Forecast for Wheat Insect Pests in 2019

Travis J. Prochaska

Janet Knodel

NDSU | EXTENSION

Life Cycle of Orange Wheat Blossom Midge

Sitodiplosis mosellana

One generation per year

Larva - 2-3 mm, orange
Drop from heads after rain or heavy dew

2 -3 mm orange

adult

cocoon

larva

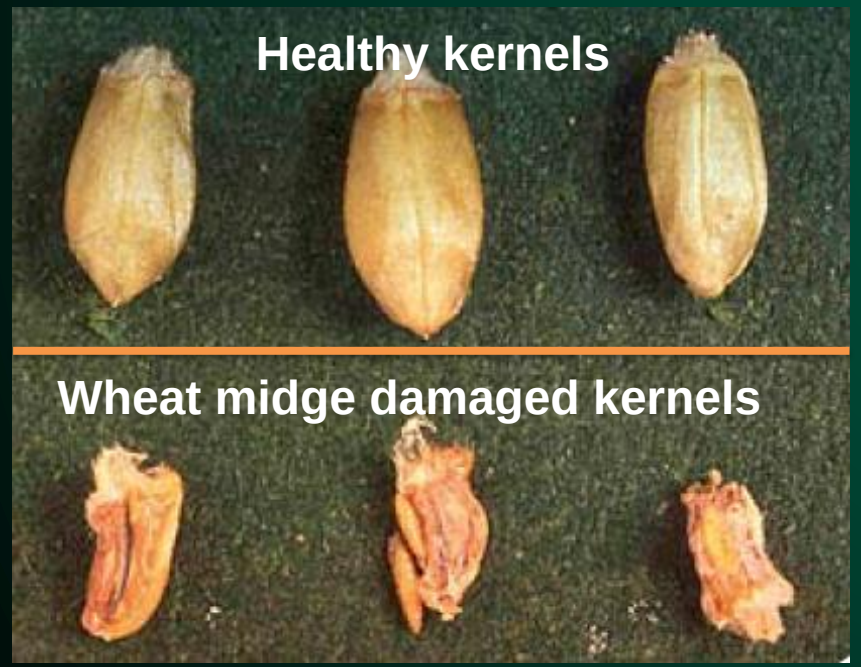
pupa

cocoon

May June July August

Crop Damage from Wheat Midge

- Estimate losses of $3 million per year without IPM



Saskatoon Research Centre, Canada

- Lower yields
- Reduced grain quality
- Vectors *Fusarium* head blight (scab)

2018 Wheat Midge Larval Soil Survey

- NDSU Extension agents collected a total of 2,000 soil core samples (10 cores per field) from 200 fields in 21 counties in fall.
- Wheat midge cocoons and number of parasitized cocoons counted in Knodel's laboratory
- Maps are posted on the NDSU Entomology website and news releases.
- Supported by:

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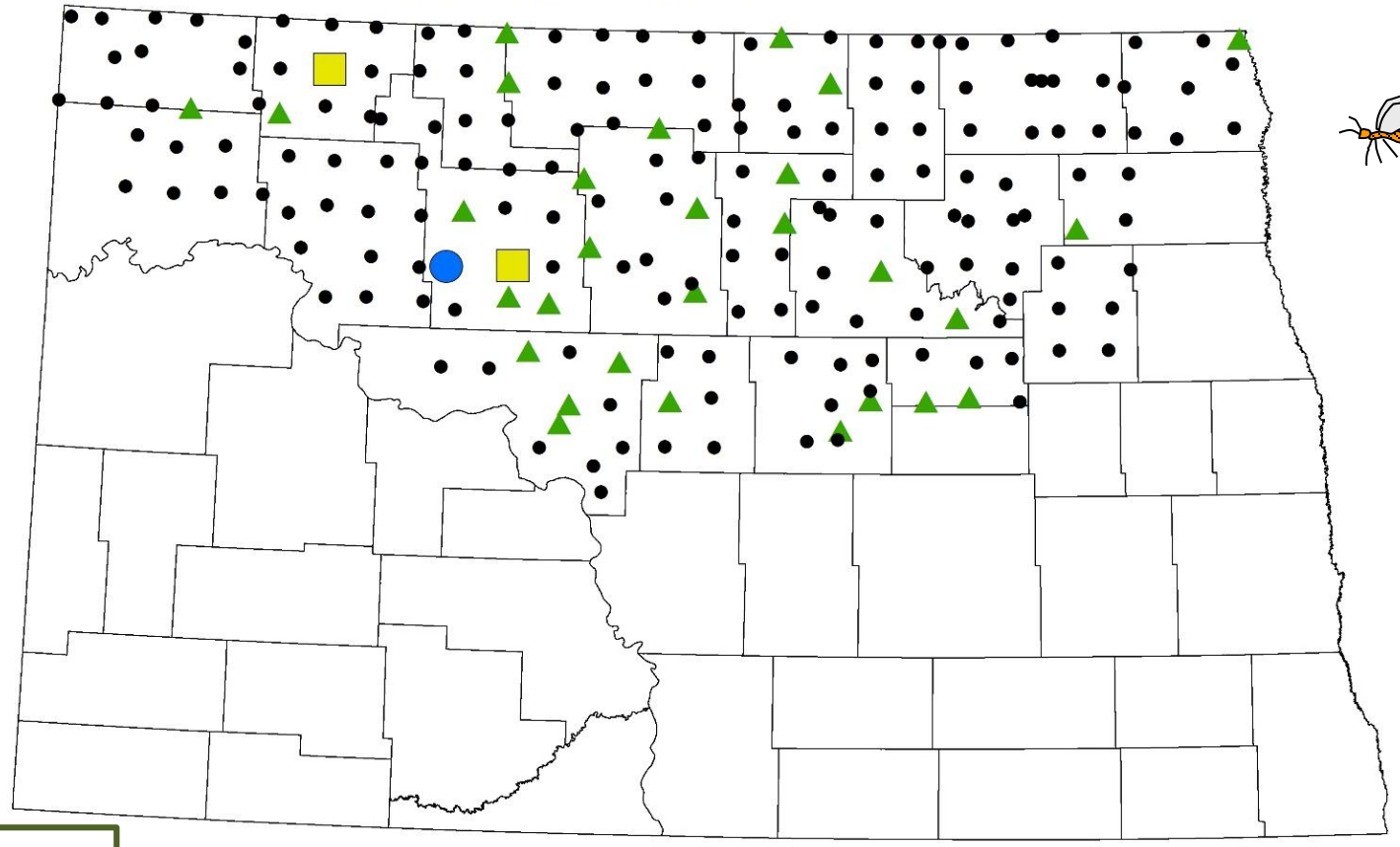
NORTH DAKOTA WHEAT COMMISSION

2018 Wheat Midge Larval Survey

North Dakota



Moderate Risk:
Burke & Ward County

0 – 607 midge larvae / m²
Average = 17 midge larvae / m²
84% of samples were 0!

