Insect Pests in Wheat

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2023 Advanced Crop Advisers Workshop

NDSU NORTH DAKOTA STATE UNIVERSITY

Order Orthoptera - Grasshoppers

- About 375 species of grasshoppers in North American rangelands
- About a third are considered to be pests, but nearly all the rest are innocuous
- Only a few grasshoppers are major importance to cropland
  - ✓ Alfalfa, corn, soybean, small grains (barley, oats, winter wheat, HRSW), sunflower, flax
- Population fluctuates low to outbreak levels depending on the weather
  - ✓ Areas with <25 inches of rain = Higher risk
  - ✓ Hot, dry weather 'Drought' = Increase risk
  - ✓ Cool, wet weather = Reduces populations and decrease risk

Grasshopper Life Cycle

1 generation per year
Egg to adult – 40-60 days

WINTER

Egg pod

EARLY SPRING

1st Instar

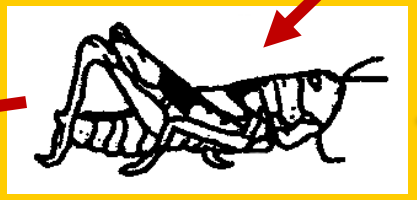
Peak egg hatch mid-June

2nd Instar

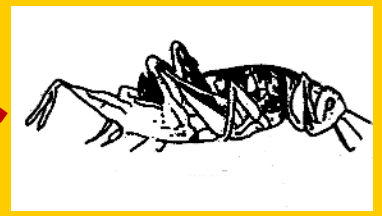
3rd Instar

SCOUT NOW!

Best time to control nymphs



4th Instar



5th Instar

ADULT

SCOUT NOW!

LATE JULY

Surviving females lay eggs

AUGUST to FALL

Each female = 8-25 egg pods
Each egg pod = 20-120 eggs

Young Grasshoppers or Nymphs

- Look like adults
- Smaller than adults
- Wing pad (red arrow) instead of wings
- 5 instars (growth stages) as nymph

Twostriped grasshopper
Melanoplus bivittatus

- **Crop pest – 1.1-1.6 inch long, brown/green**
- **Crops: alfalfa, corn, small grains**
- **Early-hatching, often first to appear in road ditches and field edges**
- **Hatching period lasts 4-6 weeks**
- **Hatching two or more burst following rain and warm temperatures**

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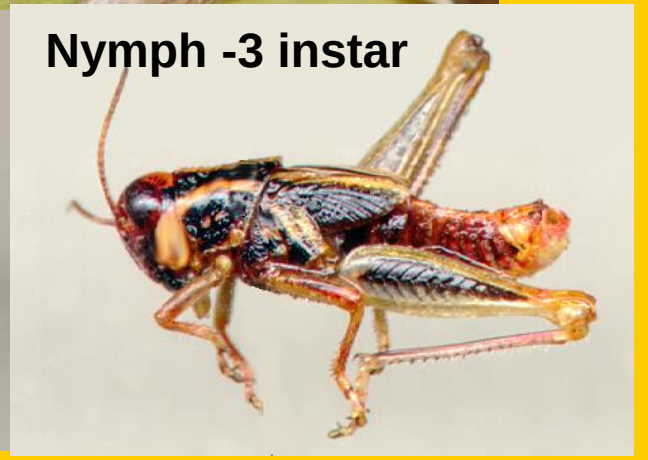
Migratory grasshopper *Melanoplus sanguinipes*

- **Crop and grassland pest – 1 $^{1}/_{8}$ inch long, brown/gray, blue or red hind tibia**
- **Crops: alfalfa, corn, winter wheat, small grains***
- **Early–hatching species**
  - ✓ **8-10 days after twostriped grasshopper**
- **Lay eggs in late-planted crops: soybean, sunflower, and field corn**
- **Adult migrate up to 30 miles per day**
  - ✓ **1938 - Highmore, SD to Beach, ND or 66 miles per day for 4 days**
- **Like sandy soils for egg laying**

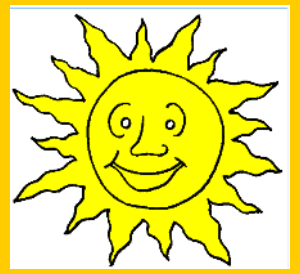
Red-legged grasshopper *Melanoplus femurrubrum*

- **Crop pest - <1 inch long, brownish-red, hind tibia red**
- **Crops: alfalfa, corn, soybeans, small grains**
- **Hatches 3 weeks after twostriped grasshopper**
- **Hatching period – 52 days**
  - ✓ **See nymphs all summer long**
- **Lay eggs into late-planted crop fields: soybean, sunflower, and field corn**



Crop Damage - Grasshoppers

- Chewing mouthparts
  - Leaf stripping or defoliation
  - Pod or wheat head clipping
- Often higher feeding injury on field edges
- Temperatures of 68 to 100 F for feeding
  - Bask in sun in AM



