



# MinnesotaCorn

## RESEARCH & PROMOTION COUNCIL

### PROGRESS REPORT

PROJECT TITLE: Enhancement of Survey Efforts for Corn Pests in Minnesota  
PROJECT NUMBER: 00076225  
REPORTING PERIOD: Q2 July 1, 2019- September 30, 2019  
PRINCIPAL INVESTIGATOR: Bruce Potter  
ORGANIZATION: University of Minnesota  
PHONE NUMBER: (507) 276-1184  
EMAIL: bpotter@umn.edu

#### **1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (*Describe project progress specific to goals, objectives, and deliverables identified in the project workplan*)**

##### **Objective I: Improve and expand the current trapping networks for corn insect pests.**

###### **Ia) Black light trap network. (Hutchison)**

- *Cooperative light trap locations operated early May through September and results posted on the U of MN VegEdge website.*
- *Degree-day models for European corn borer development posted weekly on the VegEdge site at: <https://www.vegedge.umn.edu/mnodd>.*
- *Moths collected from black-light traps (small numbers from Rosemount and Llamberton ) were transferred to the Hutchison lab and frozen for future analysis on voltinism, Nosema pathogens and % mated females.*

###### **Ib) Pheromone trap networks. (Hutchison/Potter)**

- *Corn earworm - Pheromone traps operated June 1 to September. Results were updated weekly on the VegEdge website (Figure 3).*
- *Black cutworm –none this quarter.*

###### **Ic) Corn rootworm sticky trap network. (Potter/ Hutchison/Ostlie)**

- *250 corn rootworm sticky trap survey kits were created for the 2019 survey project using unbaited Pherocon AM yellow sticky traps and updated 2019 instructions, data sheets and field history forms.*
- *A MN Crop News blog also highlighted the survey project, solicited participants and credited the corn checkoff support through MCR&PC (see Extension and Outreach Activities).*
- *Prospective participants were approached by emails through the Minnesota Corn Growers, Minnesota Independent Crop Consultant Association (MNICCA), Central crop consulting, plus the previously mentioned seed companies. (Quarter 1-2)*

- *Total number of 2019 participants is currently estimated at 200 with potentially about 425 fields expected to be monitored.*
- *Received yellow sticky trap data from Corteva (2017-2018), RobSeeCo (2018), and Wyffle Seeds (2018). We anticipate data from Bayer shortly. While too late to help with 2019 seed decisions, when combined with data from U of M volunteers, these collective data points will provide an invaluable comparative perspective for 2019 results.*

**Objective II: Develop a network of sentinel and on-farm survey plots for corn insect pests and corn diseases.**

**IIa) Corn disease and insect pest monitoring at U of M ROCs (Malvick and Potter)**

- Develop and use sentinel plots for determination of the annual prevalence of key corn pathogens and insects.
  - *Late-season diseases evaluated at Rosemount, Lamberton, Morris, and Crookston.*
- Evaluate yield loss from corn foliar fungal pathogen losses at multiple locations by comparing fungicide applications with untreated controls
  - *Priaxor (BASF) and Delaro (Bayer) fungicides were applied to three corn hybrids at the Rosemount, Lamberton, Morris and Crookston locations. Applications were made at the Vt stage with the exception of Rosemont where applications to two of the three hybrids were applied 1-2 days before tassel. The Waseca was abandoned because of poor stands and very late planting. Data analyses are waiting on yield data.*
  - *An impromptu study on fungicide effects on Physoderma node rot was placed in a Brown County field with foliar symptoms. At fungicide application time this study had 10-30% green snap. This study was hand harvested because of green snap.*

**IIb) On-farm corn insect and pathogen monitoring (fall survey for European corn borer and corn pathogens)**

- Conduct a statewide fall survey for overwintering larval corn borer populations to estimate annual geographic populations and project following year's risk. (Hutchison)
  - *Surveys were begun in September and completed in October (Q3). Most of the counties with significant corn acreage were surveyed (Figure 3).*
  - *We were able to increase the total number of surveyed fields compared to 2018 [248 in 2019 vs. 207 in 2018] and also those known to be planted to non-Bt hybrids [96 fields in 2019 vs. 70 in 2018] (Table 1.). Cooperators provided locations for most of the non-Bt fields that were sampled (Figure 4).*
  - *2019 data are in prep for meetings and an coming winter crop news.*
- Use larvae collected during the statewide fall survey to determine geographic differences in corn borer voltinism biotypes. (Hutchison)
  - *Larvae were collected from infested survey fields and placed in environmental chambers to diapause.*
  - *Voltinism and parasitism determinations from 2018 collected larvae were finalized.*

- ECB Larvae collected from the 2019 fall survey, will be held in diapause conditions (Hutchison lab), this fall, and assayed in spring for the percentage univoltine vs. univoltine and presence of the *Nosema* pathogen prevalence
- iii. Conduct a statewide survey for corn diseases to determine annual prevalence of key species. (Malvick)
- *Surveys were conducted at the same time as corn borer in September and early October.*
  - Effort to incorporate reports of unusual or new corn disease symptoms were made.