NORTH DAKOTA WHEAT COMMISSION

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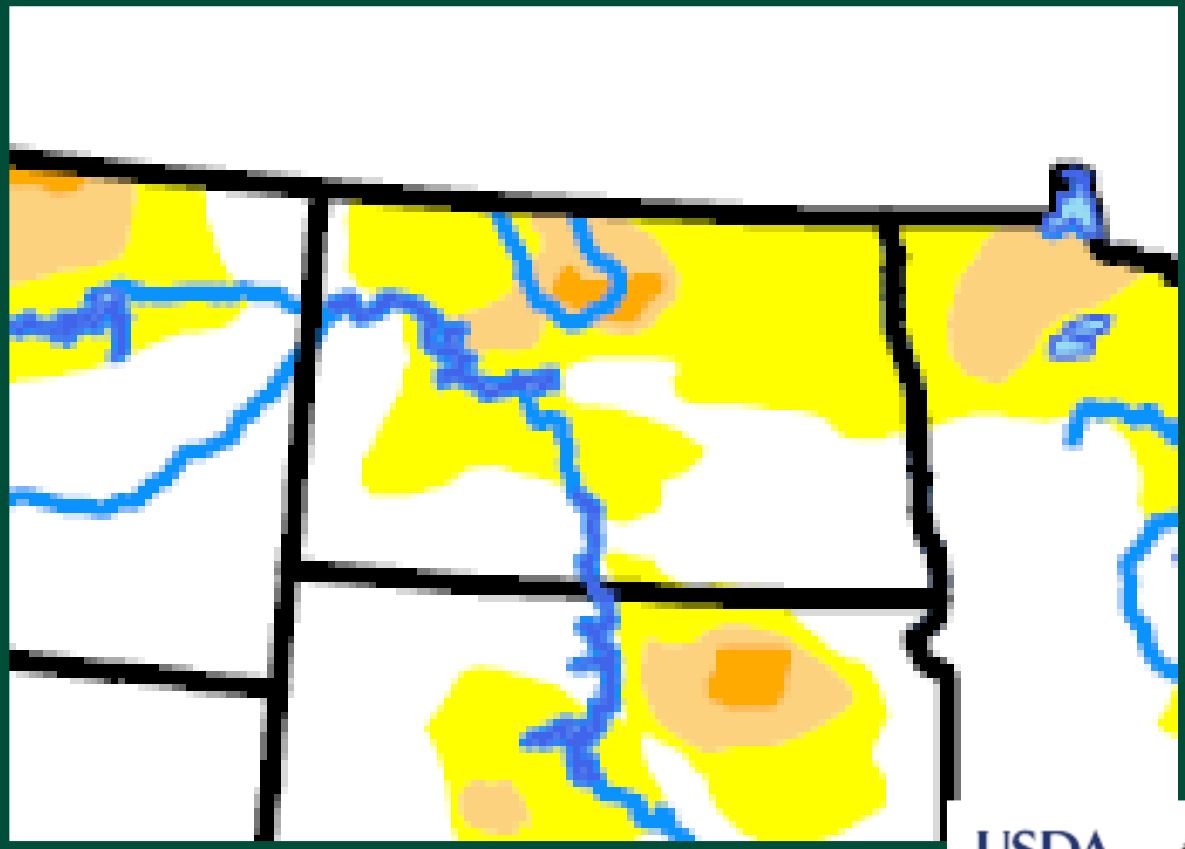
Drought Monitor – August 14, 2018

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

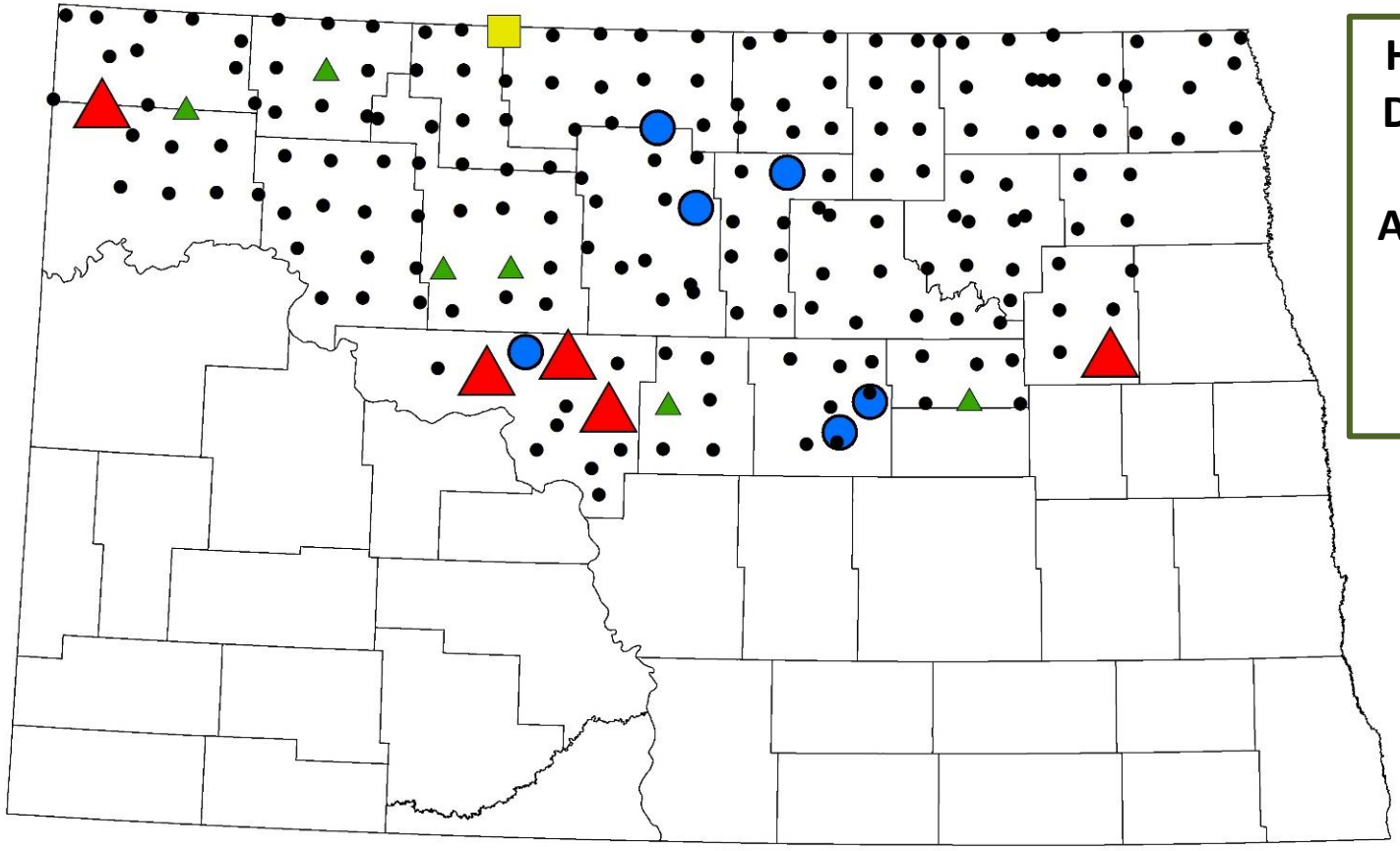


http://droughtmonitor.unl.edu/

Macroglenes penetrans
egg-larval parasite
of the Wheat Midge

2018 Wheat Midge Larval Survey

Percent Parasitism
North Dakota



Percent parasitized midge larvae

0 | 1-25 | 26-50 | 51-75 | 76-100

Highest Parasitism rate in Divide, McLean and Wells counties
Average = 4.8% parasitism rate
91% of samples had 0 parasitism

NORTH DAKOTA WHEAT COMMISSION

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IPM: Scouting for Wheat Midge in Field

- Regular field scouting on multiple nights in succession
- Inspect wheat heads after dusk - after 9 pm
- Temperatures >60^{o}F for midge to be active
- Wind speeds >5 mph limit activity of midge
- Use Degree Day Model for forecasting wheat midge emergence NDAWN