Pile of dead grasshoppers after wheat harvest 2022, McKenzie County, ND

Tammy Duchsherer, Scheresky Ag Services

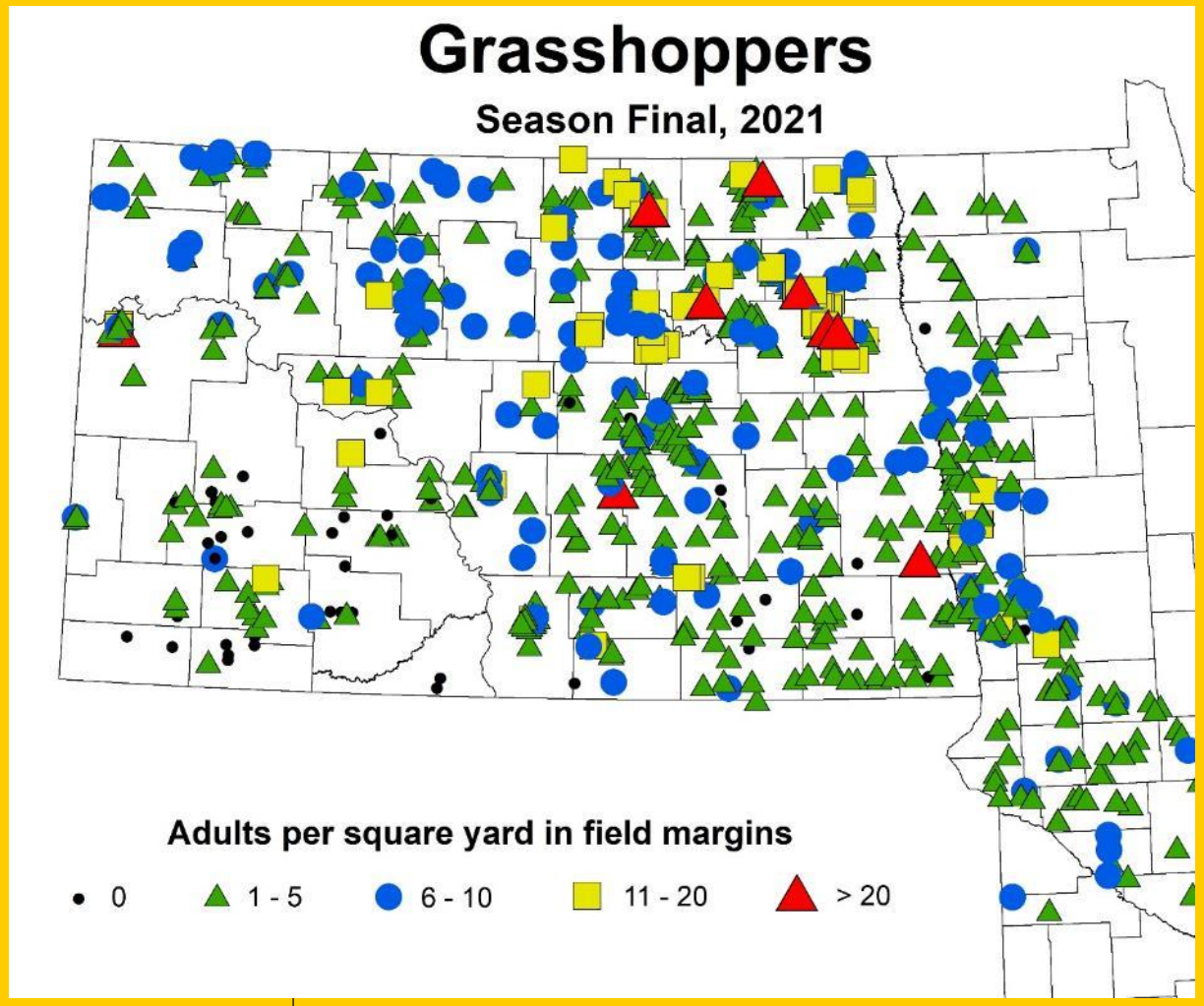
Crop Damage - Grasshoppers

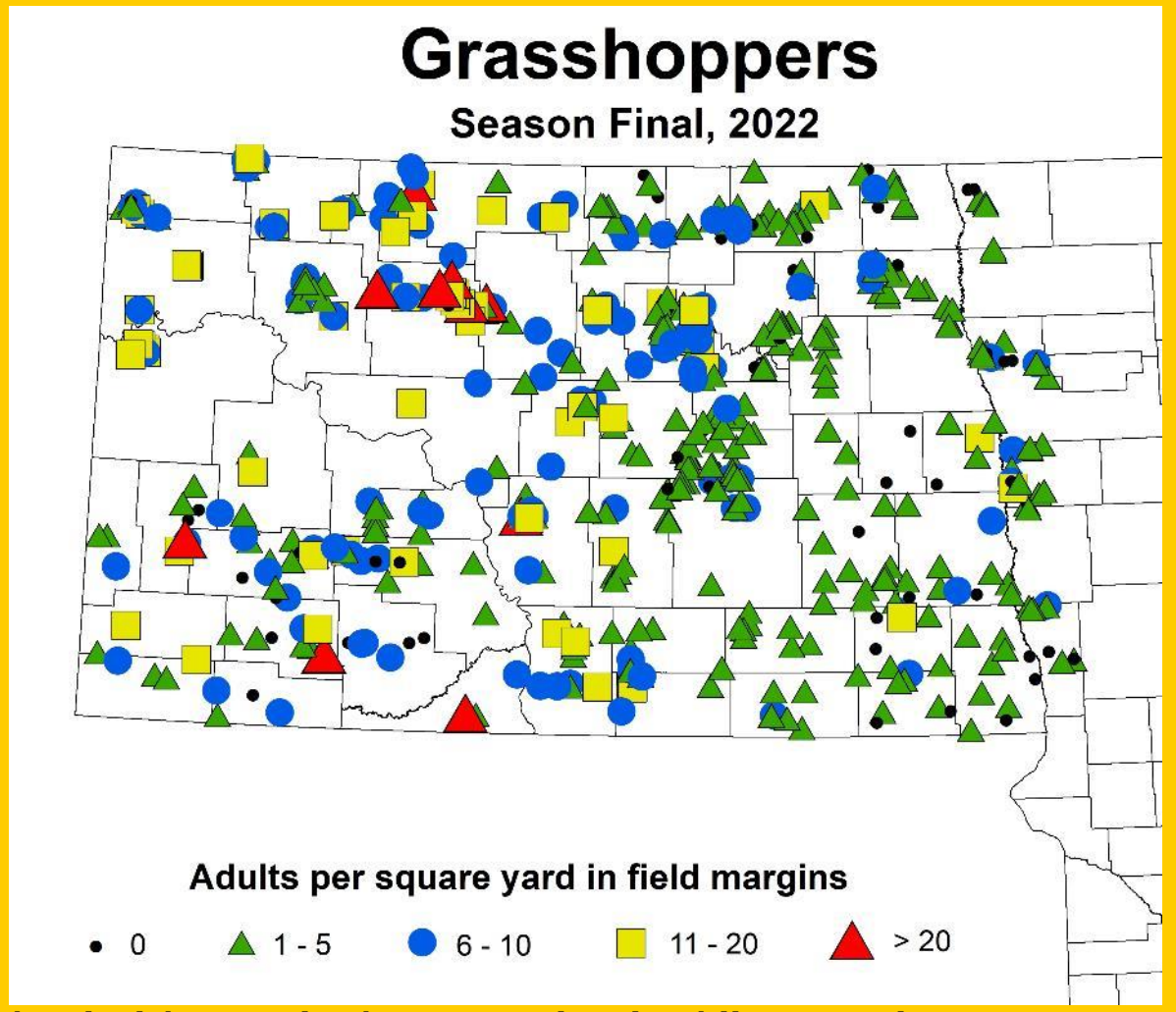
Sunflower defoliated by grasshoppers in SD 2020

Grasshoppers feeding directly on corn ear in ND 2020
Veronica Calles Torrez

Soybean field edge defoliated by grasshoppers 2021
Jeff Stachler, Griggs County

Grasshopper Maps 2021- 2022





https://www.ndsu.edu/agriculture/ag-hub/ag-topics/crop-production/diseases-insects-and-weeds/integrated-pest-management/grasshoppers

Estimating Grasshopper Infestations

- Scout for Nymphs & Adults
  - Inspect field once a week
    - Visual (# grasshoppers per square yard)
    - Sweep net
  - Higher levels, scout 2-3 times a week
  - Ditches & Field Edges
    - Nymphs - Late May to mid-July
  - Ditches, field edges & in field
    - Adults – late July to harvest

Nymph or Adult Grasshoppers

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

4 - 180 degree sweeps = 1 square yard

15-inch sweep net

Insect supplier: Great Lakes IPM

Estimate number of grasshoppers in a square foot, repeat 18 times and then divide by 2 for # per square yard (9 square feet)

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Wheat Insecticides - Grasshoppers

IRAC Class	Trade Name	Active Ingredient(s)	Rate Range (oz/acre)		Cost ($/acre)		PHI
			Low	High	Low	High	
15	Dimilin 2L*	diflubenzuron	1	2	$ 1.47	$ 2.94	50 days
1B	Dimate 4E	dimethoate	12	12	$ 5.52	$ 5.52	35 days
1B	Malathion 5**	malathion	16	32	$ 8.00	$ 16.00	7 days

