Field Crop Insect Pest Problems in North Dakota

Dr. Janet Knodel, Professor & Extension Entomologist
Pat Beauzay, Extension Entomology Research Research Specialist
Lesley Lubenow, Ph.D. Graduate Student
Veronica Calles-Torrez, Post-Doctoral Scientist

NDSU EXTENSION

Soil and Crops 2020 – March 10-11, 2020
Agriculture in North Dakota

- 90% of land used for agriculture
- 40 million acre devoted to farming & ranching
- 24% of population is employed in the ag sector alone
- Economic impact is about $10.9 billion/year

### TOP 5 NORTH DAKOTA CROPS 2019

- **SOYBEANS**: $1.4 Billion
- **CORN**: $1.6 billion
- **CANOLA**: $420 million
- **WHEAT**: $1.4 billion
- **HAY**: $320 million

(Source: North Dakota Agricultural Statistics Service)
#1 Crops of North Dakota

- Honey 2019
  - 3.8 million lbs
  - $71 million
Wireworms

- Family Elateridae (click beetles)
- 885 wireworm species in N.A.
  - Prairie grain wireworm (*Selatosumus aeripennis destructor*)
  - Sugarbeet wireworm (*Limonius californicus*)
- Larvae feed on roots and tunnel in roots/stems
Multiyear Wireworm Life Cycle

Winter
Adults overwinter in soil. Larvae move deeper into the soil profile to overwinter.

Spring
Adults and resident larvae migrate up the soil profile once environmental conditions become favorable.

Summer
All life stages present. Resident and neonate larva feed on cereal crop until soil conditions become unfavorable. Move down the soil profile.

Fall
Adults and larvae from current and previous seasons prepare to overwinter in the soil.

3-5 years

Eggs hatch, becoming larvae
Residents larva feed on seedlings
Adults mate & lay eggs
Larvae feed on plant roots
Pupae transform to adults
Mature larva prepare for pupation
Wireworms

- 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
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
• Threshold of more than one wireworm per trap

Photo credit: Dr. Wanner, Montana State University
Wireworm Bait Trap

1. Fill ½ full with vermiculite
2. Add wheat to bait trap
3. Top with vermiculite
4. Soak with water!
Wireworm Bait Trap

- Core holes for bait trap about 6 inches deep and 4 inches wide
Wireworm Bait Trapping

Joslin and Miro

NDSU EXTENSION
Insecticide - Application Technology for Wireworm Management

- Insecticide seed treatments
- In-furrow treatment at plant
- FMC - 3RIVE 3D system
  - Planter attachment and delivers a foam formulation of insecticide to the furrow around the seed.
  - Eliminates the need for frequent refilling of water on the planter
# Current Sunflower Insecticides Registered for Wireworm

<table>
<thead>
<tr>
<th>IRAC Group</th>
<th>Class</th>
<th>Active Ingredient</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>3A</td>
<td>Synthetic Pyrethroid</td>
<td>Zeta-cypermethrin</td>
<td>Mustang Maxx (At plant)</td>
</tr>
<tr>
<td>3A</td>
<td>Synthetic Pyrethroid</td>
<td>Bifenthrin</td>
<td>Pending 2020 EPA label</td>
</tr>
<tr>
<td>4A</td>
<td>Neonicotinoid (seed treatment)</td>
<td>Imidacloprid</td>
<td>Dyna-Shield, Gaucho 600, Senator 600FS</td>
</tr>
<tr>
<td>4A</td>
<td>Neonicotinoid (seed treatment)</td>
<td>Thiamethoxam</td>
<td>Cruiser 5FS</td>
</tr>
<tr>
<td>28</td>
<td>Diamides (seed treatment)</td>
<td>Cyantraniliprole</td>
<td>Fortenza</td>
</tr>
</tbody>
</table>
In-furrow Pyrethroid and Neonic Seed Treatment Efficacy Trials in Sunflowers 2016-2019