## 2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.

### Objective I: Improve and expand the current trapping networks for corn insect pests.

#### Ia) Black light trap network. (Hutchison)

- *Both light trap and degree-day models (Appendix I, Fig. 1, Fig. 2) were available to help time scouting efforts for multivoltine and univoltine corn borer.*
- *European corn borer flights were low at all light trap locations.*
- *In August, we received a few scattered reports of economic ECB infestations in non-Bt corn began to come in from WC and SE MN.*
- *In spite of large flights in areas to the south and west (e.g. Nebraska), black light trap captures of western bean cutworm moths in Minnesota remained relatively low. Western bean cutworm moths were captured at the Lamberton location for the first time in several years. Low numbers of moths were also captured in SC and SE MN.*

#### Ib) Pheromone trap networks. (Hutchison/Potter)

- *Black cutworm – none this quarter.*
- *Corn earworm – Significant flights were very late and predominately detected in SC and SE MN. Very few infestations of non-Bt field corn were detected during corn borer survey. This was in spite of very late planting in much of SW and WC Minnesota. An exception was a late-planted field in Lac Qui Parle County where a high percentage of ear tips were infested.*

#### Ic) Corn rootworm sticky trap network. (Potter/ Hutchison/Ostlie)

- *Traps distributed and run for 4-6 weeks during late July to early Sept. window of adult activity. Data analysis has not been completed.*

### Objective IIa) Corn disease and insect pest monitoring at U of M ROCs (Malvick and Potter)

- i. Develop and use sentinel plots for determination of the annual prevalence of key corn pathogens and insects.
- *In spite of the wet growing season, we observed relatively low season disease and insect pressure at all sites.*
  - *Preliminarily, incidences of bacterial leaf streak, Goss's wilt and stalk rots were lower than previous years.*

- *Green snap occurred at the Lamberton location and, similar to field observations, appeared to be hybrid dependent.*
- ii. Evaluate yield loss corn foliar fungal pathogen losses at multiple locations by comparing fungicide applications with untreated controls
  - *Observations indicated low disease levels but analyses have not yet been completed.*
  - *Obvious visual differences between treated and untreated plots were not observed for stalk rot or foliar disease other than perhaps common rust but analyses are not completed.*
  - *Awaiting fungicide study yield data to complete yield analyses.*
  - *The Brown Co. Physoderma study was hand harvested (Quarter 3) but data have not yet been analyzed.*

**Objective IIb) On-farm corn insect and pathogen monitoring (fall survey for European corn borer and corn pathogens)**

- i. Conduct a statewide fall survey for overwintering larval corn borer populations to estimate annual geographic populations and project following year's risk. (Hutchison)
  - *Surveys were completed by mid- October.*
  - *Preliminary analyses indicate that corn borer populations in portions of NW and WC Minnesota increased from 2018 to 2019 (Table 1, Figure 5). The detection of this increase was due, in part, to the inclusion in the survey of fields not planted to Bt (Figures 5, 6).*
  - *Analyses of tunneling may reveal additional impacts from the first generation multivoltine biotype above the presence of overwintering borers (Figures 3, 7).*
- ii. Use larvae collected during the statewide fall survey to determine geographic differences in corn borer voltinism biotypes. (Hutchison)
  - *None for 2019 survey*
  - *Additional genetic information from larvae collected during 2018 survey*
    - *Some adults and larval specimens were analyzed for genetic markers for univoltine. vs. multivoltine, via the per and Pdfr circadian clock genes ((Erik Dopman lab, Tufts University)\* \**
      - *Univoltine-like period allele frequency = 9/10*
      - *Univoltine-like Pdfr allele frequency = 1/10*
      - *Most of the 2018 larvae (9/10) were collected from the NW and, WC districts and were expected to be mostly be univoltine.*
      - *Larval and adult sample size available for analysis will continue to be an issue going forward due to the ongoing ECB suppression effect, for the majority of the state.*
    - *From a sample of 20 moths, the Z strain pgFAR allele frequency was 100%. As expected or a Midwest population, no E-strain detected. This has significance in Bt resistance as the reported Canadian populations showing resistance are E-strain.*

*\*\* Relevant References*

Coates, B.S., E.B. Dopman, K.W. Wanner and T.W. Sappington. 2018. Genomic mechanisms of sympatric ecological and sexual divergence in a model agricultural pest, the European corn borer. *Current Opinion in Insect Science*. 26:50-56. <https://doi.org/10.1016/j.cois.2018.01.005>.