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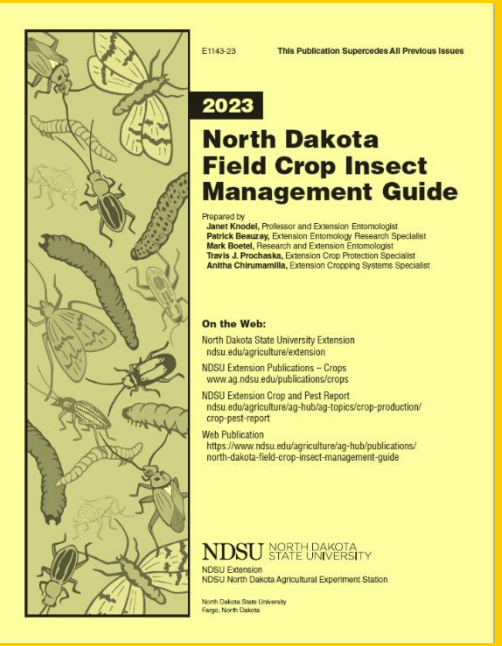
3A	Fastac CS	alpha-cypermethrin	3.2	3.8	$ 4.61	$ 5.47	14 days
3A	Baythroid XL	beta-cyfluthrin	1.8	2.4	$ 5.40	$ 7.20	30 days
3A	Tombstone Helios	cyfluthrin	1.8	2.4	$ 4.77	$ 6.36	30 days
3A	Warrior II	lambda-cyhalothrin	1.28	1.92	$ 3.94	$ 5.91	30 days
3A	Mustang Maxx	zeta-cypermethrin	3.2	4	$ 5.41	$ 6.76	14 days
3A, 28	Besiege	lambda-cyhalothrin + chlorantraniliprole	6	10	$ 15.84	$ 26.40	30 days
28	Vantacor***	chlorantraniliprole	0.7	2.5	$ 11.82	$ 42.23	1 day

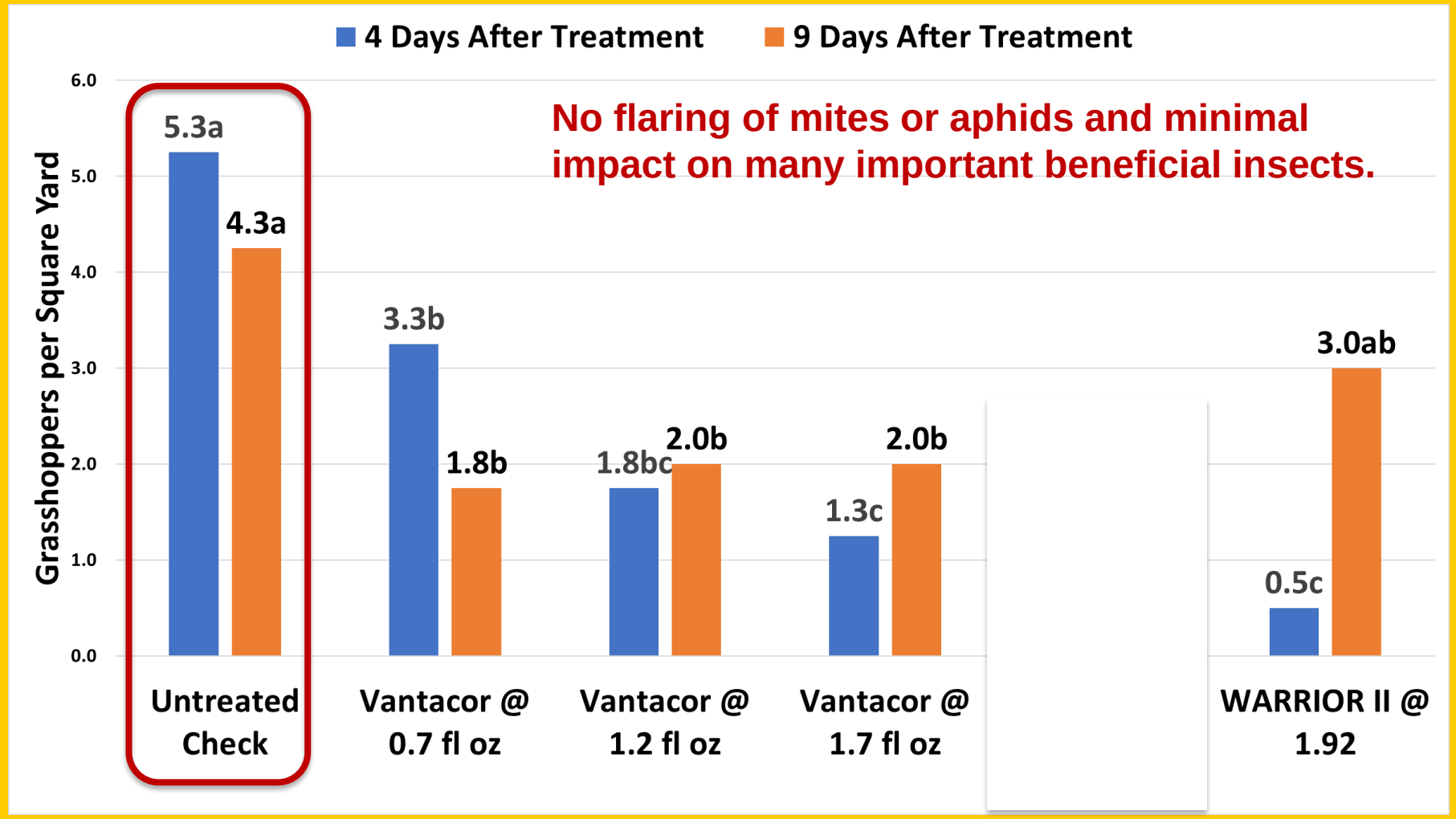
2022 FMC – Vantacor

- FMC Corporate
  - A.I. Chlorantraniliprole (Diamides, IRAC group 28)
  - MOA – Muscle poison - *activate muscle ryanodine receptors, leading to contraction and paralysis*
  - Registered for foliar use in sunflower, soybean, corn, wheat and other crops
  - Above ground **lepidopteran pests, and grasshoppers**
  - **Grasshoppers** - use MSO adjuvant at 1% v/v and target 2nd-3rd instars)



Source: FMC Website

Adult Grasshopper Trial in Soybean, Casselton, 2021



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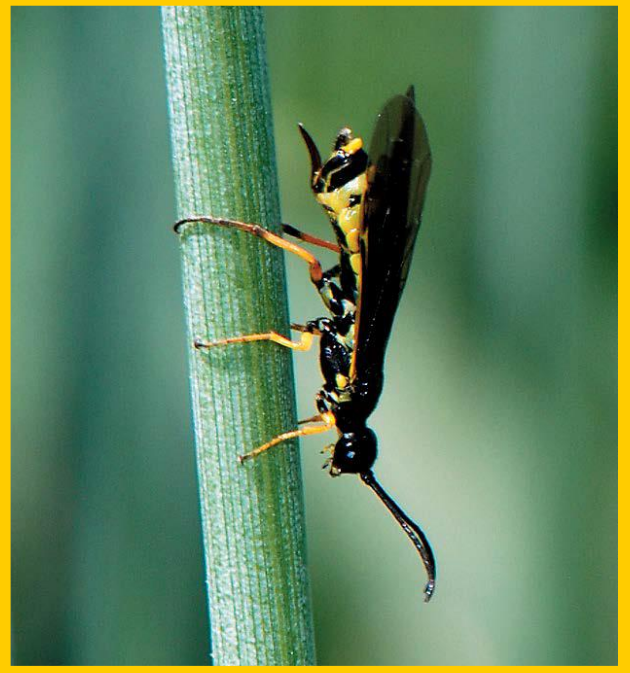
Wheat Stem Sawfly – *Cephus cinctus*

