.5 qts 0.5 - 1.5 qts	21 days for seed and hay 14 days for grazing and forage		●	●	●	●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cutworms	Grasshoppers	Lygus Bugs	Seed Corn Maggot	Wireworms
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Yuma 4E *RUP*	Preplant broadcast: 2 pt At-plant T-band: 1.8 fl oz per 1,000 linear feet at 30" row spacing	None						●	
chlorantraniliprole Coragen	3.5 - 5 fl oz	1 day		●					
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5.0 - 8.0 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	●		
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 4 oz 0.8 - 3.2 fl oz 0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	‡	●	●	●		
dimethoate Dimethoate 4E Dimethoate 400	0.5 - 1 pt	None Do not feed vines	●			●	●		
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	21 days Do not feed or graze treated vines	●		●	●			
flubendiamide Belt SC	2 - 3 fl oz	14 days 3 days for forage and hay		●	●				
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	21 days Do not graze or feed treated vines	●	●	●	●	●		
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	**COMMERCIAL SEED TREATMENT ONLY** 1.6 - 3.2 fl oz per cwt	Not indicated	●						●
imidacloprid Enhance AW	5 oz per cwt	Do not graze or feed livestock on treated area for 60 days after planting	●						●
imidacloprid Impulse 1.6F Nuprid 1.6F Pasada 1.6F Prey 1.6F Sherpa	Foliar application: 3.5 fl oz	7 days	●						

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cutworms	Grasshoppers	Lygus Bugs	Seed Corn Maggot	Wireworms
imidacloprid Advise 2FL Alias 2F AmTide Imidacloprid 2F Couraze 2F Macho 2FL Montana 2F Nuprid 2F Nuprid 2SC Widow	Soil applications: 16.0 - 24.0 fl oz	21 days	●						
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL Nuprid 2SC	Foliar application: 2.8 fl oz	7 days	●						
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Soil applications: 8.0 - 12.0 fl oz	21 days	●						
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar application: 1.4 fl oz	7 days	●						
imidacloprid Admire Pro Nuprid 4.6F Pro	Soil applications: 7.0 - 10.5 fl oz	21 days	●						
imidacloprid Admire Pro	Foliar application: 1.2 fl oz	7 days	●						
imidacloprid Malice 75WSP	0.9 oz	7 days	●						
lambda-cyhalothrin Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z Warrior II *RUP*	1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 0.96 - 1.92 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	●		
methomyl Lannate LV *RUP*	1.5 - 3 pts	14 days	●	●	●		●		
methoxyfenozide Intrepid 2F	4 - 8 fl oz (early season) 8 - 16 fl oz (late season)	7 days		●					

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cutworms	Grasshoppers	Lygus Bugs	Seed Corn Maggot	Wireworms
spinosad Blackhawk Entrust Spintor 2SC Success	2.2 - 3.3 oz 1.25 - 2 oz 4 - 6 fl oz 3 - 6 fl oz	28 days Do not feed forage or hay		‡					
spinetoram Radiant SC	4 - 8 fl oz	28 days		‡					
spirotetramat Movento	4 - 5 fl oz	7 days	●						
thiamethoxam Cruiser 5FS CruiserMAXX	1.28 fl oz per cwt 3 fl oz per cwt	None	●					●	●
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	At plant T-band or in-furrow application: 4 fl oz	Not indicated			●				●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.4 - 4.3 fl oz 1.28 - 4 fl oz	21 days	●	●	●	●	●		

RUP = Restricted Use Pesticide
● = Control
† = Suppression only
‡ = Control of first and second instar larvae

CORN INSECTS

Other Resources Available Through NDSU Extension Service:

Publications	E631	Corn Insects of North Dakota Affecting Planting Decisions (2005)
	E-1300	Corn Insects of North Dakota Affecting the Crop After Emergence (2005)
	E188	Wireworm Control (2001)
	E830	The Armyworm and the Army Cutworm (2000)
	E272	Grasshopper Management (1997)
	E493	Aphid Management in Small Grains, Corn and Sorghum (1993)

APHIDS

Corn Leaf and Greenbug

The greenbug and corn leaf aphid are the most common aphid species causing problems in corn and sorghum. The greenbug is the most injurious because it injects a toxin with its saliva during feeding.

Threshold: The critical period for injury by corn leaf aphid is during tassel emergence through pollination. Treatment is suggested only when 50% of the corn plants have 100+ aphids per plant during tassel emergence and plants are drought stressed.

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.

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: Treat when 25% to 30% of the plants have 2 or more worms **or** 75% of the plants have 1 worm.

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

CORN ROOTWORM LARVAE

Rootworm larvae injure the root system of the corn plant. Yield potential may be reduced and/or lodging of plants may occur. Annual crop rotation from corn should prevent serious damage and losses. Early planting of corn allows for better root development prior to the late June hatch of rootworm eggs.

Threshold: The decision to rotate from corn or to use an insecticide may be based on field scouting for adult beetles during a three week period after pollination. Record the number of corn rootworm beetles on the foliage and silk of 100 plants. When the adult population averages 1 beetle per plant in continuous corn or 0.5 beetles per plant in first-year corn fields, the potential for larval root damage the next summer is sufficient to rotate from corn or to apply an insecticide.

CORN ROOTWORM ADULTS

Rootworm beetles feed on the leaves, silk and pollen of corn. Occasionally, the beetles congregate and feed on silks during early pollen shed. If silks are chewed back to the tips of ears (less than 1/2 inch of silks protruding) during the period of maximum pollen shed, poor pollination and grain set can occur. Adult injury very seldom occurs in North Dakota.

Threshold: When an average of 5 or more beetles per silk mass are found during the first week of pollen shed, control may be necessary. Another management threshold uses silk clipping. When silk clipping is occurring on 25% to 50% of the plants during pollen shed, control would be justified.

CUTWORMS

Several cutworm species affect regional crops. 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. 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. Because eggs of the important cutworms are laid during late summer in North Dakota, soil moisture at this time is important for their winter survival. Growers should be cautious when planting corn following pasture, alfalfa, or clover sites; survival may be greater at these locations.

Thresholds: Begin scouting for cutworms when corn is up to a stand and continue until mid-June. Treat when 3% to 6% of the plants are cut and small larvae (<3/4 inch) are present. Application rate of 15 to 20 gallons of water per acre by ground application is suggested.

EUROPEAN CORN BORER

Managing corn borer in North Dakota is a challenge due to the lengthy emergence interval of the moths from overwintering. In North Dakota, borers have the potential for one or two generations during the season. The two generation borers are present in the southern region of the state. They begin emerging in early June and represent the first flush of larval feeding. The single-generation borer is present throughout North Dakota, emerging from mid-June to August. The challenge of the crop manager is to distinguish when egg laying and larval populations can be tolerated or if they need to be controlled. Corn should be monitored weekly for ***at least*** **five weeks** once plants exceed an extended leaf height of 17 inches. At this point, corn borer larvae will be able to survive on the plant. Inspect plants for the presence of egg masses, whorl feeding, and active larvae. Observing moth activity around field margins or within the field may alert you to developing infestations. Recent corn borer infestations in North Dakota developed in mid to late July and August as a result of the late emergence of the numerous single-generation type borers. In other years, the two- generation borers emerging first may contribute more to significant infestations.

Field scouting for corn borers:

Whorl stage corn . . . . Pull the whorls from 10 plants at 5 locations across the field. Select whorls at random, avoiding damaged plants. Unwrap the whorl leaves; count and record the number of live larvae found.

Worksheet for whorl stage corn -- You fill in the blanks

1. __ % of plants infested x __ Avg no. borers/plant = __ Borers per plant
2. __ borers per plant x __ percent yield loss per borer* = __ percent yield loss
3. __ percent yield loss x __ expected yield (bu. per acre) = __ bushels per acre loss
4. __ bushel loss per acre x __ price per bushel = $ __ loss per acre
5. __ loss per acre x __ percent control** = $ __ preventable loss/a
6. __ preventable loss/acre- __ cost of control per acre = $ __ profit (loss)/acre

*5% for corn in the early whorl stage; 4% for late whorl; 6% for pretassel
**80% for granules; 75% for sprays.

Tassel stage or older corn . . . . Examine the underside of the middle 7 leaves (3 leaves above and 3 leaves below the ear leaf) on 20 plants from 5 locations in the field. Multiply the number of egg masses found by 1.1 (correction factor for eggs on other leaves). Complete worksheet to determine the need for treatment.

Worksheet for tassel stage or older corn -- You fill in the blanks

1. __ egg masses per plant* x 4.5 borers per egg mass = ___ borers per plant
2. __ borers per plant x __ percent yield loss per borer** = ___ percent yield loss
3. __ percent yield loss x __ expected yield (bu. per acre) = ___ bushels per acre loss
4. __ bushel loss per acre x __ price per bushel = $ ___ loss per acre
5. __ loss per acre x 80 percent control = $ ___ preventable loss/acre
6. __ preventable loss/acre - __ cost of control per acre = $ ___ profit (loss) / acre

*Cumulative counts taken five to seven days later can be added here
**Use 0.04 for pollen-shedding corn, 0.03 if kernels are initiated

Economic Threshold (Corn Borer/plant) When Factoring Crop Value and Control Costs

Control Costs[2] ($/acre)	Value of Corn Crop1 ($/acre)								
	200	250	300	350	400	450	500	550	600
6	0.75	0.60	0.50	0.43	0.38	0.34	0.30	0.27	0.25
7	0.88	0.70	0.58	0.50	0.44	0.39	0.35	0.32	0.29
8	1.00	0.80	0.67	0.57	0.50	0.45	0.40	0.37	0.34
9	1.12	0.90	0.75	0.64	0.56	0.50	0.45	0.41	0.38
10	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.46	0.42
11	1.38	1.10	0.92	0.79	0.69	0.61	0.55	0.50	0.46
12	1.50	1.20	1.00	0.86	0.75	0.67	0.60	0.55	0.50
13	1.63	1.30	1.08	0.93	0.81	0.72	0.65	0.59	0.54
14	1.75	1.40	1.17	1.00	0.88	0.78	0.70	0.64	0.59
15	1.88	1.50	1.25	1.07	0.94	0.84	0.75	0.68	0.63
16	2.00	1.60	1.33	1.14	1.00	0.89	0.80	0.73	0.68

[1] *Crop value = expected yield (bu/acre) X projected price ($/bu)*
[2] *Control costs = insecticide price ($/acre) + application costs ($/acre)*

Handy Bt Trait Table

Reprinted with approval from authors - C. DiFonzo, Michigan State University and E. Cullen, University of Wisconsin

Insect targets listed in table: BCW - black cutworm, CEW - corn earworm, CRW - corn rootworm, ECB - European corn borer, FAW - fall armyworm, SB - stalk borer, WBC - western bean cutworm

Herbicide traits listed in table: GT - glyphosate tolerant, LL - Liberty Link or glufosinate tolerant, RR2 - Roundup Ready or glyphosate tolerant

Trait Group (Current 20 Oct. 2011)	Bt protein (s)	Insects controlled (bold) or *suppressed (italics)* Above ground	In soil	Herbicide Tolerance	Refuge % & Location
Agrisure					
Agrisure CB/LL	Cry1Ab	**ECB** *CEW, FAW, SB*	---	LL	20% - ½ mile
Agrisure GT/CB/LL	Cry1Ab	**ECB** *CEW, FAW, SB*	---	GT, LL	20% - ½ mile
Agrisure RW	mCry3A	**---**	**CRW**	--	20% - adjacent
Agrisure GT/RW	mCry3A	**---**	**CRW**	GT	20% - adjacent
Agrisure CB/LL/RW	Cry1Ab mCry3A	**ECB** *CEW, FAW, SB*	**CRW**	LL	20% - adjacent
Agrisure 3000GT	Cry1Ab mCry3A	**ECB** *CEW, FAW, SB*	**CRW**	GT, LL	20% - adjacent
Agrisure Viptera 3110	Cry1Ab Vip3A	**BCW, CEW, ECB, FAW, WBC, SB**	---	GT, LL	20% - ½ mile
Agrisure Viptera 3111	Cry1Ab mCry3A Vip3A	**BCW, CEW, ECB, FAW, WBC, SB**	**CRW**	GT, LL	20% - adjacent
Agrisure 3122 Refuge Renew	Cry1Ab Cry1F mCry3A Cry34/35Ab1	**BCW, CEW, ECB, FAW, WBC, SB**	**CRW**	GT, LL	5% - adjacent
Agriusre Viptera 3220	Cry1Ab Cry1F Vip3A	**BCW, CEW, ECB, FAW, WBC, SB**	---	GT, LL	5% - ½ mile
Herculex					
Herculex 1 (HX1)	Cry1F	**BCW, ECB, FAW, WBC** *CEW*	---	LL, RR2 (some)	20% - ½ mile
Herculex RW (HXRW)	Cry34/35Ab1	---	**CRW**	LL	20% - adjacent
Herculex XTRA (HXX)	Cry1F Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW*	**CRW**	LL, RR2 (some)	20% - adjacent
Optimum					
Optimun Intrasect	Cry1F Cry1Ab	**BCW, ECB, FAW, WBC** *CEW, SB*	---	LL, RR2	5% - ½ mile
Optimun AcreMax (OAM)	Cry1F Cry1Ab	**BCW, ECB, FAW, WBC** *CEW, SB*	---	RR2	5% **in the bag**
Optimum AcreMaxRX	Cry34/35Ab1	---	**CRW**	RR2	10% **in the bag**
Optimum AcreMax1	Cry1F Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW*	**CRW**	LL, RR2	10% **in the bag** (CRW) 20% - ½ mile (ECB)
Optimum AcreMax Xtra	Cry1F Cry1Ab Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL, RR2	10% **in the bag**
Yieldgard					
YGCB	Cry1Ab	**ECB** *CEW, FAW, SB*	---	RR2 (some)	20% - ½ mile
YGRW	Cry3Bb1	---	**CRW**	RR2 (some)	20% - adjacent
YieldGard Plus	Cry1Ab Cry3Bb1	**ECB** *CEW, FAW, SB*	**CRW**	RR2 (some)	20% - adjacent
YieldGard VTRW	Cry3Bb1	---	**CRW**	RR2	20% - adjacent
YieldGard VT Triple (VT3)	Cry1Ab Cry3Bb1	**ECB** *CEW, FAW, SB*	**CRW**	RR2	20% - adjacent
Genuity/ SmartStax Products					
Genuity VT Double Pro (VT2P)	Cry1A.105 Cry2Ab2	**CEW, ECB, FAW**	---	RR2	5% - ½ mile
Genuity VT Triple Pro (VT3P)	Cry1A.105 Cry2Ab2 Cry3Bb1	**CEW, ECB, FAW**	**CRW**	RR2	20% - adjacent
SmartStax (Dow) or Genuity SmartStax (Monsanto) (GENSS)	Cry1A.105 Cry2Ab2 Cry1F Cry34/35Ab1 Cry3Bb1	**BCW, CEW, ECB, FAW, WBC**	**CRW**	RR2, LL	5% **in the bag**
Genuity SmartStax RIB Complete (Mon)	Same as GENSS	**BCW, CEW, ECB, FAW, WBC**	**CRW**	RR2, LL	5% **in the bag**

Trait Group (Current 20 Oct. 2011)	Bt protein (s)	Insects controlled (bold) or *suppressed (italics)* Above ground	In soil	Herbicide Tolerance	Refuge % & Location
REFURGE ADVANCED Powered by SmartStax (Dow)	Same as GENSS	**BCW, CEW, ECB, FAW, WBC**	**CRW**	RR2, LL	5% **in the bag** A structured 5% refuge option may be available.

Weblink for Handy Bt Trait Table:
http://www.ag.ndsu.nodak.edu/aginfo/entomology/entupdates/General_Ag/28BtTraitTable20Oct2011_Final.pdf

GRASSHOPPERS

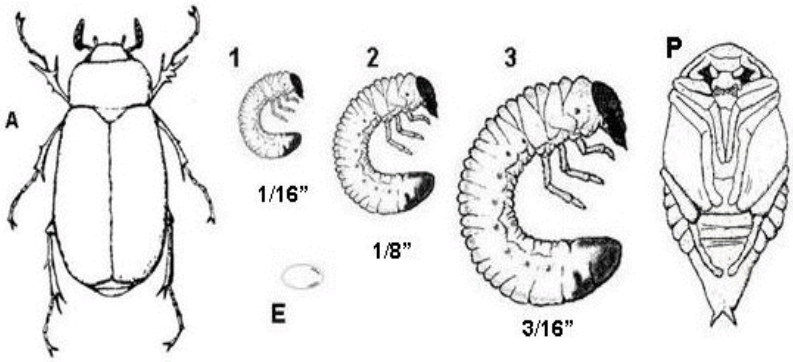
In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Peak hatch occurs about mid-June. Heavy infestations typically occur in areas of low rainfall or during drought years. Outbreaks are usually preceded by several years of hot, dry summers and warm autumns. Cool,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

Thresholds: The threatening rating is considered the action threshold for grasshoppers. 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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

WHITE GRUBS (LARVAE)

White grubs that are destructive to field crops in North Dakota have a three-year life cycle. In southeast North Dakota, the most common white grub pest occurs in continuous cropping situations at sites where willow and cottonwood trees are present. In other areas of the state, white grubs are most likely to be found when rotation from grassland, pasture, or grassy weed sites occur. Most root feeding occurs in the second year of the life cycle. In most cases, the number of second-year grubs will only be great enough to justify control once every three years.



Life stages of Phyllophaga implicita: A - adult June beetle; E - egg; grub stages with their head width in inches, 1 - first; 2 - second; 3 - third; and P - pupa.

Thresholds: Treatment is recommended when sampling indicates an average of one or more white grubs per square foot are found. The following sampling procedure provides treatment decisions based on this guideline.

Soil sampling: Fields need to be sampled to determine grub abundance and aid in determining if control is necessary. Sampling in late summer or early fall, before a freeze, provides a more reliable estimate of populations than spring sampling just before planting. Larvae are typically present in the upper 6 inches of soil until a killing frost occurs in the fall. Take soil samples, 1 square foot in size to a depth of 8 inches. Begin taking samples 45 yards from shelterbelts. A total of 30 samples per field, randomly spaced along the shelterbelts, are necessary. If at least a single grub is found in less than 40% of the samples, treatment may be required only out 20 yards from the tree line. If 40% to 60% of the samples are infested, treatment is needed to this distance and maybe as far as 65 yards. If greater than 60% of the samples are infested, treatment may be needed out to 90 yards from the tree line.

WIREWORMS

Wireworms are most likely to be problems 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.

Thresholds: There is no easy way to estimate wireworm infestations. Two methods are currently used.

***Soil Sampling*:** Sample 20, well spaced, 1 square foot sites to a depth of 4 to 6 inches for every 40 acres being planted. If an average of 1 wireworm per square foot is found, treatment would be justified.

***Solar Baiting*:** In September, establish bait stations for 2 to 3 weeks before freeze. Place bait stations randomly through the field, but representing all areas of the field. There should be 10 - 12 stations per 40 acre field. Place one cup wheat and one cup shelled corn in a 4- to 6-inch deep hole. Cover grain with soil and then an 18-inch square piece of clear plastic. Dig up the grain. If an average of one or more wireworm larvae are found per station, treatment would be justified.

Seed Treatment: Seed treatments and/or planter box treatment available for use on corn for managing wireworm. Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN CORN

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
abamectin + thiamethoxam Avicta Complete Corn (Combination of insecticide and fungicide products) *RUP*	See individual product labels for rates and use directions (Avicta Duo Corn, Cruiser, Apron XL and/or Dynasty)	See individual product labels								●	●
Bacillus thuringiensis Biobit HP DiPel DF DiPel ES XenTari DF	0.5 - 2 lbs 0.5 - 2 lbs 0.5 - 2.5 pts 0.5 - 2	None		‡				●			
beta-cyfluthrin Baythroid XL *RUP*	At Plant: 0.12 - 0.16 fl oz per 1,000 row-feet (2 - 2.8 fl oz per acre)	21 days for grain and fodder								●	●
beta-cyfluthrin Baythroid XL *RUP*	Foliar Application: 0.8 - 2.8 fl oz	21 days for grain and fodder		●		●	●	●	●		
bifenthrin Bifenthrin 2EC Bifenture EC Brigade 2EC Discipline 2EC Fanfare 2EC Sniper Tundra EC *RUP*	At Planting: 0.15 - 0.3 fl oz per 1,000 row-feet Pre-plant Broadcast: 2.56 fl oz per acre Pre-plant Incorporated: 3 - 4 fl oz per acre	30 days for grain and feed		●	●		●			●	●
bifenthrin Bifenthrin 2EC Bifenture EC Brigade 2EC Discipline 2EC Fanfare 2EC Sniper Tundra EC *RUP*	Foliar Application: 2.1 - 6.4 fl oz	30 days for grain and feed	●			●	●	●	●		
bifenthrin Capture 1.15G *RUP*	At Planting: 3.2 - 8 oz per 1,000 row-feet	30 days for grain and feed			●		●			●	●
bifenthrin Capture 1.15G *RUP*	Foliar Application: 3.5 - 8.7 lbs	30 days for grain and feed		●				●			