Kozak, G.M., C.B. Wadsworth, S.C. Kahne, S.M. Bogdonowicz, R.G. Harrison, B.S. Coates and E.B. Dopman. 2019. Genomic basis of circannual rhythm in the European corn borer moth. *Current Biology*: 3501-3509. <https://doi.org/10.1016/j.cub.2019.08.053>.

**iii. Conduct a statewide survey for corn diseases to determine annual prevalence of key species. (Malvick)**

- *Diseases were evaluated during the fall corn borer survey, Tar spot was evaluated in all fields but not detected. Stalk rots were evaluated in SW and several other areas of MN (Figure 87). The incidence tended to be lower in 2019 than previous years. However, this reduction could have related to many of the observations being made on the late-planted and late-maturing 2019 corn in much of Minnesota. SW and portions of SC and WC Minnesota continue to serve as a pilot for this project. *Physoderma* brown spot and node rot was observed in several fields (Figure 9) and there are indications that this disease is increasing in prevalence and geographic distribution within Minnesota.*
- *Reports of tar spot of corn caused by the fungus *Phyllachora maydis*, were received from cooperators and confirmed by the University of MN in late September. This is the first confirmation of this disease in Minnesota. The disease was confirmed in 2019 at low levels in four SE MN counties (Figure 10). Information was distributed through Minnesota Crop News and other media in early October.*
- *The detection of crop pest issues, such as tar spot, that are limited in distribution or prevalence highlight the need to enhance the cooperative network between private and public groups;*
- *Project investigators handled numerous requests for diagnosis of corn symptoms. This project provided funding to determine the cause of several unusual symptoms on corn symptoms some were determined to be physiological.*

**3.) CHALLENGES ENCOUNTERED. (Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project workplan.)**

Ia ii) Evaluate yield loss corn foliar fungal pathogen losses at multiple locations by comparing fungicide applications with untreated control.

- *Wet spring weather greatly delayed planting (June) at the Waseca site and produced highly variable plant stands and the site was abandoned.*
- *Wet soil conditions impacted some plots at the Morris site and the number of replications available for analysis may be reduced.*

Ic) Corn rootworm sticky trap network. (Potter/ Hutchison/Ostlie)

- *Buyout / mergers of major seed companies disrupted their 2018 participation in the corn rootworm survey, despite previous commitments to share these data. For example, Bayer [Monsanto] did not designate their new management until January 2019 and wanted to give their new agronomic and trait managers the opportunity to re-assess this commitment. Now they are working through the legal aspects of who owns data collected*

*from affiliated Corn States companies. Similarly, the DuPont Pioneer – Dow AgroSciences merger also resulted in new management who needed to confirm participation. Finally, ag professionals, e.g., crop consultants, are working with their growers to confirm participation and willingness to share data.*

- *Data coordination among entities engaged in corn rootworm scouting is a logistical challenge with cooperators differing in when trapping was initiated, the numbers of traps per field, and duration of trapping efforts. Enthusiasm is great with groups sharing the vision of combining data but resolution of farmer privacy / corporate data propriety concerns is ongoing. We are patiently working through these concerns with participants and expect excellent participation in 2019.*

**4.) FINANCIAL INFORMATION (Describe any budget challenges and provide specific reasons for deviations from the projected project spending.)**

**5.) EDUCATION AND OUTREACH ACTIVITIES. (Describe any conferences, workshops, field days, etc attended, number of contacts at each event, and/or publications developed to disseminate project results.)**

Ib) Pheromone trap networks. (Hutchison/Potter)

- *Fruit and Vegetable News: Late season corn earworm alert*

Ic) Corn rootworm sticky trap network. (Potter/ Hutchison/Ostlie)

- *The extension fact sheet on corn rootworm monitoring, initially developed in 2017 and revised in 2018 to reflect MN research, was updated to reflect current corn rootworm situation and new thresholds. Ostlie, K.R. and T. Leaf. 2019. Corn Rootworm Scouting Using Yellow Sticky Traps. MN Extension Service Fact Sheet. 2 p.*
- *MN Extension re-did its website, took down all content, and began installing new content in its revised format. We are working with Phyllis Bongard to re-install and update the corn insect section, including corn rootworm, in this revised format.*
- *A MN Crop News blog also highlighted the survey project, solicited participants and credited the corn checkoff support through MCR&PC (Quarter 1). Ostlie, K. and B. Potter. 2019. Whats your risk from the corn rootworms? Assess it by scouting and join the MN rootworm survey project. Minnesota Crop News – June 19.*