Identification

- Adult: Slender black and yellow wasp with dark wings, about 1” long, female with short sword-like ovipositor
- Larva: Creamy white, well developed head capsule, about 0.5” long when mature
- Prepupa: Found in cut stub at base of plant, characteristic “S” shape



Wheat Stem Sawfly – Life Cycle

- **One generation per year**

Adults emerge from mid- to late June
Live 7-10 days
Emergence 3 weeks

Adult

Egg

Deposited eggs in lumen of elongating wheat stems

Larva

Consume tissue inside the stem

Pupa

Spring

Mature Larva

Overwinters as mature larva in cut stub
Stub plugged with frass

Overwintering

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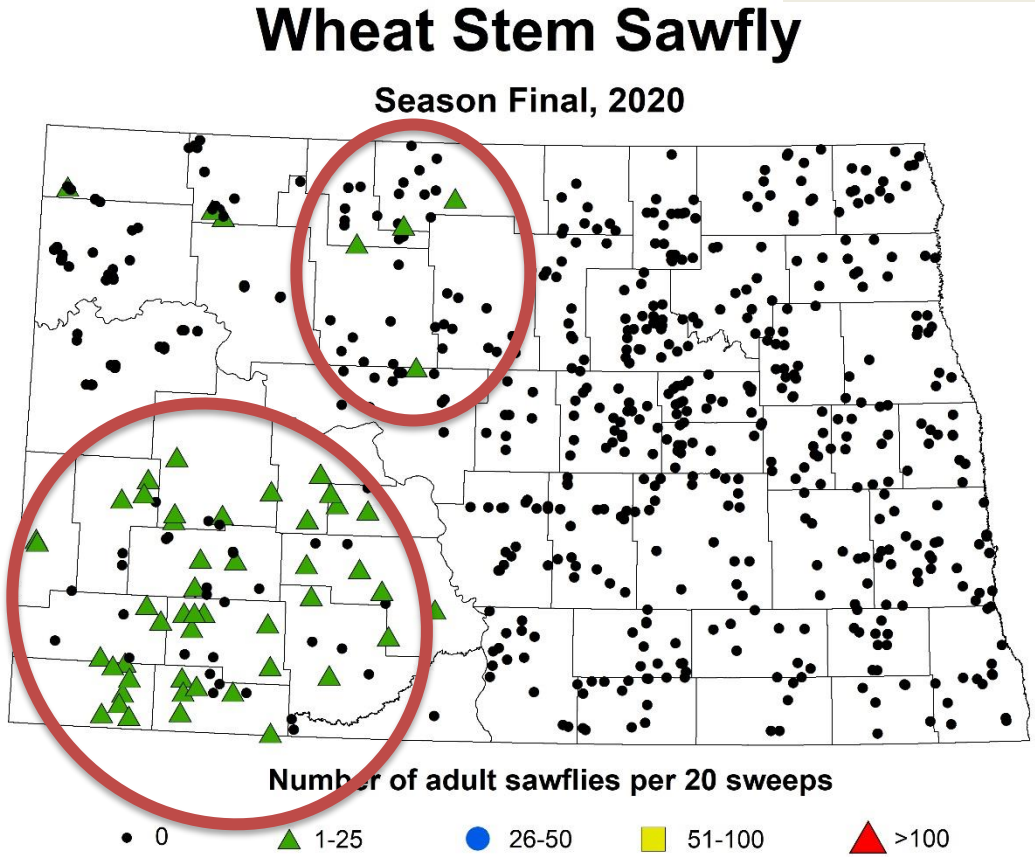
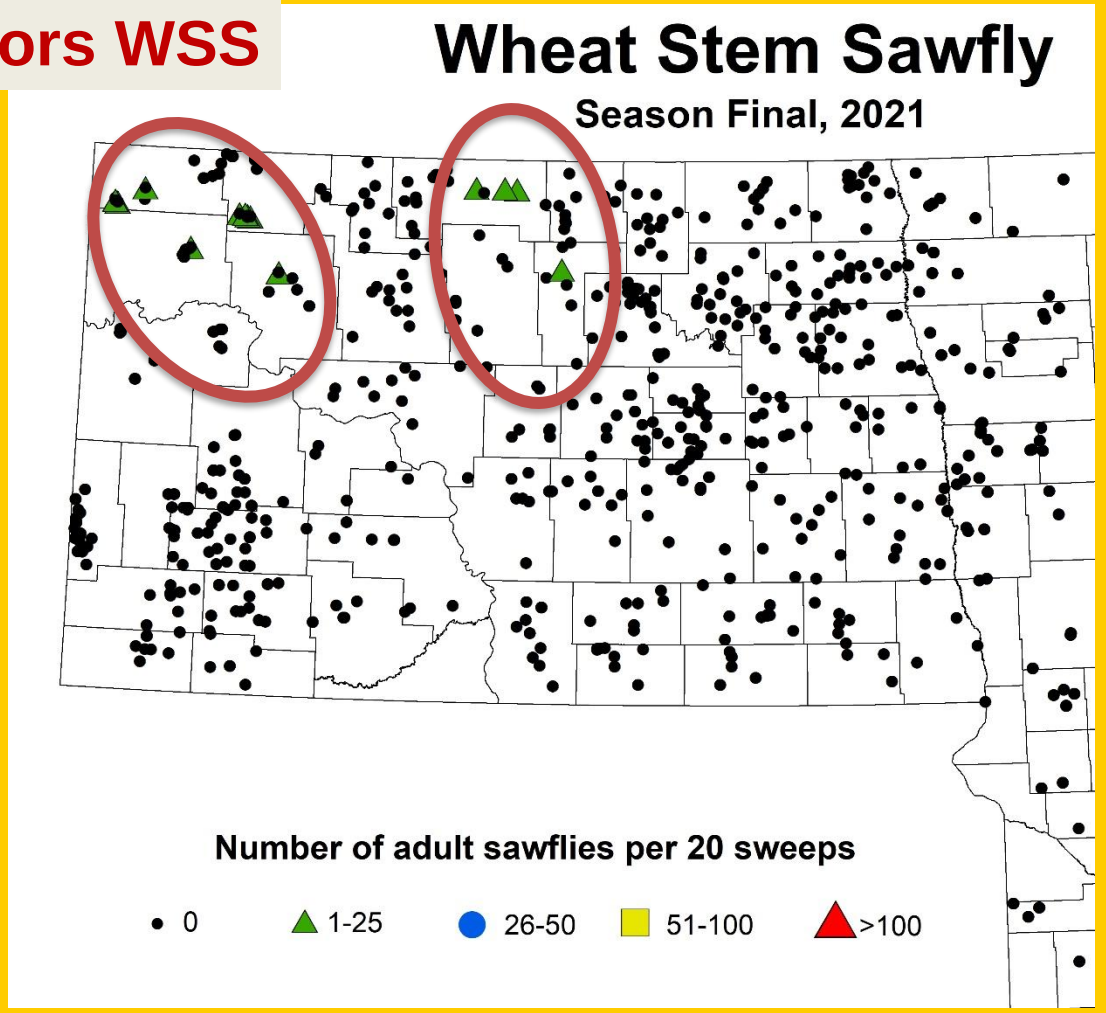
Damage caused by Wheat Stem Sawfly