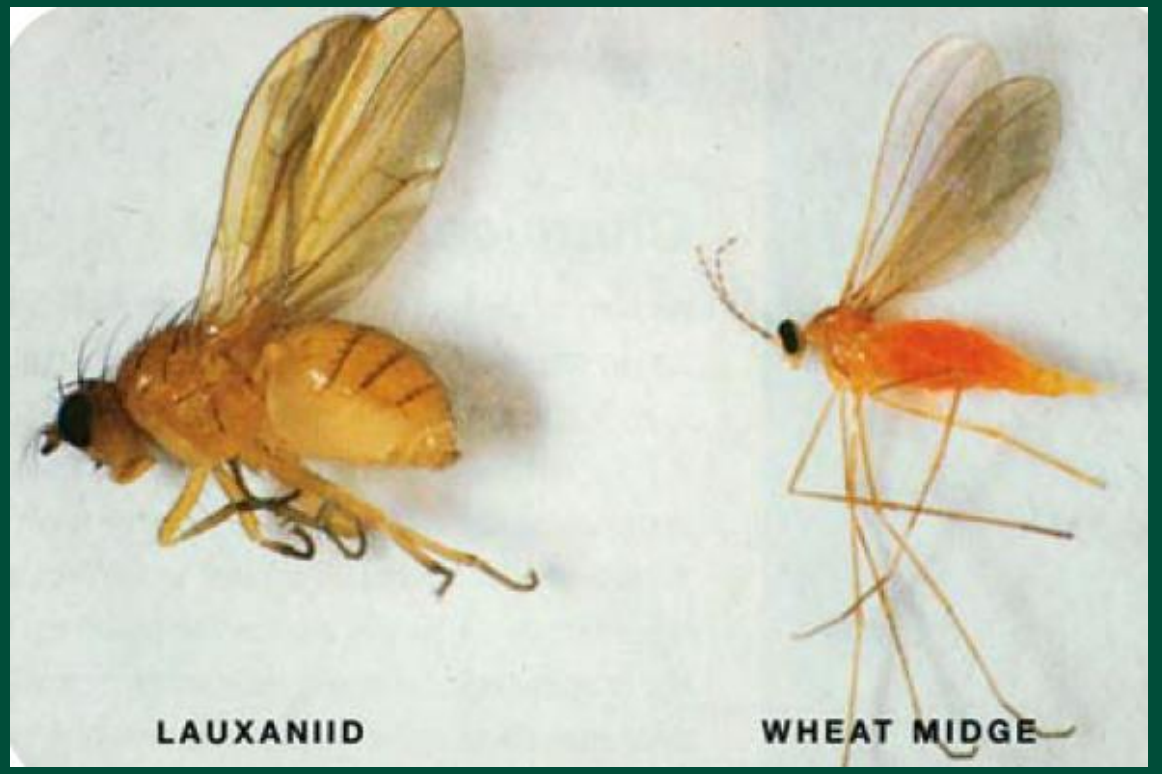
Identification

Lauxanid fly

versus

Wheat midge fly

NDSU Extension Service



Saskatoon Research Centre, Canada

Degree Days as a Tool for Wheat Midge Scouting

DD	Biological Event
450	Wheat midge breaks larval cocoons and move close to soil surface to form pupal cocoons.
1,300	10 percent of females will have emerged.
1,475	About 50 percent of females will have emerged.
1,600	About 90 percent of females will have emerged.

Threshold Temperature = 40 F

NDAWN – https://ndawn.ndsu.nodak.edu/wheat-growing-degree-days.html

NDAWN Wheat GDD / Growth Stages & Midge DD

Minot

Entered ‘May 18, 2018’ planting date

Date	Max Air Temp (°F)	Min Air Temp (°F)	Total Rain fall (inch)	Wheat GDD (°F)	Wheat AGDD (°F)	Est. Haun Growth Stage	Growth Stage Comment	Wheat Suscept. to Midge	Midge DD (°F)	Midge ADD (°F)	Midge Comment
2018-06-29	76	60	0.61	36	1394	9.0		No	28	1581	
2018-06-30	73	56	0.00	33	1427	9.2	Boot Swell	No	25	1606	~ 90% females emerged
2018-07-01	77	55	0.00	34	1461	9.5		No	26	1632	
2018-07-02	79	53	0.00	34	1495	9.7		No	26	1658	
2018-07-03	80	58	0.37	37	1532	10.0		Yes	29	1687	
2018-07-04	73	59	0.06	34	1566	10.2	Boot Cmplt.	Yes	26	1713	
2018-07-05	76	51	0.00	31	1597	10.4	Head Beg.	Yes	23	1736	
2018-07-06	84	58E	0.00	39E	1636	10.7		Yes (E)	31E	1767E	
2018-07-07	90	68	0.00	47	1683	11.0	Head Compl.	Yes	39	1806	Female numbers decline - no action required except no till
2018-07-08	84	60	0.00	40	1723	11.3		Yes	32	1838	
2018-07-09	84	56	0.00	38	1761	11.6	Flwr. Beg.	Yes	30	1868	
2018-07-10	84	65	0.44	42	1803	11.9	Flwr. Compl.	No	34	1902	Activity ceases even in no or min till field
2018-07-11	81	65	0.00	41	1844	12.1	Wtry. Ripe	No	33	1935	
2018-07-12	83	61	0.00	40	1884	>12		No	32	1967	

https://ndawn.ndsu.nodak.edu/wheat-growing-degree-days.html

IPM: Crop Rotation

Plot	Crop Rotation Interval	Larvae /head	% Kernel Inf.	Viable Cocoons/ sq. m.	% Par.	Yield bu/A
108-NT	0 yr.	12.1	51	428	12.5	23.8
104-NT	1 yr.	4.2	16	0	--	37.8
109-NT	2 yr.	4.6	18	0	--	38.9

HRSW cv. Alsen, planted on May 10, 2001
Sprayed with 16 oz./A Lorsban on July 10, 2001

IPM - Chemical Control

- Economic Threshold =

Hard Red Spring Wheat = one or more wheat midge for every four or five heads

Durum Wheat = one or more wheat midge for every seven or eight wheat heads

- Best timing: 70% of wheat heads are at late heading to early flowering
- Evening application
- Okay to tank-mix with fungicides for scab

Small Grain Management Recommendations

Wheat midge

NDSU Extension Service

Registered Insecticides

Chlorpyrifos: Lorsban 4E-SG* & generics

Chlorpyrifos + lambda-cyhalothrin:

Cobalt Advanced*

Chlorantraniliprole + lambda-cyhalothrin:

Besiege*

Lambda-cyhalothrin: Warrior* & generics

Gamma-cyhalothrin: Delcare*

** restricted use insecticide*

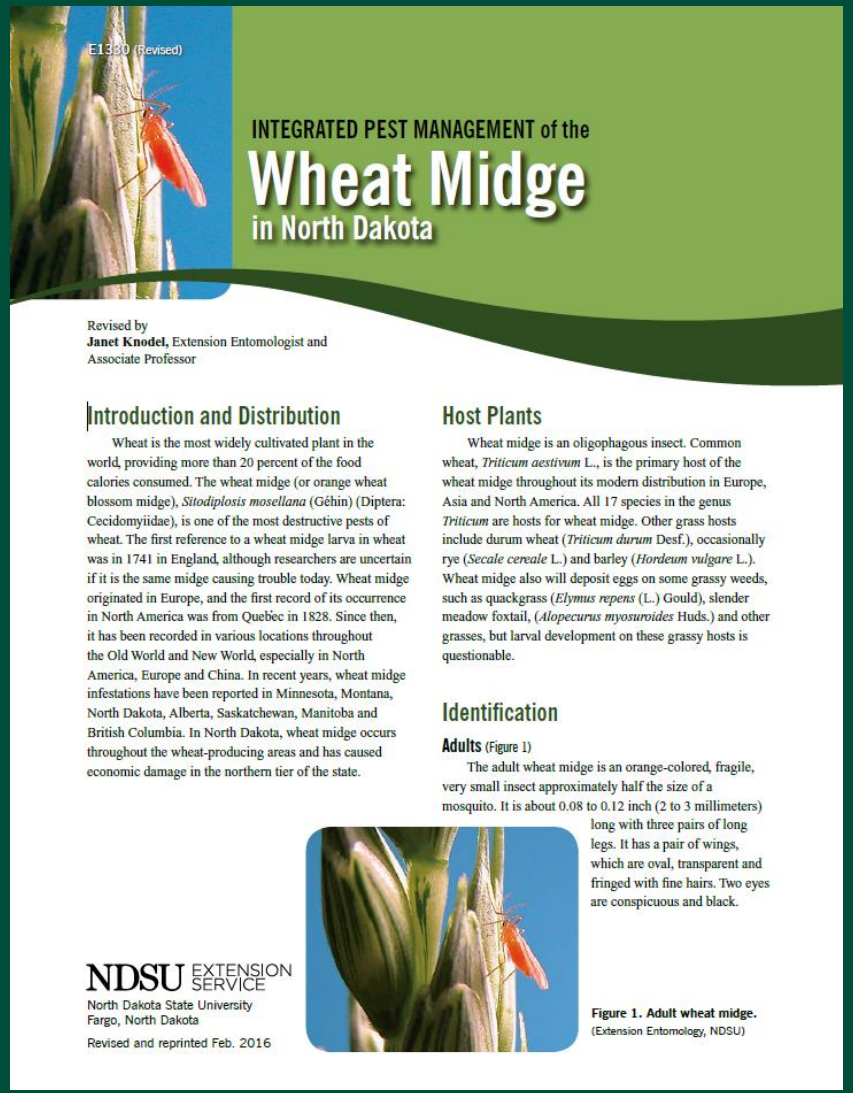
IPM – New Tool
Use of Resistant Wheat Varieties Against Wheat Midge