Ib i) Conduct a statewide fall survey for overwintering larval corn borer populations to estimate annual geographic populations and project following year's risk. (Hutchison)

- *Potter, B, B. Hutchison and D. Malvick. 2019. Assistance with 2019 European corn borer and corn disease survey requested – Sept. 09. <https://blog-crop-news.extension.umn.edu/2019/09/assistance-with-2019-european-corn.html>.*

iv. Ib iii) Conduct a statewide survey for corn diseases to determine annual prevalence of key species. (Malvick)

- *Malvick, D. 2019. Tar spot of corn found for the first time in Minnesota Crop News - Oct.1. <https://blog-crop-news.extension.umn.edu/2019/10/tar-spot-of-corn-found-for-first-time.html>*
- *Malvick, D. 2019. Update on tar spot of corn found for the first time in Minnesota Crop News -Oct.11. <https://blog-crop-news.extension.umn.edu/2019/10/update-on-tar-spot-of-corn-in-minnesota.html>*

## Appendix I.

PRELIMINARY

Table 1. Statewide data for ECB larvae in field corn, Minnesota 2017-19

Year	Random Fields	Known Non Bt Fields only
	Mean #ECB larvae/plant (n)	Mean #ECB larvae/plant (n)
2017	0.0054 (149)	0.0288 (52)
2018	0.0080 (137)	0.0386 (70)
2019	0.0039 (152)	0.0865 (96)

Table 2. Northwest crop reporting district data for ECB larvae in field corn, Minnesota 2017-19

Year	Random Fields	Known Non Bt Fields only
	Mean #ECB larvae/plant (n)	Mean #ECB larvae/plant (n)
2017	0.0167 (18)	0.0727 (11)
2018	0.0000 (15)	0.0840 (25)
2019	0.0060 (18)	0.1460 (37)

Table 3. West Central crop reporting district data for ECB larvae in field corn, Minnesota 2017-19

Year	Random Fields	Known Non Bt Fields only
	Mean #ECB larvae/plant (n)	Mean #ECB larvae/plant (n)
2017	0.0000 (24)	0.0857 (7)
2018	0.0000 (20)	0.0091 (11)
2019	0.0042 (24)	0.0111 (9)