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
bifenthrin Capture LFR *RUP*	At Planting: 0.2 - 0.49 fl oz per 1,000 row-feet Pre-plant Broadcast: 3.4 fl oz per acre Pre-plant Incorporated: 4 - 5.3 fl oz per acre	None		●	●		●			●	●
bifenthrin + chlorethoxyfos SmartChoice 5G Lock n Load *RUP*	3 - 5 oz per 1,000 row-feet	None			●		●			●	●
bifenthrin + imidacloprid Swagger *RUP*	At Plant: 1.2 - 2.4 fl oz per 1,000 row-feet PRE and PPI: 12.03 - 15.87 fl oz per acre	30 days 30 days		●	●		●			●	●
bifenthrin + imidacloprid Swagger *RUP*	Foliar: 8.45 - 25.6 fl oz	30 days	●	●		●	●	●	●		
bifenthrin + zeta-cypermethrin Hero *RUP*	At Plant: 4 - 10.3 fl oz	30 day for grain, 60 days for forage		●			●			●	●
bifenthrin + zeta-cypermethrin Hero *RUP*	Foliar: 4 - 10.3 fl oz	30 day for grain, 60 days for forage	●	●		●	●	●	●		
carbaryl Sevin 4F Sevin 80S Sevin XLR Plus	1 - 2 qts 1.25 - 2.5 lbs 1 - 2 qts	48 days for grain and fodder 14 days for grazing and forage		●		●	●	●			
chlorantraniliprole Coragen	3.5 - 5 fl oz	14 days		●				●			
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5 - 9 fl oz	21 days for grain, fodder and silage, 1 day for grazing	●	●		●	●	●	●		
chlorethoxyfos Fortress 2.5G Fortress 5G *RUP*	2.5G: 6 oz per 1,000 row-feet 5G: 3 oz per 1,000 row-feet	None			●					●	●
chlorpyrifos Lorsban 15G Lorsban 15G SmartBox Saurus	Soil Applications: 8 oz per 1,000 row-feet or 5 - 6.5 lbs per acre	21 days		●	●		●	●		●	●
chlorpyrifos Warhawk Whirlwind *RUP*	PPI: 2 - 6 pts	21 days for grain, forage and fodder			●		●			●	●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	At Plant and PRE (Conservation Tillage): 1 - 2 pts	21 days for grain, forage and fodder		●			●				
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	Foliar: 0.5 - 2 pts	21 days for grain, forage and fodder	●	●		●	●	●	●		
chlorpyrifos + lambda-cyhalothrin Cobalt Advanced *RUP*	At Plant: 1.89 - 3.8 fl oz per 1,000 row-feet	21 days for grain, forage and fodder					●			●	●
chlorpyrifos + lambda-cyhalothrin Cobalt Advanced *RUP*	32 - 42 fl oz Apply at cultivation or through sprinkler irrigation	21 days for grain, forage and fodder			●						
chlorpyrifos + lambda-cyhalothrin Cobalt Advanced *RUP*	Foliar Application: 6 - 38 fl oz	21 days for grain, forage and fodder	●	●		●	●	●	●		
cholrpyrifos + zeta-cypermethrin Stallion *RUP*	At Plant: 11.75 fl oz per acre Consult label for rate per 1,000 row-feet	30 days for grain, 60 days for forage					●				
cholrpyrifos + zeta-cypermethrin Stallion *RUP*	Foliar Application 3.75 - 11.75 fl oz	30 days for grain, 60 days for forage	●	●		●	●	●	●		
clothianidin Poncho 600	**COMMERCIAL SEED TREATMENT ONLY** 1.13 - 5.64 fl oz per 80,000 seed unit Use high rate for corn rootworm larvae	None			●					●	●
clothianidin + *Bacillus firmus* Poncho Votivo	**COMMERCIAL SEED TREATMENT ONLY** 2.7 fl oz per 80,000 seed unit	None			●					●	●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
cyfluthrin Tombstone Tombstone Helios *RUP*	At Plant: 0.12 - 0.16 fl oz per 1,000 row-feet	21 days for grain and fodder								●	●
cyfluthrin Tombstone Tombstone Helios *RUP*	Foliar: 0.8 - 2.8 fl oz	21 days for grain and fodder		●		●	●	●	●		
cyfluthrin + tebupirimiphos Aztec 2.1G *RUP*	6.7 oz per 1,000 row-feet	None			●		●			●	●
cyfluthrin + tebupirimiphos Aztec 4.67G *RUP*	**FOR USE IN SMARTBOX SYSTEM ONLY** 3 oz per 1,000 row-feet	None			●		●			●	●
deltamethrin Battalion 0.2EC Delta Gold *RUP*	7.7 - 14.1 fl oz 0.8 - 1.9 fl oz	21 days for grain, 12 days for grazing and forage	●	●		●	●	●	●		
dimethoate Digon 400 Dimate 4E Dimethoate 4E Dimethoate 4EC Dimethoate 400	0.67 - 1 pt	28 days for grain 14 days for forage	●			●			●		
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	21 days	●			●	●	●	●		
fipronil Regent 4SC *RUP*	0.24 fl oz per 1,000 row-feet (30" row spacing) See label for rates at different row spacings	90 days			●					●	●
flubendiamide Belt SC	2 - 3 fl oz	28 days for grain 1 day for green forage and silage		●			●	●			
gamma-cyhalothrin Declare *RUP*	At Plant: 0.26 fl oz per 1,000 row-feet	21 days			●		●			●	†
gamma-cyhalothrin Proaxis *RUP*	At Plant: 0.66 fl oz per 1,000 row-feet	21 days									†
gamma-cyhalothrin Declare Proaxis *RUP*	Foliar: 0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	21 days	●	●		●	●	●	●		
imidacloprid Concur	Planter Box: 1.5 oz per 42 lbs of seed	None								●	●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	0.72 - 6 fl oz per 80,000 seed unit Use high rate for corn rootworm (protection not adequate in heavy corn rootworm populations)	None	●		●			●		●	●
lambda-cyhalothrin Grizzly Z Nufarm Lamda Cyhalothrin 1EC Lambda-Cy EC LambdaStar Lambda-T Lamcap Province Silencer Silencer VC Taiga Z *RUP*	At Plant: 0.66 fl oz per 1,000 row-feet	21 days for grain, fodder and silage, 1 day for grazing			●		●			●	●
lambda-cyhalothrin Grizzly Z Nufarm Lamda Cyhalothrin 1EC Lambda-Cy EC LambdaStar Lambda-T Lamcap Province Silencer Silencer VC Taiga Z *RUP*	Foliar: 1.92 - 3.84 fl oz	21 days for grain, fodder and silage, 1 day for grazing	†	●		●	●	●	●		
lambda-cyhalothrin Warrior II *RUP*	At Plant: 0.33 fl oz per 1,000 row-feet	21 days for grain, fodder and silage, 1 day for grazing			●		●			●	●
lambda-cyhalothrin Warrior II *RUP*	Foliar: 1.28 - 1.92 fl oz	21 days for grain, fodder and silage, 1 day for grazing	●	●		●		●	●		
malathion Cheminova Malathion 57% Malathion 5	1.5 pts 1 - 2 pts	7 days	●	‡		●			●		
malathion Fyfanon ULV Malathion ULV	4 - 8 fl oz	5 days	●			●			●		
methomyl Lannate LV *RUP*	0.75 - 1.5 pts	21 days for grain 3 days for forage	●	●		●	●	●			
methoxyfenozide Intrepid 2F	4 - 16 fl oz	21 days		●				●			
methyl parathion Cheminova Methyl 4EC *RUP*	0.5 - 1 pt	12 days	●	●		●			●		
methyl parathion Penncap-M *RUP*	1 - 4 pts	12 days **REI = 31 days**	●			●		●	●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
permethrin Pounce 1.5G *RUP*	Soil applications: 8 - 16 oz per 1,000 row-feet or 6.7 - 13.3 lbs per acre	None		●			●				●
permethrin Pounce 1.5G	Foliar applications: 5 - 10 lbs per acre	30 days		●			●	●			
permethrin Ambush *RUP*	Soil applications: 0.5 fl oz per 1,000 row-feet or 6.4 - 12.8 fl oz per acre	None		●			●				
permethrin Ambush 25W *RUP*	Pre-emerge broadcast: 6.4 - 12.8 oz per acre	None		●			●				
permethrin Arctic 3.2EC PermaStar AG Permethrin 3.2EC Perm-UP 3.2EC Pounce 3.2EC *RUP*	Soil applications: 0.3 - 0.6 fl oz per 1,000 row-feet or 4 - 6 fl oz per acre	None		●			●				
permethrin Ambush Ambush 25W Arctic 3.2EC PermaStar AG Permethrin 3.2EC Perm-Up 3.2 EC Pounce 3.2EC *RUP*	Foliar applications: 6.4 - 12.8 fl oz 6.4 - 12.8 oz 4 - 6 fl oz 4 - 8 fl oz 4 - 8 fl oz 4 - 6 fl oz 4 - 8 fl oz	30 days		●		●	●	●			
permethrin Kernel Guard Supreme	Planter Box: 1.5 oz per 42 lbs of seed	45 days for grazing or feeding									●
phorate Phorate 20G Thimet 20G Lock n Load Thimet 20G SmartBox *RUP*	4.5 - 6 oz per 1,000 row-feet	30 days			●					†	●
spinosad (microbial) Blackhawk Entrust Success Tracer	1.67 - 3.3 oz 0.5 - 2 oz 3 - 6 fl oz 1 - 3 fl oz	28 days for fodder 7 days for forage 1 day for grain		●				●			
spinetoram Radiant SC	3 - 6 fl oz	28 days for grain, 3 days for fodder and forage		●				●			
tefluthrin Force 3G Force 3G SmartBox Force CS *RUP*	3G: 4 - 5 oz per 1,000 row-feet CS: 0.46 - 0.57 oz per 1,000 row-feet	None			●		●	●		●	●
terbufos Counter 15G SmartBox Counter 15G Lock n Load *RUP*	6 - 8 oz per 1,000 row-feet	30 days for grazing and forage			●		†			●	●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Corn Rootworm Larvae	Corn Rootworm Adults	Cutworms	European Corn Borer	Grasshoppers	White Grubs	Wireworms
thiamethoxam Cruiser 5FS	0.25 - 8 mg active ingredient per kernel (1 fl oz contains 17.7 g active ingredient)	None	●				●			●	●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC	At Plant: 0.16 fl oz per 1,000 row-feet	30 days for grain 60 days for forage					●				
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.28 - 4 fl oz	30 days for grain, 60 days for forage	●	●		●	●	●	●		

RUP = Restricted Use pesticide
● = Control
† = Suppression Only
‡ = Control of first and second instar larvae only

FIELD PEA INSECTS

NDSU Pulse-info website: http://www.ndsu.edu/pubweb/pulse-info/index.html

CUTWORMS

Cutworms are an occasional problem in field pea. Cutworms overwinter as eggs or young larvae that feed on the newly emerged shoots in spring. The shoots may be cut off below the soil surface. Cotyledons (seeds) of pea often remain below the soil surface and can recover from cutworm damage if cool, moist growing conditions. However, recovered plants are generally set back 4 to 7 days by the damage.

Threshold: The risk is low, unless more than 2 to 3 cutworms per square yard occur in the top 3 inches of soil.

GRASSHOPPERS

Grasshoppers are usually not a major problem in pea. Pea is not typically a preferred host, but grasshoppers can cause damage to field pea, especially during the flower to pod-filling stages.

Thresholds: The threatening rating is considered the action threshold for grasshoppers. 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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

LYGUS BUG (TARNISHED PLANT BUG)

The lygus bug or "tarnished plant bug" has been documented as a serious pest of many fruit and vegetable crops, but has not yet been demonstrated to cause significant problems in North Dakota field pea. Lygus bugs feed preferentially on meristematic tissue or developing reproductive tissue. Damage to flower buds or developing seeds occurs in other legume crops. It was suspected that lygus feeding caused a problem referred to as “chalk spot.” It is a chalky white spot which may appear on the cotyledons of some legumes. It affects the appearance of the seed, lowering the grade and marketability. In 1996, chalk spot was a major concern in the North Dakota pea crop; however, no evidence was found that lygus bug caused the damage. The probable cause was pea being harvested at too high a moisture content. Peas harvested at high moisture levels are susceptible to bruising when harvested or handled roughly, resulting in damage similar to chalk spot.

Threshold: None has been determined for the region.

PEA APHID

The most common insect pest found in field pea is the pea aphid. They are small, about 1/8+ inch long, and pale green. In North Dakota, aphids usually do not reach economic levels in field pea. Aphid populations are usually kept low by heavy rains or by beneficial insects such as parasitoid wasps and predators such as lady bird beetle and lacewings. Scouting for aphids in pea is conducted using either a sweep net or examining the number of aphids per plant tip when 50 to 75 percent of the peas are flowering. Take 180 degree sweeps using a15-inch sweep net or check at least five 8-inch plant tips from four different locations in the field. Population estimates should be calculated by averaging counts taken from four separate areas of the field.

Thresholds: Canadian entomologists suggest the following guidelines. Economic thresholds may vary depending on the value of the crops and cost of control, as well as variation in potential seed weight caused by variation in precipitation and heat stress. The economic threshold in peas at $5.71 per bushel and average control cost of $6.73-$9.25/acre is 2 to 3 aphids per 8-inch plant tips, or 9 to 12 aphids per sweep (or 90 to 120 aphids per 10 sweeps), at flowering. If the economic threshold is exceeded, a single application of insecticide when 50% of plants have produced some young pods will protect the crop against yield loss and be cost-effective. Cultivars of peas may also vary in their tolerance to feeding by pea aphids, thus economic injury levels may differ between cultivars. The economic thresholds presented above were developed using “Century” field peas.

Aphid feeding on peas in the flowering and early pod stage can result in lower yields due to less seed formation and smaller seed size. Protein content and other quality issues do not appear to be affected. The following table relates yield loss in peas for average aphid counts from 1 to 8 aphids per 8-inch pea stem tip when about 25% of the crop has begun to flower.

Aphids per sweep	Aphids per tip	% yield loss
7	1	3.4
10	2	4.9
12	3	6.1
15	4	7.1
16	5	8.0
18	6	8.8
20	7	9.6
21	8	10.3

Research in Manitoba has shown that insecticides applied when pods first form protects pea yield better than earlier or later applications. Control at the early pod stage provides protection through the pod formation and elongation stages, which are very sensitive to aphid damage.

WIREWORMS

Wireworms are most likely to be problems when field peas follows pasture or grassland. Infestations often are found in coarse textured soils (sandy loam) where moisture is abundant, perhaps in low spots of fields.

Thresholds: There is no easy way to estimate wireworm infestations. Two methods are currently used.

Soil Sampling: Sample 20, well spaced, 1 square foot sites to a depth of 4 to 6 inches for every 40 acres being planted. If an average of 1 wireworm per square foot is found, treatment would be justified.

Solar Baiting: In September, establish bait stations for 2 to 3 weeks before freeze. Place bait stations randomly through the field, but representing all areas of the field. There should be 10 - 12 stations per 40 acre field. Place one cup wheat and one cup shelled corn in a 4- to 6-inch deep hole. Cover grain with soil and then an 18-inch square piece of clear plastic. Dig up the grain. If an average of one or more wireworm larvae are found per station, treatment would be justified.

Seed Treatments: Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN FIELD PEA

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cutworms	Grasshoppers	Lygus Bugs	Wireworms
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	●	●	●	
beta-cyfluthrin + imidacloprid Leverage 360 *RUP*	2.4 - 2.8 fl oz	7 days Do not feed treated vines or hay	●	●	●		
bifenthrin Bifenture EC Brigade 2EC Fanfare 2EC Sniper Tundra EC *RUP*	2.1 - 6.4 fl oz	14 days	●	●	●	●	
bifenthrin Capture LFR *RUP*	3.4 - 6.8 fl oz 0.2 - 0.39 fl oz per 1000 linear feet	14 days		●			●
bifenthrin + imidacloprid Brigadier Swagger *RUP*	3.8 - 5.6 fl oz 7.6 - 11.2 fl oz	14 days	●	●	●	●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cutworms	Grasshoppers	Lygus Bugs	Wireworms
bifenthrin + zeta-cypermethrin Hero *RUP*	4.0 - 10.3 fl oz	21 days	●	●	●	●	
carbaryl Sevin 4F Sevin XLR Plus	0.5 - 1.5 qts 0.5 - 1.5 qts	21 days for seed and hay 14 days for grazing and forage		●	●	●	
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5.0 - 8.0 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 4 oz 0.8 - 3.2 fl oz 0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	†	●	●	●	
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	21 days Do not feed or graze treated vines	●	●	●		
flubendiamide Belt SC	2 - 3 fl oz	14 days 3 days for forage and hay		●			
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	21 days Do not graze or feed treated vines	●	●	●	●	
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	**COMMERCIAL SEED TREATMENT ONLY** 1.6 - 3.2 fl oz per cwt	None	●				●
imidacloprid Enhance AW	5 oz per cwt	Do not graze or feed livestock on treated area for 60 days after planting	●				●
imidacloprid Impulse 1.6F Nuprid 1.6F Pasada 1.6F Prey 1.6F Sherpa	Foliar application: 3.5 fl oz	7 days	●				
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	Soil applications: 16.0 - 24.0 fl oz	21 days	●				

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cutworms	Grasshoppers	Lygus Bugs	Wireworms
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL Nuprid 2SC	Foliar application: 2.8 fl oz	7 days	●				
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Soil applications: 8.0 - 12.0 fl oz	21 days	●				
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar application: 1.4 fl oz	7 days	●				
imidacloprid Admire Pro Nuprid 4.6F Pro	Soil applications: 7.0 - 10.5 fl oz	21 days	●				
imidacloprid Admire Pro	Foliar application: 1.2 fl oz	7 days	●				
imidacloprid Malice 75WSP	0.9 oz	7 days	●				
lambda-cyhalothrin Warrior II Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z *RUP*	0.96 - 1.92 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●	
spirotetramat Movento	4 - 5 fl oz	7 days	●				
thiamethoxam Cruiser 5FS CruiserMAXX	1.28 fl oz per cwt 3 fl oz per cwt	None	●				●
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	At plant T-band or in-furrow application: 4 fl oz	None		●			●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.4 - 4.3 fl oz 1.28 - 4 fl oz	21 days	●	●	●	●	

RUP = Restricted Use Pesticide
● = Control
† = Suppression Only

FLAX INSECTS

Flax may be infested from the time of emergence to maturity by various insect pests. Fields should be examined regularly and controls applied when infestations reach the economic threshold. The following species are potentially damaging but often occur in too low of numbers to cause economic loss.

ARMY CUTWORM

Larvae of the army cutworm, *Euxoa auxiliaris*, damage flax and many other crops by feeding on foliage in the spring, and to a lesser degree, in the fall. It can be an important pest in southwestern North Dakota. Populations of 9 per square yard can cause significant damage.

ASTER LEAFHOPPER

The aster leafhopper, *Macrosteles quadrilineatus*, can damage flax. This insect feeds by sucking juices from the flax plants. More importantly, aster leafhoppers can carry the Aster Yellows mycoplasm and the crinkle virus, and can infect the plants with these diseases while feeding. The damage from these insects is most serious on late-seeded crops.

BERTHA ARMYWORM

The bertha armyworm, *Mamestra configurata*, was a regular pest of flax before canola and mustard were grown on the prairies. However, since their widespread introduction, the bertha armyworm rarely causes economic damage to weed-free flax fields. If bertha armyworm-infested canola fields are swathed and green flax fields are nearby, the flax can suffer significant damage from invading larvae. When abundant, bertha armyworms cause serious damage by chewing through the stems below the bolls, causing them to drop to the ground. Young bertha larvae are green but larger larvae are usually velvet-black.

GRASSHOPPERS

Grasshoppers have been the **No. 1 threat to North Dakota flax** in recent years. Young grasshoppers may attack young plants and cause damage. However, more damage is done to the crop before harvest by the older, larger grasshoppers. They can quickly cause large numbers of bolls to drop by chewing through the more succulent portions of the stem below the bolls. Growers need to be aware of grasshopper activity in the vicinity of flax fields well before adult migration begins in July. Because of the limited availability of insecticides to control insects in flax, attempts to reduce grasshopper populations in neighboring crops and non-crop areas are advisable.

PALE WESTERN AND REDBACKED CUTWORMS

Two subterranean species of cutworms, the redbacked (*Euxoa ochrogaster*), and the pale western (*Agrotis orthogonia*), attack flax. The adult moths of these species lay eggs on the soil surface in weedy summer fallow fields during late summer. These eggs overwinter and the young larvae feed on flax seedlings in the spring. Cutworms usually remain below ground, cut off the young plants near the soil surface and draw them down where they are eaten. An average population of 10 cutworms per square yard can cause a 10% reduction in the yield of flax, and control should be considered.

WIREWORMS

Wireworms, although often serious pests of cereal grains in the seedling stage, seldom damage flax. Cruiser and Gaucho are labeled as commercial seed treatment for control of wireworm on flax and use decisions must be made at time of seed purchase. Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN FLAX

INSECTICIDE	PRODUCT PER ACRE	PHI	Army Cutworm	Aster Leafhopper	Berth Armyworm	Other Cutworms	Grasshoppers	Wireworms
carbaryl								
Sevin 4F	1 - 1.5 qts	42 days for seed and straw			●			
Sevin 80S	1.25 - 1.875 lbs							
Sevin XLR Plus	1 - 1.5 qts							

INSECTICIDE	PRODUCT PER ACRE	PHI	Army Cutworm	Aster Leafhopper	Berth Armyworm	Other Cutworms	Grasshoppers	Wireworms
imidacloprid Dyna-Shield Imidacloprid 5 Gaucho 600F Senator 600FS	10.2 - 25.6 fl oz per cwt	None						●
thiamethoxam Cruiser 5FS	10.24 fl oz per cwt	None						●
zeta-cypermethrin Mustang Max Mustang Max EC *RUP*	4 fl oz	7 days	●		●	●	●	

RUP = Restricted Use Pesticide
● = Control

FORAGE INSECTS

NOTE: When spraying legume fields, apply insecticides between 8 p.m. and 8 a.m. to protect the local bee population. Never spray fields in bloom.

ALFALFA BLOTCH LEAFMINER

Alfalfa acreage in the upper Midwest was recently invaded by the alfalfa blotch leafminer (ABL). ABL is a gnatlike fly (Diptera) from Europe that was first detected in North America, in Massachusetts, in 1968. By 1994, populations of ABL reached northern Minnesota and by 1997 could be found throughout Wisconsin, the northern 2/3 of Minnesota, and the northeastern corner of Illinois. By October 1998, ABL was distributed throughout Minnesota, Wisconsin, northern Illinois, and eastern North Dakota. Observations suggest that this insect may reduce alfalfa yields by 7% to 20% and protein content by 10% to 20%. Both adults and larvae damage the plant. Females feed by puncturing leaves with their ovipositors, creating characteristic "pinholes," and consuming plant juices. A single female creates an average of 3,769 pinholes during her lifetime. Larvae emerging from eggs create distinctive mines as they feed. Within a field, it is not uncommon for 70% or more of the leaflets to be attacked. The wounds also increase the susceptibility of alfalfa to diseases, especially spring black stem. Still unclear is the economic impact of damage caused by ABL, but the visible damage caused by even low numbers of flies can be disturbing. In the northeastern United States, populations have been supressed by parasitic wasps and control is not recommended.

Severe infestations appear one year after initial colonization by the leafminer. Infestations have now spread to central North Dakota. The first generation in May-June causes the most visible damage. Infested fields take on a whitish cast due to the larval mines in the leaves. The same appearance can be confused with alfalfa weevil feeding; however, you do not have the skeletonizing of the leaves by the leafminers.

Thresholds: Treatment is suggested if 30% to 40% of the plants exhibit pinhole feeding injury. Though several insecticides are available for ABL control in alfalfa, insecticide efficacy trials in Minnesota have not demonstrated significant economic return. If insecticides are used, they must be applied during the "pinhole" stage.

ALFALFA WEEVIL

Larvae

Historically, alfalfa weevil larvae are not a widespread concern in North Dakota, occurring mainly in the southern counties when they are a problem. The light green larvae have a white stripe down the center of the back. They feed in the terminal buds of the growing alfalfa. They may be found in rolled up leaves at the growing tip of the plant. Feeding injury appears as small, circular holes in leaves. As larvae increase in size, feeding injury is more evident. Severely damaged fields take on a silvery appearance due to browning of injured leaf tissue.

Alfalfa Weevil Management: If alfalfa weevil infestations are observed, one of the best strategies is to cut fields for hay early. After cutting, monitor carefully for signs of damage or delayed regrowth, particularly in the swath area where larvae may be concentrated. When early cutting of the crop is not possible, treatment should be considered when 30% of the plants show feeding damage and larvae are still present. The second cutting should be scouted for feeding injury. Treat if 50% of the crowns have weevil feeding, and re-growth is delayed 3-6 days. Feeding injury is often concentrated underneath the windrows. To sample, inspect 20 stems from each of 5 sites in the field, recording the percent of damaged plants and whether larvae were found.

CUTWORMS

The variegated cutworm is an occasional pest of alfalfa and sweetclover in North Dakota. These larvae are about 2 inches long when full grown. Their color ranges from black to light greenish-yellow or tan. They have a distinctive row of pale yellow spots down the middle of their backs. Generally, the most serious damage from this cutworm would be on the stubble following the first cutting. Larvae may concentrate beneath windrows, causing severe damage to these areas.

Threshold: Treatments would be justified when more than 2 worms per square foot are present after the hay has been cut - if larvae are not expected to pupate in the next 3 to 4 days. Another management strategy is to delay cutting if larvae are close to full size and about to pupate. By delaying cutting, the feeding is distributed through the dense canopy of an established stand which is less detrimental than concentrated feeding on the young regrowth.

GRASSHOPPERS

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Most grasshoppers emerge from eggs deposited in uncultivated ground or where plant cover attracted adults the previous season. Infestations could occur any time after emergence begins. Later infestations may develop when grasshopper adults migrate from harvested fields.

Thresholds: Threatening is considered the action threshold for grasshoppers. 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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

LEAFHOPPERS

The potato leafhopper is wedge-shaped and pale green in color. It is only 1/8 inch long. Adults are very active, jumping or flying when disturbed. Both adults and nymphs will run backwards or sideways rapidly. Damage by leafhoppers is referred to as hopper-burn. Foliage becomes dwarfed, crinkled and curled. Small triangular brown areas appear at the tips of leaves, gradually spreading around the entire leaf margin.

Thresholds: Suggested treatment guidelines are presented below. Thresholds are based on the number of leafhoppers per sweep when swinging a sweep net in a pendulumlike motion through the tops of the plants.

LYGUS OR PLANT BUGS

Lygus bugs are a serious pest of alfalfa seed production. These insects are 1/4 inch long and range in color from pale green to light brown to reddish-brown. There is a light-colored, heart-shaped spot on the back. The nymphs are pale green and look similar to aphids, but are much more active movers. Lygus bugs feed on foliage, but the most serious feeding is on the flower buds, flowers, and developing seeds. Feeding causes blossoms to drop, and seeds to shrivel, turn brown and then fail to germinate.

Threshold: Treatments are justified when sweep net samples collect an average of 3 to 5 lygus bugs (adults and nymphs) per pendulum sweep. If insecticides are considered, attempt to time treatments for the control of nymphs prior to the onset of bloom. Protecting insect pollinators in seed production fields is very important.

PEA APHID

The pea aphid is light green and about 1/4 inch long. Alfalfa infested by pea aphids may appear wilted and have a bronze color. When present, pea aphids will crowd together on the terminal shoot, leaves or stems. Monitor fields closely during periods of slow plant growth.

