Efficacy of exclusion tactics to control thrips and MCMV in maize

By
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Background
- Family farm near Plainview, IL
  - Corn, soy, wheat, forage crops, cattle

Education
- Eastern Illinois University
  - B.S. Biological Science

Personal life
- Wife Tamra of 5 years
  - Engineer in oil & gas industry
  - Expecting our first child in July
- Things I don’t get to do enough:
  - Hiking, canoeing, hunting, fishing, camping, traveling, and farming

Career
- Seed industry – Monsanto
Hawaii Seed Industry

- Continuous year long growing conditions
- Plant breeding, counter season hybrid nursery, and parent lines increases
- Seed industry presence on Kauai, Oahu, Molokai, Maui
- Pioneer, BASF, Dow, Monsanto, Syngenta
- Seed corn is highest value crop in Hawaii
- Valued at $146.3 million, 2500+ jobs statewide
- Domestic seed movement efficiency, subject to USDA, EPA regulation
A beautiful day in Kihei in 2011...

“This looks like MCMV”

- Tissue samples quickly confirmed via ELISA (Enzyme-linked immunosorbent assay)
- Numerous emergency containment measures put in place, none successful

Fast forward 18 months and nurseries are being plowed in with no expected seed return
**Maize Chlorotic Mottle Virus**

**MCMV symptoms**

- **Leaf mosaic** - Fine, chlorotic, longitudinal streaks, parallel to leaf veins, apparent 10 days after inoculation
- **Leaf chlorosis/necrosis** - Streaks can coalesce, followed by leaf necrosis, and plant death
- **Stunting** - Shortened internode length and stem diameter
- **Ear malformation** - Short ears, partially filled, prematurely aged husks
- **Tassel malformation** - Short prematurely aged tassels

**Synergistic disease**

**MCMV + MDMV = CLN**

Maize chlorotic mottle virus + maize dwarf mosaic virus = corn lethal necrosis

- **Symptoms** - Accelerated tissue aging, necrosis spreading from leaf margins, reduced seed set, plant death
- Insignificant row crop pest in most regions
- Only confirmed arthropod vector of MCMV in Hawaii
- Tiny at ~2 mm but visible with naked eye
- Generation time 7-13 days
- Effective virus transmission after 3 hours exposure
- Vector for 6 days after exposure ceases

Corn Thrips
*(Frankliniella williamsi* Hood)
IPM for Thrips

**Chemical control**
- Neonicotinoid seed treatments
  - Imidacloprid, clothianidin (Poncho 1250) most effective
- Limited spray chemistries
  - Spinosad (Radiant SC) most effective
  - Frequent applications required
    - 1-3 sprays weekly
  - Pest-pesticide contact difficult to achieve
    - Burrowed in whorl

**Cultural practices**
- Fallow periods
- Forced break in host availability
- Spatial isolation
- Limit green bridge effect
What about exclusion...

- Fine diameter mesh screen effective in greenhouses and vegetable row cages

- The two experiments that follow were conducted to test No-Thrips screen in a field setting in corn
Materials & Methods

- **No-Thrips screen**
  - Purchased through Hummerts International
    - 4500 Earth City Expressway, Earth City, MO 63045
  - 11.5 ft x 100 ft section ordered for trial purposes

- **Specifications**
  - UV stabilized monofilament
  - 150 micron diameter mesh
    - Thrips stated to be ~192 micron
  - 0.15mm thread thickness

- **Cage structures**
  - Screen cut into treatment sections
    - Four 25 ft x 11.5 ft sections
  - Screens cut again for second trial
  - Supported with 24” rebar arches
  - Attached to ground with 4” landscape fabric pins
Net Experiment 1 - Setup

Parameters

- 2 Net treatments
- 2 Inbred corn lines
- Treatments and inbreds randomized
- 2 replications
- Plot = 2 rows x 18 feet
- 36 seeds planted per row
- Seed treated with Poncho 1250
- Net cover applied at 2 days after planting
- Followed standard early season IPM practices
- Net removed 23 days after planting
Net Experiment 1 – Data Collection

**Observations**

**Stand**
- Emerged seedlings counted at net removal
- Used to normalize MCMV observations

**MCMV**
- Visual assessment of presence or absence of symptoms
- Used with stand count to arrive at percent MCMV symptomatic per plot

**Thrips**
- Half emerged plants sampled for thrips via whorl dissection
- Destructive sampling method, thrips counted as leaves pulled apart
- Used with number of samples to arrive at average thrips per plant on plot basis
Parameters

- 2 Net treatments
- 4 Inbred corn lines
- Treatments and inbreds randomized
- 2 replications
- Plot = 2 rows x 10 feet
- 26 seeds planted per row
- Seed treated with Poncho 1250
- Net cover applied at 2 days after planting
- Followed standard early season IPM practices
- Net removed 26 days after planting
# Net Experiment 2 – Data Collection

## Observations

| **Stand** | • Emerged seedlings counted at net removal
|           | • Used to normalize other observations |
| **MCMV**  | • ELISA analysis for virus presence, positive or negative
|           | • Non-destructive plant tissue sample, all plants sampled
|           | • Used with stand count to arrive at percent MCMV positive per plot |
| **Thrips** | • Half emerged plants sampled for thrips via whorl dissection
|           | • Destructive sampling method, thrips counted as leaves pulled apart
|           | • Used with number of samples to arrive at average thrips per plant on plot basis |
Hypotheses Tested - Thrips

Net Treatment

- \( H_0 \): Row cover with No-Thrips netting will have no significant effect on plot average number of thrips per plant at time of net removal.
- \( H_A \): Row cover with No-Thrips netting will have significant effect on plot average number of thrips per plant at time of net removal.