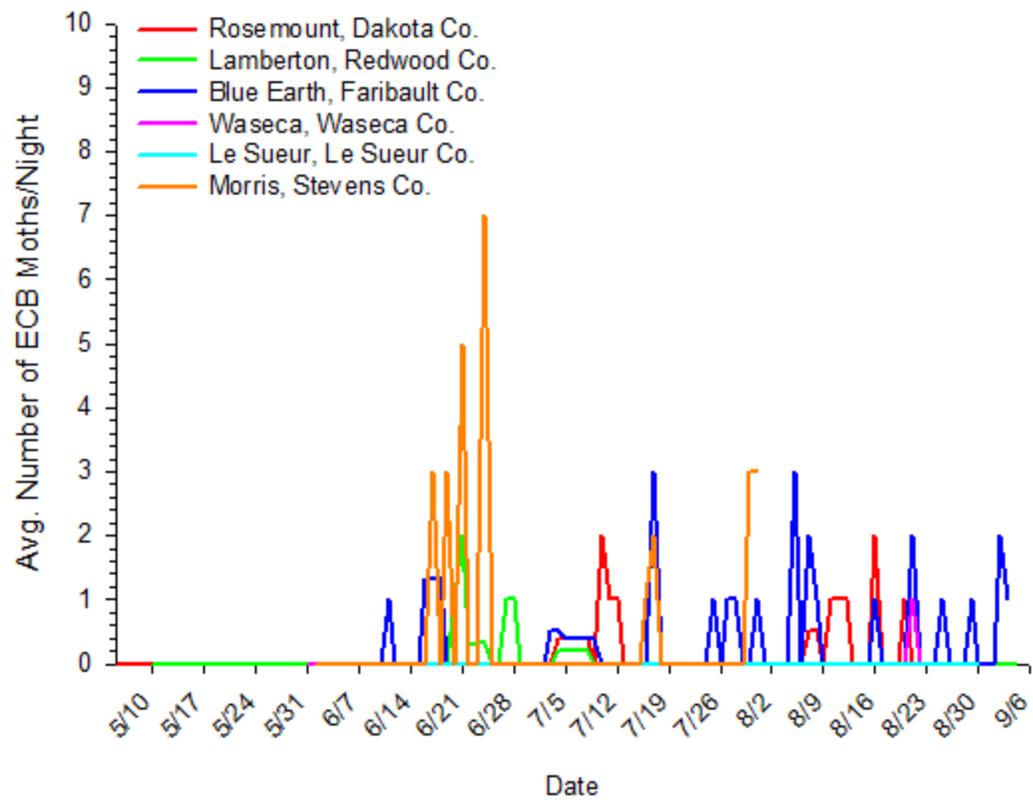
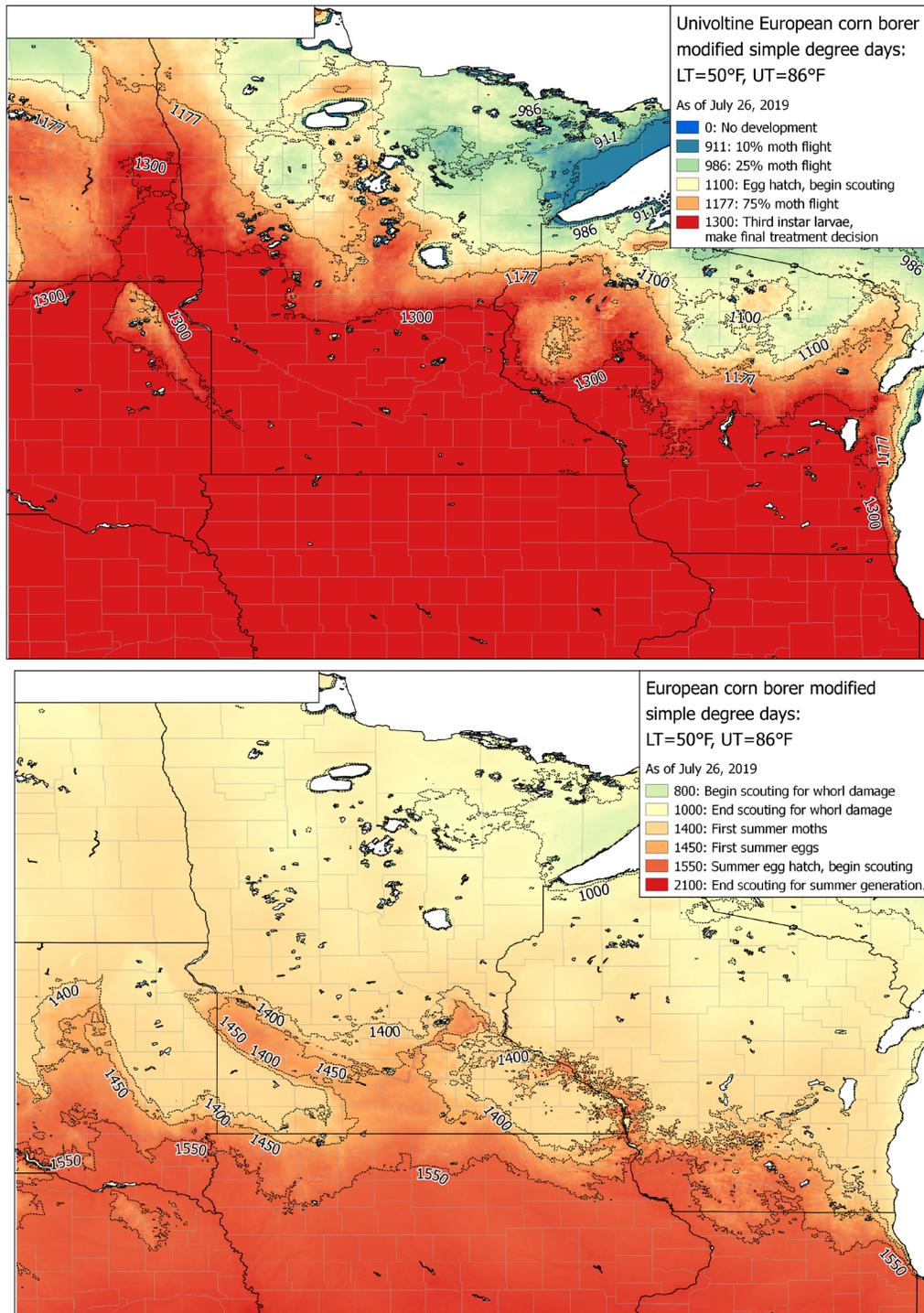
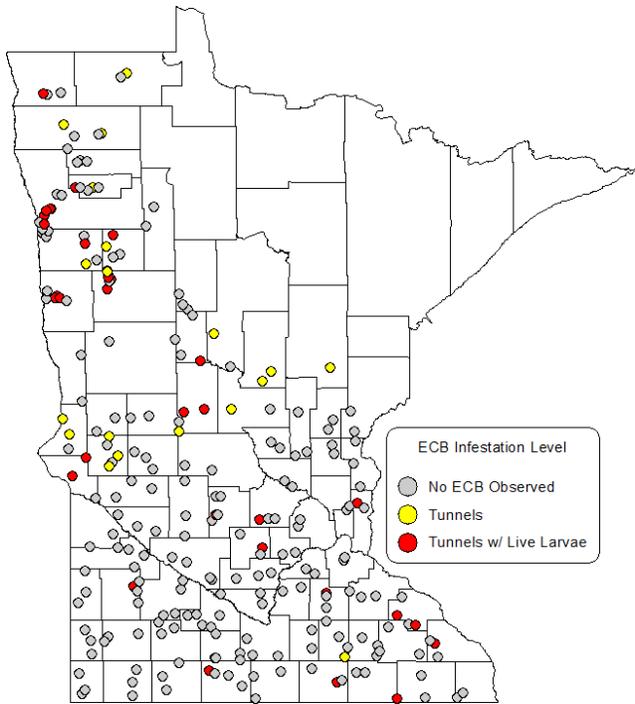