- Larval tunneling in stem
- Reduced yield
- Stunted head with fewer kernels and lower kernel weight
- Reduced protein content
- Lodging
  - Harvest problems

Wheat Stem Sawfly Maps 2020- 2021

Drought favors WSS





IPM: Cultural Strategies

- **Crop Rotation**
  - **Wheat on wheat favors increases in sawfly populations**
  - **Plant immune or resistant crops**
    - Oats immune
    - Barley – sawfly do not thrive
    - Durum – less cutting due to tougher outer stems tissues and increased pith
    - Broadleaf crops = non-hosts

IPM: Cultural Strategies

- **Early harvest before sawfly-infested wheat lodges**
  - If more than 15 percent of stems are infested by sawflies, producers should swath early
  - Swathing as soon as kernel moisture drops <40%

Solid-Stemmed Wheat Cultivars with Resistance to Wheat Stem Sawfly

Table 1. Released wheat cultivars with resistance to wheat stem sawfly.

Wheat cultivar	Type[1]	Year Released	Releasing Agency[2]
Choteau	HRS	2003	MAES
AC Lillian	HRS	2005	AC
Corbin	HRS	2006	WB
Mott	HRS	2009	NDAES
Duclair	HRS	2011	MAES
SY Tyra	HRS	2011	AP
WB Gunnison	HRS	2011	WB
WB 9879 CLP	HRS	2012	WB
WB 9377	HRS	2014	WB
WB9653	HRS	2015	WB
Genou	HRW	2004	MAES
Bearpaw	HRW	2011	MAES
Judee	HRW	2011	MAES
WB Quake	HRW	2011	WB
Warhorse	HRW	2013	MAES
Explorer	HWS	2002	MAES
Agawam	HWS	2005	WB
WB Prestea	HWS	2012	WB

[1] HRS = hard red spring wheat, HRW = hard red winter wheat, HWS = hard white spring wheat.

[2] AC = Agriculture Canada; AP = AgriPro; MAES = Montana Agricultural Experiment Station; NDAES = North Dakota Agricultural Experiment Station; WB = WestBred LLC.

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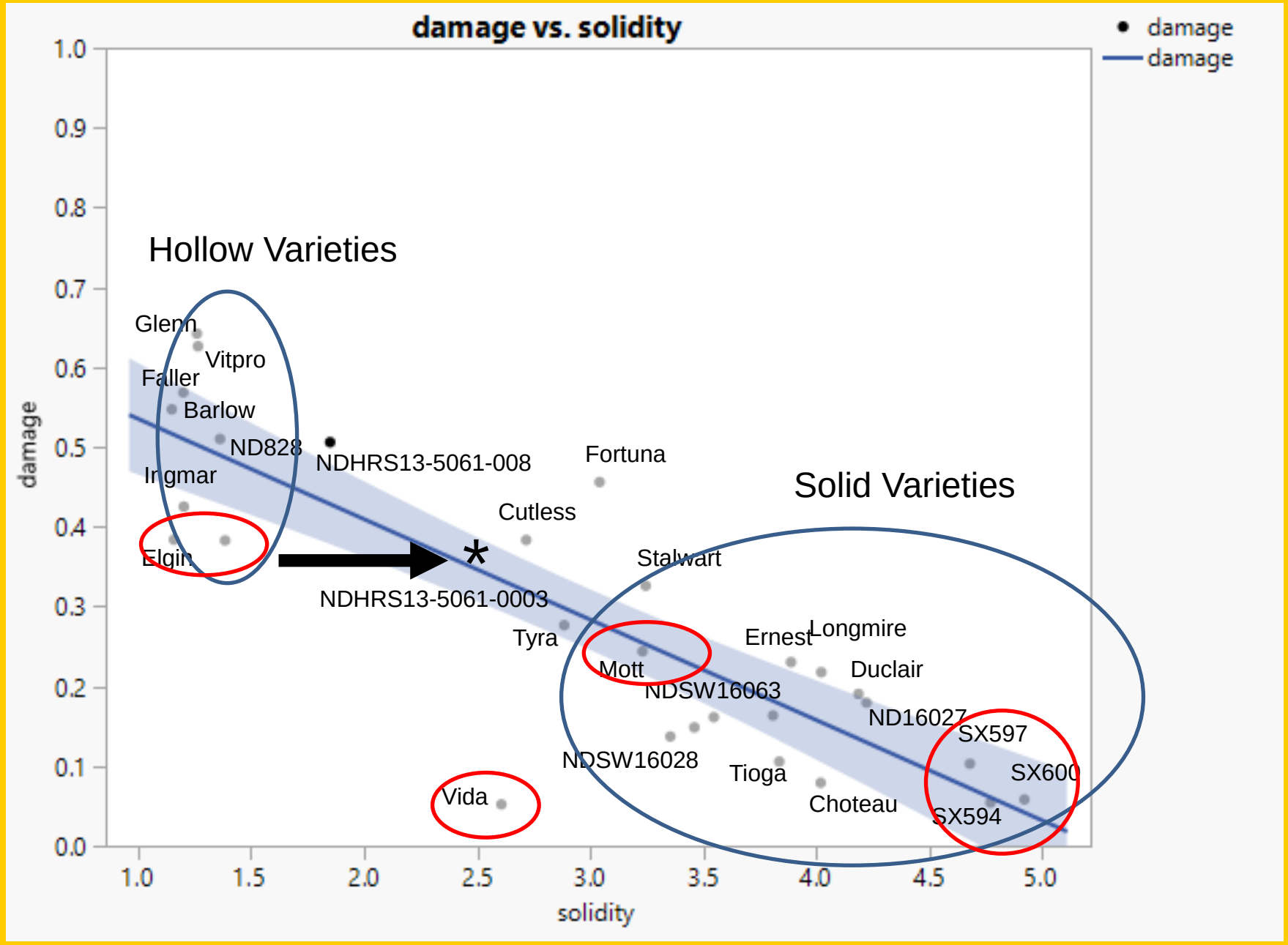
Wheat Isolines Evaluation for Wheat Stem Sawfly in Greenhouse