<table>
<thead>
<tr>
<th>Insecticide Class</th>
<th>Active Ingredient</th>
<th>Trade name</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonicotinoid</td>
<td>Thiamethoxam</td>
<td>Cruiser 5FS</td>
<td>0.25 mg ai/seed</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>Thiamethoxam</td>
<td>Cruiser 5FS</td>
<td>0.375 mg ai/seed</td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>Zeta-cypermethrin</td>
<td>Mustang Maxx</td>
<td>4 fl oz/acre</td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>Bifenthrin</td>
<td>Capture LFR</td>
<td>4-8 fl oz/acre</td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>Bifenthrin</td>
<td>Ethos XB</td>
<td>4-8 fl oz/acre</td>
</tr>
</tbody>
</table>
Mohall, 2017

Treatment Means for Plant Population and Yield

22,500 target plant population

- **Capture 3RIVE 3D @ 4 fl oz**
  - Plants per Acre: 18,992 a
  - Percentage: 16%
  - Yield (Lbs per Acre): 1,041 ab

- **Cruiser 5FS @ 0.25 mg**
  - Plants per Acre: 18,034 ab
  - Percentage: 20%
  - Yield (Lbs per Acre): 974 ab

- **Ethos 3D @ 4 fl oz**
  - Plants per Acre: 17,969 ab
  - Percentage: 21%
  - Yield (Lbs per Acre): 1,059 a

- **Capture LFR @ 4 fl oz**
  - Plants per Acre: 17,337 ab
  - Percentage: 24%
  - Yield (Lbs per Acre): 1,172 a

- **Cruiser 5FS @ 0.375 mg**
  - Plants per Acre: 17,337 ab
  - Percentage: 24%
  - Yield (Lbs per Acre): 1,159 a

- **Mustang Maxx @ 4 fl oz**
  - Plants per Acre: 16,204 bc
  - Percentage: 29%
  - Yield (Lbs per Acre): 1,185 a

- **Ethos XB @ 4 fl oz**
  - Plants per Acre: 741 b
  - Percentage: 39%
  - Yield (Lbs per Acre): 963 ab

- **Untreated Check**
  - Plants per Acre: 13,678 c
  - Percentage: 39%
  - Yield (Lbs per Acre): 741 b
Treatment Means for Plant Population and Yield
Mohall, 2018

2,076 a
17,791 a
21%

2,069 a
17,332 a
23%

2,104 a
15,957 a
29%

2,076 a
15,865 a
30%

1,971 a
15,131 a
33%

1,330 b
8,712 b
61%

Untreated Check

Plants per Acre

Yield (Lbs per Acre)

Cruiser 5FS @ 0.25 + Capture 3RIVE 3D @ 4

Capture 3RIVE 3D @ 4

Capture 3RIVE 3D @ 8

Cruiser 5FS @ 0.25

Cruiser 5FS @ 0.25 + Capture 3RIVE 3D @ 8

Untreated Check

22,500 target plant population
Treatment Means for Plant Population and Yield
Mohall, 2019

22,500 target plant population

Plants per Acre

Ethos 3D @ Ethos 3D @ Capture LFR @ Capture 3RIVE 3D @ Ethos XB @ Cruiser 5FS @ 0.25 + Mustang Maxx @ 4 Cruiser 5FS @ 0.25 Capture 3D @ 4 Mustang Maxx @ 4 Cruiser 5FS @ 0.25 Untreated

Yield (Lbs per Acre)

0 200 400 600 800 1,000 1,200 1,400 1,600 1,800

4,000 8,000 12,000 16,000 20,000 24,000

Ethos 3D @ 4.6 Ethos 3D @ 9.2 Capture LFR @ 4.2 Capture 3RIVE 3D @ 4 Ethos XB @ 4.27 Cruiser 5FS @ 0.25 + Mustang Maxx @ 4 Cruiser 5FS @ 0.25 Capture 3D @ 4 Mustang Maxx @ 4 Cruiser 5FS @ 0.25 Untreated

23% 23% 24% 30% 30% 33% 30% 37% 37% 39% 43%
Wireworm ‘Control’

- Increasing rates or stacking ST + in furrow pyrethroids did not improve efficacy
- Insecticide ST, in-furrow pyrethroid or 3RIVE 3D applications provided ‘better’ stand establishment than the untreated check