Thresholds: Many aphids per plant are required before the vigor of that plant is reduced. Light populations may be beneficial by providing a food source for predatory and parasitic insects. On 10-inch tall alfalfa, treatment would not be needed until aphids exceed 50 per stem. Taller alfalfa will tolerate greater numbers.

INSECTICIDES REGISTERED FOR USE IN ALFALFA AND GRASS FORAGE CROPS

INSECTICIDE	PRODUCT PER ACRE	PHI	Alfalfa Blotch Leafminer	Alfalfa Weevil	Cutworms	Grasshoppers	Leafhoppers	Lygus or Plant Bugs	Pea Aphid
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 2.8 fl oz	7days for hay or grazing	●	●	●	●	●	●	†
carbaryl Sevin 80S Sevin 4F Sevin XLR Plus	1.25 - 1.875 lbs 1 - 1.5 qts 1 - 1.5 qts	**Alfalfa:** 7days for hay or grazing **Grasses:** 14 days for hay or grazing	●	●	●		●	●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Alfalfa Blotch Leafminer	Alfalfa Weevil	Cutworms	Grasshoppers	Leafhoppers	Lygus or Plant Bugs	Pea Aphid
chlorantraniliprole + lambda-cyhalothrin **ALFALFA ONLY** Voliam Xpress *RUP*	5 - 9 fl oz	7 days for hay 1 day for forage	●	●	●	●	●	●	●
chlorpyrifos **ALFALFA ONLY** Lorsban 15G Saurus	In-furrow or PPI at stand establishment: 6.7 lbs per acre	None			●				
chlorpyrifos **ALFALFA ONLY** Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	0.5 - 2 pts	7 days for hay or grazing for 0.5 pt 14 days for 1 pt 21 days for > 1 pt	●	●	●	●	●	●	●
chlorpyrifos + lambda-cyhalothrin **ALFALFA ONLY** Cobalt Advanced *RUP*	6 - 38 fl oz	7 days for hay or grazing for 6-13 fl oz 14 days for 13-26 fl oz 21 days for > 26 fl oz	●	●	●	●	●	●	●
chlorpyrifos + zeta-cypermethrin **ALFALFA ONLY** Stallion *RUP*	2.5 - 11.75 fl oz	7 days for hay, grazing or seed		●	●	●	●	●	●
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 3.5 oz 0.8 - 2.8 fl oz	7 days for hay or grazing	●	●	●	●	●	●	†
dimethoate **ALFALFA ONLY** Digon 400 Dimate 4E Dimethoate 4E Dimethoate 4EC Dimethoate 400	0.5 - 1 pt	10 days for hay or grazing		†		●	●	●	●
gamma-cyhalothrin **ALFALFA ONLY** Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	7 days for hay 1 day for grazing	●	●	●	●	●	●	●
indoxacarb Steward EC	4.6 - 11.3 fl oz	7 days		●			†		

INSECTICIDE	PRODUCT PER ACRE	PHI	Alfalfa Blotch Leafminer	Alfalfa Weevil	Cutworms	Grasshoppers	Leafhoppers	Lygus or Plant Bugs	Pea Aphid
lambda-cyhalothrin									
Warrior II	0.96 - 1.92	**Alfalfa:** 7 days for hay, 1 day for grazing **Grasses:** 7 days for hay, 0 days for grazing							
Grizzly Z	1.92 - 3.84 fl oz								
Lambda-Cy	1.92 - 3.84 fl oz								
Lambda-T	1.92 - 3.84 fl oz								
LambdaStar	1.92 - 3.84 fl oz								
Lamcap	1.92 - 3.84 fl oz								
Nufarm Lambda Cyhalothrin 1EC	1.92 - 3.84 fl oz		●	●	●	●	●	●	●
Province	1.92 - 3.84 fl oz								
Silencer	1.92 - 3.84 fl oz								
Silencer VC	1.92 - 3.84 fl oz								
Taiga Z	1.92 - 3.84 fl oz								
RUP									
malathion									
Cheminova Malathion 57%	1.5 - 2 pts	0 days		‡		●	●	●	●
Malathion 5	1.5 - 2 pts								
Malathion 57EC	1.5 - 2 pts								
malathion									
Fyfanon ULV	6 - 8 fl oz	0 days	●	‡		●	●	●	●
malathion									
Malathion ULV	8 - 16 fl oz	5 days		‡		●			
methomyl									
ALFALFA ONLY									
Lannate LV	0.75 - 3 pts	7 days for hay or grazing	●	●	●			●	●
RUP									
methyl paration									
Cheminova Methyl 4EC	0.5 - 1 pt	15 days for cutting or grazing		●	●	●	●	●	●
RUP									
permethrin									
ALFALFA ONLY									
Ambush 25W	3.2 - 12.8 oz	14 days							
Ambush	6.4 - 12.8 fl oz								
Arctic 3.2EC	4 - 8 fl oz								
PermaStar	4 - 8 fl oz			●	●		●	●	●
Permethrin 3.2EC	4 - 8 fl oz								
Perm-Up 3.2EC	4 - 8 fl oz								
Pounce 3.2EC	4 - 8 fl oz								
RUP									
phosmet									
Imidan 70W	1 - 1.33 lbs	7 days for hay and grazing		●		●	●		
zeta-cypermethrin									
Mustang Max	2.24 - 4 fl oz	3 days for hay or grazing 7 days for seed		●	●	●	●	●	●
Mustang Max EC									
RUP									
zeta-cypermethrin									
ALFALFA ONLY									
Respect	2.24 - 4 fl oz	3 days for hay or grazing 7 days for seed		●	●	●	●	●	●
Respect EC									

RUP = Restricted Use Pesticide

● = Control

† = Suppression only

‡ = Not effective against alfalfa weevil adults

LENTIL INSECTS

NDSU Pulse-info website: http://www.ndsu.edu/pubweb/pulse-info/index.html

CUTWORMS

Cutworms are an occasional problem in lentil. Cutworms overwinter as eggs or young larvae that feed on the newly emerged shoots in spring. The shoots may be cut off below the soil surface. Cotyledons (seeds) of lentil often remain below the soil surface and can recover from cutworm damage if cool, moist growing conditions. However, recovered plants are generally set back 4 to 7 days by the damage.

Threshold: The risk is low, unless more than 2 to 3 cutworms per square yard occur in the top 3 inches of soil.

GRASSHOPPERS

Grasshoppers are a potential problem in lentil. Lentil crops are less tolerant to grasshopper feeding than some other pulse crops. In lentils, grasshoppers pose the greatest threat from the bud stage through early pod development. Damage on lentil plants is often not highly visible because grasshoppers do not normally prefer lentil foliage. However, grasshoppers will consume flower buds and especially early pods of lentil plants. This can result in yield loss and a delay in maturity due to delayed pod set.

Threshold: Scout fields from the early bud stage through pod development. Research conducted by Agriculture and Agri-Food Canada in Saskatoon found that 2 grasshoppers per square yard, feeding on lentil flowers or pods, can reduce yields enough to warrant insecticide treatment.

LYGUS BUG (TARNISHED PLANT BUG)

Lygus bug feeding on the immature reproductive structures of lentils causes seed and pod abortion, as well as a serious seed-quality problem known as "chalk spot." This problem has been reported for lentil in the Pacific Northwest production areas, but has not been seen as a significant problem in North Dakota. Lygus bugs feed with piercing, sucking mouthparts and inject toxic saliva into the immature seed. This forms a depression around the feeding area and leaves a chalky blemish. Monitor adult lygus bug populations during blooming and podding by using a sweep net, making 25, 180° sweeps in at least 5 randomly selected places in a field.

Threshold: Insecticide treatment is recommended when 7 to 10 adults are collected per 25 sweeps.

PEA APHID

The most common insect pest found in lentil is the pea aphid. They are small, about 1/8+ inch long, and pale green. In North Dakota, aphids usually do not reach economic levels in field pea. Aphids have many natural enemies, including lady bird beetles, parasitic wasps, lacewings and syrphid flies, but chemical control may be necessary if these insects do not keep aphids at subeconomic levels.

Threshold: Insecticide treatment for pea aphid control should be considered (1) when an economic threshold of 30 to 40 aphids are collected per 180° sweep of a 15-inch diameter insect net, (2) when few natural enemies are present, and (3) when aphid numbers do not decline over a 2-day period.

INSECTICIDES REGISTERED FOR USE IN LENTIL

INSECTICIDE	PRODUCT PER ACRE	PHI	Cutworms	Grasshoppers	Lygus Bugs	Pea Aphid
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	●	●	●	†
beta-cyfluthrin + imidacloprid Leverage 360 *RUP*	2.4 - 2.8 fl oz	7 days Do not feed treated vines or hay	●	●		●

INSECTICIDE	PRODUCT PER ACRE	PHI	Cutworms	Grasshoppers	Lygus Bugs	Pea Aphid
bifenthrin Bifenture EC Brigade 2EC Fanfare 2EC Sniper Tundra EC *RUP*	2.1 - 6.4 fl oz	14 days	●	●	●	●
bifenthrin + imidacloprid Brigadier Swagger *RUP*	3.8 - 5.6 fl oz 7.6 - 11.2 fl oz	14 days	●	●	●	●
bifenthrin + zeta-cypermethrin Hero *RUP*	4.0 - 10.3 fl oz	21 days	●	●	●	●
carbaryl Sevin 4F Sevin XLR Plus	0.5 - 1.5 qts 0.5 - 1.5 qts	21 days for seed and hay 14 days for grazing and forage	●	●	●	
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5.0 - 8.0 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 4 oz 0.8 - 3.2 fl oz 0.8 - 3.2 fl oz	7 days Do not feed treated vines or hay	●	●	●	†
dimethoate Digon 400 Dimate 4E Dimethoate 4E Dimethoate 4EC Dimethoate 400	0.5 - 1 pt	14 days Do not feed vines			●	●
esfenvalerate Adjourn Asana XL *RUP*	5.8 - 9.6 fl oz	21 days Do not feed or graze treated vines	●	●		●
flubendiamide Belt SC	2 - 3 fl oz	14 days 3 days for forage and hay	●			
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	21 days Do not graze or feed treated vines	●	●	●	●
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	**COMMERCIAL SEED TREATMENT ONLY** 1.6 - 3.2 fl oz per cwt	None				‡
imidacloprid Enhance AW	5 oz per cwt	Do not graze or feed livestock on treated area for 60 days after planting				‡

INSECTICIDE	PRODUCT PER ACRE	PHI	Cutworms	Grasshoppers	Lygus Bugs	Pea Aphid
imidacloprid Impulse 1.6F Nuprid 1.6F Pasada 1.6F Prey 1.6F Sherpa	Foliar application: 3.5 fl oz	7 days				●
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	Soil applications: 16.0 - 24.0 fl oz	21 days				‡
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL Nuprid 2SC	Foliar application: 2.8 fl oz	7 days				●
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Soil applications: 8.0 - 12.0 fl oz	21 days				‡
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar application: 1.4 fl oz	7 days				●
imidacloprid Admire Pro Nuprid 4.6F Pro	Soil applications: 7.0 - 10.5 fl oz	21 days				‡
imidacloprid Admire Pro	Foliar application: 1.2 fl oz	7 days				●
imidacloprid Malice 75WSP	0.9 oz	7 days				●
lambda-cyhalothrin Warrior II Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z *RUP*	0.96 - 1.92 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz	21 days Do not graze or harvest vines for forage or hay	●	●	●	●
spirotetramat Movento	4 - 5 fl oz	7 days				●

INSECTICIDE	PRODUCT PER ACRE	PHI	Cutworms	Grasshoppers	Lygus Bugs	Pea Aphid
thiamethoxam Cruiser 5FS CruiserMAXX	1.28 fl oz per cwt 3 fl oz per cwt	None				‡
zeta-cypermethrin Mustang Max Mustang Max EC Respect *RUP*	At plant T-band or in-furrow application: 4 fl oz	None	●			
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.4 - 4.3 fl oz 1.28 - 4 fl oz	21 days	●	●	●	●

RUP = Restricted Use Pesticide
● = Control
† = Suppression only
‡ = Early season Pea Aphid control only

LUPINE INSECTS

Lupine has been grown as a grain legume. One of the primary insect pests of lupine in North Dakota has been blister beetles. Most species of blister beetles have one generation per year. Adults emerge from the soil throughout the growing season (May through September), though periods of peak activity vary with the species. Most species are more abundant in July and August. Common blister beetle species that feed on lupine are the ash gray and black blister beetles. The larvae of most blister beetle species infesting legumes prey on grasshopper egg pods. Therefore, large populations of blister beetles are frequently associated with grasshopper outbreaks. Consequently, legumes grown near rangeland have a greater likelihood of blister beetle infestation.

INSECTICIDES REGISTERED FOR USE IN LUPINE FOR BLISTER BEETLE CONTROL

INSECTICIDE	PRODUCT PER ACRE	PHI	Blister Beetles
beta-cyfluthrin			
Baythroid XL *RUP*	2.4 - 3.2 fl oz	7 days Do not feed treated vines or hay to livestock	●
bifenthrin + zeta-cypermethrin			
Hero *RUP*	4.5 - 11.2 fl oz	21 days Do not graze or harvest vines for forage or hay	●
carbaryl			
Sevin 4F Sevin XLR Plus	0.5 - 1 qt	21 days for grain or hay 14 days for grazing or forage	●
cyfluthrin			
Renounce 20W Tombstone Tombstone Helios *RUP*	3 - 4 oz 2.4 - 3.2 fl oz 2.4 - 3.2 fl oz	7 days Do not feed treated vines or hay to livestock	
gamma-cyhalothrin			
Declare Proaxis *RUP*	1.02 - 1.54 fl oz 2.56 - 3.84 fl oz	21 days Do not graze or harvest vines for forage or hay	●
lambda-cyhalothrin			
Warrior II Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z *RUP*	1.28 - 1.92 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz 2.56 - 3.84 fl oz	21 days Do not graze or harvest vines for forage or hay	●
lambda-cyhalothrin + chlorantraniliprole			
Voliam Xpress *RUP*	6 - 9 fl oz	21 days Do not graze livestock or harvest vines for forage or hay	●
zeta-cypermethrin			
Mustang Max Mustang Max EC Respect *RUP*	2.72 - 4 fl oz	21 days Do not graze or harvest vines for forage or hay	●

RUP = Restricted Use Pesticide
● = Control

MUSTARD INSECTS

Yellow mustard (*Sinapis alba*) is the most common type grown in North Dakota; small acreages of brown and Oriental (*Brassica juncea*) are also being grown. These mustards are grown for the seed and used as a condiment. Insects that affect canola may also affect mustard grown for seed. Fortunately, these insects have not caused serious problems for mustard seed on an annual basis.

FLEA BEETLES

Mustard grown for seed has generally not been at risk to significant flea beetle feeding injury. However, circumstances can develop that put mustard seedlings at greater risk. This crop has demonstrated greater tolerance to flea beetle feeding and is less attractive to the beetles when canola is available. However, if weather delays emergence (cold soils, mid-May snows, etc.) mustard plants may also be more vulnerable to flea beetle attack. Mustard plants may attract beetles in large numbers and put the crop at greater risk of stand loss. Once the crop advances beyond the seedling stage, serious damage usually does not occur, since vigorously growing mustard can outgrow the beetle defoliation. No major effects on plant vigor have been noted from the feeding of the larvae on plant roots.

Insecticides are not generally available for use in mustard seed production. Insecticides for mustard greens are numerous, but are not permitted for use in mustard seed. Insecticides labeled for canola are not approved for use in mustard grown for seed. It is hoped that efforts underway to address insecticide availability for this crop will be successful. In December 2003, the insecticide **seed treatment** Gaucho 600 was labeled for use on mustard grown for seed. As with canola, mustard seed growers now have an insecticide option that can provide some early season protection from flea beetle feeding, but they must plan on this approach as they acquire planting seed in the winter.

INSECTICIDES REGISTERED FOR USE IN MUSTARD FOR FLEA BEETLE CONTROL

INSECTICIDE	PRODUCT PER ACRE	PHI	Flea Beetles
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600F Senator 600FS	10.24 - 25.6 fl oz per cwt	None	●
thiamethoxam Cruiser 5FS	10.24 fl oz per cwt	None	●
zeta-cypermethrin Mustang Max Mustang Max EC *RUP*	4 fl oz	7 days	●

RUP = Restricted Use Pesticide
● = Control

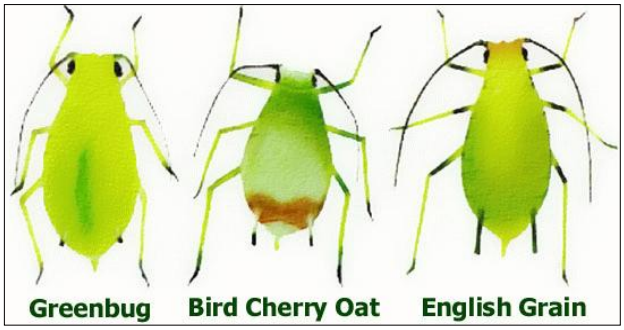
OATS INSECTS

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)

APHIDS

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 principal 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 population grows 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: 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, 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.

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: 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.

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 3 eggs and/or 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.

At the boot stage to 1 larvae or more per flag leaf.

CUTWORMS

Several cutworm species affect regional crops. 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. 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.

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

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.

Thresholds: The threatening rating is considered the action threshold for grasshoppers. 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 per square yard		**Adults per square yard**	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

INSECTICIDES REGISTERED FOR USE IN OATS

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cereal Leaf Beetle	Cutworms	Grasshoppers
Bacillus thuringiensis							
Biobit HP	0.5 - 2 lbs	None		‡			
Dipel DF	1 - 2 lbs						
Dipel ES	2 - 4 pts						
beta-cyfluthrin							
Baythroid XL *RUP*	1 - 2.4 fl oz	30 days for grain 3 days for grazing or forage	●	‡	●	●	●
diflubenzuron							
Dimilin 2L **FOR USE WEST OF US HIGHWAY 281 ONLY** *RUP*	1 - 4 fl oz	50 days for grain or straw 15 days for hay 3 days for forage			‡		‡
imidacloprid							
Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	0.8 - 2.4 fl oz per cwt	45 days for grazing or forage	*				*
imidacloprid							
Enhance AW	4 oz per cwt	45 days for grazing or forage	*				
imidacloprid							
Rancona Crest Rancona Crest WR	5 - 8.33 fl oz per cwt	45 days for grazing or forage	*				
lambda-cyhalothrin							
Warrior II	0.96 - 1.92 fl oz	30 days for grain or straw 7 days for grazing or forage	●	●	●	●	●
Grizzly Z	1.92 - 3.84 fl oz						
Lambda-Cy EC	1.92 - 3.84 fl oz						
LambdaStar	1.92 - 3.84 fl oz						
Lambda-T	1.92 - 3.84 fl oz						
Lamcap	1.92 - 3.84 fl oz						
Nufarm Lambda Cyhalothrin 1EC	1.92 - 3.84 fl oz						
Province	1.92 - 3.84 fl oz						
Silencer	1.92 - 3.84 fl oz						
Silencer VC *RUP*	1.92 - 3.84 fl oz						
malathion							
Cheminova Malathion 57%	1.5 pts	7 days	●	●	●		‡
Malathion 5	1 - 2 pts						
Malathion 57EC	1.5 - 1.6 pts						
malathion							
Fyfanon ULV Malathion ULV	4 - 8 fl oz	7 days			●		●
methomyl							
Lannate LV *RUP*	0.75 - 1.5 pts	7 days	●	●	●		
methyl parathion							
Cheminova Methyl 4EC *RUP*	0.75 - 1.5 pts	15 days	●	●		●	●
methyl parathion							
Penncap-M *RUP*	2 - 3 pts	14 days **REI: 31 days**	●	●			●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cereal Leaf Beetle	Cutworms	Grasshoppers
spinetoram							
Radiant SC	2 - 6 fl oz	21 days for grain or straw 3 days for forage, fodder or hay		●	●		†
spinosad							
Blackhawk	1.1 - 3.3 oz	21 days for grain or straw 3 days for forage, fodder or hay		●	●		†
Entrust	0.5 - 2 oz						
Spintor 2SC	2 - 6 fl oz						
Success	2 - 6 fl oz						
Tracer	1 - 3 fl oz						

RUP = Restricted Use Pesticide
● = Control
* = Seed treatments may not provide early-season aphid and grasshopper control
† = Suppression only
‡ = Control of first and second instar larvae or nymphs only

POTATO INSECTS

Other resources available through NDSU Extension Service:

Publications:	E1001 Potato Leafhopper Biology and Control
	EB No. 26 Potato Production and Pest Management in North Dakota and Minnesota
Video	282 Potato Production in the Red River Valley

APHIDS

Aphids are major pests of seed potatoes because they transmit viruses which lead to rejection of the seed lot. For this reason, seed producers must keep aphid numbers lower than what can be tolerated on table stock. The most common aphid found on potato is the green peach aphid, an important vector of potato leaf roll virus (PLRV). Many aphids can transmit potato virus Y (PVY). Control measures are targeted specifically against aphids to keep virus spread to a minimum in seed production; control is not as common in normal commercial production.

Thresholds

***Seed Stock*:** To prevent the spread of PLRV, treat when aphid populations reach levels of 10 aphids per 100 leaves. Insecticides will not effectively prevent the spread of PVY.

***Table Stock*:** To prevent a yield loss from direct feeding by aphids, treat when aphid densities reach 30 aphids per 100 leaves. Sample only middle to lower leaves; aphids will rarely be found on young leaves.

CABBAGE LOOPER

Many different defoliating insects can be found on potatoes. Potatoes are relatively tolerant of some defoliation, especially if the attack is not sustained. The cabbage looper is a light green caterpillar with white or pale yellow stripes down the side. They have only three pair of fleshy prolegs, causing them to loop when moving forward.

Threshold: Normal populations seldom reach economically significant levels in North Dakota.

COLORADO POTATO BEETLE

This beetle is the most common and destructive leaf feeding pest of potato. Both adults and larvae feed on foliage. The adult is 3/8 inch long, with oval body and a yellow-brown color with 5 black stripes on each wing cover. The larvae are 1/8 to 3/8 inch long, brick red to light orange in color. Eggs are laid on the underside of leaves in clusters of 10 to 30 and are orange colored when ready to hatch. In North Dakota, overwintered beetles emerge from May to June. The first-generation larvae are present in the fields from June through July. Beetles from these larvae appear in fields in July, feeding and laying eggs for a second generation. One of the greatest concerns with management programs for beetles is resistance to insecticides. The best way to manage the development of resistance in an insect population is the reduced use of compounds, limiting the selection of surviving (resistant) individuals. In North Dakota, resistance to the pyrethroid insecticides has been documented and the use of these compounds should be limited to one application per season. If control failures occur following the application of any product, switching to a different class of insecticides is recommended.

Threshold: The current recommendation is that spraying be initiated at first egg hatch. Best results have been achieved by flagging the first egg masses that can be located, monitoring these daily, and spraying at 15 to 30% hatch. If the insecticide used is effective but not persistent, a second application should be made 5 to 10 days later. With this approach, the first-generation beetle larvae should be controlled with one or two applications.

POTATO LEAFHOPPER

Direct feeding damage to foliage is the primary concern with leafhoppers. The potato leafhopper migrates north in the spring, arriving before potatoes emerge. Leafhoppers develop in alfalfa first, moving to potatoes later.

Leafhopper adults are wedge-shaped, 1/8 inch long, and lime green to yellow green in color. The nymphs resemble the adults but are wingless. When disturbed, the nymphs move across the leaf in a sideways fashion.

Damage by leafhoppers is referred to as hopper-burn. Foliage becomes dwarfed, crinkled, and curled. Small triangular brown areas appear at the tips of leaves, gradually spreading around the entire leaf margin. Immature leafhoppers are more destructive than the adults, and generally more numerous than adults.

Threshold: Treatments are recommended when potato leafhoppers can be found at a level of 1 nymph per 10 leaves. Sample 35 leaves in each of 5 locations in a field. Pluck leaves from the plants and inspect the underside of the leaf for the presence of nymphs.

FLEA BEETLE

Flea beetles are small, dull black beetles, about 1/16 inch long, with hind legs adapted for jumping. The adults overwinter in the soil, emerging in the spring to begin feeding on young foliage. Newly emerged plants are most vulnerable. When abundant, flea beetles shot-hole the foliage with numerous small round holes. Severely damaged leaves do not recover.