Source: Kirk Anderson, USDA ARS, Fargo

IPM: Biological Control

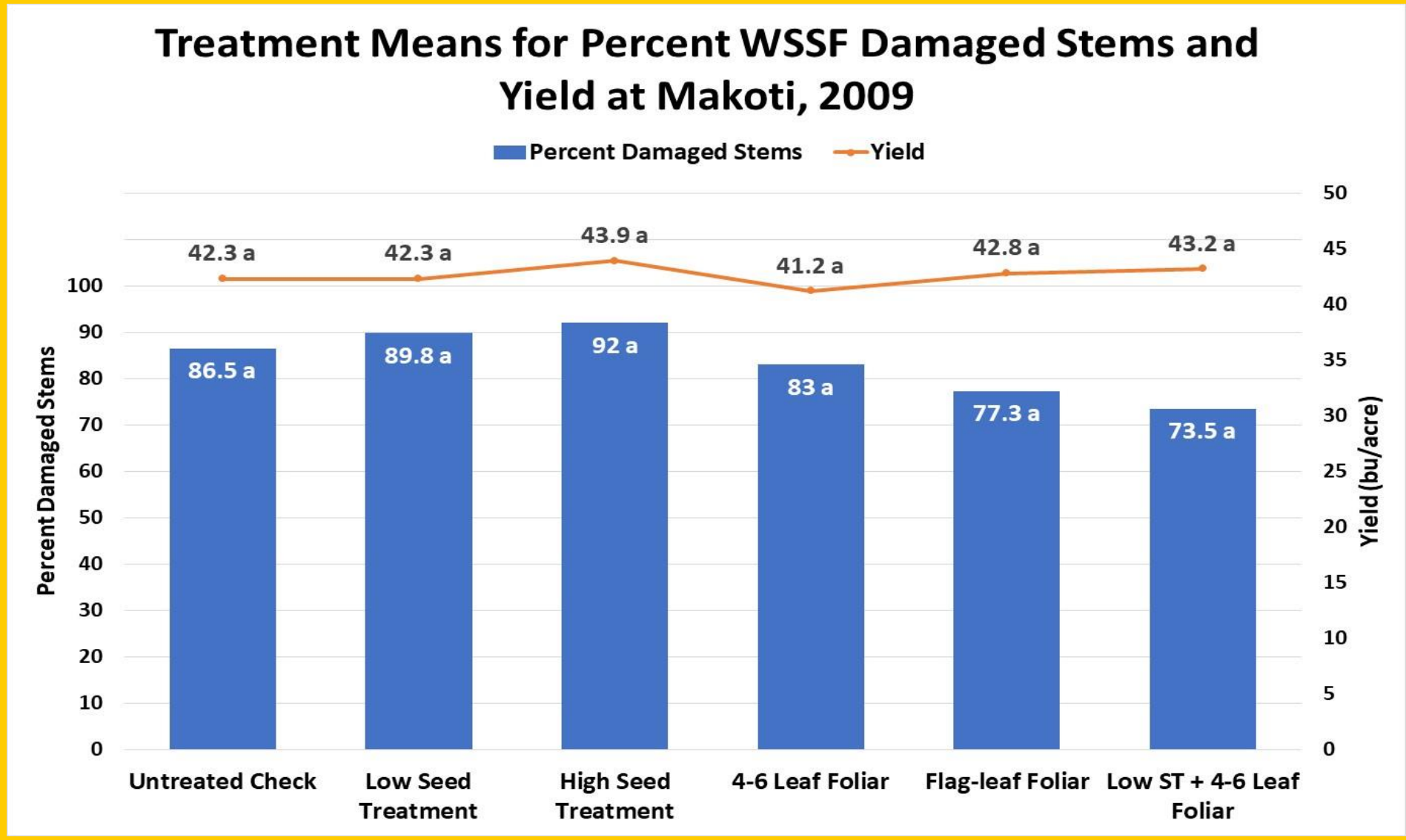
- **Parasitic Wasps**
  - **Avg 35% parasitism in ND and MT**
- ***Bracon cephi***
  - ✓ **Wheat**
- ***Bracon lissogaster***
  - ✓ **Native grasses**

Photos courtesy of RKD Peterson, MSU

Wheat Stem Sawfly – Insecticide Trial

- Untreated check
- Foliar insecticide
  - Warrior® (lambda-cyhalothrin), 2.56 fl oz/A
    - 4-6 leaf
    - Flag leaf
- Seed treatment (ST)
  - Cruiser 5FS® (thiamethoxam), Syngenta Crop Protection
    - Low rate = 1 fl oz/cwt
    - High rate = 1.33 fl oz/cwt
- Foliar insecticide on top of low rate ST at 4-6 leaf
- Dividend Extreme® (difenoconazole + mefenoxam), Syngenta Crop Protection 2 fl oz/cwt

Wheat Stem Sawfly – Insecticide Trial



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Wheat Stem Sawfly Insecticide Conclusion

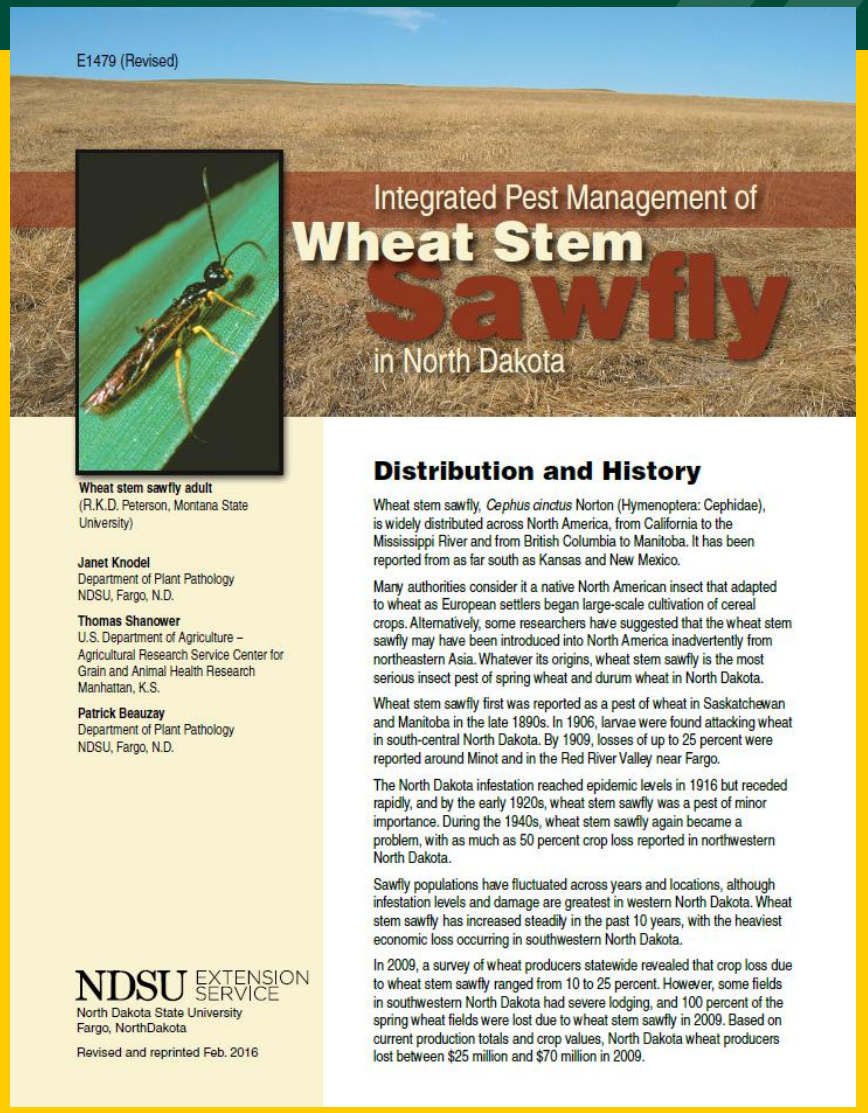
- **Different insecticide mode of actions, application methods and timings: All were NOT effective for WSS pest management**
- **Why?**
  - **Adult WSS emergence period is long (≈1 month)**
  - **Adult WSS has a short life span and spends little time feeding or imbibing water, so insecticides would only kill by 'contact' at time of application (Wallace & McNeal 1966)**