Egan Wheat field near Kalispell, MT.
Photo courtesy of MSU NW Ag. Res. Center

- Sm1 gene – tolerance
- "Refuge in the Bag" to prevent development of resistance
  - No other known source of midge tolerance
  - 90% midge tolerant variety and 10% susceptible variety
  - Canada Varieties - AC® Unity, AC® Goodeve VB, AC® Glencross VB, AC® Fieldstar VB, AC® Shaw VB, AC® Utmost VB, AC® Conquer VB, AC® Vesper VB
  - Montana Variety – Egan (released in 2014)
- New NDSU wheat breeder, Dr. Andrew Green

Extension Outreach – Wheat Midge

- **E1479 - IPM of Wheat Midge in ND**
  - http://www.ag.ndsu.edu/publications
- **NDSU Extension Website:**
  - ND Wheat Midge Risk Maps (1995-present)
  - https://www.ag.ndsu.edu/extensionentomology/field-crops-insect-pests/nd-wheat-midge-risk-maps



E1330 (Revised)

INTEGRATED PEST MANAGEMENT of the

Wheat Midge

in North Dakota

Revised by
Janet Knodel, Extension Entomologist and Associate Professor

Introduction and Distribution

Wheat is the most widely cultivated plant in the world, providing more than 20 percent of the food calories consumed. The wheat midge (or orange wheat blossom midge), *Sitodiplosis mosellana* (Géhin) (Diptera: Cecidomyiidae), is one of the most destructive pests of wheat. The first reference to a wheat midge larva in wheat was in 1741 in England, although researchers are uncertain if it is the same midge causing trouble today. Wheat midge originated in Europe, and the first record of its occurrence in North America was from Québec in 1828. Since then, it has been recorded in various locations throughout the Old World and New World, especially in North America, Europe and China. In recent years, wheat midge infestations have been reported in Minnesota, Montana, North Dakota, Alberta, Saskatchewan, Manitoba and British Columbia. In North Dakota, wheat midge occurs throughout the wheat-producing areas and has caused economic damage in the northern tier of the state.

Host Plants

Wheat midge is an oligophagous insect. Common wheat, *Triticum aestivum* L., is the primary host of the wheat midge throughout its modern distribution in Europe, Asia and North America. All 17 species in the genus *Triticum* are hosts for wheat midge. Other grass hosts include durum wheat (*Triticum durum* Desf.), occasionally rye (*Secale cereale* L.) and barley (*Hordeum vulgare* L.). Wheat midge also will deposit eggs on some grassy weeds, such as quackgrass (*Elymus repens* (L.) Gould), slender meadow foxtail, (*Alopecurus myosuroides* Huds.) and other grasses, but larval development on these grassy hosts is questionable.

Identification

Adults (Figure 1)

The adult wheat midge is an orange-colored, fragile, very small insect approximately half the size of a mosquito. It is about 0.08 to 0.12 inch (2 to 3 millimeters) long with three pairs of long legs. It has a pair of wings, which are oval, transparent and fringed with fine hairs. Two eyes are conspicuous and black.

Figure 1. Adult wheat midge.
(Extension Entomology, NDSU)

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota
Revised and reprinted Feb. 2016

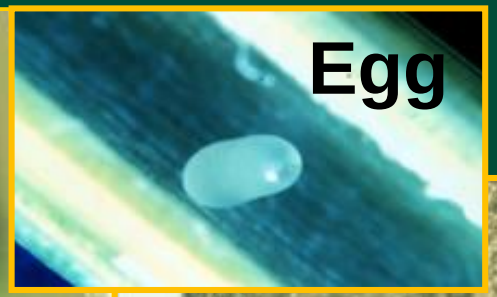
Wheat Stem Sawfly
Cephus cinctus Norton (Cephidae)

One generation per year

Summer

Adult
Live 5-7 days

Egg



Summer

Larva

Summer

Pupa

Spring

Winter

Fall

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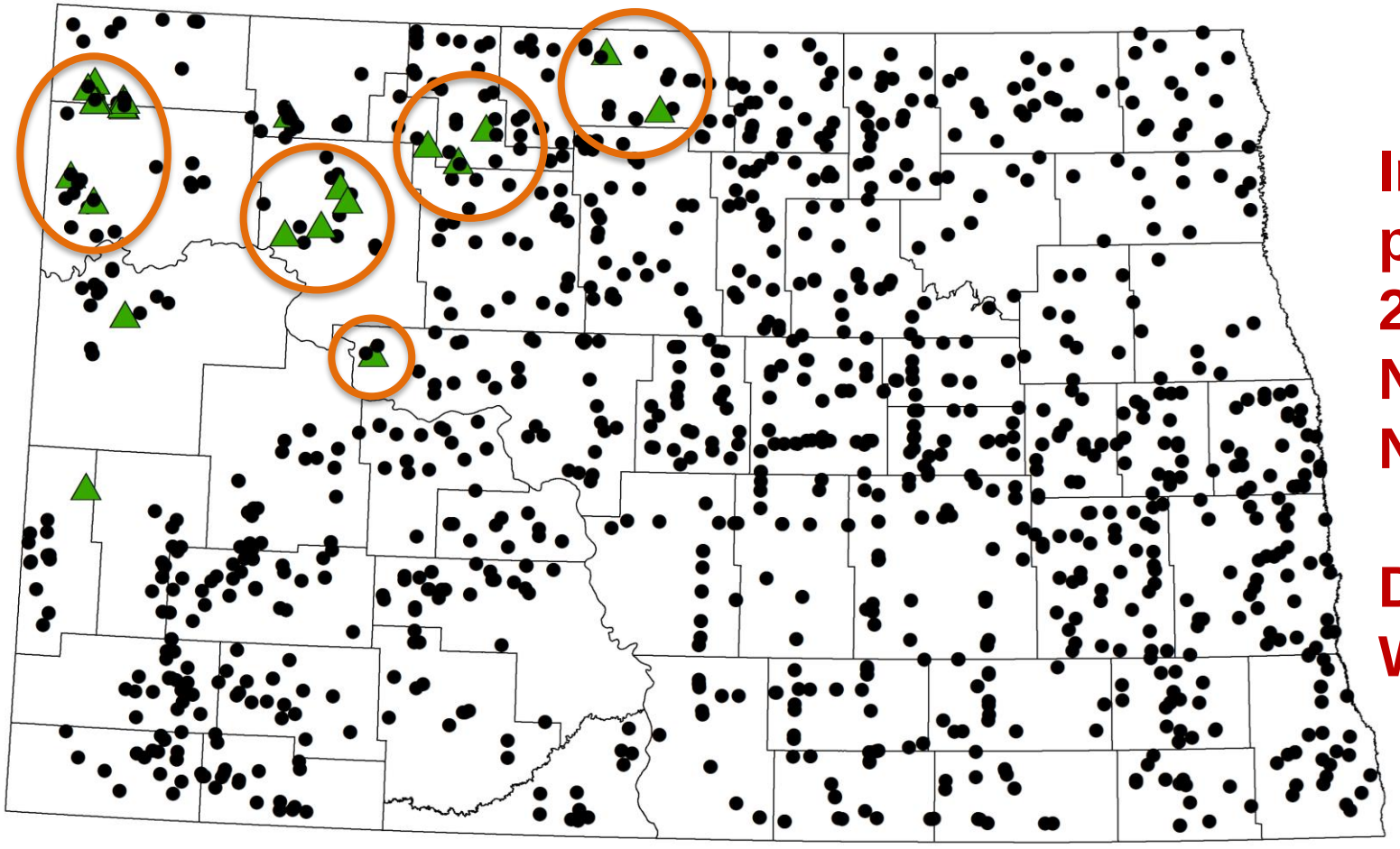
Damage caused by Wheat Stem Sawfly