Threshold: Thresholds for this pest are not well-defined. Past recommendations have suggested treatment when 10% of the leaf area is lost due to flea beetle feeding. Early season weed control and removal of crop debris make fields less attractive to flea beetles.

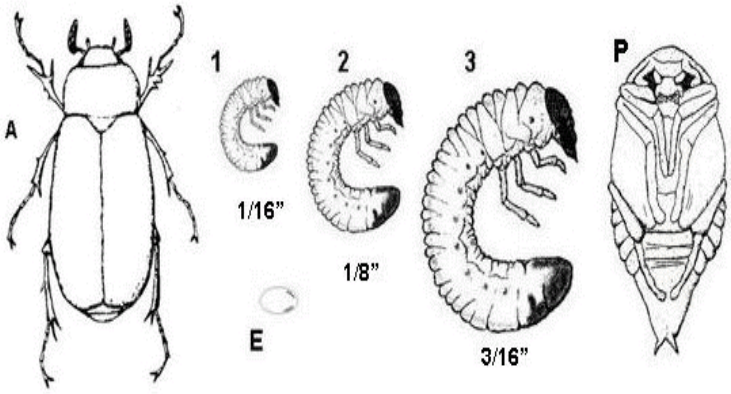
VARIEGATED CUTWORM

The variegated cutworm is an occasional pest of potato in the region. These larvae are about 2 inches long when full grown. Their color ranges from black to light greenish-yellow or tan. They have a distinctive row of pale yellow spots down the middle of their backs. The variegated cutworm is a climbing cutworm, feeding in the plant canopy at night. Variegated cutworm have been responsible for below-ground feeding that damages tubers. The variegated cutworm overwinters in states to the south of North Dakota, making annual predictions of problems difficult. Moths migrate to the region during the spring and summer months. There are multiple generations of this cutworm, numbering two to three, depending on environmental conditions.

Threshold: Treatments would be justified when 4 or more worms per square foot are present.

WHITE GRUBS

White grubs that are destructive to field crops in North Dakota have a three-year life cycle. In southeast North Dakota, the most common white grub pest occurs in continuous cropping situations at sites where willow and cottonwood trees are present. In other areas of the state, white grubs are most likely to be found when rotation from grassland, pasture, or grassy weed sites occur. Most root feeding occurs in the second year of the life cycle. In most cases, the number of second-year grubs will only be great enough to justify control once every three years.



Life stages of Phyllophaga implicita: A - adult June beetle; E - egg; grub stages with their head width in inches, 1 - first; 2 - second; 3 - third; and P - pupa.

Thresholds: Treatment is recommended when sampling indicates an average of one or more white grubs per square foot are found. The following sampling procedure provides treatment decisions based on this guideline.

***Soil sampling*:** Fields need to be sampled to determine grub abundance and aid in determining if control is necessary. Sampling in late summer or early fall, before a freeze, provides a more reliable estimate of populations than spring sampling just before planting. Larvae are typically present in the upper 6 inches of soil until a killing frost occurs in the fall. Take soil samples, 1 square foot in size to a depth of 8 inches. Begin taking samples 45 yards from shelterbelts. A total of 30 samples per field, randomly spaced along the shelterbelts, are necessary. If at least a single grub is found in less than 40% of the samples, treatment may be required only out 20 yards from the tree line. If 40% to 60% of the samples are infested, treatment is needed to this distance and maybe as far as 65 yards. If greater than 60% of the samples are infested, treatment may be needed out to 90 yards from the tree line.

WIREWORMS

Wireworms are most likely to be problems when dry beans follows pasture or grassland. Infestations often are found in coarse textured soils (sandy loam) where moisture is abundant, perhaps in low spots of fields.

Thresholds: There is no easy way to estimate wireworm infestations. Two methods are currently used.

***Soil Sampling*:** Sample 20, well spaced, 1 square foot sites to a depth of 4 to 6 inches for every 40 acres being planted. If an average of 1 wireworm per square foot is found, treatment would be justified.

***Solar Baiting*:** In September, establish bait stations for 2 to 3 weeks before freeze. Place bait stations randomly through the field, but representing all areas of the field. There should be 10 - 12 stations per 40 acre field. Place one cup wheat and one cup shelled corn in a 4- to 6-inch deep hole. Cover grain with soil and then an 18-inch square piece of clear plastic. Dig up the grain. If an average of one or more wireworm larvae are found per station, treatment would be justified.

INSECTICIDES REGISTERED FOR USE IN POTATO

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cabbage Looper	Colorado Potato Beetle	Flea Beetles	Potato Leafhopper	Potato Psyllid	Variegated Cutworm	White Grubs	Wireworms
abamectin ABBA 0.15EC Agri-Mek 0.15EC Epi-Mek 0.15EC Nufarm Abamectin 0.15EC Reaper 0.15EC Temprano Timectin 0.15EC *RUP*	8 - 16 fl oz	14 days Do not allow livestock to graze or feed treated foliage to livestock			●			●			
acetamiprid Assail 30SG Assail 70WP	1.5 - 4 oz 0.6 - 1.7 oz	7 days	●		●	●	●				
avermectin + bifenthrin Athena *RUP*	7 - 17 fl oz	21 days	●	●	●	●	●	●	●		
Bacillus thuringiensis Biobit HP Dipel DF Dipel ES Xentari DF	0.5 - 1 lb 0.5 - 1 lb 1 - 2 pts 0.5 - 1.5 lbs	None		‡					‡		
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 2.8 fl oz	None for tubers 14 days for grazing if more than 5.6 fl oz per acre is applied	†	●	●	●	●	●	●		
beta-cyfluthrin + imidacloprid Leverage 360 *RUP*	2.8 fl oz	7 days	●	●	●	●	●	●	●		
bifenthrin Bifenture EC Brigade 2EC Fanfare 2EC Sniper Tundra EC *RUP*	At Plant, In-furrow or T-band: 19.2 fl oz Lay-by: 3.2 - 9.6fl oz	21 days								●	●
bifenthrin Bifenture EC Brigade 2EC Fanfare 2EC Sniper Tundra EC *RUP*	Foliar Application: 2.1 - 6.4 fl oz	21 days				●					
bifenthrin Capture LFR *RUP*	At Plant In-furrow, T-band or Lay-by: 12.75 - 25.5 fl oz	35 days								●	●
bifenthrin + imidacloprid Brigadier Swagger *RUP*	At Plant: 16 - 25.6 fl oz 32 - 51.2 fl oz	21 days	●		●	●	●	●		●	●
bifenthrin + imidacloprid Brigadier Swagger *RUP*	Foliar Application: 3.8 - 6.14 fl oz 7.6 - 12.28 fl oz	21 days	●	●	●	●	●	●			

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cabbage Looper	Colorado Potato Beetle	Flea Beetles	Potato Leafhopper	Potato Psyllid	Variegated Cutworm	White Grubs	Wireworms
bifenthrin + zeta-cypermethrin Hero *RUP*	2.6 - 10.3 fl oz	21 days	●	●	●	●	●		●		
carbaryl Sevin 4F Sevin 80S Sevin XLR Plus	0.5 - 2 qts 0.625 - 2.5 lbs 0.5 - 2 qts	7 days			●	●	●		●		
chlorantraniliprole Coragen	3.5 - 5 fl oz	14 days		●	●						
chlorantraniliprole + lambda-cyhalothrin Voliam Xpress *RUP*	5 - 9 fl oz	14 days	●	●	●	●	●	●	●		
chlorantraniliprole + thiamethoxam Voliam Flexi	4 oz	14 days	●	●	●	●	●				
clothianidin Belay	In-furrow or Side-dress Application: 9 - 12 fl oz	None	●		●	●	●	†			
clothianidin Belay	Foliar Application: 2 - 3 fl oz	14 days	●		●	●	●				
clothianidin Belay 50 WDG	1 - 1.5 fl oz	14 days	●		●		●				
cyfluthrin Renounce 20WP Tombstone Tombstone Helios *RUP*	1 - 3.5 oz 0.8 - 2.8 fl oz 0.8 - 2.8 fl oz	0 days for tubers 14 days for grazing	†	●	●	●	●	●	●		
deltamethrin Battalion 0.2EC Delta Gold *RUP*	7.7 - 17.9 fl oz 1 - 2.4 fl oz	3 days Do not graze livestock on vines	†	●	●	●	●		●		
dimethoate Digon 400 Dimate 4E Dimethoate 4E Dimethoate 4EC Dimethoate 400	0.5 - 1 pt	14 days	●				●				
dinotefuran Scorpion 35SL	Soil Application: 11 - 13 fl oz Foliar Application: 2 - 2.75 fl oz	7 days	†		●	●	●	●			
dinotefuran Venom 20SG	Soil Application: 1.4 - 1.65 lbs Foliar Application: 0.33 lb	7 days	†		●	●	●	●			
dinotefuran Venom	Soil Application: 6.5 - 7.5 oz Foliar Application: 1 - 1.5 oz	14 days			●	●	●				

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cabbage Looper	Colorado Potato Beetle	Flea Beetles	Potato Leafhopper	Potato Psyllid	Variegated Cutworm	White Grubs	Wireworms
esfenvalerate Adjourn Asana XL *RUP*	2.9 - 9.6 fl oz	7 days	●	●	●	●	●	●	●		
fipronil Regent 4SC *RUP*	At Plant In-furrow: 0.184 - 0.22 fl oz per 1,000 row-feet depending on row spacing	90 days									●
flonicamid Beleaf 50G	2 - 2.8 oz	7 days	●								
imidacloprid Impulse 1.6FL Nuprid 1.6F Pasada 1.6F Prey 1.6 Sherpa	Foliar Application: 3.8 fl oz	7 days	●		●	●	●	●			
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	In-furrow, Side-dress or Banded Application: 0.9 - 1.3 fl oz per 1,000 row-feet	None	●		●	●	●	●			●
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL MANA Alias 2F Montana 2F Nuprid 2F Nuprid 2SC Widow	Seed Piece Treatment: 0.4 - 0.8 fl oz per cwt	None	●		●	●	●	●			●
imidacloprid Advise 2FL AmTide Imidacloprid 2F Couraze 2F Macho 2FL Montana 2F Nuprid 2SC	Foliar Application: 3 fl oz	7 days	●		●	●	●	●			
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	In-furrow, Side-dress or Banded Application: 0.45 - 0.65 fl oz per 1,000 row-feet	None	●		●	●	●	●			●
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max Wrangler	Seed Piece Treatment: 0.2 - 0.4 fl oz per cwt	None	●		●	●	●	●			●

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cabbage Looper	Colorado Potato Beetle	Flea Beetles	Potato Leafhopper	Potato Psyllid	Variegated Cutworm	White Grubs	Wireworms
imidacloprid Couraze 4F Mana Alias 4F Montana 4F Nuprid 4F Max	Foliar Application: 1.5 fl oz	7 days	●		●	●	●	●			
imidacloprid Admire Pro Nuprid 4.6F Pro	In-furrow, Side-dress or Banded Application: 5.7 - 8.7 fl oz per acre	None	●		●	●	●	●			●
imidacloprid Admire Pro Nuprid 4.6F Pro	Seed Piece Treatment: 0.17 - 0.35 fl oz per cwt	None	●		●	●	●	●			●
imidacloprid Admire Pro	Foliar Application: 1.3 fl oz	None	●		●	●	●	●			
imidacloprid Malice 75WSP	1 oz	7 days	●		●	●	●	●			
indoxacarb Avaunt	2.5 - 6 oz	7 days		●	●						
lambda-cyhalothrin Grizzly Z Lambda-Cy EC LambdaStar Lambda-T Lamcap Nufarm Lambda Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z Warrior II *RUP*	1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 0.96 - 1.92 fl oz	7 days	●	●	●	●	●	●	●		
lambda-cyhalothrin + thiamethoxam Endigo ZC *RUP*	3.5 - 4.5 fl oz	14 days	●	●	●	●	●	●	●		
malathion Cheminova Malathion 57% Malathion 5 Malathion 57EC	1.5 - 2 pts 1 pt 1 - 1.5 pts	None	●				●				
methomyl Lannate LV *RUP*	1.5 - 3 pts	6 days	●	●		●	●		●		
novaluron Rimon 0.83EC	6 - 12 fl oz	14 days		●	●						
oxamyl Vydate C-LV *RUP*	8.5 - 34 fl oz	7 days	●		●	●	●				
oxamyl Vydate L *RUP*	In-furrow: 1 - 2 gal Foliar Application: 1 - 4 pts	7 days	●		●	●	●				

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Cabbage Looper	Colorado Potato Beetle	Flea Beetles	Potato Leafhopper	Potato Psyllid	Variegated Cutworm	White Grubs	Wireworms
permethrin Ambush 25W Ambush Arctic 3.2EC PermaStar Permethrin 3.2EC Perm-UP 3.2EC Pounce 3.2EC *RUP*	3.2 - 12.8 oz 3.2 - 12.8 fl oz 4 - 8 fl oz 4 - 8 fl oz 4 - 8 fl oz 4 - 8 fl oz	14 days	●	●	●	●	●	●	●		
phorate Phorate 20G Thimet 20G SmartBox Thimet 20G Lock n Load *RUP*	At Plant for Light or Sandy Soils: 8.5 - 11.3 oz per 1,000 row-feet At Plant for Heavy or Clay Soils: 13 - 17.3 oz per 1,000 row-feet	90 days	●		●	†	●	●			●
phosmet Imidan 70W	1.33 lbs	7 days			●	●	●				
pymetrozine Fulfill	2.75 - 5.5 oz	14 days	●					†			
spinetoram Radiant SC	4.5 - 8 fl oz	7 days		●	●						
spinosad Blackhawk Entrust Spintor 2SC Success	1.7 - 3.5 oz 1 - 3 oz 3.2 - 9.6 fl oz 4.5 - 10 fl oz	7 days		●	●						
spiromesifen Oberon 2SC	8 - 16 fl oz	7 days						●			
spirotetramat Movento	4 - 5 fl oz	7 days	●								
thiamethoxam Actara	1.5 - 3 fl oz	14 days	●		●	●	●				
thiamethoxam Cruiser 5FS	Seed Piece Treatment: 0.11 - 0.16 fl oz per cwt **Consult label for correct rate based on seeding rate**	None	●		●	●	●	●			●
thiamethoxam Cruiser MAXX Potato	Seed Piece Treatment: 0.19 - 0.27 fl oz per cwt **Consult label for correct rate based on seeding rate**	None	●		●	●	●	●			
thiamethoxam Platinum Platinum 75SG	Soil Applications: 5 - 8 fl oz 1.66 - 2.67 fl oz **Consult label for soil application methods**	None	●		●	●	●	●			●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.28 - 4 fl oz	1 day Do not use leaves or vines for food or feed	†	●	●	●	●		●		

RUP = Restricted Use Pesticide
● = Control
† = Suppression only
‡ = Control of first and second instar larvae only

RANGELAND AND NON-CROP SITES
GRASSHOPPER MANAGEMENT

Summary of North Dakota Law Regarding Grasshopper Control Along Roadsides

***Townships and Counties*:** Townships and counties are authorized to control grasshoppers infesting road rights of way under their authority (1991 law).

Requirements

- Pesticides **must be labeled** for use on forage crops so they **may be hayed**
- Written notice to all landowners or tenants 3 days prior to treatment
  - Date of treatment
  - Name of pesticide and restrictions on harvest and use of forage
  - Must exclude areas opposed by adjacent landowner or occupant

***State Highway Rights of Way*:** Counties may enter into agreement with DOT to control grasshoppers in state highway system rights of way. (Contact DOT district office)

North Dakota Department of Agriculture must approve plan when state funds involved (Contact North Dakota Department of Agriculture at 701.328.4765)

- Request for approval form is submitted by County Pest Coordinator
- Plan must include county or township roads
- Scouting to verify economic infestation
- Treatments must be made prior to adult stage

Financing Summary

Counties: Governing body may use county emergency fund (57-15-28) to pay for control costs in county road system rights of way and for cost share with townships.

Maximum balance

- 5 mills for large counties (Burleigh, Cass, Grand Forks, Ward)
- 10 mills for small counties

Tax limitation for emergency purposes (57-15-06.7)

- Tax for emergency purposes not to exceed 2 mills.

Townships: Electors may appropriate funds (57-15-19) for controlling grasshoppers in township rights of way. Total annual tax levy (for all purposes) in a civil township may not exceed 18 mills.

Roadside Right of Way Grasshopper Spray Program Considerations

Treatment of grasshoppers when they are young, concentrated in hatching areas, and highly susceptible to lower rates of insecticide is a long standing management strategy. Roadside rights of way are sometimes major hatching areas for grasshoppers. Infestations are often variable and not all roadsides are likely to be infested. Roadsides that were weedy or had enough green vegetation to attract adult grasshoppers during the previous year's egg-laying period are more likely to be infested with eggs. Roadsides adjacent to late-season crops that are themselves attractive egg-laying sites are also more heavily infested.

Numerous other areas on the farm can also be hatching areas, including fencerows, shelterbelts, rock piles, grass waterways, weedy waste areas, some CRP, alfalfa and haylands, and last year's weedy fallow and weedy fields. Fields planted to a late-season crop last year, such as sunflower, safflower, flax and soybean, are attractive especially when summer-fallowed this year.

Treatment timing can be difficult. Egg hatch normally occurs over a 4 - 6 week period and the developing grasshoppers gradually move out from their hatching areas. Spraying too early can miss later hatching grasshoppers while spraying too late allows early hatching hoppers to move into crops and escape treatment and perhaps cause serious crop damage.

What are Reasonable Expectations

1. Roadside programs conducted when roadsides are generally infested and a major contributor as hatching areas can reduce but not eliminate the threat of grasshopper damage.
2. Farmers may be disappointed if they do not make efforts to identify, monitor, and manage other hatching areas.
3. Roadside programs may reduce, but are unlikely to eliminate, the need for additional crop protection measures in years favorable for grasshoppers.
4. Roadside programs may contribute to, but are unlikely to be responsible for, preventing grasshoppers from laying eggs and creating the potential for problems next year.

Roadside Programs should:

1. Include scouting to determine if a sufficient percentage of roadsides are infested to warrant a roadside program. Roadside infestations are frequently spotty and other areas frequently contribute to the grasshopper problem.
2. Treatments should generally be applied prior to significant movement of grasshoppers into fields. Movement normally begins as hoppers approach the 3rd instar. Treatments after adults appear are not effective.

3. Farmers should be encouraged to scout and if necessary treat other hatching areas with threatening populations.

GRASSHOPPERS

Threshold: The threatening rating is considered the action threshold for grasshoppers. 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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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+

INSECTICIDES REGISTERED FOR USE ON RANGELAND AND/OR NON-CROP AREAS: GRAZED OR CUT FOR HAY

INSECTICIDE	PRODUCT PER ACRE	PHI	Rangeland	Non-crop Areas
beta-cyfluthrin				
Baythroid XL *RUP*	1.6 - 2.8 fl oz	None for grazing and haying	●	
carbaryl				
Sevin 4F	0.5 - 1 qt	14 days for grazing and haying for pastures and non-crop areas	●	●
Sevin 80S	1.25 - 1.875 lb			
Sevin 80WSP	1.25 - 1.875 lb			
Sevin SL	0.5 - 1 qt			
Sevin XLR Plus	0.5 - 1 qt	None for grazing and haying for rangeland		
cyfluthrin				
Renounce 20WP	2 - 3.5 oz	None for grazing and haying	●	
Tombstone	1.6 - 2.8 fl oz			
Tombstone Helios *RUP*	1.6 - 2.8 fl oz	7 days for grazing and haying in mixed stands with alfalfa		
diflubenzuron				
Dimilin 2L *RUP*	0.5 - 2 fl oz Use high rate for non-crop areas	1 day for haying	●	●
lambda-cyhalothrin				
Warrior II	0.96 - 1.92 fl oz	None for grazing and forage	●	
Grizzly Z	1.92 - 3.84 fl oz			
Lambda-Cy EC	1.92 - 3.84 fl oz	7 days for haying		
LambdaStar	1.92 - 3.84 fl oz			
Lambda-T	1.92 - 3.84 fl oz			
Lamcap	1.92 - 3.84 fl oz			
Nufarm Lambda Cyhalothrin 1EC	1.92 - 3.84 fl oz			
Province	1.92 - 3.84 fl oz			
Silencer	1.92 - 3.84 fl oz			
Silencer VC	1.92 - 3.84 fl oz			
Taiga Z *RUP*	1.92 - 3.84 fl oz			
malathion				
Fyfanon ULV	8 - 12 fl oz	None for grazing, forage and haying	●	
Malathion 5	1.5 - 2.25 pts			

INSECTICIDE	PRODUCT PER ACRE	PHI	Rangeland	Non-crop Areas
zeta-cypermethrin Mustang Max Mustang Max EC *RUP*	2.24 - 4 fl oz	None for grazing, forage and haying 7 days for straw	●	

RUP = Restricted Use Pesticide

INSECTICIDES REGISTERED FOR USE ON NON-CROP AREAS: NOT GRAZED OR CUT FOR HAY

INSECTICIDE	PRODUCT PER ACRE	COMMENTS
acephate		
Acephate 90 Prill	4.4 oz	
Acephate 90 WDG	0.28 lb	
Acephate 97	4 oz	
Acephate 97 UP	4 oz	
Orthene 97	1.5 - 2 oz	
carbaryl		
Sevin 4F	0.5 - 1 qt	
Sevin 80S	1.25 - 1.875 lb	
Sevin 80WSP	1.25 - 1.875 lb	
Sevin SL	0.5 - 1 qt	
Sevin XLR Plus	0.5 - 1 qt	
diflubenzuron		
Dimilin 2L *RUP*	0.5 - 2 fl oz Use high rate for non-crop areas	
esfenvalerate		
Adjourn Asana XL *RUP*	2.9 - 9.6 fl oz	Not labeled for use on public lands
gamma-cyhalothrin		
Proaxis *RUP*	1.92 - 3.84 fl oz	Not labeled for use on public lands
lambda-cyhalothrin		
Warrior II	0.96 - 1.92 fl oz	Not labeled for use on public lands
Grizzly Z	1.92 - 3.84 fl oz	
Lambda-Cy EC	1.92 - 3.84 fl oz	
LambdaStar	1.92 - 3.84 fl oz	
Lambda-T	1.92 - 3.84 fl oz	
Lamcap	1.92 - 3.84 fl oz	
Nufarm Lambda Cyhalothrin 1EC	1.92 - 3.84 fl oz	
Province	1.92 - 3.84 fl oz	
Silencer	1.92 - 3.84 fl oz	
Silencer VC	1.92 - 3.84 fl oz	
Taiga Z *RUP*	1.92 - 3.84 fl oz	

RUP = Restricted Use Pesticide

SAFFLOWER INSECTS

Safflower may be infested from the time of emergence to maturity by various insect pests. The most susceptible periods is the bud to flower stage. Fields should be examined regularly and controls applied when infestations are damaging.

CUTWORMS

Several species of cutworms (*Agrotis* spp.) attack safflower. Cutworms are caterpillars that live below ground and cut off seedling at or just below the soil line. Areas in the field are often barren following cutworm feeding. If sufficient plants are present, safflower can compensate for some seedling loss. If damage is severe, protection of seedlings with insecticide may be necessary. There is no known economic threshold for cutworms in safflower in North Dakota.

WIREWORMS

Wireworms, although often serious pests of cereal grains in the seedling stage, seldom damage safflower. Imidacloprid and thiamethoxam are labeled as commercial seed treatment and use decisions must be made at time of seed purchase. Please the seed treatment section in the introduction for more information.