Inbred

- \( H_0 \): Inbred line will have no significant effect on plot average number of thrips per plant at time of net removal.
- \( H_A \): Inbred line will have significant effect on plot average number of thrips per plant at time of net removal.
Thrips Exclusion – Net Experiment 1

Results

- Higher average thrips per plant observed in uncovered plots in both inbreds
- No interaction between inbred and net treatment expected

- One-way ANOVA performed across inbreds
- Results significant; p<0.0355
- Fit with expectations, and aligned with manufacturers exclusion claims

- Reject $H_0$, accept $H_A$
- Row cover with No-Thrips netting has significant effect on plot average number of thrips per plant
Thrips Exclusion – Net Experiment 2

Results

- Higher average thrips per plant observed in uncovered plots in all inbreds.
- Again no interaction between inbred and net treatment expected.

One-way ANOVA performed across inbreds

- Results significant; p<0.0001

Reject $H_0$, accept $H_A$

- Row cover with No-Thrips netting has significant effect on plot average number of thrips per plant.

Dramatic increase in thrips pressure compared to Net Exp 1

- Position relative to neighbor nursery, younger green bridge.
- Missed IPM sprays due to rain.
Thrips Exclusion – Inbred Treatment

Results

- No significant difference observed in plot average thrips per plant between inbreds
- One-way ANOVA performed across net treatments
  - Net Exp 1; $p = 0.7645$
  - Net Exp 2; $p = 0.9272$

- Fail to reject $H_0$
  - Inbred line has no significant effect on plot average number of thrips per plant

- Results fit expectations
Hypotheses Tested - MCMV

**Net Treatment**

- $H_0$: Row cover with No-Thrips netting will **have no** significant effect on number of MCMV symptomatic plants per plot at time of net removal.
- $H_A$: Row cover with No-Thrips netting will **have** significant effect on number of MCMV symptomatic plants per plot at time of net removal.

**Inbred**

- $H_0$: Inbred line will **have no** significant effect on number of MCMV symptomatic plants per plot at time of net removal.
- $H_A$: Inbred line will **have** significant effect on number of MCMV symptomatic plants per plot at time of net removal.
MCMV Avoidance – Net Experiment 1

Results

- Higher percent MCMV observed in uncovered plots in both inbreds
- Inbred B showed higher MCMV in covered plots than expected
- No interaction between inbred and net treatment expected

One-way ANOVA performed across inbreds
- Difference not significant; p<0.0817

Potential explanations:
- Outlier effect amplified by small number of plots compared
- Mis-identification of symptoms resulting in false positives
- Incomplete or interrupted seal could have resulted in partial exposure during the test

Methodology for Net Experiment 2 adjusted in response to findings
Results

Greater percent MCMV per plot observed in uncovered plots across all inbred

No interaction between inbred and net treatment expected

One-way ANOVA performed

Results significant; p<0.0001

Reject $H_0$, accept $H_A$

Row cover with No-Thrips netting has significant effect on number of MCMV symptomatic plants per plot

Improved sampling methodology

More sophisticated detection method – ELISA

Eliminated human error in symptom mis-identification
Results

- No significant difference observed in percent MCMV between inbreds
- One-way ANOVA performed across net treatments
  - Net Exp 1; p = 0.1349
  - Net Exp 2; p = 0.9061

Fail to reject H₀

- Inbred line has no significant effect on number of MCMV symptomatic plants per plot

Results fit expectations
Conclusion

Thrips exclusion is possible using No-Thrips net material

MCMV avoidance is possible using No-Thrips net material

Inbred did not factor significantly in thrips exclusion or MCMV avoidance

- Even brief disruptions in net ground seal may have lead to outliers
- Net treatment provided shade and wind protection during early development
  - Vulnerability to wind damage when net removed
- Protection conferred ceases at net removal
  - Later infection serves as increased viral load in overall nursery system
  - Later infection serves to impact seed movement regardless of yield impact
Overall eradication of MCMV in Hawaii is unlikely

Netting materials and labor costs limit scalability
  Sound cultural and chemical control practices will continue to be necessary to protect nursery operations on large scale

In high pressure settings protection of critical material on a small scale could be possible via full season containment screenhouses
  High value generations in plant breeding process
  Important component of two step quarantine to secure seed movement between Hawaii and other geographies


Questions?