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

Wheat Stem Sawfly

Season Final, 2018



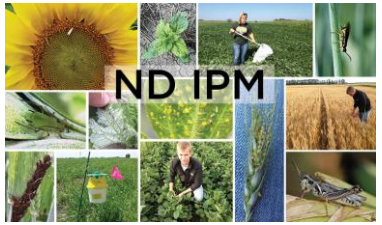
Increased WSS populations in 2018 at:
NC and NW ND
NW MN

Drought favors WSS

Number of adult sawflies per 20 sweeps

0 | 1-25 | 26-50 | 51-100 | >100

United States Department of Agriculture
National Institute of Food and Agriculture



IPM: Cultural Strategies

- Crop Rotation
  - 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
  - Wheat on wheat favors increases in sawfly populations

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

Dr. Andrew Green
NDSU Wheat Breeder

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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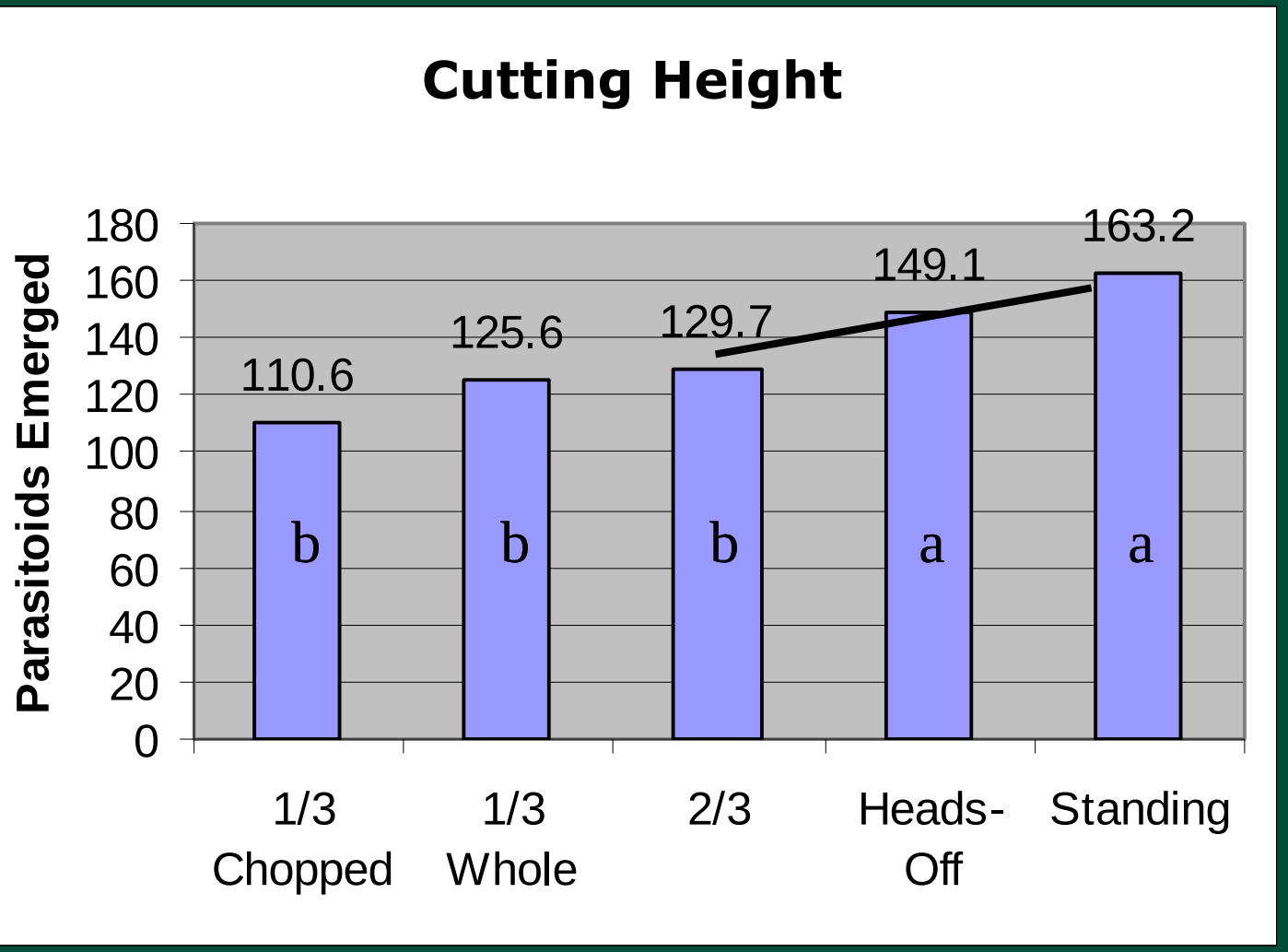
IPM: Biological Control

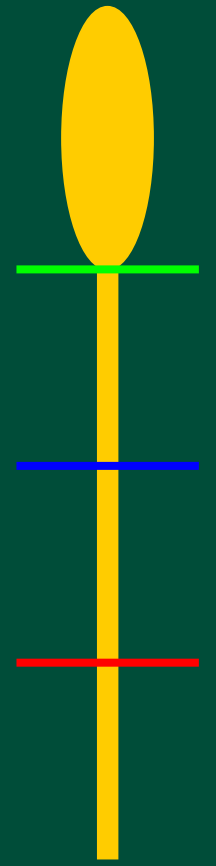
- Parasitic Wasps
- *Bracon cephi* (Gahan)
  - ✓ Wheat
  - ✓ Effective in solid-stemmed wheat varieties
- *Bracon lissogaster Muesebeck*
  - ✓ Native grasses
  - ✓ **Stems are NOT cut**
  - ✓ **Parasitoids reduce sawfly survival and head damage**

Source: D. Weaver, Montana State Univ.