![Average Percent Stand Loss Across Site Years (2016-2019)]
Wireworm Stand Loss

Untreated Check

Mustang Maxx

Photo by P. Beauzay
Wireworm ‘Control’

• Current insecticides do not provide mortality or long-term management of wireworms
  – Neonicotinoid seed treatments (such as thiamethoxam) cause ‘temporary’ morbidity
  – Pyrethroids are repellents and nonlethal

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 Pest Management

• Thiamethoxam seed treatment, in-furrow and 3rive applications of pyrethroids provided ‘improved’ protection over the untreated check
• Stacking seed treatment plus in-furrow pyrethroids did not improve control over single application
• Consider your crop rotation and know your field history with wireworm pressures
• Adjust seeding rate +10-20% to compensate for wireworm stand loss
• New Mode of Action – Syngenta and BASF
New Chemistry for Wireworm Control in Cereals from BASF

• Broflanilide, the new Group 30 insecticide
• Teraxxa Insecticide Seed Treatment
• Small grain cereals late this year
  – Crops: wheat, barley, rye, and triticale
• High activity against various pests, including Lepidopteran, Coleopteran, and Thysanopteran pests
• Not seeking registration for Teraxxa in sunflowers

Armyworm Immobility, body contractions, and vomiting
Flea Beetles in 2019
Fall Canola Survey

Flea Beetle

**PI:** Janet Knodel

**Identifier:**
Patrick Beauzay

**Surveyors:**
Ryan Buetow, DREC
Audrey Kalil, WREC
Scott Knoke, Benson Co. Ext.
Lesley Lubenow, LREC
T.J. Prochaska, NCREC

Recently swathed canola.
Flea Beetles – *Phylloptreta* species

- **Adult beetle**
  - ⅛ inch long
  - Enlarged hind legs
- **Crucifer flea beetle**
  - Iridescent blue sheen on black wing covers
- **Striped flea beetle**
  - 2 yellow strips on black wing covers
Objective

• To provide information on the population levels and distribution of different species of flea beetles in canola throughout North Dakota during swathing (late August – Sept.)
• Differences in *Phyllotreta cruciferae* and *Phyllotreta striolata* tolerance to Neonicotinoid Seed Treatments

*Tansy et al. 2008 J. Econ. Entomol. 101: 159-167.*
Materials & Methods

- Surveyed swathed canola fields in NC, NW, SW and NE ND
- Collected flea beetles using 15-inch sweep net
- 20 sweeps per 5 locations (total of 100 sweeps per field site)
- Flea beetles placed in plastic bags and stored in freezer
- Flea beetle species identified and counted for each field site
82 canola fields surveyed for flea beetles in 18 counties of ND.
2019 Canola Flea Beetle Survey
Crucifer Flea Beetle (*Phyllotreta cruciferae*)

- 66,976 total specimens
- 99% of flea beetles collected
- 89% of the fields positive
- 17 counties out of 18
2019 Canola Flea Beetle Survey
Striped Flea Beetle (*Phyllotreta striolata*)

- 107 total specimens
- 0.2% of flea beetles collected
- 26% of the fields positive
- 8 counties out of 18
Striped Flea Beetle (SFB) Populations in Canola from 2014-2019

- % of Surveyed Field Positive for SFB
- Density # SFB per Field
Spring Sticky Card Survey

• Timing: Spring 2017-2019
• 10 sticky cards in farmer field
• Changed 2x per week
• 5 counties:
  – NE – Cavalier and Towner
  – NC - Renville and Ward
  – SW – Stark
Striped vs. Crucifer Flea Beetles

At Peak Emergence

Typically, Crucifer flea beetle is #1

However, striped flea beetle dominates in some years in northeast and north central ND.