Figure 1. 2019 ECB moth captures by trap site.

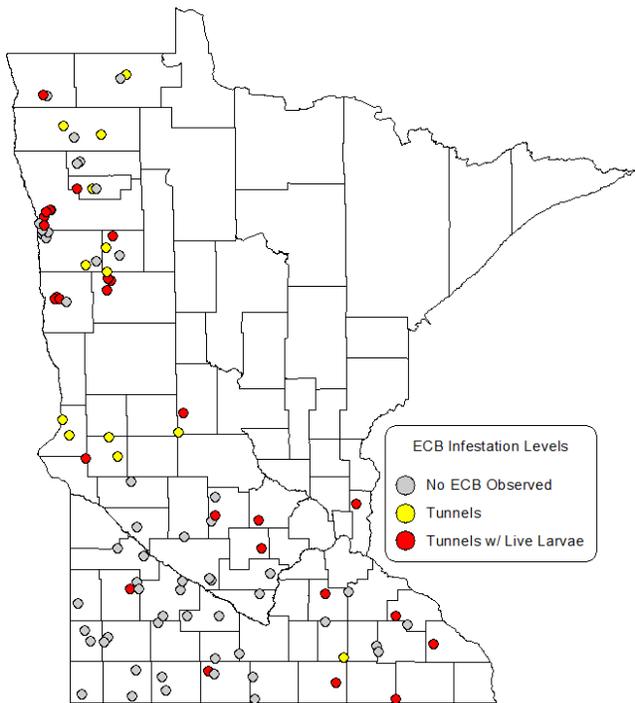


*Figure 2. Example ECB development based on degree-day accumulations.*

*Source A. Hansen , U of MN VegEdge*



*Figure 3. 2019 locations of fields surveyed for overwintering ECB larval populations\*.*