Parasitoid Conservation

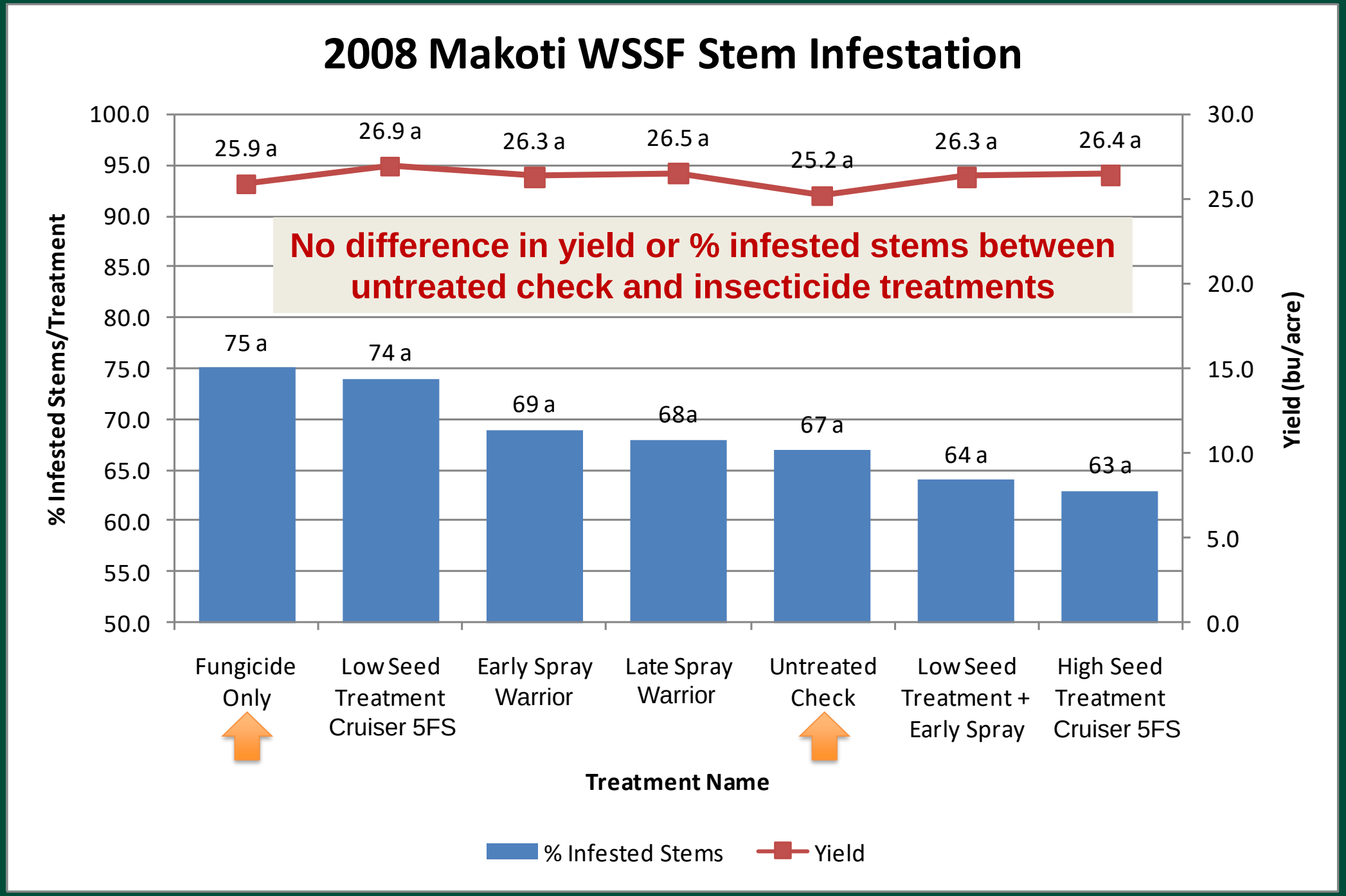


Taller residue is better



Source: D. Weaver, MSU

Wheat Stem Sawfly Ward Co.



Warrior:
Early Spray
4-6 leaf

Late Spray
Flag leaf

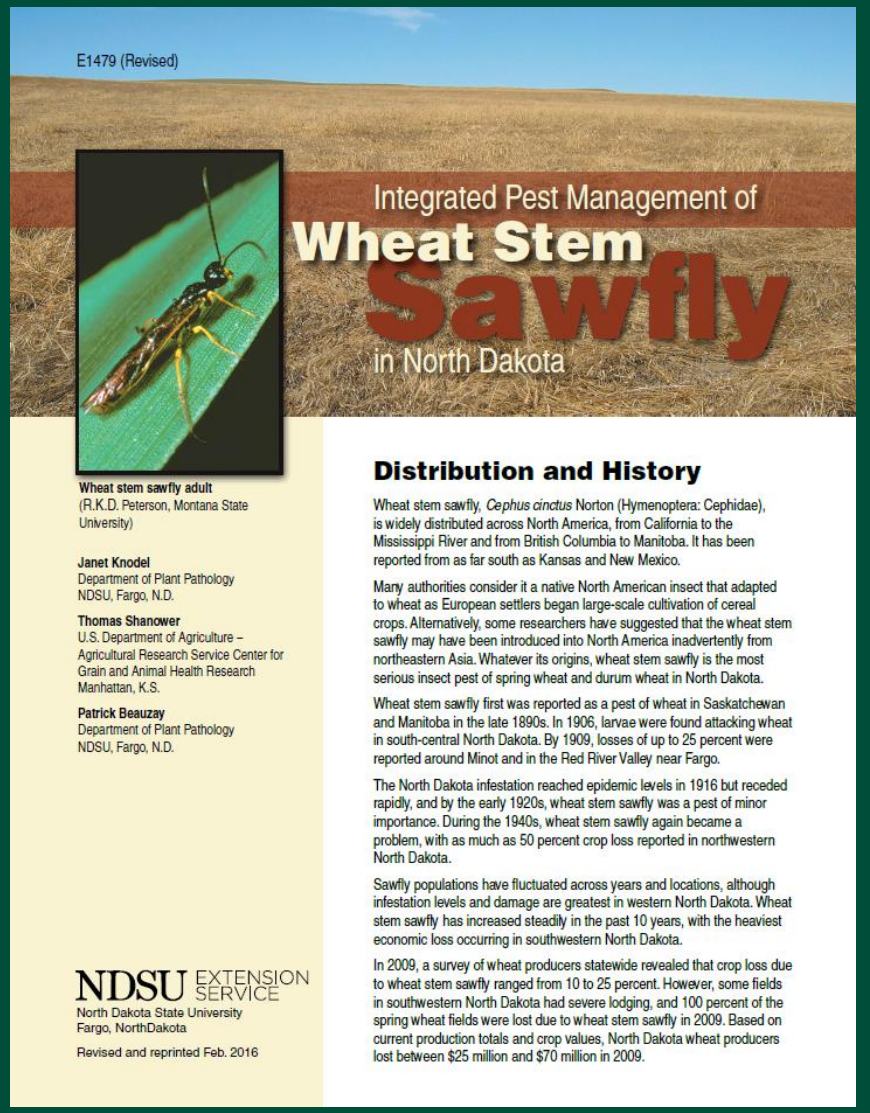
Why Do Insecticides Not Control Wheat Stem Sawfly (WSS)?

- 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
- Eggs, larvae and pupae are protected inside stem
- Most foliar insecticides are short residual of <7-10 days
- Adult WSS prefer to oviposit in stems of spring wheat during stem elongation (60-70 days after planting)
  - Seed treatment - Thiamethoxam residual = 30-40 days

Knodel et al. 2009. J. Agric. Urban Entomol. 26 (4): 183-197

Extension Outreach – Wheat Stem Sawfly

- **E1479 - IPM of Wheat Stem Sawfly in ND**
  - http://www.ag.ndsu.edu/publications
- **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)

Janet Knodel
Department of Plant Pathology
NDSU, Fargo, N.D.

Thomas Shanower
U.S. Department of Agriculture – Agricultural Research Service Center for Grain and Animal Health Research
Manhattan, K.S.

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NDSU EXTENSION SERVICE
North Dakota State University
Fargo, NorthDakota

Revised and reprinted Feb. 2016

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.