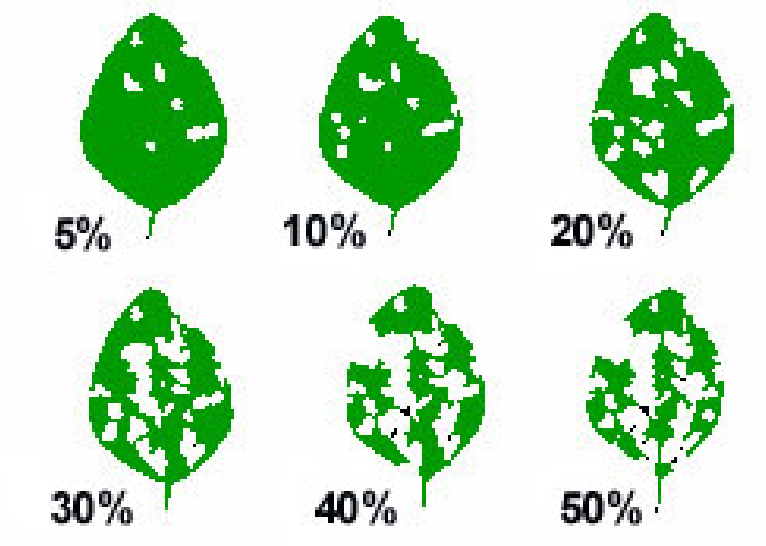
INSECTICIDES REGISTERED FOR USE IN SAFFLOWER

INSECTICIDE	PRODUCT PER ACRE	PHI	Cutworms	Wireworms
imidacloprid Dyna-Shield Imidacloprid 5 Gaucho 600F Senator 600FS	12.8 fl oz per cwt	None		●
thiamethoxam Cruiser 5FS	10.24 fl oz per cwt	None		●
zeta-cypermethrin Mustang Max EC *RUP*	4 fl oz	14 days	●	

RUP = Restricted Use Pesticide
● = Control

Estimating Damage Caused by Defoliating Insects

In soybeans, field scouting to assess insect populations is based on either the number of insects per foot of row, insects per plant, or the level of defoliation. Insects per foot of row is determined by shaking plants over the inter-row space, on which a strip of cloth has been laid. Count the total number of insect pests per foot of row that fall on the cloth. If sampling a narrow row or drilled soybeans, the use of a "Texas vertical beat sheet" should be considered. The vertical beat sheet is made from a piece of galvanized metal flashing or similar stiff material, 36 inches wide, 32 inches tall and crimped at the bottom to form a collecting trough 4 inches wide. Place the device next to the row and shake the plants against the vertical surface. Insects dislodged from plants collect in the trough where they can be counted or collected. Percent defoliation is determined by estimating the amount of leaf loss based on visual inspection of randomly selected plants. The growth stage of the soybean plant is important. Under most conditions, moderate defoliation early in the season has little effect on final bean yield. As plants reach the flowering and pod filling stages, then defoliation poses a greater threat to yield. For example, research indicates that the soybean plant can sustain a 35% leaf loss prior to the pre-bloom period. From pod-set to maturity, the plant can tolerate only a 20% defoliation level.



ARMYWORMS

Armyworms are greenish-brown with longitudinal stripes. Full grown larvae are smooth, striped and almost hairless. Armyworms feed for three to four weeks. When full grown, larvae are 1½ to 2 inches in length. Armyworm larvae have six growth stages, or instars. The armyworm's final instar lasts about 10 days and they consume large amounts of plant material during that time.

Armyworms are inactive during the day, resting under plant trash, clumps of grass or lodged plants. They feed at night or on cloudy days, crawling up on plants and consuming foliage. Due to their habit of feeding at night, armyworms may go undetected until significant damage has occurred. Armyworms do not overwinter in the region. The moths migrate from Southern states in late spring and early summer. This helps explain the sporadic infestations that occur. When moths arrive, they prefer to lay their eggs in moist, shady areas, usually where grasses have lodged. Infestations that develop within soybean fields are often due to grassy weed problems. Armyworms are more of a problem in small grains and corn. Damage to soybeans can occur when the armyworm's usual host plants become exhausted due to feeding or dry conditions. When their food is depleted in the hatching site, the armyworms may move in large numbers, or "armies," eating and destroying plants or crops in their path.

Threshold: Control of armyworms is recommended when 25% to 30% of the foliage is destroyed or if significant injury to pods is evident. Most often in soybeans, infestations are due to migrating armyworms. Under these circumstances, treatment of a couple of swaths ahead of the migrating armyworms to establish a barrier strip is suggested to prevent further migration and injury.

BEAN LEAF BEETLE

Bean leaf beetles have been increasing in North Dakota over the past years. Adult bean leaf beetles emerge from overwintering sites and moving into soybean or dry bean fields. The adults are yellow to reddish-brown and three to four black spots with a black border on wing covers. Adults emerge from overwintering, moving into bean fields as the seedlings emerge. The white larvae develop in the soil, feeding on the roots and nodules. New adults emerging in August feed on foliage and pods. Feeding injury to leaves appears as small round holes between the leaf veins. Injury to pods appears as lesions similar in size and shape to leaf-feeding holes. The injury to pods results in secondary infections by fungi and bacteria, causing rotting and discoloration.

Threshold: Treatment thresholds from other regions are 3 to 7 beetles per sweep or based on defoliation: 50% defoliation during early vegetative, 40% defoliation during pre-bloom, 35% defoliation during bloom and 20-25% defoliation or 10% pod feeding (or

the presence of clipped pods) or 0.5 beetle/plant during pod set to fill. Late season feeding on the foliage and pods by the new adults that emerge in August appears to be more important than early season feeding. This may increase the risk of virus transmission and cause secondary infections (rotting and discoloration) from fungi and bacteria.

CUTWORMS

Several cutworm species affect regional crops. 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. Soybeans and other 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. Most damage by cutworms occurs when soybean plants are in the early stage of development. Damage consists of young plants being chewed off slightly below or at ground level. Some cutworm feeding injury may occur on foliage. Cutworms primarily feed at night. When checking soybean fields for cutworms during the day, dig down into soil an inch or two around recently damaged plants; there you can find the gray to gray-brown larva.

Threshold: Economic thresholds for cutworm treatment decisions are not well established. Treatment guidelines used over the years include when one cutworm or more is found per 3 feet of row and the larvae are small (<3/4 inch long). Another guideline is when 20% of plants are cut or when gaps of 1 foot or more exist in the plant row. When making a final decision, consider that surviving soybeans are able to compensate for early stand reductions because of the plant's long growth period.

FOLIAGE FEEDING CATERPILLARS

Green Cloverworm, Cabbage Looper, Velvetbean Caterpillar, Thistle Caterpillar and Alfalfa Webworm

Populations of these caterpillars have been negligible in North Dakota and little treatment to control them has been required. Sampling for these insects is accomplished through the use of a drop cloth or a vertical beat sheet, placed between two rows of plants. The larvae are dislodged from the plants and counted on the cloth or collection tray to arrive at an estimate of the number per row feet.

Green cloverworm: These caterpillars are green with two narrow, white stripes down the side. When mature, the worms are 1 ¼ inches long. These caterpillars have only three pairs of fleshy prolegs on the abdomen, plus a pair of prolegs on the back segment. When moving, the worms move by arching the middle of the body, or "looping." Young worms scrape leaf tissue creating a transparent skin, or "window," on the leaf surface. Older cloverworms eat holes in the leaves.

Cabbage looper: These caterpillars are light to dark green, with lighter colored stripes along the side and on the top, running the length of the body. When mature, the worms are 1 ½ inches long. These caterpillars have only two pairs of fleshy prolegs on the abdomen, plus the pair on the back tip. When moving, the caterpillars move by arching the middle of the body, or "looping." These worms feed on leaves in the interior and lower portion of the plant. As defoliation occurs, worms feed higher in the plant. Feeding injury is similar to the cloverworm.

Velvetbean caterpillar: This insect does not overwinter in the region; instead, moths migrate from Southern locations. These caterpillars have dark lines bordered by lighter colored, narrower lines running the length of the body. The background color ranges from a pale yellow-green to brown or black. These larvae have four pairs of fleshy prolegs to distinguish them from the cloverworm and the looper. Young velvetbean caterpillars feed on the underside of leaves in the upper portion of the plant. Older larvae consume the entire leaf, except for the leaf veins.

Thistle caterpillar: This insect is the larva of the butterfly known as the Painted Lady. This butterfly does not overwinter in the region, but migrates from Southern locations each spring. These caterpillars are brown to black in color with yellow stripes along each side of the body. They are covered with spiny hairs that give the caterpillar a prickly appearance. Full grown larvae are about 1 ½ inches long. The caterpillars feed on the leaves, webbing them together at the feeding site.

Alfalfa webworm: These larvae are 1 inch when full grown. They are greenish to nearly black with a light stripe that runs down the middle of the back. There are three dark spots, each with hairs, on the side of each segment. These larvae feed for about 3+ weeks. Infestations are characterized by light webbing over the leaves. Beneath the web is where the larvae feed, consuming the leaves. These larvae move very rapidly, forward or backward, when disturbed.

Threshold: Rather than using thresholds for individual defoliating insect species present in the field consider total leaf area lost as a threshold when defoliators are actively feeding: vegetative 50%, bloom 40%, bloom-pod fill 20% and pod fill-harvest 35%. An average infestation of 4 to 8 larvae per row foot typically caused 20-30% defoliation.

GRASSHOPPERS

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Most grasshoppers emerge from eggs deposited in uncultivated ground. Soybean growers should expect to find grasshoppers feeding first along bean field margins adjacent to non-crop sites where the nymphs are hatching. Later infestations may develop when grasshopper adults migrate from harvested small grain fields. Grasshoppers will feed upon leaves and pods, chewing holes in them. A result of these migrations is soybean fields becoming sites for significant egg laying.

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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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 in soybeans will be the heaviest on the field margins. Treating these areas may lessen the total numbers of grasshoppers successfully entering a field. Soybeans are most sensitive to defoliation during pod development (growth stages R4 to R6). During this time, plants can only tolerate up to 20% defoliation. Of greater concern would be direct feeding damage to pods and seeds. Grasshoppers are able to chew directly through the pod walls and damage seed directly. If more than 5% to 10% of the pods are injured by grasshoppers, an insecticide application would be recommended.

POTATO LEAFHOPPER

The adult is wedge-shaped and pale green in color. Adults are very active, jumping or flying when disturbed. Nymphs are wingless. Both adults and nymphs run backwards or sideways rapidly when disturbed. Nymphs feed on the underside of the leaf, usually completing their growth on the leaves near where they hatched. Large numbers of adults may appear early in the season, but their presence is dependent on migration from the eastern United States.

Soybeans with moderate to dense pubescence, or plant hairs, are tolerant to leafhopper infestations. The short plant hairs form a barrier that discourages leafhoppers from feeding and ovipositing eggs on plant tissue. When feeding does occur, damage by leafhoppers is referred to as hopper-burn. Foliage becomes dwarfed, crinkled and curled. Small triangular brown areas appear at the tips of leaves, gradually spreading around the entire leaf margin. Potential damage to soybeans by potato leafhopper is based on very limited research data. Damage would be more likely when drier growing conditions occur.

Threshold: The threshold for basing spray decisions is when an average of 5 leafhoppers (adults + nymphs) per plant are found in the vegetative stages, and 9 leafhoppers (adults + nymphs) per plant in early bloom stages. A treatment should be considered when visible injury symptoms are combined with large leafhopper populations.

SEED CORN MAGGOT

Seedcorn maggot attacks soybean seed, preventing sprouting or weakening the seedlings. The yellowish white maggot is found burrowing in the seed, emerging stem or the cotyledon leaves. Damage to the seedlings results in a condition called “snakeheads,” or plants without cotyledon leaves. The adult flies emerge in spring when soil temperatures reach 50^{o} F. They deposit eggs in soil where there is abundant organic matter and decaying crop residue, or on the seed or seedling. Injury from seedcorn maggots is usually most severe during wet, cold springs and in fields with high organic matter soils. When cool, wet conditions occur during planting, the slow emergence of the seedling extends the period of time it is vulnerable to feeding by the maggot.

Threshold: When conditions are wet and cool, or when planting into high crop residue conditions, seed treatments provide the best defense against injury. For additional information on seed treatments, refer to page 7.

SOYBEAN APHID

A new aphid pest feeding on soybeans was found in the Midwestern states of Michigan, Illinois, Wisconsin, Iowa, and Minnesota in late July and early August 2000. It was confirmed that this aphid was the **soybean aphid**, *Aphis glycines*, an aphid native to Asia but never reported in the United States prior to this discovery. Soybean aphid was found in North Dakota in August 2001. The aphid is generally established in the eastern half of the state, but there are still many questions about the population levels surviving through the winter. The soybean aphid is light yellow with black cornicles (“tail-pipes”) and a pale colored cauda (tail projection). As with other aphids, the soybean aphid is small, about the size of a pinhead. Nymphs are smaller. Aphids suck fluid from plants. When infestations are large, infested leaves are wilted or curled. The aphids excrete honeydew, a sweet substance that accumulates on surfaces of lower leaves and promotes the growth of sooty mold. This aphid colonizes tender leaves and branches from seedling to blooming. Later, as the growing point slows, the aphids slow their reproductive rate, move down to the middle and lower part of the plant, and feed on the undersides of leaves. Toward the end of the season, the colonies begin to rapidly increase in number again. These increases are followed by a migration to the overwintering, alternate host, buckthorn. Future observations will lead to a better understanding of what soybean aphid will do in the United States.

Scouting

Currently, the guidelines for making soybean aphid treatment decisions are:

Begin scouting soybean fields at the V3 to V4 stage to determine if soybean aphids are present in fields. No treatment is recommended at this time and is discouraged so insecticides do not reduce the presence of predators and parasites. The critical growth stages for making most soybean aphid treatment decisions in North Dakota appears to be the late vegetative to early reproductive stages (V*n* to R3). Assessing aphid populations at this time is critical. Typically aphid treatments occur from mid-July to mid-August.

Economic Thresholds are based on the following growth stages:

R1 to R5 (beginning seed) = 250 aphids/plant when populations are actively increasing in 80% of field

R6 (full seed) = No treatment necessary. Research trials throughout the north central states have not demonstrated a yield benefit to treating soybean for soybean aphid management at the R6 and later stages.

SPIDER MITES

Mites are small and magnification is required to see them. A quick sampling procedure to determine whether mites are present is to hold a piece of white paper below leaves then slap them to dislodge the mites. Or, pulling plants and examining the underside of the leaves from the bottom of plants upwards. The mites appear as tiny dust specks; however, they will move after being knocked off the leaf. Feeding damage by mites first appears as small yellow spots ("stippling"). As feeding activity increases, leaves become yellow, bronzed or brown, and eventually shed from the plant. Be sure to scout during full pod (R4) through beginning seed (R5) stages since these crop stages are the most important contributors to soybean yield.

Mites usually become a problem when hot, dry weather occurs. Infestations typically are first noted near field edges. These environmental conditions stress the plant, whether mites are present or not. If conditions continue, treating for mites is no guarantee plants will recover. In addition, products labeled for mite control often do not give adequate control and the population of mites may rebound quickly to pretreatment levels or higher. When rain and humidity are present, natural reductions in mite populations occur due to infection by a fungal pathogen. Conditions that are good for the development of the pathogen are temperatures cooler than 85^{o} F, with at least 90% R.H. for 12 to 24 hours.

Threshold: Deciding whether to treat is difficult. There is no specific threshold that has been developed for two-spotted spider mite in soybean. Sample plants at least 100 feet into the field and walk in a "U" pattern sampling two plants per location at 20 different locations. Assess mite damage using the following scale from the University of Minnesota:

0 - No spider mites or injury observed.

1 - Minor stipling on lower leaves, no premature yellowing observed.

2 - Stipling common on lower leaves, small areas or scattered plants with yellowing.

3 - Heavy stippling on lower leaves with some stipling progressing into middle canopy. Mites present in middle canopy with scattered colonies in upper canopy. Lower leaf yellowing common. Small areas with lower leaf loss

(Spray Threshold)

4 - Lower leaf yellowing readily apparent. Leaf drop common. Stipling, webbing and mites common in middle canopy. Mites and minor stipling present in upper canopy.

(Economic Loss)

5 - Lower leaf loss common, yellowing or browning moving up plant into middle canopy, stipling and distortion of upper leaves common. Mites present in high levels in middle and lower canopy.

Remember to use an organophosphate insecticide (e.g. Lorsban, Dimethoate) over a pyrethroid insecticide to avoid flaring mite populations. Reasons for the increase in mite populations include: disruption of the natural enemies that control spider mites (predatory mites); increased movement of mites out of fields, and increased reproductive rates of female mites. Early detection facilitates timely and effective rescue treatments. Current insecticides for soybeans provide short-term protection, maybe 7 days, from the pest. Fields will need to be re-monitored continually for resurging populations. The efficacy of an insecticide can be improved significantly with sufficient coverage (>18 GPA of water) and application at high pressure to penetrate foliage. Edge treatments are not effective in controlling mites since mites have already moved throughout the field before visual symptoms are observed.

WIREWORMS

To decide whether wireworms are a potential problem, refer to the discussion in the corn insects section. Imidacloprid and thiamethoxam are labeled as active ingredients for commercial seed treatment and use decisions must be made at time of seed purchase. Please the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN SOYBEAN

INSECTICIDE	PRODUCT PER ACRE	PHI	Armyworms	Bean Leaf Beetle	Cutworms	Foliage Caterpillars	Grasshoppers	Potato Leafhopper	Seed Corn Maggot	Soybean Aphid	Spider Mites	Wireworms
abamectin + thiamethoxam + fungicides												
Avicta Complete Beans *RUP*	**Commercial Seed Treatment Only** Consult individual product labels for rates	Consult individual product labels										●
acephate												
Acephate 90 PRILL	0.28 - 1.1 lbs	14 days	●	●		●	●	●		●		
Acephate 90WDG	0.28 - 1.1 lbs	Do not graze or harvest for hay or forage										
Acephate 97	0.25 - 1 lb											
Acephate 97UP	0.25 - 1 lb											

INSECTICIDE	PRODUCT PER ACRE	PHI	Armyworms	Bean Leaf Beetle	Cutworms	Foliage Caterpillars	Grasshoppers	Potato Leafhopper	Seed Corn Maggot	Soybean Aphid	Spider Mites	Wireworms
Orthene 90S Orthene 97	0.28 - 1.1 lbs 0.25 - 1 lb											
Bacillus thuringiensis Biobit HP Dipel DF Dipel ES Xentari DF	0.5 -2 lbs 0.25 - 2 lbs 1 - 4 pts 0.5 - 2 lbs	None	‡			‡						
beta-cyfluthrin Baythroid XL *RUP*	0.8 - 2.8 fl oz	21 days for seed 15 days for hay and green forage	‡	●	●	●	●	●		●		
beta-cyfluthrin + imidacloprid Leverage 360 *RUP*	2.4 - 2.8 fl oz	21 days for seed 15 days for hay and green forage	‡	●	●	●	●	●		●		
bifenthrin Bifenture EC Brigade 2EC Discipline 2EC Fanfare 2EC Sniper Tundra EC *RUP*	2.1 - 6.4 fl oz	18 days	●	●	●	●	●	●		●	●	
bifenthrin + imidacloprid Brigadier *RUP*	3.8 - 6.1 fl oz	45 days for feeding dry vines 18 days for feeding green vines	●	●	●	●	●	●		●		
bifenthrin + imidacloprid Swagger *RUP*	7.6 - 12.2 fl oz	18 days	●	●	●	●	●	●		●	●	
bifenthrin + zeta-cypermethrin Hero *RUP*	2.6 - 10.3 fl oz	21 days Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●	●	
carbaryl Sevin 4F Sevin XLR Plus	0.5 - 1.5 qts 0.5 - 1.5 qts	21 days for seed 14 days for grazing or harvest for forage	●	●	●	●		●				
chlorpyrifos Lorsban 15G Lorsban 15G SmartBox Saurus	8 oz per 1,000 row-feet	28 days			●							
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	At Plant[1]: 1 - 2 pts Foliar Application 0.5 - 2 pts	28 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●	●	
chlorpyrifos + lambda-cyhalothrin Cobalt Advanced *RUP*	At Plant[1]: 11 - 38 fl oz Foliar Application:	30 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●	●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Armyworms	Bean Leaf Beetle	Cutworms	Foliage Caterpillars	Grasshoppers	Potato Leafhopper	Seed Corn Maggot	Soybean Aphid	Spider Mites	Wireworms
	6 - 38 fl oz											
chlorpyrifos + zeta-cypermethrin Stallion *RUP*	3.75 - 11.75 fl oz	28 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●		
clothianidin Belay	3 - 6 fl oz	21 days for seed Do not graze or harvest for hay or forage		●				●		●		
clothianidin + *Bacillus firmus* Poncho Votivo	**Commercial Seed Treatment Only** 0.13 mg ai per seed	Do not graze or feed forage and hay		●				●	●	*		●
clothianidin + fungicides Inovate System (NipsIt Inside + fungicides)	Consult individual product labels for rates	Consult individual product labesl		●				●	●	*		●
cyfluthrin Tombstone Tombstone Helios *RUP*	0.8 - 2.8 fl oz	45 days for seed and feeding of dry vines 15 days for green forage	‡	●	●	●	●	●		●		
deltamethrin Batallion 0.2EC Delta Gold *RUP*	7.7 - 14.1 fl oz 9.5 - 11.5 fl oz for soybean aphid 1 - 2.4 fl oz	21 days for seed Do not graze or harvest for hay, straw, forage or feed	‡	●	●	●	●	●		●		
diflubenzuron Dimilin 2L *RUP*	2 - 4 fl oz	21 days	‡			‡	‡					
dimethoate Digon 400 Dimate 4E Dimethoate 400 Dimethoate 4E Dimethoate 4EC	1 pt	21 days for seed 5 days for for grazing and feed		●			●	●			●	
esfenvalerate Adjourn Asana XL *RUP*	2.9 - 9.6 fl oz	21 days for seed Do not graze or harvest for hay or forage		●	●	●	●	●		●		
flubendiamide Belt SC	2 - 3 fl oz	14 days for seed 3 days for forage and hay	●		●	●						
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	30 days for seed Do not graze or harvest for hay or forage	●	●	●	●	●	●		●	†	
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600	**Commercial Seed Treatment Only** 1.6 - 3.2 fl oz per cwt	Do not graze or feed forage or hay		●					●	●		
imidacloprid Enhance AW	5 oz per cwt	Do not graze or feed forage or hay		●					●	*		●
imidacloprid Latitude	1.5 oz per 37 lbs seed	Do not graze or feed forage or hay		●					●			

INSECTICIDE	PRODUCT PER ACRE	PHI	Armyworms	Bean Leaf Beetle	Cutworms	Foliage Caterpillars	Grasshoppers	Potato Leafhopper	Seed Corn Maggot	Soybean Aphid	Spider Mites	Wireworms
imidacloprid												
AmTide Imidacloprid 2F	0.75 fl oz	7 days										
Admire Pro	1.3 fl oz											
Mana Alias 4F	1.5 fl oz											
Wrangler	1.5 fl oz			●				●		●		
Nuprid 1.6F	3.75 fl oz											
Nuprid 2SC	3 fl oz											
Nuprid 4F Max	1.5 fl oz											
Prey 1.6	3.75 fl oz											
Sherpa	3.75 fl oz											
indoxacarb												
Steward EC	4.6 - 11.3 fl oz	21 days for seed Do not graze or feed	●			●						
lambda-cyhalothrin												
Grizzly Z	1.92 - 3.84 fl oz	30 days for seed Do not graze or harvest for hay, straw, forage or feed										
Lambda-Cy EC	1.92 - 3.84 fl oz											
LambdaStar	1.92 - 3.84 fl oz											
Lambda-T	1.92 - 3.84 fl oz											
Lamcap	1.92 - 3.84 fl oz											
Nufarm Lambda-Cyhalothrin 1EC	1.92 - 3.84 fl oz		●	●	●	●	●	●		●	†	
Province	1.92 - 3.84 fl oz											
Silencer	1.92 - 3.84 fl oz											
Silencer VC	1.92 - 3.84 fl oz											
Taiga Z	1.92 - 3.84 fl oz											
Warrior II *RUP*	0.96 - 1.92 fl oz											
lambda-cyhalothrin + thiamethoxam												
Endigo ZC *RUP*	3.5 - 4.5 fl oz	30 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●	†	
methomyl												
Lannate LV *RUP*	0.4 - 1.5 pts	14 days for seed 12 days for hay 3 days for forage	●	●		●				●		
methoxyfenozide												
Intrepid 2F	4 - 8 fl oz	14 days for seed 7 days for hay and forage	●			●						
methyl parathion												
Cheminova Methyl 4EC *RUP*	0.75 - 1 pt	20 days for seed or grazing **REI = 4 days**	●		●	●				●	●	
methyl parathion												
Penncap-M *RUP*	1 - 3 pts	30 days for seed or grazing **REI = 11 days**		●		●	●	●		●		
permethrin												
Ambush 25W	3.2 - 6.4 oz	60 days for seed Do not graze or harvest for hay or forage										
Ambush	3.2 - 6.4 fl oz											
Arctic 3.2EC	2 - 4 fl oz											
Permethrin	2 - 4 fl oz			●	●	●		●				
Permethrin 3.2EC	2 - 4 fl oz											
Perm-Up 3.2 EC	2 - 4 fl oz											
Pounce 3.2EC *RUP*	2 - 4 fl oz											
permethrin												
Arctic 3.2EC *RUP*	4 - 8 fl oz (2ee recommendation for soybean aphid)	60 days for seed Do not graze or harvest for hay or forage								●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Armyworms	Bean Leaf Beetle	Cutworms	Foliage Caterpillars	Grasshoppers	Potato Leafhopper	Seed Corn Maggot	Soybean Aphid	Spider Mites	Wireworms
permethrin Kernel Guard Supreme	Planter Box: 1.5 oz per 50 lbs of seed	45 days for grazing or feeding							●			●
phorate Phorate 20G Thimet 20G Lock n Load Thimet 20G SmartBox *RUP*	9 oz per 1,000 row-feet	Do not place granules in direct contact with seed Do not graze or feed foliage						●	●			
spinetoram Radiant SC	2 - 4 fl oz	28 days	‡			‡						
spinosad Blackhawk Entrust Tracer	1.1 - 2.2 oz 0.75 - 1.25 oz 1 - 2 fl oz	28 days for seed Do not graze or harvest for hay or forage	‡			‡						
thiamethoxam Cruiser 5FS	1.28 fl oz per cwt	None		●				●	●	*		●
thiamethoxam Cruiser MAXX	3 fl oz per cwt	None		●				●	●	*		●
thiodicarb Larvin 3.2 *RUP*	10 - 30 fl oz	28 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●						
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.28 - 4 fl oz	21 days for seed Do not graze or harvest for hay, straw, forage or feed	●	●	●	●	●	●		●		