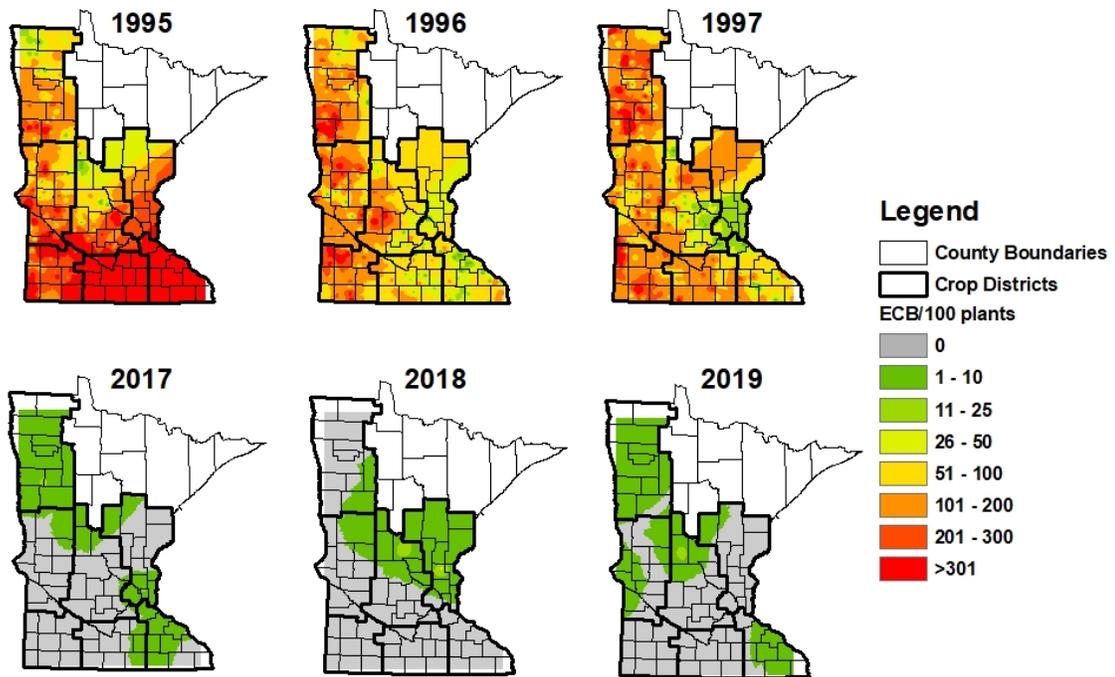


*Figure 4.*

*Figure 4. 2019 locations of fields surveyed for overwintering ECB larval populations\* and known to be planted to a non-Bt hybrid.*

*\*based on examining 10 plants /field and dissecting two with symptoms..*

## European Corn Borer populations (data interpolation) based on fall stalk dissections of MN field corn



\*European corn borer data collected and summarized by Minn. Dept. of Agriculture and Univ. of Minnesota staff.  
\*Copyright, University of Minnesota.

*Figure 5. Comparison of overwintering European corn borer populations before (1995-1997) and after (2017) adoption of Bt in Minnesota field corn.*

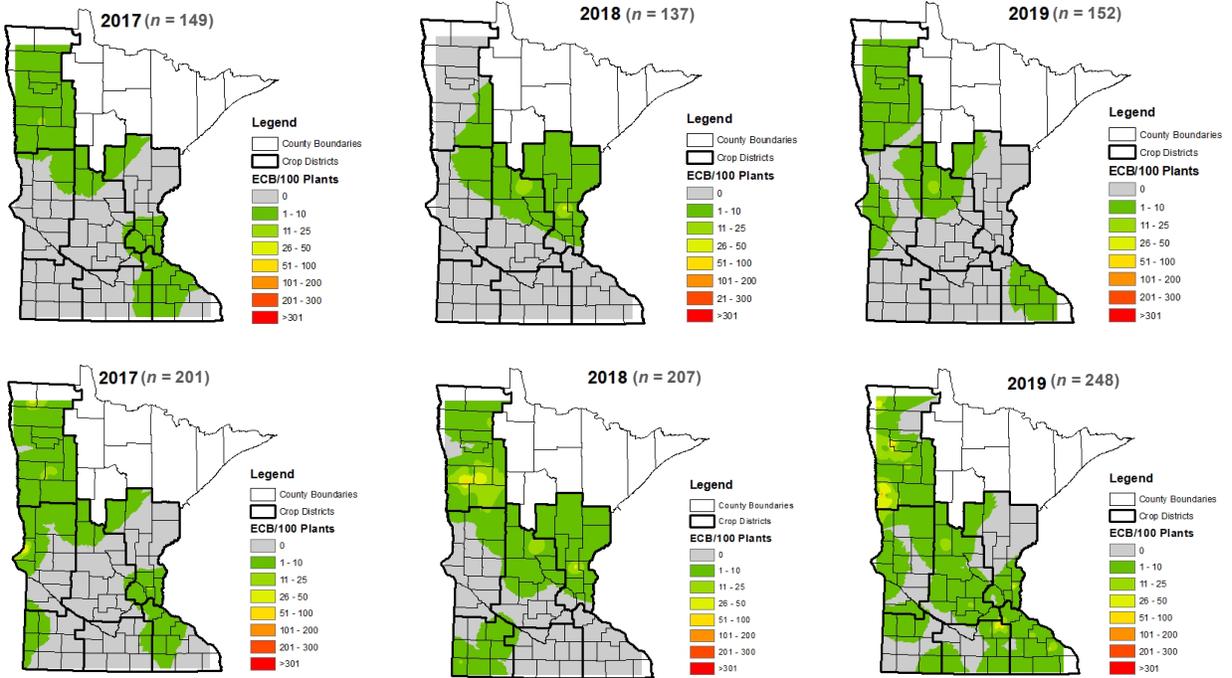


Figure 6. ECB populations in randomly selected fields (top row) and random + known non-Bt fields combined (lower row): MN.