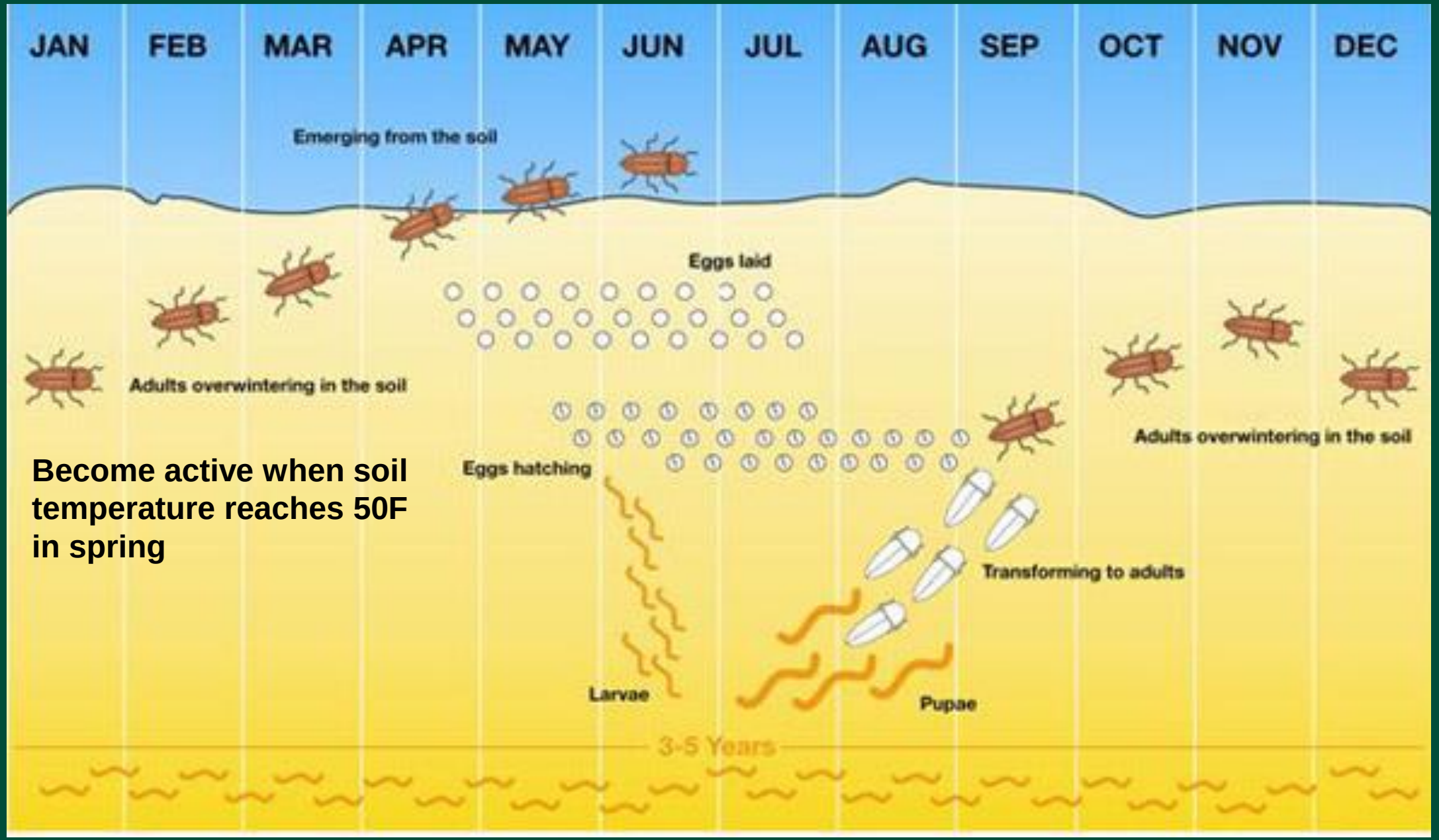
Wireworms

- **Family Elateridae (click beetles)**
- **885 wireworm species in N.A.**
  - Prairie grain wireworm (*Selatosumus aeripennis destructor*)
  - Sugarbeet wireworm (*Limonius californicus)*
- **3 to 5 year life cycle**
- **Larvae feed on roots and tunnel in roots/stems**


S. Brown, Univ. GA, bugwood.org


M. Boetel, NDSU

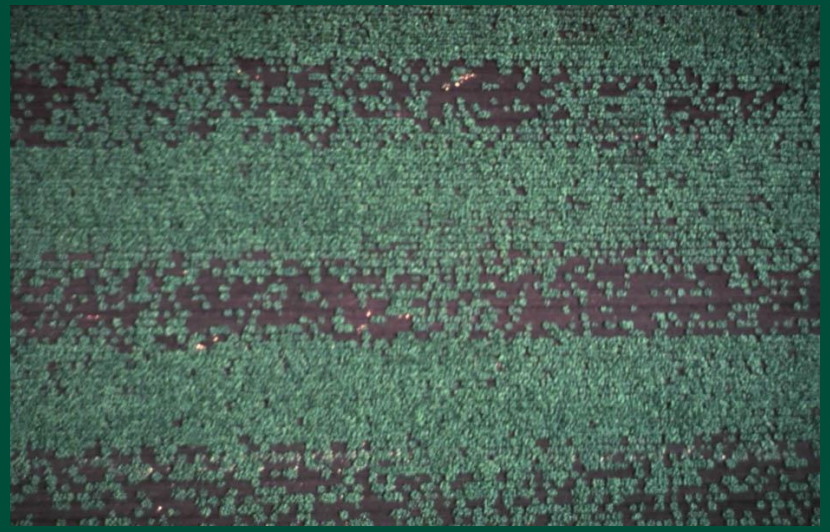
Wireworms Life Cycle



Become active when soil temperature reaches 50F in spring

Wireworm Crop Damage

- Plant losses due to wireworm feeding are increasing!
- Stand loss – blank spots or ‘skips’ in the rows
- Make sure the problem is actually caused by wireworms



Wheat Insecticides Registered for Wireworm

IRAC Group	Class	Active Ingredient	Products
4A	Neonicotinoid	Clothianidin	Intego SUITE Cereals OF, NipsIt SUITE Cereals OF
4A	Neonicotinoid	Imidacloprid	Dyna-Shield, Gaucho 600, Senator 600FS
4A	Neonicotinoid	Thiamethoxam	Cruiser 5FS, Cruiser Maxx Cereals, Cruiser Vibrance Quattro, Warden Cereal VR II

*** Only neonicotinoid seed treatments for control of wireworms in wheat!**

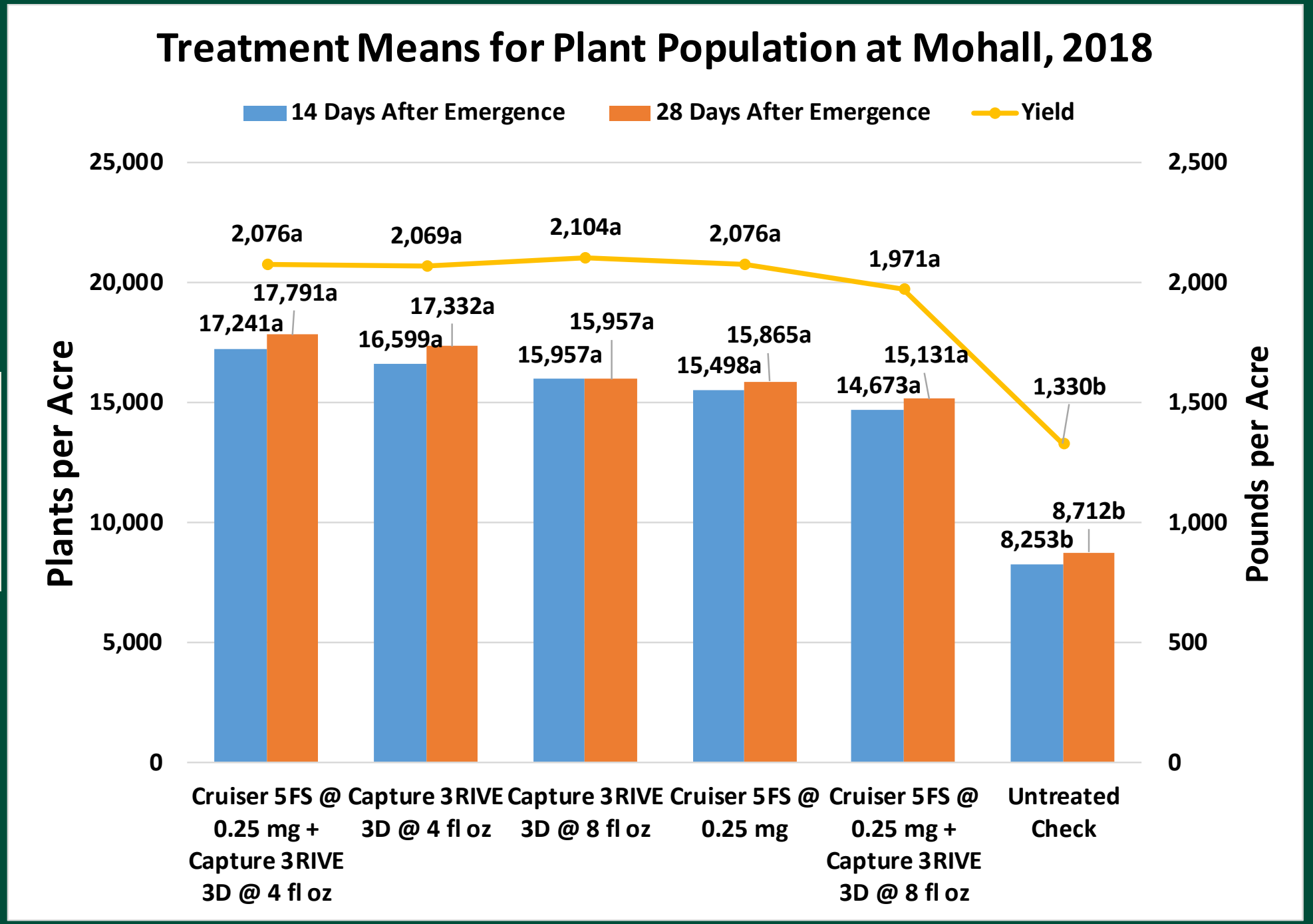
Wireworm 'Insecticide Control'