### Table: Dates for Max. Spring Numbers, Total flea beetles/trap/day, P. cruciferae, P. striolata

<table>
<thead>
<tr>
<th>Nearest Town</th>
<th>Dates for Max. Spring Numbers</th>
<th>Total flea beetles/trap/day</th>
<th>P. cruciferae</th>
<th>P. striolata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osnabrock 2019</td>
<td>Jun 3 - 6</td>
<td>2.57</td>
<td>93.4</td>
<td>6.6</td>
</tr>
<tr>
<td>Rock Lake 2019</td>
<td>May 28 - 30</td>
<td>16.95</td>
<td>92.9</td>
<td>7.1</td>
</tr>
<tr>
<td>Langdon W 2018</td>
<td>May 21 - 24</td>
<td>0.2</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Rock Lake 2018</td>
<td>May 24 - 29</td>
<td>1.8</td>
<td>72.2</td>
<td>27.8</td>
</tr>
<tr>
<td>Langdon E 2017</td>
<td>May 29 – Jun 2</td>
<td>4.2</td>
<td>34.5</td>
<td>65.5</td>
</tr>
<tr>
<td>Cando 2017</td>
<td>May 29 – Jun 2</td>
<td>0.8</td>
<td>43.8</td>
<td>56.2</td>
</tr>
<tr>
<td>Mohall 2019</td>
<td>Jun 3 – Jun 6</td>
<td>4.07</td>
<td>75.4</td>
<td>24.6</td>
</tr>
<tr>
<td>Kenmare 2019</td>
<td>May 23 - 27</td>
<td>0.15</td>
<td>86.7</td>
<td>13.3</td>
</tr>
<tr>
<td>Mohall 2018</td>
<td>May 24 - 28</td>
<td>0.65</td>
<td>23.1</td>
<td>76.9</td>
</tr>
<tr>
<td>Kenmare 2018</td>
<td>Jun 7 - 11</td>
<td>0.38</td>
<td>65.8</td>
<td>34.2</td>
</tr>
<tr>
<td>Mohall 2017</td>
<td>Jun 2 - 6</td>
<td>0.78</td>
<td>96.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Kenmare 2017</td>
<td>Jun 2 - 6</td>
<td>0.7</td>
<td>46.5</td>
<td>53.5</td>
</tr>
<tr>
<td>Dickinson 2019</td>
<td>May 31 - Jun 3</td>
<td>1.88</td>
<td>97.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Dickinson 2018</td>
<td>May 29 - Jun 1</td>
<td>6.9</td>
<td>94.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Dickinson 2017</td>
<td>Jun 1 - 5</td>
<td>2.4</td>
<td>92.7</td>
<td>7.3</td>
</tr>
</tbody>
</table>
Conclusions

- *Phyllotreta cruciferae* (crucifer flea beetle)
  - Continues to be the most common and widely distributed flea beetle species found in the 2014-2019 Canola Surveys in North Dakota

- *Phyllotreta striolata* (striped flea beetle, SFB)
  - Second most common flea beetle species in canola
  - Incidence of fields with SFB decreased and density continued to be low since 2014
  - Important baseline data on its current abundance and distribution in ND
  - Future survey efforts will help document any increases in striped flea beetle populations, distributions as well as species shift due to potential insecticide resistance in North Dakota
SEED TREATMENTS VS. BOTH SPECIES OF FLEA BEETLES
**Canola**

**Seed Treatment Insecticides**

*Restricted Use Pesticide*

**Insecticide Recommendations**

Registered Insecticides - 2020

**Neonicotinoid, Group 4A:**
- thiamethoxam - Helix Vibrance, Helix XTra
- clothianidin - NipsIt INSIDE, Prosper EverGol
- imidacloprid - Attendant 480FS, Dyna-Shield
  - Imidacloprid 5, Gaucho 600, Senator 600 FS

**Diamides, Group 28:**
- cyantranilliprole - Fortenza, Lumiderm

*Always Read and Follow Labels.*
Treatment Yields at Langdon, 2012

Heavy Flea Beetle Pressure

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (lbs/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Check</td>
<td>1,372 b</td>
</tr>
<tr>
<td>Clothianidin</td>
<td>2,583 a</td>
</tr>
<tr>
<td>Thiamethoxam</td>
<td>2,521 a</td>
</tr>
</tbody>
</table>
Greenhouse Bioassay Study