Wheat Stem Sawfly Insecticide Conclusion

- **Why?**
  - **Eggs, larvae and pupae are protected inside stem (Criddle 1923)**
  - **Most foliar insecticide short residual of <7-10 days**
  - **Adult WSS prefer to oviposit in stems of spring wheat during stem elongation (60-70 days after planting) (Criddle 1923)**
    - **Seed treatment - Thiamethoxam residual = 30-40 days**
- **Extension outreach**
  - **Not recommend use of insecticides for WSS control**
- **Knodel et al. 2009. *J. Agric. Urban Entomol.* 26 (4): 183-197.**

Extension Outreach – Wheat Insect Pests

- **E1330 – IPM of Wheat Midge in ND**
- **E1479 - IPM of Wheat Stem Sawfly in ND**
- **E830 – The Armyworm and Army Cutworm**
- **NDSU Extension YouTube Videos:**
  - IPM of Wheat Stem Sawfly (17.36 minutes)
    - http://www.youtube.com/watch?v=_4bhsCBj_u8
  - Swath Grain with Heavy Infestation of Wheat Stem Sawfly (3 minutes)
    - http://www.youtube.com/watch?v=bFpiKCGzlWY


E1479 (Revised)

Integrated Pest Management of
Wheat Stem
Sawfly
in North Dakota

Wheat stem sawfly adult
(R.K.D. Peterson, Montana State University)

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Distribution and History

Wheat stem sawfly, *Cephus cinctus* Norton (Hymenoptera: Cephidae), is widely distributed across North America, from California to the Mississippi River and from British Columbia to Manitoba. It has been reported from as far south as Kansas and New Mexico.

Many authorities consider it a native North American insect that adapted to wheat as European settlers began large-scale cultivation of cereal crops. Alternatively, some researchers have suggested that the wheat stem sawfly may have been introduced into North America inadvertently from northeastern Asia. Whatever its origins, wheat stem sawfly is the most serious insect pest of spring wheat and durum wheat in North Dakota.

Wheat stem sawfly first was reported as a pest of wheat in Saskatchewan and Manitoba in the late 1890s. In 1906, larvae were found attacking wheat in south-central North Dakota. By 1909, losses of up to 25 percent were reported around Minot and in the Red River Valley near Fargo.

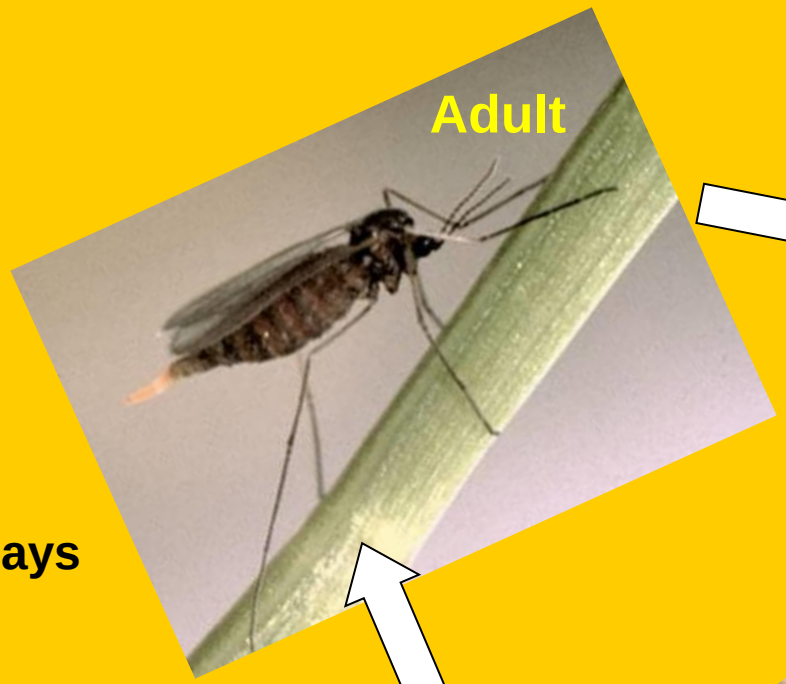
The North Dakota infestation reached epidemic levels in 1916 but receded rapidly, and by the early 1920s, wheat stem sawfly was a pest of minor importance. During the 1940s, wheat stem sawfly again became a problem, with as much as 50 percent crop loss reported in northwestern North Dakota.

Sawfly populations have fluctuated across years and locations, although infestation levels and damage are greatest in western North Dakota. Wheat stem sawfly has increased steadily in the past 10 years, with the heaviest economic loss occurring in southwestern North Dakota.

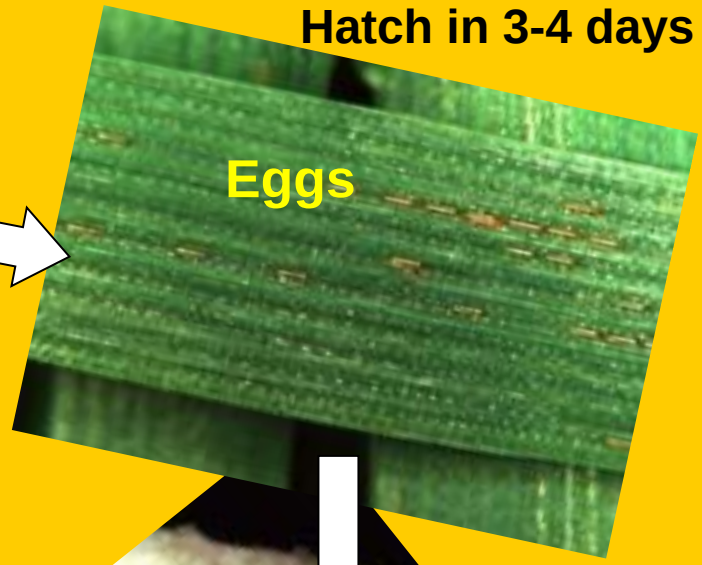
In 2009, a survey of wheat producers statewide revealed that crop loss due to wheat stem sawfly ranged from 10 to 25 percent. However, some fields in southwestern North Dakota had severe lodging, and 100 percent of the spring wheat fields were lost due to wheat stem sawfly in 2009. Based on current production totals and crop values, North Dakota wheat producers lost between $25 million and $70 million in 2009.