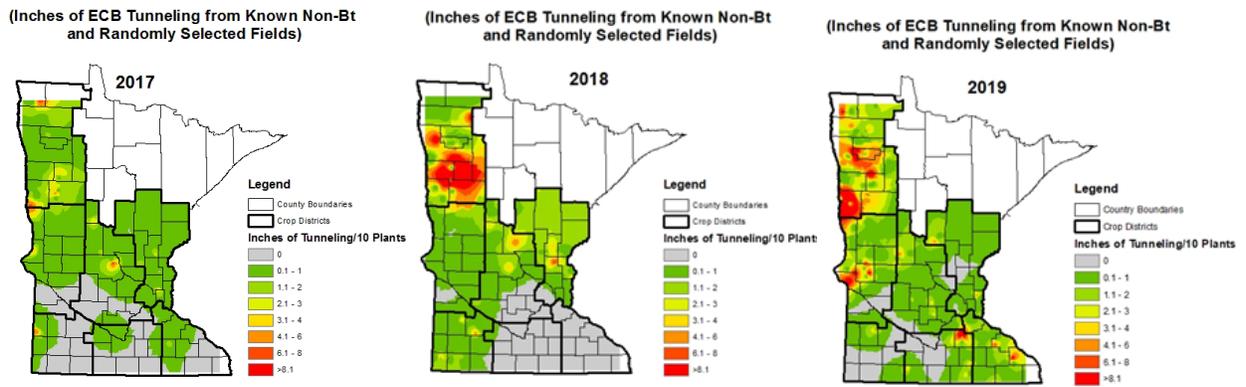
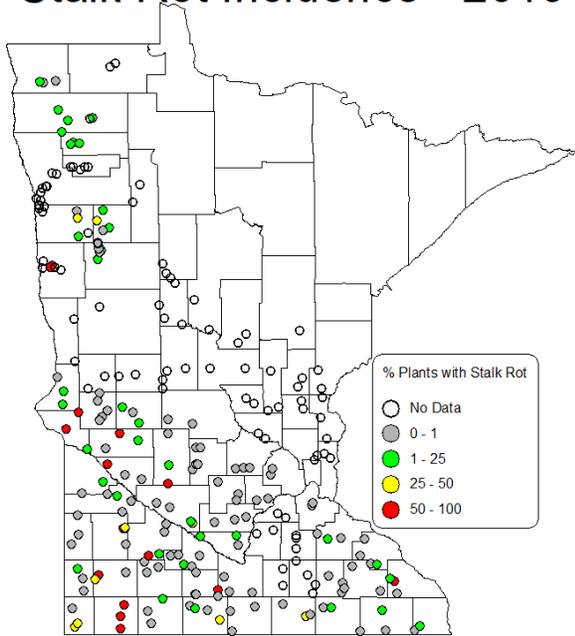


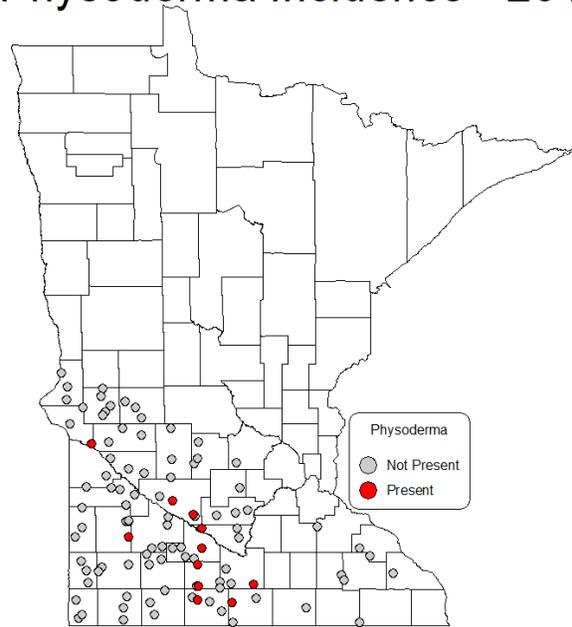
Figure 7. Changes in ECB damage (tunneling) in randomly selected and known non-Bt fields.

## Stalk Rot Incidence - 2019



*Figure 8. Incidence of corn stalk rots (push test) during 2019 fall survey.*

## Physoderma Incidence - 2019



*Figure 9. Detection of *Physoderma* during 2019 fall survey. This survey was limited in geographic scope.*



*Figure 10. MN Counties with 2019 confirmed tar spot infections.*