• Flea Beetles Rearing
  – Collected crucifer and striped flea beetles in spring 2019 from Langdon area
  – Flea beetles fed untreated canola and organic kale every three days

• 4 treatments
  – Untreated check
  – Thiamethoxam (Helix Xtra, Helix Vibrance) at 400 g/100 kg
  – Clothianidin (Prosper EverGol) at 200.8 g/100 kg
  – Cyantraniliprole (Lumiderm, Fortenza) 1000 g/100 kg
Materials and Methods

• 5 canola seedlings per pot
• 10 flea beetles per pot
  (or 2 flea beetles per seedling)
• 6 replications, RCBD
• 2 plant ages:
  – 7 and 14 DAP
Materials and Methods

• Live flea beetles counted and recorded for each pot at 1, 3, 7, 10 & 14 days after introduction (up to 10 days for the 14 DAP plants)

• Corrected Mortality (Schneider-Orelli, 1947)
  – \( M(\%) = \frac{(t - c)}{(100 - c)} \times 100 \)
  – \( t \) = percent mortality in treatments
  – \( c \) = percent mortality in controls (untreated checks)

• Data analyzed using PROC GLM in SAS statistical software

• Treatment means compared using pairwise t-tests at \( \alpha = 0.05 \)
2019 Seed Treatment Mortality to *P. cruciferae* - Langdon

Day 1 and Day 3: clothianidin = thiamethoxam > cyantraniliprole
Canola Seedling Flea Beetle Damage Rating Scale

- 1 = 0-3 pits per seedling
- 2 = 4-9 pits per seedling
- 3 = 10-15 pits per seedling
- 4 = 16-25 pits per seedling
- 5 = >25 pits per seedling
- 6 = dead seedling

Damage ratings taken at 1-leaf, 2-4 leaf, and 4-6 leaf stages (approximately once per week)
P. striolata had higher feeding injury scores than P. cruciferae, and cyantraniliprole had lower feeding injury scores.
Conclusion

• Striped flea beetles had higher survival (or lower mortality) and higher feeding injury ratings than crucifer flea beetles for all insecticide seed treatments tested.

• Continue to survey flea beetle populations and to conduct insecticide bioassays in greenhouse.
Swede Midge Trap Survey

Order Diptera
Family Cecidomyiidae
Contarinia nasturtii (Kieffer)

PI: Janet J. Knodel
Identifier: Patrick Beauzay
Trappers:
NE: Lesley Lubenow, Anitha Chirumamilla, Lindy Berg, Samantha Lahman, Traci Murphy
NC: T.J. Prochaska, LoAyne Voigt, Sara Clemens
NW: Audrey Kalil, Nicole Stanhope
SW: Ryan Buetow, Kia Ward

Photo: Susan Ellis, www.forestryimages.org
Hosts and Crop Damage

- Hosts – canola, cabbage, radish, others Brassicaceae
- Larval feeding caused plant injury
- Deformed, crumpled leaves, shoots and/or flowers
- Leaf, shoots and flower galls
- Misshapen growing points and growth of secondary shoots

Photos: Julie Kikkert, Cornell Cooperative Extension, www.forestryimages.org
Swede Midge Trap Survey

• Used commercially available pheromone lure & delta trap (Sentry Red LPD trap)
• Monitored from mid-June (rosette) through mid-August (ripening crop stage)
• Traps checked weekly (sticky trap bottoms replaced)
• Trap bottoms stored in freezer
Add the ‘New’ Canola Flower Midge to Surveys

*Contarinia brassicola*

- Family Cecidomyiidae, Order Diptera (flies)
- Hosts – canola (*Brassica napus* and *B. rapa*)
- Light brown, Small, <2mm long

*Photographs from 2019 Mori et al. Can. Entomol. 151:131-148*
Pea Leaf Weevil
Sitona lineata L.

- Discovered in Beech, Golden Valley County, SW ND in fall 2016
- Feeds on field peas, faba beans
- Non-hosts – chickpea, lentil
- Secondary hosts – alfalfa, clover (larvae do not develop)

Figure 1: Adult S. lineatus on pea leaf (Photo: L. Dosdall).