Hessian fly, *Mayetiola destructor* Life Stages

100-300 eggs per female
Orange, elliptical eggs, $^{1}/_{32}$ long
Hatch in 3-4 days



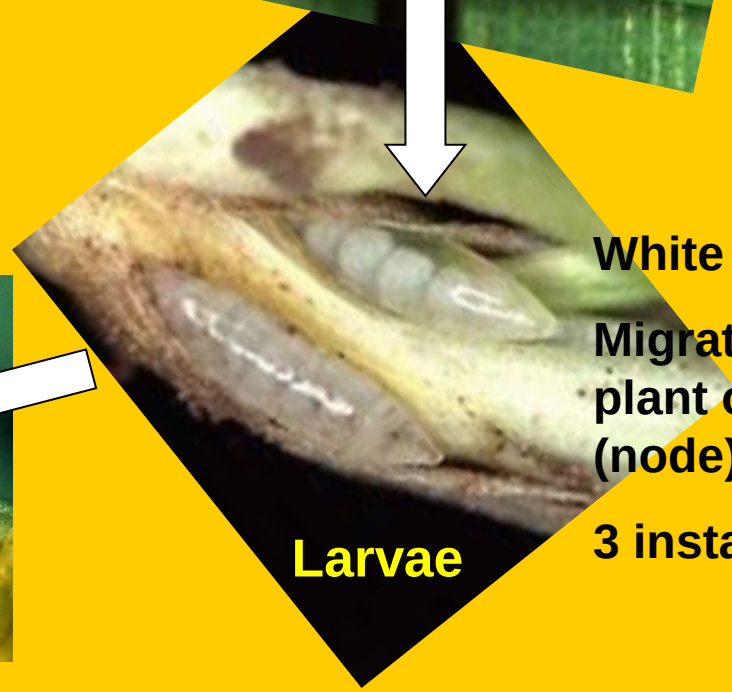
⅛ inch long
Reddish-brown
Adults live 3-4 days
Weak flyers



White larvae hatch

Migrate to feed at base of plant or base of leaf (node) for 2-3 weeks

3 instars



<⅛ inch long
Brown

14-21 days later, fully fed white larva turns brown; flaxseed stage

Hessian fly: Life Cycle

The entire life cycle requires about 40-50 days.

flax seed at joint

Larvae feed

Eggs laid

Adults emerge

Spring

Summer

aestivate as flaxseed

May - June

2 Generations

Winter

hibernate as flaxseed

Aug – Sept or October

Fall

Adults emerge

Eggs laid

Larvae feed

Flaxseed on green stem

Hessian Fly – Life History

- **When do adults emerge?**
  - Spring (May - June) generation attacks HRSW (preferred host), and durum seedlings
  - Alternative spring hosts = barley, rye, several grasses like bromegrass, wheatgrass, quackgrass
  - Early fall (September) generation infests fall-planted cereals
    - Volunteer wheat, winter wheat, rye planted as cover crop

Hessian Fly – Life History

- Cool, wet springs are ‘good’ for spring emergence of adults
- In late summer-fall
  - If temperatures are hot (>80F), Hessian fly remains in flaxseed until cooler temperatures and rain
  - If temperatures are cold (<40F), Hessian fly hibernates in flax seed stage
- If conditions are not good, larvae (flaxseed) stay in hibernation for several years!!!!!!

Hessian Fly – Crop Damage

- Larva - Larvae feed by toxic salivary secretions which interfere with plant metabolism and growth.
  - *If a seedling has not yet tillered when attacked, Hessian fly larval feeding can kill the plant = plant stunted, broad leaf blades*
  - *If a plant has tillered, feeding can kill one or more tillers*

Dead and stunted tillers caused by an early infestation of Hessian fly

Hessian Fly – Crop Damage

- If a more developed plant is infested (after jointing), the larvae feeds at the first or second node of the stem
- Feeding in the stem - reduces flow of nutrients and water to wheat head
- Head is smaller, with few & shriveled seeds
- Grain quality reduced and lower test weight
- Feeding in stem associated with lodging
- Tiller infestation reduces yield by 15-20%

Thin stand and stunted plants resulting from a severe Hessian fly infestation

Hessian Fly – Risk Factors

- High numbers in your crop or your neighbor's crop in previous year, planting into wheat stubble
- Cool, wet spring: farmers forced to plant late, at that time puts crop in best stage for Hessian fly feeding
- Good conditions for fall generation: Volunteer wheat, wild grasses, winter wheat or rye cover crop planted early enough to be infested by fall adults

Hessian Fly – IPM

- **Insecticide-treated seed**
  - Neonicotinoids - protects against spring generation, use high labeled rate, high cost
- **Foliar Insecticides**
  - Spring – applied at 2-3 leaf stage to manage adult stage
  - Pyrethroids kill adult fly and freshly hatched larvae before they become embedded behind the leaf sheaths
  - Action Threshold = 4 or more eggs per leaf (spring)

Hessian Fly – IPM

- **Plant resistant cultivars**
  - About 37 resistance genes available for Hessian fly
  - We do not know the status of currently grown ND/MN wheat cultivars for Hessian fly resistance
  - Research needs to evaluate most widely grown HRS, durum and white wheat cultivars for resistance to Hessian fly

Hessian Fly – IPM #1 Priority

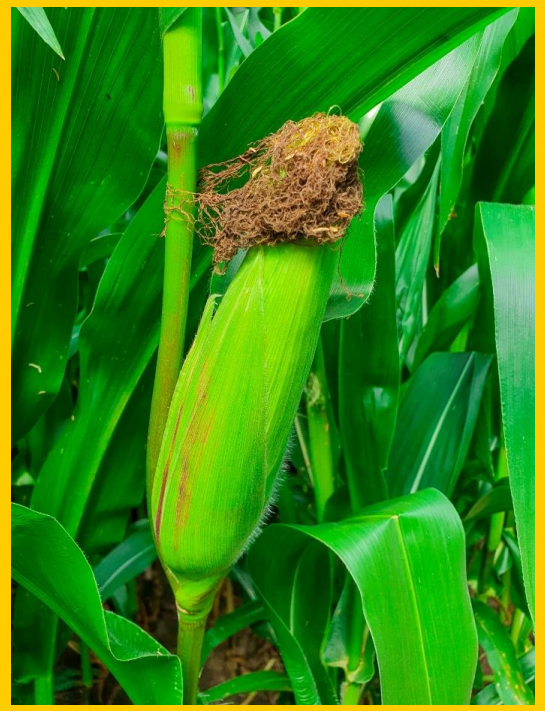
- **Reduce availability of plants needed by fall generation adults**
  - *Break the "Green Bridge"*
  - *Destroy volunteer wheat*
  - *Use non-host cereals - Oats*
  - *Plant winter wheat, rye cover crops late enough to avoid infestation by fall generation, use "fly-free" date*
    - Sept. 1 – 15 in northern ND
    - Sept 15 - 30 in southern ND

The green bridge is the method by which insect pests feed on cover crops or winter weeds long enough to survive to infect the next season's cash crops. (Illustration by Dominique Belcher)

https://www.mafes.msstate.edu/discovers/article.asp?id=172

Hessian Fly – IPM #2 Priority

- **Crop rotation with nonhost**
  - *Corn, soybean, canola, sunflower, oats, …*
  - *Never plant wheat 2 years in a row*
- **Cultural Control**
  - *Conventional tilled fields mitigate Hessian fly infestation and crop grows faster than maggots killing tillers*



NORTH DAKOTA WHEAT COMMISSION

NDGGA

Send any questions to:
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701-231-7915

EXTENDING KNOWLEDGE ›› CHANGING LIVES

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