RUP = Restricted Use Pesticide
[1] = At-plant applications of chlorpyrifos products for control of cutworm spp. only
* = Seed treatments may not provide protection against early-season soybean aphids
† = Suppression only
‡ = Control of first and second instar larvae and nymphs only

SUGARBEET INSECTS

Other sugarbeet insect resources:

Publications: Sugarbeet Production Guide (http://www.sbreb.org/production/production.htm)
Sugarbeet Research and Extension Reports (http://www.sbreb.org/research/research.htm)
Leafminers in Sugarbeets, E-1288, 2005
Lygus bugs in Sugarbeets, E-1289, 2005
Leaf-feeding Weevil in Sugarbeet, E-1273, 2004
Springtails in Sugarbeet: Identification, Biology and Management, E-1205, 2001
Rating Sugarbeets for Sugarbeet Root Maggot Feeding Damage, E-1165, 1998

Calendar of Sugarbeet Insect Activity in the Red River Valley															
April	**May**				**June**				**July**				**August**		
Flea Beetles															
	Springtails														
	White Grubs														
	Wireworms														
			Cutworms - Dingy, Dark-sided,												
				Beet Webworm - adults											
					Beet Webworm - larvae										
				Sugarbeet Root Maggot - adults											
					Sugarbeet Root Maggot - larvae										
												Tarnished Plant (*Lygus*) Bugs			
												Cutworms - Black and Variegated			

BEET WEBWORM

Beet webworms rarely occur in significant numbers in Red River Valley sugarbeet fields. Larvae are slender caterpillars and are very active when disturbed. Early-stage larvae are dark green. Older larvae are olive green. They have a dark band running down the center of their back, and it is flanked on each side by two light-colored stripes. Full-grown larvae can be up to 1½ inches long. Adults are mottled tan and brown moths with smoky grayish wing margins. The moths first appear in late May and early June. Larvae usually cause problems during the first 3 weeks of June. A second brood is also possible during late August and September.

Threshold: Insecticide treatment is recommended if 1 to 2 webworms are present on 50% to 75% of sampled leaves.

CUTWORMS

Darksided and Redbacked cutworms are the most common cutworm pests of sugarbeet in the Red River Valley. Eggs of both species hatch into larvae during late May and early June. Early detection of injury is essential to good control. Fields should frequently be checked for wilting or dead plants during early spring. Cutworms can be found within 2 inches of the soil surface near bases of wilting plants. Most feeding occurs at night. Young plants are often cut off near ground level. During periods of dry weather, larvae feed just below the soil surface as they move along the row. They feed above the soil surface if soil is excessively moist.

It is desirable to apply insecticides during late afternoon. This maximizes the amount of insecticide material present during the first nighttime hours following application, which is when larvae are often most active. Applications may be repeated as necessary during peak cutworm feeding. Liquid formulations generally provide better control of cutworms, especially during very dry periods. If severe crusting is evident in the field, the crust should be broken up before or during the insecticide application. In late July and August of 2001, variegated and black cutworm infestations damaged several sugarbeet fields. These insects migrate into our region as moths during the spring and are capable of multiple generations within a single growing season. Variegated cutworm larvae have a distinctive row of pale yellow spots down the middle of their backs. They are a climbing cutworm species that primarily feeds in the plant canopy during evening hours. Because variegated cutworms feed above ground, they can be effectively managed with foliar rescue insecticide applications. Late-season infestations of black cutworms often feed more than 2 inches below ground. Therefore, late-season control of this species can be difficult and is improbable to achieve.

Threshold: Cutworm control in young beets is suggested when 4 to 5% cutting of seedlings is observed. Control may be justified for late-season infestations of 3 to 5 larvae per square foot if they are feeding near or above the soil surface.

FLEA BEETLES

All flea beetle adults are tiny, oval-shaped, shell-winged insects with enlarged hind legs. The flea beetles most frequently found feeding on beets are shiny black in color and about 1/8 inch in length. When approached or disturbed, they readily jump to escape. Flea beetles overwinter as adults and emerge in late April and May. They feed first on weeds such as winter annuals, and move to field crops as weed hosts are depleted and crop seedlings begin emerging. Foliar feeding injury from flea beetles initially consists of small, rounded holes, and gives leaves a shot-hole appearance. Severe shot-holing damage can result in stunting, wilting, and even death of seedling plants. Plant responses will be most dramatic during the seedling stage and in periods of hot and dry weather.

Threshold: Treatment is usually justified if flea beetles threaten to reduce sugarbeet plant stands to below 35,000 plants/acre.

GRASSHOPPERS

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Most grasshoppers emerge from eggs deposited in uncultivated ground. Sugarbeet growers should expect to find grasshopper feeding first along field margins adjacent to these sites. Beets in fields that follow late-season crops may have hatching throughout the field and should be monitored carefully if adults deposited eggs in the field during the previous fall. Later infestations can develop when grasshopper adults migrate from harvested small grain fields.

Threshold: Grasshopper control is advised whenever 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. (For more information on infestation ratings, see the discussion under Grasshoppers in Small Grain Insects)

LYGUS BUG (TARNISHED PLANT BUG)

Tarnished plant bugs, commonly referred to as "Lygus bugs", have caused late-season injury to Red River Valley sugarbeets since 1998. Most feeding injury appears on new leaves and stems emerging from the sugarbeet plant crown. Feeding symptoms include curling and wilting of leaves, feeding scars on leaf petioles, seepage of a black exudate from petioles of young leaves, and blackening of the new growth near the center of the crown. Two to three generations of Lygus bugs can develop during the growing season, especially if extended periods of unseasonably warm weather prevail during early spring and summer. Populations usually build up in other host plant habitats (e.g., alfalfa, canola, small-seeded broadleaf weeds), then adults migrate to beets in late-July through August. Lygus bugs are sporadic pests in this region and their biological profile is not understood well enough to anticipate when or where future problems could arise.

Threshold: Treatment with an insecticide may be justified if an infestation **exceeds** 1 Lygus bug per plant (adults and nymphs combined) and if the crop is at least three weeks from harvest. Careful consideration of insecticide pre-harvest intervals may be a critical factor in choosing an insecticide, because Lygus bugs typically infest sugarbeet late in the growing season (i.e., late-July through August). A number of insecticides approved for use on sugarbeets have activity for controlling Lygus bugs; however, the species that typically attacks Red River Valley sugarbeet (*Lygus lineolaris*, the tarnished plant bug) is not listed as a target pest in the *sugarbeet* portion of those labels**. Examples include Asana, Sevin and Lannate SP, . It is legal to apply an insecticide if it is labeled for use in the crop**; however, if the target pest is not listed for that crop, effective control is not implied by the manufacturer and growers who choose to use the product assume their own liability for any unsatisfactory performance.

SPRINGTAILS

Springtails that damage RRV sugarbeet fields are tiny (1/32 to 3/32 inch long), wingless, white- to cream-colored insects with fleshy, forward-pointed antennae. They spend their entire life below the soil surface, and are most harmful to seedlings. Plant injury ranges from a few brown feeding punctures to extensive root scarring, severed tap roots, and seedling mortality. Field symptoms include wilted plants and plant stand losses, usually in irregular-shaped patches ranging in size of 0.5 to ten acres. *Fine-textured* (i.e., clay or silty clay) *soils* with *high organic matter content* are conducive to springtail problems. *Early-planted fields, especially where soils remain cool and wet* during early spring, can be especially vulnerable to attack. Field history is a good indicator of risk because springtails do not migrate from one field to another. Insecticides registered for use in sugarbeet against other soil-dwelling pests may be used for springtail control; however, manufacturers are not legally bound to guarantee acceptable control if springtail control is not listed on the product label.

NDSU research on springtail management suggests the following:

Counter provide good springtail control if applied at rates of 0.9 to 1.5 lb AI per acre.

-- For Counter 15G, this rate range equates to 5.9-10 lb of product per acre.

-- For the newer Counter 20G formulation, this range equates to 4.5-7.5 lb of product per acre.

Cruiser 5FS, NipsIt Inside, and Poncho Beta insecticidal seed treatments also provide good springtail control.

MustangMax has provided unsatisfactory control in some cases. It performs best when applied:

1. directly in-furrow at planting using conventional nozzles (not microtubes)
2. at full rate of 4 oz of product per acre, and
3. tank-mixed with strained 10-34-0 starter fertilizer at a ratio of 60:1 (fertilizer to insecticide).

Lorsban 15G and other chlorpyrifos-based products do not provide adequate protection from springtail injury.

SUGARBEET ROOT MAGGOT

This insect overwinters in soil at 6 to 12 inches below the surface as a mature larva in fields that had been planted to sugarbeets during the previous growing season. In late April and early May, overwintered larvae move up to within 3 inches of the soil surface to pupate. In the Red River Valley, fly emergence generally begins in late May and continues for a period of 4 to 6 weeks. Following emergence, flies move to current-year sugarbeet fields and deposit most eggs below the soil surface near or on the bases of beet plants. Egg depth is dependent on soil moisture (i.e., eggs are deposited deeper in dry soils). Plants in earlier-seeded (April - early May) fields are usually more vigorous and able to tolerate more injury than smaller, those in later-planted fields. Fields planted in areas with established maggot populations should be protected at planting-time with a soil insecticide or insecticidal seed treatmtent. If dry conditions prevail following use of an at-plant granular insecticide, a postemergence insecticide application may be needed. Additive protection may also be needed if an insecticidal seed treatment was used for at-plant protection in areas where moderate to high root maggot infestations are common. Producers should consider the following when deciding if a postemergence treatment is warranted: ***soil moisture*** - good soil moisture with spring rains should enhance planting-time insecticide performance – extreme rainfall amounts (1 to 3 inches within first 24 hours or at least 6 inches if received in 1 or 2 rainfall events within 1 week after planting) may cause movement of the insecticide from the treated target zone; ***sugarbeet size*** - plants that have 10 to 14 true leaves at peak activity (early- to mid-June) can tolerate moderate levels of feeding injury; ***population level*** - use sticky-stake traps to monitor for development of damaging population levels.

WIREWORMS

Wireworms are smooth, somewhat hard-bodied larvae that vary in length from 1/2 to 1½ inch long; however, they are most damaging when they are about 1/2 to 3/4 inch in length. Their color can range from yellowish-white to a bright or deep copper color. Wireworms feed on a wide variety of crops and weeds, and are generally difficult to detect and control. They tend to be more prevalent in light-textured soils or in soil that has not been in crop production for several years. Fields that had grassy weed escapes during the preceding season are also at risk. Frequent tillage and cropping help reduce wireworm problems.

Threshold: Currently, there is no established threshold for wireworms in sugarbeet. The following insecticides labeled for sugarbeet root maggot control will usually provide adequate protection from wireworm injury. Check with your company field representatives before treating sugarbeet seed with an insecticide. Refer to product labels for more information. Please the seed treatment section in the introduction for more information.

Insecticides Registered for Use in Sugarbeet

INSECTICIDE	PRODUCT PER ACRE	PHI	Beet Webworm	Cutworms	Flea Beetles	Grasshoppers	Lygus Bugs	Springtails	Sugar Beet Root Maggot Adults	Sugar Beet Root Maggot Larvae	Wireworms
carbaryl Sevin 4F Sevin XLR Plus Sevin 80S	1 - 1.5 qts 1 - 1.5 qts 1.25 - 1.875 lbs	28 days for roots or forage	●	●	●						
chlorpyrifos Lorsban 15G Lorsban 15G SmartBox	At-Plant T-Band: 4.5 - 9 oz per 1,000 row-feet **Do not apply granules in direct contact with seed**	30 days		●						●	†
chlorpyrifos Lorsban 15G Lorsban 15G SmartBox	Postemergence T-Band: 6.5 - 9 oz per 1,000 row-feet **Do not apply granules in direct contact with seed**	30 days								●	
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Lorsban 4E Lorsban Advanced Nufos 4E	Broadcast Foliar: 0.5 - 2 pts	30 days for roots, grazing or harvest of tops for feed	●	●	●	●	●		●		

INSECTICIDE	PRODUCT PER ACRE	PHI	Beet Webworm	Cutworms	Flea Beetles	Grasshoppers	Lygus Bugs	Springtails	Sugar Beet Root Maggot Adults	Sugar Beet Root Maggot Larvae	Wireworms
Warhawk Whirlwind Yuma 4E *RUP*											
chlorpyrifos Chlorpyrifos 4E AG Govern 4E Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	Banded Foliar: 0.67 - 2 pts	30 days for roots, grazing or harvest of tops for feed	●	●	●					●	
clothianidin NipsIt INSIDE	3.4 fl oz per 100,000 seed unit	None		●	●			●		●	●
clothianidin NipsIt SUITE Sugar Beets (NipsIt INSIDE + fungicides) **Full label (combined products) pending 2012**	**Commercial Seed Treatment Only** Consult individual registered product labels (see Valent website for more information)	Consult individual product labels		●	●			●		●	●
clothianidin + *Bacillus firmus* Ponch Votivo	**Commercial Seed Treatment Only** 4.1 fl oz per 100,000 seed unit	None		●	●			●		●	●
clothianidin + beta-cyfluthrin Poncho Beta	**Commercial Seed Treatment Only** 5.07 fl oz per 100,000 seed unit	None		●	●			●		●	●
esfenvalerate Asana XL *RUP*	At Plant: 0.45 fl oz per 1,000 row-feet	21 days		●							
esfenvalerate Adjourn Asana XL *RUP*	Foliar Application: 5.8 - 9.6 fl oz	21 days	●	●	●	●			●		
imidacloprid Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	**Commercial Seed Treatment Only** 2.4 - 5 fl oz per 100,000 seed unit	None									●
methomyl Lannate LV Lannate SP *RUP*	0.25 - 1 lb	21 days for roots 30 days for tops	●	●	●						
naled Dibrom 8 Emulsive *RUP*	1 pt	2 days					●				
phorate Phorate 20G Thimet 20G LocknLoad	3.4 - 4.5 oz per 1,000 row-feet	30 days								●	

INSECTICIDE	PRODUCT PER ACRE	PHI	Beet Webworm	Cutworms	Flea Beetles	Grasshoppers	Lygus Bugs	Springtails	Sugar Beet Root Maggot Adults	Sugar Beet Root Maggot Larvae	Wireworms
Thimet 20G SmartBox *RUP*	**Do not apply granules in direct contact with seed**										
terbufos Counter 15G Lock n Load Counter 20G SmartBox *RUP*	4 - 8 oz per 1,000 row-feet 3 - 6 oz per 1,000 row feet **Do not apply granules in direct contact with seed**	110 days for harvest of roots or harvest of tops for livestock feed		†				●		●	●
thiamethoxam Cruiser 5FS	3.39 - 3.95 fl oz per 100,000 seed unit	None						●		●	●
thiamethoxam + fungicides Cruiser MAXX Sugar Beets	Consult individual product labels for rates	Consult individual product labels						●		●	●
zeta-cypermethrin Mustang Max Mustang Max EC *RUP*	At Plant: 4 fl oz Foliar: 2.24 - 4 fl oz	50 days for roots or tops		●					†	†	●

RUP = Restricted Use Pesticide
† = Suppression only

SUNFLOWER INSECTS

Publications
- E-1457 IPM of Sunflower Insect Pests in the Northern Great Plains (2010)
- E-823 Banded Sunflower Moth (2010)
- A-1331 Sunflower Production (2007)
- E-821 Biology and Integrated Pest Management of the Sunflower Stem Weevil in the Great Plains (2002)
- E-824 Biology and Integrated Pest Management of the Sunflower Beetle in North Dakota (2000)

BANDED SUNFLOWER MOTH

Banded sunflower moths (BSM) were a major concern in recent seasons. Heavy infestations occurred in the north-central region of the state in 2006; large moth flights were observed and treated by producers.

BSM begin to emerge form the soil about mid-July. Peak activity normally occurs about the last week of July or the first week of August. Moths fly from last years field to the current year's field. At this time moths congregate around field margins. The moths move to fields during the bud stage, with a preference for the mid-bud stage. Eggs are laid on the back of the bud and the outside of the bracts. The newly hatched larvae move from these sites to the face of the flower and begin feeding on bracts and florets.

Two distinct and separate sampling procedures can be used to estimate the field damage potential from the banded sunflower moth. The first samples for eggs and the second samples for the adult (moth) stage.

Egg Sampling

The potential for banded sunflower moth damage is determined by counting eggs on the outer layer of floral bracts in the field. Because the eggs are very small a magnifier is needed to accurately count the small eggs. We recommend using a head-mounted 3.5X magnifier to leave both hands free for manipulating the bud being observed. Egg counts should be made when most of the plants in the field are at plant stage R3 (distinct bud elongated ¾ inch above the nearest leaf, yellow ray petals not visible). However, to avoid sampling bias, buds should be randomly selected without regard to plant stage. The egg sampling steps include: 1) Divide each side of the field into two sections, 2) Sample the center of each section at 20 feet into the filed from the field edge, 3) Randomly select five buds, 4) From each bud, randomly select six bracts from the outer whorl and count the eggs on each bract, and 5) Average the egg counts from the five buds and then map the average egg counts from each site to a diagram of the field. Next, calculate the economic injury level. The economic injury level (EIL) is the density or number of insects expected to cause damage that is equal to the cost of control. For Banded sunflower moth, EIL is the number of eggs per 6 bracts and considers treatment cost ($/acre), market price ($/lb), and plant population per acre.

$$\textbf{EIL} = \frac{\textbf{Treatment Cost (\$)}}{\textbf{Market Price (\$) x Plant Population x 0.00078}}$$

An **ED Calculator** is available from the North Dakota State University Department of Entomology Web site for automatically calculating the egg EIL and Economic Distance (http://www.ndsu.nodak.edu/entomology/ext.htm). The economic distance is the distance from the field margin that an economic infestation is present based on the egg density. Please obtain a copy of 2006 **Extension Bulletin E823 'Banded Sunflower Moth'** for complete details for determining the EIL, economic distance and timing of treatments.

Adult Moth Sampling during Day

Sampling sites should be at least 75 to 100 feet from the field margins. In monitoring a field, use the X pattern, counting moths on 20 plants per sampling site to obtain the total number of moths per 100 plants. Sampling should be conducted in the late bud stage (R3), usually during mid-July. If treatment is warranted, it should be applied at the R5.1 sunflower plant growth stage (when 10% of head area have disk flowers that are flowering or completed flowering). During the day (late morning to early afternoon) the moths remain quiet, resting on upper or lower surfaces of the leaves of sunflower plants. When disturbed, they flutter from plant to plant. When sampling for moths during day, the decision to treat or not is based on comparing the mean number of adult moths in the field to the EIL for moths. The EIL is the number of moths per head that will, if not managed, result in seed damage with a value equal to the cost of treatment. Use the following formula based on treatment costs, plant population and market price to determine the adult moth EIL for day sampling.

$$\textbf{EIL (moths per 100 plants)} = \left(\frac{\textbf{(Treatment Cost (\$) / Market Price)}}{\textbf{Plant Population}} \right) \textbf{ x 582.9 }) \textbf{ - 0.7}$$

The constants in the formula simplify the calculation and include the amount of loss attributable to each banded sunflower moth larva produced per moth.

Chemical Control and Application Timing: Chemical treatment is directed at the larval stage of the banded sunflower moth which is the actual damaging stage. Once the decision to treat has been made, it is critical to correctly time the spray application to get maximum control. The best sunflower plant stage to treat is the R5.1 growth stage, or when pollen shed is just beginning. This is the time when most banded sunflower moth eggs have hatched and larvae are present, but before the head has seeds forming. At this time the larvae are beginning to feed on the disk flowers, are exposed on the head, and are susceptible to the insecticide treatment. On older plants where the seeds have started maturing, most larvae will be feeding within the seeds or under the

protection of the florets and will be protected from the insecticide. By then, much of the feeding damage has already occurred. Application at an earlier growth stage may be warranted if monitoring reveals earlier than normal egg-laying activity. The **banded sunflower moth**, **seed weevil** and the **Lygus bug** have all impacted quality of **confection sunflowers** the past three to four seasons. It is recommended at this time, that **sunflowers grown for these markets be treated a minimum of two times**, once at early flowering and again 5 to 7 days later. With this type of program, a window of protection should be provided to minimize impact from all three of these seed-damaging insect pests.

CUTWORMS

Most damage by cutworms occurs when plants are in the early stage of development. Damage consists of young plants being chewed off slightly below or at ground level. Some cutworm feeding injury may occur on foliage. Cutworms primarily feed at night. When checking fields for cutworms during the day, dig down into soil an inch or two around recently damaged plants; there you can find the gray to gray-brown larva.

Threshold: Treatment is warranted when one cutworm or more is found per square foot or there is a 25% to 30% stand reduction observed.

GRASSHOPPERS

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. Most grasshoppers emerge from eggs deposited in uncultivated ground. Sunflower growers should expect to find grasshopper feeding first along field margins adjacent to these sites. Later infestations may develop when grasshopper adults migrate from harvested small grain fields.

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 per square yard		**Adults per square yard**	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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 in sunflowers will be the heaviest on the field margins. Treating these areas may lessen the total numbers of grasshoppers successfully entering a field.

LONG-HORNED SUNFLOWER STEM GIRDLER OR LONG-HORNED BEETLE

Adults appear in mid-June to early July in the southern Plains. Emergence continues through August with 50% emerged by mid-July in Texas. Eggs are laid 4-8 days after mating and eggs are deposited singly in leaf petioles. Approximately 50 eggs are laid per female with about one-third viable. Eggs hatch in 6-10 days. Larvae tunnel and feed in the petioles and stem pith and finally move to the base of the plant to overwinter. Larvae develop through 6 instars. In late summer, the mature larvae girdle the inside of the lower stalk or root crown, move below the girdle, and pack frass into the tunnels. Stalks often break at the point of girdling, leaving the larva protected in its frass packed tunnel during the winter. Larvae are cannibalistic and stalks usually harbor only a single larva even though several may have originally hatched in a stalk. There is one generation per year. Host plants include sunflower, soybean, ragweed, and cocklebur. Plant damage due to adult feeding appears to be insignificant, since the scars do not penetrate the cortex nor encircle the stalk. Larval feeding is apparent when stalks lodge at the point of the girdle, about 2.5 to 3.5 inches (7 to 9-cm) above the soil surface.

Scouting Method: None has been developed.

Threshold: None established.

Management: In the southern Plains, later planting dates and fall or winter tillage have reduced sunflower infestations by this pest. Perennial sunflower species are resistant to stalk infestation, indicating the possibility of breeding cultivars resistant to the long-horned sunflower stem girdler. Chemical treatments on soybean and sunflower are ineffective against larvae and were determined to be impractical against adults because of the extended emergence period. When larvae are present in the stalks, plants do not always lodge. Utilizing lower plant populations that encourage thicker stalks may help to reduce damage from lodging. If fields are suspected to be infested, prompt harvesting will limit losses from lodging.