- Insecticide use is a preventive strategy – there are no rescue treatment options
- Insecticide seed treatments – neonicotinoids (IRAC 4A)
- Applications provide seedling protection – **they do not provide significant wireworm mortality**
  - Neonicotinoid seed treatments (such as thiamethoxam) cause 'temporary' morbidity
  - Pyrethroids (such as bifenthrin) are repellents and non-lethal

van Herk et al. 2015. Contact behavior and mortality of wireworms exposed to six classes of insecticide applied to wheat seed. J Pest Sci 88: 717-739.

Wireworm Insecticide Control in Sunflowers

Untreated check:
35% lower yield
48% lower stand



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Wireworm Pest Management

- Neonicotinoid seed treatments provided ‘acceptable’ protection
- *New Modes of Action in wheat – Syngenta and BASF
  - Knodel testing – new products look promising
- Consider your crop rotation (wireworms prefer grasses to lay eggs)
- Know your field history and wireworm infestations
- Weed management
- Adjust seeding rate +10% to compensate for wireworm stand loss

EXTENDING KNOWLEDGE ›› CHANGING LIVES

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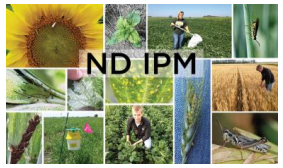
Wheat Midge Pheromone Trap

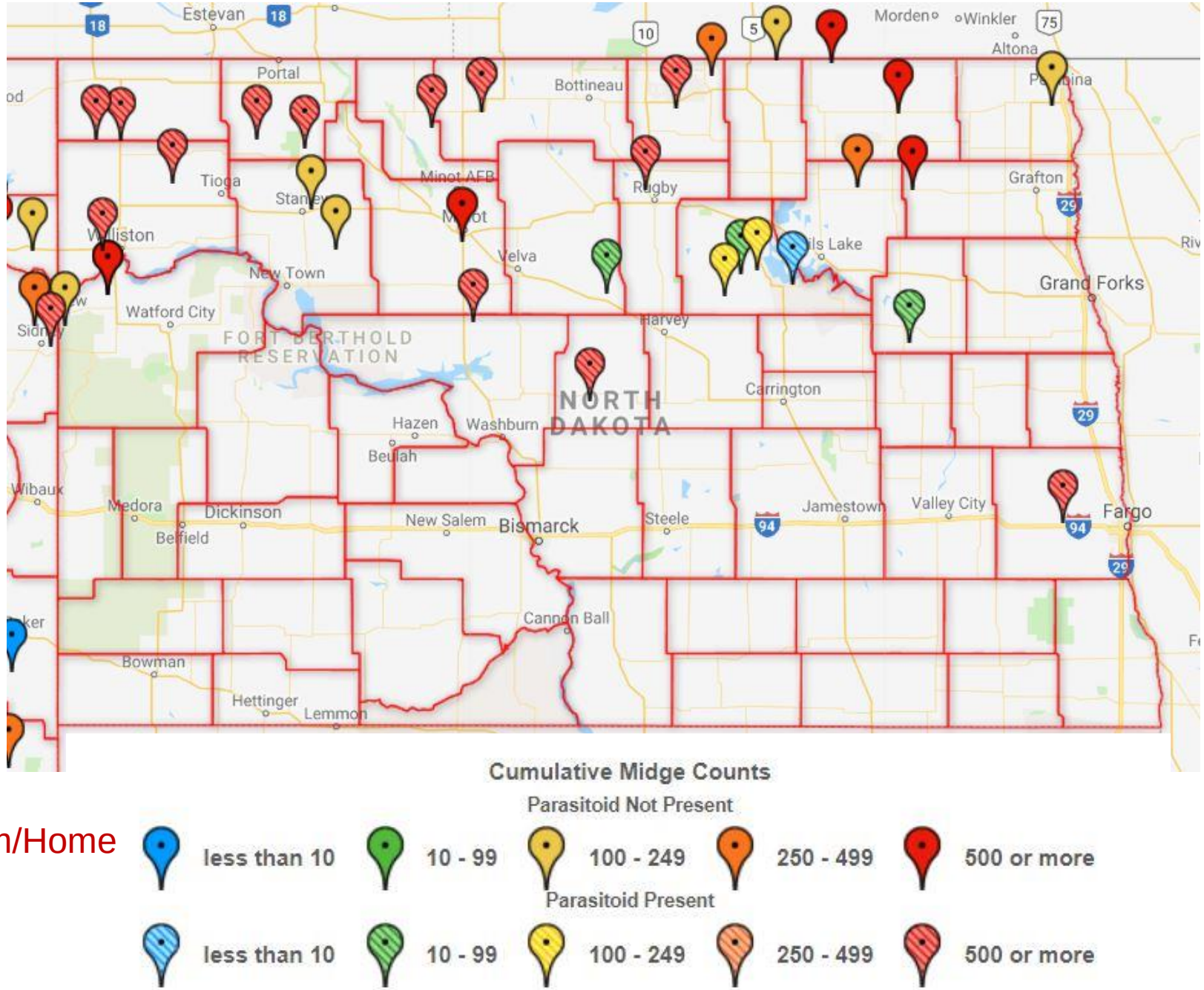
- Place traps in field during heading (at wheat head height)
- Three traps per 160 acres
  - 75 ft in field and at least 300 ft apart
- Examine every 1-2 days
- Threshold = >10 captured males per trap indicate NEED TO SCOUT FIELDS
- Available for $7.20/ trap unit
  (trap + pheromone)
- Great Lake IPM (source of insect trap supplies)
- http://www.greatlakesipm.com/

2018 Pheromone Trapping for Wheat Midge and Parasitoid in North Dakota

NDSU Ext. IPM Survey



PestWeb
Montana State University
https://pestweb.montana.edu/Owbm/Home



United States Department of Agriculture
National Institute of Food and Agriculture

Wireworm Field Sampling

- Difficult to survey and to predict whether wireworms will be a problem
- Wide host range, but grasses are preferred
- Crops most at risk following small grains, corn or CRP/non-crop

Photo credit: Dr. Wanner, Montana State University

If more than one wireworm per trap (threshold), use soil insecticide at plant or insecticide seed treatment!

Insecticide treated seed