Figure 2: Dorsal view of adult S. lineatus (Photo: H. Goulet).
Pea Leaf Weevil Feeding Injury

- Adult – chew feeding notches on leaves; often higher on field edges or fields next to pastures or riparian areas.
- Larva – chew and tunnel in nitrogen-fixing nodules
- Reduce nitrogen fixation by plant and results in poor plant growth and lower seed yields
Pea Leaf Weevil Distribution in North Dakota, 2017-2019

14 counties positive for pea leaf weevil

Presence of Plant Notching

- Absent
- Present in 2017
- Present in 2018
- Present in 2019
New Pulse Crop Insect Extension Publications

Integrated Pest Management of Pea Leaf Weevil in North Dakota

Pea leaf weevil (P. p. var.) is an invasive insect pest that first was detected in southwestern North Dakota on field peas in Golden Valley County during the fall of 2016. Pea leaf weevil is a significant insect pest of field peas and faba beans, and can reduce yields severely.

Host Plants
Pea leaf weevil attacks cultivated and wild legume species, including field peas, faba beans, and dry pea species. Damage in pea fields reduces yields, and faba bean fields may become unmarketable. Insects are also known to feed on dry bean, lima bean, lupine, and vetch, but do not cause economic damage.

Geographic Range
Pea leaf weevil, native to Europe and North Africa, first was reported in North America during the 1960s. Since then, it has become established in parts of Idaho, Montana, Texas, the Pacific Northwest (Washington, Oregon, and California), and British Columbia (Alberta and Saskatchewan). In the last decade, P. p. var. populations have been moving eastward, affecting increasing field pea acreage in North Dakota. NDSU Extension entomologists confirmed P. p. var. in 2018 and 2019 in the following years: southwest, central, and Novon County. Faba bean growers should monitor P. p. var. populations, especially in the field pea crop and should report their observations to the local Extension offices or NDSU Extension entomology specialists.

Pulse Crop Insect Diagnostic Series

Field Pea, Lentil, and Chickpea

Pulse Crops Infested
Field peas also prefers faba beans.

Identification
Adult. FIGURE 1
- Adult weevils: slender, grayish-brown beetle, approximately 1/2 inch long with a broad, bladed antennal collar.

Immature (Larval). FIGURE 2
- Legmas larva, soft-bodied and milky white with a dark head, about 1/6 inch long.
- When exposed, larvae curl into a "C" shape.

Crop Damage
Overwintering adults migrate from perennial habitats into pea fields in the spring. Adult feeds on seedlings, causing characteristic notching along the clam-shell margins. FIGURE 3. If severe, leaf feeding can reduce stand counts. Notching typically occurs during the first five to seven weeks of plant growth. The most severe injury occurs when the plants are young. A single female can lay up to 3,000 eggs during her lifetime. Larvae hatch from eggs laid in the soil and migrate to the nitrogen-fixing root nodules, where they feed (FIGURE 4). Larvae actively feed on the nitrogen-fixing nodules, which can cause severe damage to the pea plant, requires the level of nitrogen available to the crop and can reduce yields. In August and September, adult weevils emerge from the peas and migrate to overwintering sites.

Scouting Tips
- Look closely during the early crop stages.

Cultural Controls
- Practice reduced tillage rather than conventional tillage.
- Seed later than early.
- Plant a trap crop (faba beans) along borders.
New Pulse Crop Extension Publications

**Pea Seed-borne Mosaic Virus (PSbMV) in Field Peas and Lentils**

Pea seed-borne mosaic virus (PSbMV) is an economically damaging viral pathogen of field peas and lentils that can cause significant losses in seed yield and quality, especially when infections occur before or during bloom. It has been observed on field peas and lentils in North Dakota and other field peas in Montana. PSbMV is distributed worldwide, and it presumably was introduced to North Dakota and Montana on seed imported from other regions.

PSbMV is seed-transmitted and spread between plants by aphids. When aphid populations are high, strikingly low levels of infected seed can result in severe epidemics. Infected seed and the movement of aphids from infected crops are important contributors to the local spread of PSbMV.