LYGUS BUG (TARNISHED PLANT BUG)

Lygus bug is primarily an insect pest concern in confection sunflowers. The damage has been named “kernel brown spot” because of the dark spot on the kernel. All evidence suggests the problem is due to feeding by lygus on the developing seed. Lygus are noted for being a pest of seed production to many crops. Their feeding preference is meristematic tissue, embryonic tissue or new growth of any kind. Lygus insert their mouthparts into the host, start a "pre-digestion pump" to inject saliva and start digestion, and then suck the fluid

into the stomach. This is where the seed injury originates. The saliva is toxic to plant tissue, helping reduce the plant fluid into a digestible source. The result in sunflower seeds is the brown to black spot resulting from tissue death at that feeding site.

To minimize the damage which results in a quality reduction, a general approach to protecting sunflower from lygus and other seed feeding insects is being recommended. Sunflower is susceptible to lygus damage during flowering, from anthesis through seed hardening. A number of insecticides labeled for controlling head feeding insects in sunflower are available. Of these, the organophosphate (Lorsban) and pyrethroid (Asana XL, Baythroid XL, Warrior II) insecticides are labeled for control of lygus on numerous other crops. Lygus can be treated at the same time confection sunflower is treated for other insects, such as the seed weevil and banded sunflower moth.

Treatment Guidelines

***Confection*:** Entomologists found that populations of adult Lygus bugs at levels of 1 per 9 heads could result in economic loss to the producer through the reduction of seed quality. As a result, two treatments are needed to sufficiently protect confection sunflower heads from insect feeding: one application at the onset of pollen shed, or approximately 10% bloom, followed by a second treatment 7 days later. This program should adequately control insects on confection sunflower throughout flowering, minimizing the potential feeding damage.

***Oilseed*:** Oilseed sunflowers are not believed to be at risk to damage from Lygus feeding at this time.

SUNFLOWER BEETLE

Sunflower beetles begin feeding shortly after they emerge from overwintering. Emergence starts in mid-May. Most feeding by the adults is concentrated on the true leaves. Adults quickly begin laying pale yellow eggs singly on stems and the underside of leaves. Eggs hatch in about 8 days. The pale green, humpbacked larvae begin feeding, eating holes throughout the leaf. Larvae do not feed during the day, resting in the plant tops where they are easily observed.

Thresholds

***Adults*:** Treatment is recommended when scouting determines that an average of 1 to 2 beetles per plant can be found throughout the field.

***Larvae*:** When an average of 10 to 15 larvae per plant is found, defoliation levels of 25% to 30% would be expected. Treatment is suggested when damage levels reach this point and most larvae are 1/4 inch in size.

SUNFLOWER MIDGE

The midge is a small fly, 3/32 inch in length, that is tan colored. The midge emerges in early July. They prefer to lay eggs on developing buds 1 to 2 inches in diameter. The cream to yellowish-orange larvae feed on bract tissue at first and later on the flowers and seeds. When populations are low and feeding is confined to the bracts, damage results in little economic loss. At higher populations, seed production is reduced or prevented. This type of injury appears as twisted and gnarled flowers. Often, infestations will be limited to field margins. When populations are large, damage may extend into the field and significant field losses may be observed. Historically, infestations and losses have increased with increased sunflower production. Also, environmental conditions contribute to midge outbreaks. Good soil moisture in the month of June promotes survival and emergence of midge.

Threshold: There are no effective chemical controls currently recognized for this pest. The best management strategy has been **rotation** to crops other than sunflower in the vicinity of large infestations. Staggering **planting dates** to promote different budding periods between fields aids in reducing risk of damage to all fields in the same geographic areas. Sunflower hybrids have recently been evaluated for their tolerance to sunflower midge. **Selecting hybrids** for their ability to tolerate infestations should be considered when choosing seed for the upcoming season. The midge tolerance ratings for hybrids evaluated during 2010 are listed below.

2011 Sunflower Midge Hybrid Evaluation Trial – Mapleton, ND

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Hybrid	Growth Stage (R)	Head Diameter (cm)	Sunflower Midge				
			Round Index	Necrosis Index (0-5)		Bracken Scale (0-5)	
				Hybrid Mean	Relative Mean	Hybrid Mean	Relative Mean
CHS 11-M1	7.2	16.6	0.024	1.40	0.86	0.75	0.87
CHS 11-M2	6.9	13.9	0.027	1.50	0.92	0.60	0.70
CHS 11-M3	7.5	14.6	0.022	1.85	1.13	0.85	0.99
CHS 11-M4	6.7	15.1	0.027	1.70	1.04	1.00	1.16
CHS 11-M5	7.3	19.0	0.043	2.85	1.74	1.65	1.92
CHS 11-M6	6.2	15.3	0.013	1.85	1.13	0.90	1.04
CHS 11-M7	6.6	16.7	0.030	1.85	1.13	0.80	0.93
CHS 11-M8	6.3	19.9	0.017	1.40	0.86	0.90	1.04
CHS 11-M9	6.3	15.5	0.021	1.90	1.16	1.00	1.16
CHS 11-M10	5.8	13.1	0.030	2.53	1.54	1.42	1.65
Mycogen 8N270CLDM	7.5	15.6	0.015	1.90	1.16	0.95	1.10
Mycogen E070947	6.9	16.6	0.015	1.55	0.95	0.75	0.87
Mycogen E070948	6.3	18.2	0.034	1.10	0.67	0.55	0.64
Mycogen E257687	7.3	16.9	0.016	2.15	1.31	1.15	1.34
Mycogen E279687	6.8	15.7	0.041	1.40	0.86	0.85	0.99
Mycogen E289687	7.0	16.3	0.012	1.65	1.01	1.00	1.16
Mycogen E81423DM	6.6	16.0	0.016	0.60	0.37	0.45	0.52
Mycogen E81424DM	6.7	16.5	0.020	1.55	0.95	1.00	1.16
Mycogen E81551	6.4	17.1	0.022	0.75	0.46	0.45	0.52
Mycogen E81552DM	6.4	20.8	0.025	1.45	0.89	0.90	1.04
Nidera LN9994	6.9	15.1	0.030	1.85	1.13	0.95	1.10
Nidera MN11812	7.1	15.8	0.017	1.85	1.13	1.00	1.16
Nidera MN12070	6.9	16.5	0.024	1.10	0.67	0.50	0.58
Nidera ON17799	7.0	18.8	0.027	1.85	1.13	1.15	1.34
RRC 2215	7.0	16.3	0.031	1.05	0.64	0.55	0.64
RRC 2217	6.8	15.2	0.030	1.35	0.83	0.85	0.99
RRC 2215CL	6.6	16.8	0.049	1.05	0.64	0.55	0.64
Seeds 2000 Badger DMR	7.5	15.9	0.039	0.55	0.34	0.40	0.46
Seeds 2000 Camaro	7.3	17.9	0.020	0.85	0.52	0.45	0.52
Seeds 2000 Jaguar	7.6	14.7	0.023	1.60	0.98	1.05	1.22
Seeds 2000 Jaguar DMR	7.2	14.3	0.030	2.85	1.74	1.30	1.51
Seeds 2000 Torino	7.3	16.0	0.018	0.65	0.40	0.40	0.46
Seeds 2000 X3207	7.5	13.4	0.028	2.45	1.50	1.50	1.74
Seeds 2000 X3213	7.7	15.6	0.029	2.10	1.28	0.85	0.99
Seeds 2000 X3274	6.8	15.7	0.027	1.40	0.86	0.80	0.93
Seeds 2000 X4219	7.3	17.9	0.010	1.80	1.10	0.75	0.87
Seeds 2000 X4519	6.4	16.2	0.031	1.15	0.70	0.75	0.87
Seeds 2000 X9822	7.6	14.2	0.015	1.65	1.01	0.80	0.93
Syngenta 3158 NS/CL/DM	7.2	17.7	0.027	1.30	0.79	0.60	0.70
Syngenta 3495 NS/CL/DM	7.1	15.1	0.027	1.25	0.76	0.60	0.70
Syngenta 3733 NS/DM	7.0	16.1	0.022	1.00	0.61	0.65	0.75

Hybrid	Growth Stage (R)	Head Diameter (cm)	Sunflower Midge				
				Necrosis Index (0-5)		Bracken Scale (0-5)	
			Round Index	Hybrid Mean	Relative Mean	Hybrid Mean	Relative Mean
Syngenta 3845 HO	7.3	16.0	0.024	1.95	1.19	0.85	0.99
Syngenta 3990 NS/CL/DM	7.5	18.9	0.019	1.05	0.64	0.60	0.70
Syngenta 3995 NS/SU	7.0	13.0	0.035	1.10	0.67	0.70	0.81
Syngenta 4596 HO/DM	7.1	16.2	0.024	1.75	1.07	0.85	0.99
Syngenta 4651 NS/DM	7.2	15.6	0.016	1.20	0.73	0.70	0.81
Syngenta NX01162	7.5	16.8	0.067	2.20	1.35	1.55	1.80
Syngenta NX82758	7.4	14.8	0.057	1.35	0.83	1.00	1.16
USDA 412HO/472	7.4	14.3	0.026	0.95	0.58	0.65	0.75
USDA 412HO/473	7.6	14.9	0.030	2.25	1.38	1.00	1.16
USDA 412HO/474	6.9	14.2	0.038	1.65	1.01	0.90	1.04
USDA 412HO/475	6.8	14.7	0.020	1.30	0.79	0.60	0.70
USDA 445/472	7.8	13.5	0.038	1.65	1.01	0.80	0.93
USDA 445/473	7.9	14.9	0.022	3.20	1.96	1.10	1.28
USDA 445/474	7.4	13.6	0.053	3.10	1.90	1.75	2.03
USDA 445/475	7.5	17.2	0.016	3.05	1.86	0.95	1.10
USDA 894 Check	7.1	14.8	0.029	1.90	1.16	0.75	0.87

Plant growth stage measurements and ratings taken on 1 September 2011; hybrids planted on 25 May in single row plots randomized and replicated 4 times; 5 plants were evaluated per row (20 total per hybrid). Later than normal planting date may have mitigated sunflower midge damage in 2011.
Round index measures the head deviation from the expected round shape with larger values indicating a greater deviation from the round shape.
Necrosis index measures the extent of necrosis at the base of the bracts caused by sunflower midge larval feeding and the range is 0 (no injury) to 5 (50% or more of each quadrant of the head with midge necrosis).
Relative necrosis index is the hybrid mean divided by the trial mean. Values less than one indicate a rating less than the average of the trial.
Bracken scale measures sunflower midge injury symptoms on a 0 (no injury) to 5 (head closed, no seeds present) scale. **Relative Bracken scale** is the hybrid mean divided by the trial mean. Values less than one indicate a rating less than the average of the trial.

SUNFLOWER MOTH

The sunflower moth migrates to North Dakota from Southern states. Because of the migratory nature of the insect, it has not been a major problem in North Dakota in recent years. This grayish-tan moth moves into fields in early bloom. It deposits its eggs on the face of the flower. Damage is similar to that caused by the banded sunflower moth. Since female moths lay eggs on the face of sunflower heads, insecticide should be applied in early flowering (R5.1 - R5.3).

Threshold: When 1 to 2 moths are found for every 5 plants inspected, treatments should be considered.

SUNFLOWER SEED WEEVIL

The red sunflower seed weevil begins to emerge in early July and continues until mid-August. Peak emergence occurs in late July. Start counting adult seed weevils when the yellow ray petals are just beginning to show. Counts should continue until the economic threshold level has been reached or most plants have reached 70% pollen shed. A plant that has reached 70% pollen shed has few seeds still suitable for red seed weevil egg laying. Fields where most plants are at the 70% pollen shed stage should no longer be susceptible to further significant damage. When sampling, use the X pattern and begin counting at least 70 to 100 feet into the field to avoid field margin effects. Count the number of weevils on five plants at each site for a total of 25 plants. The ideal plant stage for treatment is when most individual plants are at 40% pollen shed. However, we recommend that treatment be considered when three out of 10 plants are just beginning to shed pollen.

Thresholds

***Oilseed Sunflower*:** The threshold can be calculated using the following formula:

$$\textbf{Threshold (weevils per head)} = \frac{\textbf{Cost of Insecticide Treatment}}{\textbf{(Market Price x 21.5) x (0.000022 x Plant Population + 0.18)}}$$

example for calculating threshold: **Price for Oilseed Sunflowers = $0.19**						
Plant Population	**Treatment Cost ($)**					
	6.00	**7.00**	**8.00**	**9.00**	**10.00**	**11.00**
17,000	3	3	4	4	4	5
18,000	3	3	3	4	4	5
19,000	2	3	3	4	4	5
20,000	2	3	3	4	4	4
21,000	2	3	3	3	4	4
22,000	2	3	3	3	4	4
23,000	2	2	3	3	4	4
24,000	2	2	3	3	3	4
25,000	2	2	3	3	3	4

Estimation of absolute red sunflower seed weevil adults when sampling using a commercial formulation of mosquito repellent.					
Number counted in the field	Absolute number	Number counted in the field	Absolute number	Number counted in the field	Absolute number
1	1.4	7	12.4	13	23.1
2	2.9	8	14.2	14	24.9
3	4.4	9	16.0	15	26.6
4	5.8	10	17.8	16	29.3
5	7.3	11	19.5	17	31.1
6	10.7	12	21.3	18	32.9

***Confection or Hulling Sunflower Market*.** Red sunflower seed weevil control on confection sunflower is based on a need to keep seed damage below 0.5% due to industry standards. Treatment is recommended when 1 to 2 weevils are found per plant. The **banded moth**, **seed weevil** and the **Lygus bug** have all impacted quality of these sunflowers the past three to four seasons. It is recommended at this time that **sunflowers grown for these markets be treated a minimum of two times**, once at early flowering and again 5 to 7 days later. With this type of program, a window of protection should be provided to minimize impact from all three of these seed damaging insect pests. Growers should plan treatment schedules early. When flowers begin blooming across the region, competition for access to aerial applicators increases.

SUNFLOWER STEM WEEVIL

The sunflower stem weevil can cause serious stalk breakage. This occurs when 25 to 30 larvae are present in a stalk, weakening the stalk when larvae make their overwintering cells in the stalk's base. Breakage is most likely to occur during drought stress or high winds.

The sunflower stem weevil is 3/16 inch in length, and grayish-brown with varying shaped white spots on the wing covers. The weevils emerge in mid to late June. Eggs are deposited in epidermal tissue of the stem. If controls are directed at the adults in order to minimize egg laying, treatments should be initiated during the first few days in July. About 50% of the eggs will be deposited by this weevil by mid-July. Scouting for these insects is difficult due to their size, coloration and habit of "playing dead." Examine 5 plants each at 5 locations and keep a record of the number of weevils found. Approach plants carefully to avoid alarming the weevils, causing them to drop to the ground. Scout from late June to mid-July.

Threshold: Treat for sunflower stem weevils when scouting determines that an average of 1 adult per three plants is found.

WIREWORMS

To decide whether wireworms are a potential problem, refer to the discussion in the corn insects section. Cruiser and Gaucho 600 is labeled as commercial seed treatment and use decisions must be made at time of seed purchase. Please see the seed treatment section in the introduction for more information.

INSECTICIDES REGISTERED FOR USE IN SUNFLOWER

INSECTICIDE	PRODUCT PER ACRE	PHI	Banded Sunflower Moth	Cutworms	Grasshoppers	Longhorned Beetle	Lygus Bugs	Sunflower Beetle	Sunflower Moth	Sunflower Seed Weevil	Sunflower Stem Weevil	Wireworms
Bacillus thuringiensis												
Biobit HP	0.5 - 1 lb	None							●			
Dipel DF	0.5 - 1 lb											
Xentari DF	0.5 - 2 lbs											
Bacillus thuringiensis												
Dipel ES	1.5 - 2.5 pts	None	●						●			
beta-cyfluthrin												
Baythroid XL *RUP*	0.8 - 2.8 fl oz	30 days	●	●	●			●	●	●	●	
carbaryl												
Sevin 4F	1 - 1.5 qts	60 days for seed 30 days for grazing or forage		●				●	●		●	
Sevin XLR Plus	1 - 1.5 qts											
Sevin 80S	1.25 - 1.875 lbs											
chlorpyrifos												
Lorsban 15G	8 oz per 1,000 row-feet	7 days		●								
Lorsban 15G SmartBox												
Saurus												
chlorpyrifos												
Chlorpyrifos 4E AG	PPI[1]:	42 days Do not allow grazing in treated areas										
Govern 4E	2 - 4 pts											
Hatchet												
Nufos 4E	Foliar:											
Lorsban 4E	1 -2 pts		●	●	●		●	●	●	●	●	
Lorsban Advanced												
Warhawk												
Whirlwind												
Yuma 4E *RUP*												
chlorpyrifos + lambda cyhalothrin												
Cobalt Advanced *RUP*	6 - 38 fl oz	45 days Do not allow grazing in treated areas	●	●	●		●	●	●	●	●	
chlorpyrifos + zeta-cypermethrin												
Stallion *RUP*	3.75 - 11.75 fl oz	42 days Do not allow grazing in treated areas	●	●	●	●		●	●	●	●	
cyfluthrin												
Tombstone	0.8 - 2.8 fl oz	30 days	●	●	●			●	●	●	●	
Tombstone Helios *RUP*												
deltamethrin												
Battalion 0.2EC	7.7 - 11.5 fl oz	21 days	●	●	●			●	●	●	●	
Delta Gold *RUP*	1 - 1.5 fl oz											
esfenvalerate												
Adjourn	1.45 - 9.6 fl oz	28 days	●	●	●			●	●	●	●	
Asana XL *RUP*												

INSECTICIDE	PRODUCT PER ACRE	PHI	Banded Sunflower Moth	Cutworms	Grasshoppers	Longhorned Beetle	Lygus Bugs	Sunflower Beetle	Sunflower Moth	Sunflower Seed Weevil	Sunflower Stem Weevil	Wireworms
gamma-cyhalothrin												
Declare	0.77 - 1.54 fl oz	45 days	●	●	●			●	●	●	●	
Proaxis	1.92 - 3.84 fl oz											
RUP												
imidacloprid												
Dyna-Shield Imidacloprid 5	12.8 fl oz per cwt	45 days										●
Gaucho 600												
Senator 600FS												
lambda-cyhalothrin												
Grizzly Z	1.92 - 3.84 fl oz	45 days										
Lambda-Cy	1.92 - 3.84 fl oz											
LambdaStar	1.92 - 3.84 fl oz											
Lambda-T	1.92 - 3.84 fl oz											
Lamcap	1.92 - 3.84 fl oz											
Nufarm Lambda-Cyhalothrin 1EC	1.92 - 3.84 fl oz		●	●	●			●	●	●	●	
Province	1.92 - 3.84 fl oz											
Silencer	1.92 - 3.84 fl oz											
Silencer VC	1.92 - 3.84 fl oz											
Taiga Z	1.92 - 3.84 fl oz											
Warrior II	0.96 - 1.92 fl oz											
RUP												
methyl parathion												
Cheminova Methyl 4EC	2 pts	30 days							●	●		
RUP												
thiamethoxam												
Cruiser 5FS	0.25 mg active ingredient per seed	None						●				●
zeta-cypermethrin												
Mustang Max	At Planting: 4 fl oz	30 days		●								●
RUP												
zeta-cypermethrin	Foliar Application:	30 days										
Mustang Max	1.28 - 4 fl oz											
Mustang Max EC			●	●	●	●		●	●	●	●	
Respect												
RUP												

RUP = Restricted Use Pesticide

● = Control

[1] = PPI applications of chlorpyrifos products for control of cutworms only

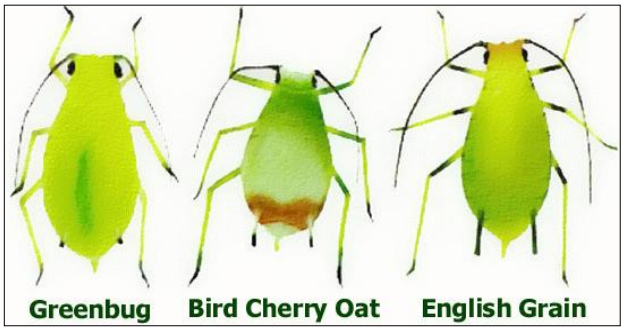
WHEAT INSECTS

Other Resources Available Through NDSU Extension Service:

Publications
- E-1479 Integrated Pest Management of Wheat Stem Sawfly in North Dakota (2010)
- E1330 Integrated Pest Management of the Wheat Midge in North Dakota (2008)
- E1230 Cereal Leaf Beetle Management (2002)
- E188 Wireworm Control (2001)
- E830 The Armyworm and the Army Cutworm (2000)
- E272 Grasshopper Management (1997)
- E493 Aphid Management in Small Grains, Corn and Sorghum (1993)
- E1007 Biology and Management of Barley Thrips (1991)

APHIDS

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 principal 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: 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. Journal 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.

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: 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.

CEREAL LEAF BEETLE

The cereal leaf beetle is an imported insect pest from Europe. This insect has only 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 3 eggs and/or 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.

At the boot stage to 1 larvae or more per flag leaf.

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.

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

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.

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 per square yard		Adults per square yard	
Rating	Margin	Field	Margin	Field
Light	25-35	15-25	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.

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.

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.

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 5% 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.

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 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.

INSECTICIDES REGISTERED FOR USE IN WHEAT

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cereal Leaf Beetle	Cutworms	Grasshoppers	Hessian Fly	Wheat Midge	Wheat Stem Maggot	Wireworms
Bacillus thuringiensis											
Biobit HP	0.5 - 2 lbs	None		‡							
Dipel DF	1 - 2 lbs										
Dipel ES	2 - 4 pts										
Xentari DF	0.5 - 2 lbs										
beta-cyfluthrin											
Baythroid XL *RUP*	1 - 2.4 fl oz	30 days 3 days for grazing or forage	●	‡	●	●	●			●	
chlorpyrifos											
Chlorpyrifos 4E AG Govern 4E Hatchet Lorsban 4E Lorsban Advanced Nufos 4E Warhawk Whirlwind Yuma 4E *RUP*	0.5 - 1 pt	28 days for grain and straw 14 days for grazing, forage and hay	●	●	●	†	●		●		
chlorpyrifos + lambda-cyhalothrin											
Cobalt Advanced *RUP*	6 - 25 fl oz	28 days for grain and straw 14 days for grazing, forage and hay	●	●	●	●	●		●		
chlorpyrifos + zeta-cypermethrin											
Stallion *RUP*	3.75 - 11.75 fl oz	28 days for grain and straw 14 days for grazing, forage and hay	●	●	●	●	●			●	
clothianidin											
NipsIt SUITE Cereals OF NipsIt SUITE Cereals CVR NipsIt Inside + fungicides **Product registration pending 2012**			*								●
cyfluthrin											
Tombstone Tombstone Helios *RUP*	1 - 2.4 fl oz	30 days 3 days for grazing or forage	●	‡	●	●	●				
diflubenzuron											
Dimilin 2L **FOR USE WEST OF US HIGHWAY 81 ONLY** *RUP*	1 - 4 fl oz	50 days for grain and straw 15 days for hay 3 days for forage			‡		‡				

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cereal Leaf Beetle	Cutworms	Grasshoppers	Hessian Fly	Wheat Midge	Wheat Stem Maggot	Wireworms
dimethoate Digon 400 Dimate 4E Dimethoate 4E Dimethoate 4EC Dimethoate 400	0.5 - 0.75 pt	35 days for grain 14 days for grazing	●				●				
gamma-cyhalothrin Declare Proaxis *RUP*	0.77 - 1.54 fl oz 1.92 - 3.84 fl oz	30 days	●	●	●	●	●	●	●		
imidacloprid Attendant 600 Dyna-Shield Imidacloprid 5 Gaucho 600 Senator 600FS	0.8 - 2.4 fl oz per cwt	45 days for grazing or feeding	*					●			†
imidacloprid* Enhance AW	4 oz per cwt	45 days for grazing or feeding	*					†			†
imidacloprid* Foothold Extra Sativa IM Max	3.4 - 5 fl oz per cwt	45 days for grazing or feeding	*					●			●
imidacloprid Sativa IM RTU	5 fl oz per cwt	45 days for grazing or feeding									†
imidacloprid Rancona Crest	5 - 8.33 fl oz per cwt	45 days for grazing or forage	*					†			†
imidacloprid Rancona Crest WR	5 - 8.33 fl oz per cwt	45 days for grazing or forage									†
imidacloprid Raxil MD-W	5 fl oz per cwt	45 days for grazing or forage									†
lambda-cyhalothrin Grizzly Z Lambda-Cy LambdaStar Lambda-T Lamcap Nufarm Lambda-Cyhalothrin 1EC Province Silencer Silencer VC Taiga Z *RUP*	1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz 1.92 - 3.84 fl oz	30 days for grain and straw 7 days for grazing and forage	●	●	●	●	●	●	●		
lambda-cyhalothrin Warrior II *RUP*	0.96 - 1.92 fl oz	30 days for grain and straw 7 days for grazing and forage	●	●	●	●	●	●	●	●	
malathion Cheminova Malathion 57% Cheminov 57EC	1 - 1.5 pts 1.5 - 1.6 pts	7 days	●		●		●				
malathion Malathion 5	1 - 2 pts	7 days	●	●	●		●				
malathion Fyfanon ULV Malathion ULV	4 - 8 fl oz	7 days			●		●	●	●		
methomyl Lannate LV *RUP*	0.75 - 1.5 pts	7 days	●	●	●		‡				

INSECTICIDE	PRODUCT PER ACRE	PHI	Aphids	Armyworms	Cereal Leaf Beetle	Cutworms	Grasshoppers	Hessian Fly	Wheat Midge	Wheat Stem Maggot	Wireworms
methyl parathion Cheminova Methyl 4EC *RUP*	0.5 - 1.5 pts	15 days **REI = 4 days**	●	●		●	●				
methyl parathion Penncap-M *RUP*	2 - 3 pts	14 days **REI = 31 days**	●	●			●		●		
spinetoram Radiant SC	2 - 6 fl oz	21 days for grain and straw 3 days for forage, fodder and hay		●	●		†				
spinosad Blackhawk Entrust Success Spintor 2SC Tracer	1.1 - 3.3 oz 0.5 - 2 fl oz 2 - 6 fl oz 2 - 6 fl oz 1 - 3 fl oz	21 days for grain and straw 3 days for forage, fodder and hay		‡	●		†				
thiamethoxam* Cruiser 5FS	0.75 - 1.33 fl oz per cwt	None	*					●			●
thiamethoxam CruiserMaxx Cereals[1]	5 fl oz per cwt	None	*					●			●
zeta-cypermethrin Mustang Max Mustang Max EC Respect Respect EC *RUP*	1.28 - 4 fl oz	14 days	●	●	●	●	●				

RUP = Restricted Use Pesticide
● = Control
† = Suppression only
‡ = Control of first and second instar larvae or control of young grasshoppers, depending on product indicated
* = Seed treatments may not provide control of early season grain aphids
[1] = For protection against early season aphids and Hessian fly, CruiserMaxx Cereals must be mixed with 0.48 - 1 fl oz per cwt of Cruiser 5FS; consult each label for registered use rates and follow all label instructions

STORED GRAIN

Preparing Bins For Storage: The key to good grain storage is anticipating and preventing potential problems through good bin management.

Before treating with protectant, make sure that the bins are free of insect-infested grain. Leftover grain should be removed from the bin, and the walls should be swept and vacuumed. All grain handling equipment including augers, combines, trucks and wagons should be thoroughly cleaned and grain residues removed before harvest.

A residual bin spray such as malathion, Tempo, Diacon or a combination of the two should be applied to all interior bin surface areas 2 to 3 weeks before new grain is placed in the bin. The treatment will kill insects merging from their hiding places (cracks, crevices, under floors and in aeration systems). Also, insects crawling or flying in from the outside will be killed.

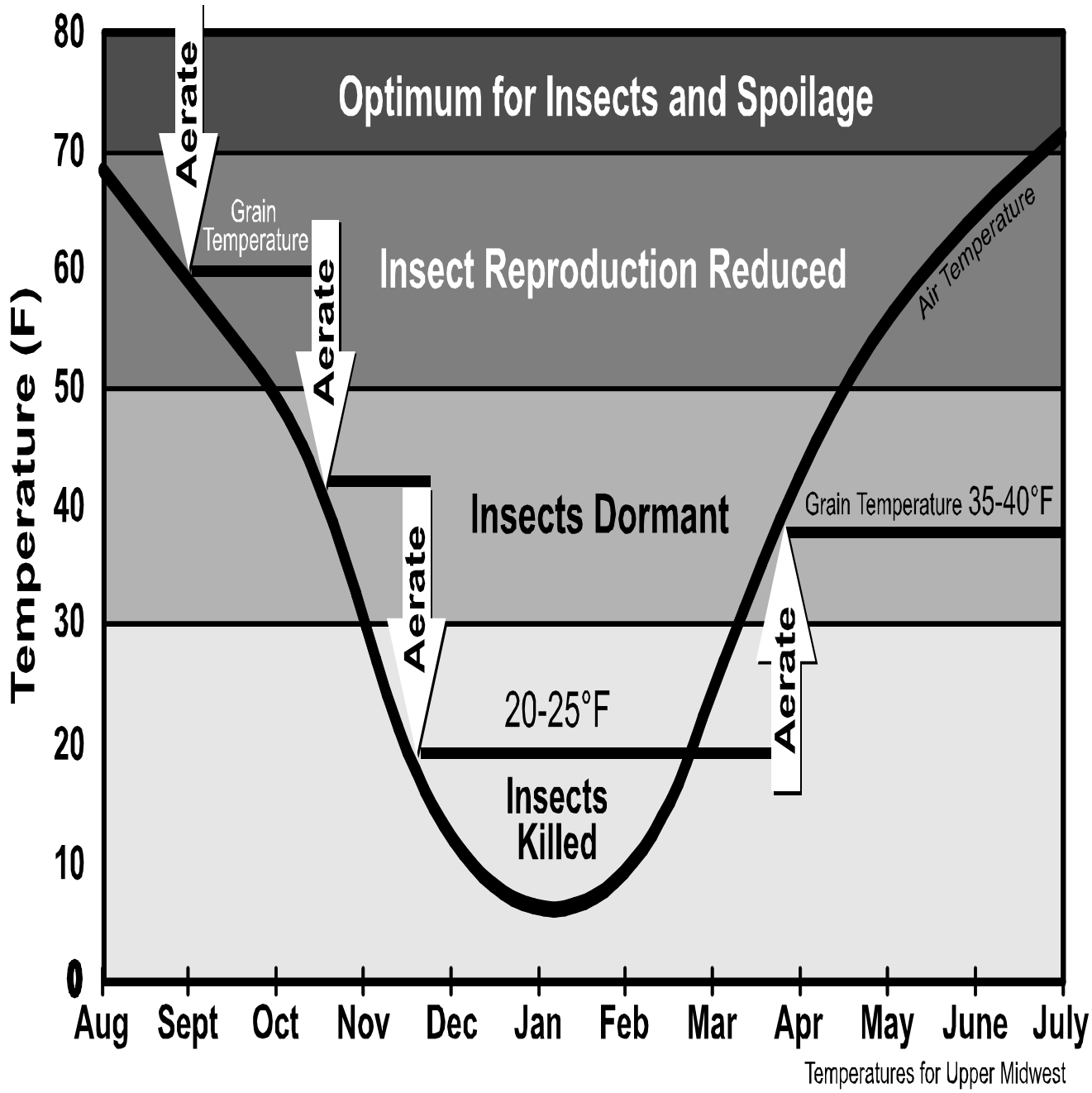
Apply the spray to as many surfaces as possible, especially joints, seams, cracks, ledges and corners. Spray the ceiling, walls and floors to the point of runoff. Use a coarse spray at a pressure of more than 30 lb per square inch and aim for the cracks and crevices.

Spray beneath the bin, its supports, and a 6 ft border around the outside foundation. Treat the outside surface, especially cracks and ledges near doors and fans.

The increased use of metal bins with perforated floors for grain drying and aeration has helped produce a serious insect problem in farm-stored grain. Grain dockage (broken kernels, grain dust, and chaff) sifts through the floor perforations and collects in the subfloor plenum creating a favorable environment for insect development. Unfortunately, the floors are usually difficult to remove, making inspection, cleaning and insecticide spraying in the plenum difficult if not impractical. The infested plenum may be disinfected with an approved fumigant such as chloropicrin.

TYPE OF TREATMENT	CROP	INSECTICIDE	Comments
Residual Bin Sprays: (empty bins) Clean, sweep and spray all bins before harvest. **Note**: Do not add grain to a treated bin for at least 24 hours or until walls have dried thoroughly.	All bins	**(S)-methoprene** Diacon II Diacon-D	Active ingredient is an insect growth regulator. It prevents the development of larvae into adults. Adult insects are not controlled. Recommend that it is mixed with Tempo for adulticide.
		malathion	May not provide control of Indian meal moth. Check label for listing of this use.
		cyfluthrin Tempo	Check product label for rates of application. Do not apply to grain.
		chlorpyrifos-methyl + cyfluthrin Storcide II	Storcide combines the active ingredients of Reldan (chlorpyrifos methyl) and Decis (deltamethrin).
Surface Treatment: Apply insecticide to surface after grain is binned. **Note**: To ensure control, remove all surface crusting and webbing before treatment.	Wheat Barley Corn Oats Rye Soybeans Sunflowers	***Bacillus thuringienesis, subspecies kurstaki*** Dipel	(Indian meal moth larvae only.) As a surface treatment, apply ½ lb of Dipel in 5-10 gal. of water per 500 sq ft of grain surface area: mix into top 4 inches.
		(S)-methoprene Diacon II Diacon-D	Active ingredient is an insect growth regulator. It prevents the development of larvae into adults. Adult insects are not controlled. Soybeans are not on Diacon II and Diacon-D labels. Canola and legumes are also on Diacon-D label.
		diatomaceous earth Insecto, Dryacide	4.0 lbs per 1,000 sq ft. Treat only the top 1 to 2 ft of the grain mass.
Grain Protectant: All the grain is treated when bin is being filled. Insecticides may be applied as a spray or dust to the grain as it is being augered into the bin. These products may also be used for treatment of the grain surface for registered commodities.	Corn Sorghum	**pirimiphos-methyl** Actellic 5E	No food or feeding restrictions. Lesser grain borer is not listed as a target pest.
	Wheat Barley Oats Sorghum Corn	**(S)-methoprene** Diacon II Diacon-D	Active ingredient is an insect growth regulator. It prevents the development of larvae into adults. Adult insects are not controlled. Sunflowers are on Diacon II and Diacon-D labels. Canola and legumes are also on Diacon-D label.
		malathion	May not provide control of Indian meal moth. Products not labeled specifically for application to stored grain should not be used.
		chlorpyrifos-methyl + cyfluthrin Storcide II	Storcide II combines the active ingredients of Reldan (chlorpyrifos methyl) and Decis (deltamethrin). Storicide II does NOT have export restrictions on the label.

Cool Grain to Prevent Storage Problems



* Prevent crusting due to moisture migration by cooling grain to within 15°F of average outdoor temperatures.
* Cooling grain by 10°F doubles its allowable storage time

Dr. Kenneth J. Hellevang, PE
NDSU Extension Service

FUMIGANTS

The two principal types of fumigants used for the treatment of farm-stored grain are liquids (chloropicrin) and solids (aluminum phosphide). Limited amounts of methyl bromide (a compressed gas) are also used in farm storage. These vapors permeate the grain mass and kill insects by suffocation or by chemical action on their breathing system, preventing the assimilation of oxygen or other vital functions. In order for a grain fumigant to kill insects, it is necessary that the vapor or gas remain at a toxic concentration for a sufficient period of time for the insects to contact the gas. No fumigant kills insects instantaneously; usually it requires several hours of exposure, even under ideal conditions, for fumigating.

Some Important Steps for Successful Fumigation

1. Do not attempt fumigating grain unless the grain temperature is 60^{o} F or higher.
2. Before applying fumigants, level the grain surface and break up any surface "caking."
3. Apply fumigants on a calm day. Seal bin as tightly as possible. The fumigant should be retained in the grain and not allowed to "leak" out. Use polyethylene and/or caulk to cover or seal all holes and cracks. Cover the grain with a tarpaulin or polyethylene if there is a large air space above the grain.
4. All fumigants should be handled with extreme care because the fumes are highly toxic. Apply the fumigant from the outside of the bin whenever possible. Always have a second person nearby while fumigating. Use a self-contained breathing apparatus if you must enter the bin.
5. Always use the recommended dosage.
6. Keep all people and animals out of the building for at least 48 hours.
7. Never use fumigants when the grain temperature is below 60^{o} F. During the cold winter months, it would be better to aerate, turn or move the grain.

FUMIGANT*	COMMODITIES	COMMENTS
Chloropicrin *RUP*	Empty-bin treatment only. (See comments on right.)	Chloropicrin is no longer registered for direct application to stored grain. However, the fumigant can still be used for treating the perforated floors in empty bins in order to control insects in the subfloor area prior to bin filling.
Aluminum phosphide ** *RUP*	Wheat, barley, rye, oats, corn sorghum, safflower seed, sunflower seed, soybeans, triticale and millet	Aluminum phosphide is available under trade names such as Fumitoxin, Weevil-Cide and Phostoxin in pellet or tablet form. Since phosphine gas is only slightly heavier than air, it is very important that the bins are tightly sealed and the grain surface covered with plastic sheeting after the fumigant has been probed into the grain mass. Since there is a delay time of 1 to 2 hours with tablets before dangerous amounts of phosphine gas are released, applicators can normally complete application before toxic fumes begin to develop in the bin.
Methyl bromide *RUP*	Wheat (similar small grain), shelled corn and milo (grain sorghum)	Methyl bromide can affect the germination of seeds at high moisture levels and high dosages. It is more than 3 times the weight of air, and recirculation techniques may be needed to ensure even distribution. This, plus the fact that methyl bromide is very hazardous to work with, are reasons that this product should only be used by trained professional fumigators.

RUP - Restricted use pesticides are to be applied by or under the direct supervision of certified pesticide applicators only.

*Dosage rates for the fumigants listed will vary depending upon the commodity and type of storage structure to be treated. Read and follow label directions carefully!

****Fumigation Management Plan**

- The certified applicator is responsible for working with the owners and/or responsible employees of the structure and/or area to be fumigated to develop and follow a Fumigation Management Plan (FMP). The FMP is intended to ensure a safe and effective fumigation. The FMP must address characterization of the structure and/or area, and include appropriate monitoring and notification requirements, consistent with, but not limited to, the following:
- Inspect the structure and/or area to determine its suitability for fumigation.
- When sealing is required, consult previous records for any changes to the structure, seal leaks and monitor any occupied adjacent buildings to ensure safety.
- Prior to each fumigation, review any existing FMP, MSDS, Applicator's Manual and other relevant safety procedures with company officials and appropriate employees.
- Consult company officials in the development of procedures and appropriate safety measures for nearby workers who will be in and around the area during application and aeration.
- Consult with company officials to develop an appropriate monitoring plan that will confirm that nearby workers and bystanders are not exposed to levels above the allowed limits during application, fumigation and aeration.
- This plan must also demonstrate that nearby residents will not be exposed to concentrations above the allowable limits.

- Consult with company officials to develop procedures for local authorities to notify nearby residents in the event of an emergency.
- Confirm the placement of placards to secure entrance into any structure under fumigation.
- Confirm the required safety equipment is in place and the necessary manpower is available to complete a safe and effective fumigation.
- Written notification must be provided to the receiver of a vehicle that is fumigated in transit.

These factors must be considered in putting an FMP together. It is important to note that some plans will be more comprehensive than others. All plans should reflect the experience and expertise of the applicator and circumstances at and around the structure and/or area. In addition to the plan, the applicator must read the entire label and Applicator's Manual and follow its directions carefully. The FMP and related documentation, including monitoring records, must be maintained for a minimum of two years.

REASONS FOR FUMIGATION FAILURES

Insufficient Fumigant: Because the efficiency of a fumigant depends on the maintenance of a killing concentration in the grain, any factor that affects gas concentration is important. You cannot get satisfactory results by applying less than the recommended dosage (a common problem). Be sure to use the amount of fumigant required for the capacity of the bin, not the amount of grain contained in the bin.

Storage Structure: A loosely constructed, leaky bin may not retain fumigants long enough to kill the insects while a tight concrete or metal bin may hold the fumigant in killing concentrations for several days. The depth of the grain in relation to its surface area also affects the efficiency of a fumigant. In general, the greater the surface area of the grain in proportion to the bulk, the greater the difficulties encountered in fumigation. This is the practical reason (except for leaks) that flat storages require higher dosages than round silo-type bins. Storage structures with a large amount of space over the grain are also difficult to fumigate effectively, as large amounts of gas escape into the head space.

Type of Grain and Dockage: The kind of grain affects the efficiency of a fumigant in accordance with its sorption quality. For example, shelled corn and grain sorghum appear to be much more sorptive than wheat. Wheat with dockage exceeding 3% requires nearly twice the dosage than wheat with less than 1% dockage requires.

Moisture: The moisture content of the grain has a profound effect on the efficiency of a fumigant - the higher the moisture content, the higher the dosage required. As the moisture content increases above 12%, a proportionally higher dosage is required. Generally you cannot satisfactorily fumigate grain having a surface moisture content of 15% to 20% because the fumigant vapors will not penetrate the moist layer.

Temperature: During fumigation the gas quickly assumes the temperature of the grain. An increase in temperature results in greater molecular activity of gases, which facilitates the diffusion and penetration of the fumigant. However, there are limiting factors for both extremes of high or low temperatures. If grain temperature reaches 115^{o} F, the fumigants vaporize very rapidly and may escape from the bin before lethal gas concentrations can be obtained. Most stored grain insects cannot survive in grain at 115^{o} F or above, thus eliminating the need for fumigating. You need not fumigate stored grain with a temperature of 60^{o} F or below as the insects are inactive at this temperature.

INSECTICIDE PRICE LIST

The prices listed are approximate retail prices for dry ounces (oz), fluid ounces (fl oz), pounds (lb) or quarts (qt), depending on the product. Prices do not include costs of additives or application costs. Prices may vary depending on area of the state, wholesaler, bulk discounts, generic products in stock, seasonal changes, quantities purchased, and special offers. Growers should consult their local agricultural product suppliers for current prices. The listed prices are based on 2011 prices adjusted upwards by 10%. Only products for which prices could be determined are listed below.

Trade Name	Active Ingredient	Cost ($) per Unit
Actara	thiamethoxam	3.15/oz
Admire Pro	imidacloprid	2.95/fl oz
Agri-Mek 0.15EC	abamectin	1.97/fl oz
Ambush	permethrin	0.17/fl oz
Ambush 25W	permethrin	0.66/lb
Arctic 3.2EC	permethrin	0.64/fl oz
Asana XL	esfenvalerate	0.81/fl oz
Avaunt	indoxacarb	6.06/oz
Aztec 2.1G	cyfluthrin tebupirimiphos	0.19/oz
Aztec 4.67G	cyfluthrin tebupirimiphos	0.49/oz
Baythoid XL	beta-cyfluthrin	2.69/fl oz
Belay	clothianidin	2.64/fl oz
Beleaf 50G	flonicamid	5.78/fl oz
Belt SC	flubendiamide	6.15/fl oz
Brigade 2EC	bifenthrin	1.08/fl oz
Brigadier	bifenthrin imidacloprid	1.34/fl oz
Capture LFR	bifenthrin	2.20/fl oz
Cobalt Advanced	chlorpyrifos lambda-cyhalothrin	0.43/fl oz
Coragen	chlorantraniliprole	7.10/fl oz
Counter 15G Lock n' Load	terbufos	0.16/oz
Counter 20G SmartBox	terbufos	0.24/oz
Cruiser 5FS	thiamethoxam	9.72/oz
Cruiser MAXX	thiamethoxam	4.42/oz
Cruiser MAXX Cereals	thiamethoxam	0.71/fl oz
Cruiser MAXX Potato	thiamethoxam	9.55/fl oz
Delta Gold	deltamethrin	1.93/fl oz
Diacon II	methoprene	5.08/fl oz
Diacon D	methoprene	3.75/lb
Dibrom 8 Emulsive	naled	0.80/fl oz
Dimate 4E	dimethoate	0.38/fl oz
Dimethoate 400	dimethoate	0.38/fl oz
Dimethoate 4E	dimethoate	0.38/fl oz
Dimethoate 4EC	dimethoate	0.38/fl oz
DiPel DF	Bt	0.89/oz
DiPel ES	Bt	0.32/fl oz
Dyna-Shield Imidacloprid 5	imidacloprid	4.75/fl oz
Endigo ZC	lambda-cyhalothrin thiamethoxam	1.80/fl oz
Entrust	spinosad	33.52/oz
Foothold Extra	imidacloprid	1.02/fl oz
Force 3G	tefluthrin	0.33/oz
Force 3G SmartBox	tefluthrin	0.39/oz
Force CS	tefluthrin	2.86/fl oz
Fortress 5G	chlorethoxyfos	0.32/oz
Fulfill	pymetrozine	5.78/oz
Gaucho 600	imidacloprid	6.65/fl oz
Grizzly Z	lambda-cyhalothrin	1.60/fl oz
Hero	bifenthrin zeta-cypermethrin	1.43/fl oz
Intrepid 2F	methoxyfenozide	1.88/fl oz
Lannate LV	methomyl	0.62/fl oz
Larvin 3.2	thiodicarb	0.65/fl oz
Leverage 360	beta-cyfluthrin imidacloprid	2.06/fl oz
Lorsban 15G	chorpyrifos	0.12/oz
Lorsban 15G SmartBox	chorpyrifos	0.16/oz
Lorsban 4E	chlorpyrifos	0.33/fl oz
Lorsban Advanced	chlorpyrifos	0.33/fl oz
Malathion 5	malathion	0.28/fl oz
Malathion 57EC	malathion	0.30/fl oz
MANA Alias 2F	imidacloprid	0.80/fl oz
Movento	spirotetramat	6.90/fl oz
Mustang Max	zeta-cypermethrin	1.72/fl oz
Nuprid 2F	imidacloprid	0.57/fl oz
Oberon 2SC	spiromesifen	3.30/fl oz
Orthene 97	acephate	0.46/oz
Penncap-M	methyl parathion	0.30/fl oz
Permethrin 3.2EC	permethrin	0.42/fl oz
Platinum	thiamethoxam	2.29/fl oz
Platinum 75SG	thiamethoxam	6.30/oz
Pounce 1.5G	permethrin	0.10/oz
Radiant SC	spinetoram	5.54/fl oz
Raxil MD-W	imidacloprid	0.72/fl oz
Regent 4SC	fipronil	5.98/oz
Renounce 20WP	cyfluthrin	2.16/oz
Respect	zeta-cypermethrin	2.01/fl oz
Rimon 0.83EC	novaluron	1.77/fl oz
Sevin 4F	carbaryl	10.20/qt
Sevin XLR Plus	carbaryl	10.84/qt
SmartChoice 5G Lock n' Load	bifenthrin chlorethoxyfos	0.25/oz
Sniper	bifenthrin	0.99/fl oz
Stallion	chlorpyrifos zeta-cypermethrin	0.70/fl oz
Steward EC	indoxacarb	1.79/fl oz
Success	spinosad	5.54/fl oz
Thimet 20G Lock n' Load	phorate	0.20/oz
Tombstone Helios	cyfluthrin	2.56/fl oz
Tracer	spinosad	8.62/fl oz
Tundra EC	bifenthrin	1.24/fl oz
Venom	dinotefuran	8.45/oz
Voliam Xpress	chlorantraniliprole lambda-cyhalothrin	3.87/fl oz
Vydate C-LV	oxamyl	0.77/fl oz
Vydate L	oxamyl	0.70/fl oz
Warhawk	chlorpyrifos	0.28/fl oz
Warrior II	lambda-cyhalothrin	3.67/fl oz
Widow	imidacloprid	0.55/fl oz
Xentari DF	Bt	1.07/oz

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For information regarding pesticide certification, contact the **North Dakota State University Extension Pesticide Program**

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www.ndsupesticide.org

For pesticide enforcement, compliance assistance, registration, and other regulatory issues, contact the **Agriculture Chemical Division at the North Dakota Department of Agriculture**

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For more information on this and other topics: **www.ag.ndsu.edu**

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