**Symptoms**

In peas, PSbMV causes stunting, reduced internode lengths and malformation, and often results in the formation of malformed terminal rosettes (Fig. 1, 2). The virus also delays plant maturity, leading to uneven crop maturation (Fig. 3, 4). Infected leaves can exhibit mottling and veining of veins, slight downward curling of leaf margins, chlorosis and/or a mottled or mosaic distortion (Fig. 5). Plants often are deformed (Fig. 6), and seeds produced from infected plants can exhibit pronounced discolorations (Fig. 7), with reduced seed coats (Fig. 8), shriveling and reduced size.

**Pulse Crop Production Field Guide for North Dakota**

Revised by
- Gregory Esko, NDSU Extension Specialist/Cropping Systems
- Shuta Foster, NDSU North Central Research Extension Center Director
- Rens Kavelaars, Extension Agronomist/Small Grains
- Julie Parche, NDSU Plant Pathologist
- Michael Weng, Extension Plant Pathologist
- Janet Koedel, Extension Entomologist
- Kenneth Haugen, Extension Agricultural Engineer
Thank you!
Wheat Midge Forecast 2020

Midge / m²
- No infestation
- < 600
- 600 ≤ 1200
- 1200 ≤ 1800
- > 1800
- Not surveyed

Map showing the distribution of wheat midge infestations across different regions.
Crop Damage from Wheat Midge

- Estimate losses of $3 million per year without IPM
- Lower yields
- Reduced grain quality
- Vectors *Fusarium* head blight (scab)

Saskatoon Research Centre, Canada
Life Cycle of Orange Wheat Blossom Midge
*Sitodiplosis mosellana*

- **Egg**
- **Larva**: 2-3 mm, orange
  - Drop from heads after rain or heavy dew
- **Pupa**
- **Adult**

One generation per year

May: cocoon
June: larva
July: pupa
August: cocoon

Cocoons
Extraction of Wheat Midge Larvae in Soil

- Washing soil and collecting organic matter in sieves
- Saline floatation
- Examining organic matter for cocoons
2019 Wheat Midge Larval Survey
North Dakota

0 – 1,357 midge larvae / m²
Average = 79 midge larvae / m²
58% of samples were 0!

High Risk: Ramsey & Wells
Moderate Risk: Bottineau, Mountrail & McLean
Canada: 25 mm of precipitation prior to the end of May is required for proper development of wheat midge.

*Elliott et al. 2009 Crop Protection* 28: 588-594
Macroglenes penetrans
good-larval parasite of the Wheat Midge
Highest Parasitism rate in Bottineau, Williams, & Cavalier counties
Average = 36% parasitism rate
85% of samples had 0% parasitism
Other Areas of Interest

• Soybean aphids – Pyrethroid Resistance
• Soybean gall midge (*Resseliella maxima*) – Invasive insect pest of soybeans (not in ND)
• Corn – Corn rootworm & European corn borer monitoring network, Bt resistance
• Pollinator (bees & syrphids) work in field crops and perennial flowers
• IPM Survey for insect pests & diseases in wheat, barley, soybeans and sunflowers
## Bee Count Summary in Soybean 2014 and 2016 Combined

<table>
<thead>
<tr>
<th>Family</th>
<th>No. of Genera</th>
<th>No. of Species</th>
<th>No. of Individuals</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrenidae</td>
<td>4</td>
<td>7</td>
<td>13</td>
<td>0.1</td>
</tr>
<tr>
<td>Megachilidae</td>
<td>2</td>
<td>8</td>
<td>19</td>
<td>0.2</td>
</tr>
<tr>
<td>Colletidae</td>
<td>2</td>
<td>5</td>
<td>29</td>
<td>0.3</td>
</tr>
<tr>
<td>Apidae</td>
<td>11</td>
<td>31</td>
<td>998</td>
<td>9.2</td>
</tr>
<tr>
<td>Halictidae</td>
<td>8</td>
<td>57</td>
<td>9,763</td>
<td>90.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
<td><strong>108</strong></td>
<td><strong>10,822</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Contact information:
Janet J. Knodel
Phone: 701-231-7915
janet.knodel@ndsu.edu