# Seed Treatments

Agronomics and Environmental Impacts

Matt O’Neal

# Key studies on neonic seed treatments

- "What's on your seed?" 2022. Grint and Smith.
  - https://ipcm.wisc.edu/wp-content/uploads/sites/54/2022/11/Whats_on_your_seed_web.pdf
- "Probability of cost-effective management of soybean aphid in North America" 2009. Johnson et al.
  - https://doi.org/10.1603/029.102.0613
- "High-Input Management Systems Effect on Soybean Seed Yield, Yield Components, and Economic Break-Even Probabilities" 2016. Orlowski et al.
  - https://acsess.onlinelibrary.wiley.com/doi/full/10.2135/cropsci2015.10.0620
- "A Machine learning interpretation of the contribution of foliar fungicides to soybean yield in the north-central US. 2021. Shah et al.
  - https://doi.org/10.1038/s41598-021-98230-2
- "Iowa State University Report of Insecticide" Hodgson et al. 2020.
  - https://store.extension.iastate.edu/product/16055
- "Beyond the Headlines: The influence of insurance pest management on an unseen silent entomological majority." 2020. Krupke and Tooker. https://doi.org/10.3389/fsufs.2020.595855
- "Quantifying neonicotinoid insecticide residues in milkweed and other forbs sampled from prairie strips established in maize and soybean fields. 2022. Hall et al.
  - https://doi.org/10.1016/j.agee.2021.107723

# “What’s on your seed?”

https://ipcm.wisc.edu/wp-content/uploads/sites/54/2022/11/Whats_on_your_seed_web.pdf

- 133 product trade names across 4 treatment types:
  - Fungicides
  - Insecticides
  - Nematicides
  - Plant Growth Regulators

# “Probability of cost-effective management of soybean aphid in North America”

2009. Johnson et al.

https://doi.org/10.1603/029.102.0613

# 4 methods compared in 3 states over 3 years*

1. untreated **control** = no insecticides.
2. **Prophylactic** = insecticide & fungicide applied to foliage when soybeans flower.
3. **Seed-treatment** = Cruiser only.
4. **IPM** approach = fields scouted and insecticide applied as needed.

*Johnson et al. 2009. Journal of Economic Entomology 102: 2101-2108.

# Not all insecticide use pays off. gain threshold = break even point

**Table 6. Probability of yield gain from treatments exceeding the gain threshold at four soybean prices**

| Scouting cost | Treatment | Probability by soybean price per 27.2 kg[a] | | | |
|---|---|---|---|---|---|
| | | $6.00 | $8.00 | $10.00 | $12.00 |
| $0.00 per ha | IPM | 0.81 | 0.83 | 0.84 | 0.85 |
| $19.76 per ha | IPM | 0.69 | 0.74 | 0.77 | 0.79 |
| NA | Prophylactic | 0.51 | 0.63 | 0.70 | 0.74 |
| NA | Seed-treatment | 0.43 | 0.47 | 0.50 | 0.51 |

[a] 27.2 kg = 1 US bushel.

*Johnson et al. 2009. Journal of Economic Entomology 102: 2101-2108.

# “High-Input Management Systems Effect on Soybean Seed Yield, Yield Components, and Economic Break-Even Probabilities”

2016. Orlowski et al.

https://acsess.onlinelibrary.wiley.com/doi/full/10.2135/cropsci2015.10.0620

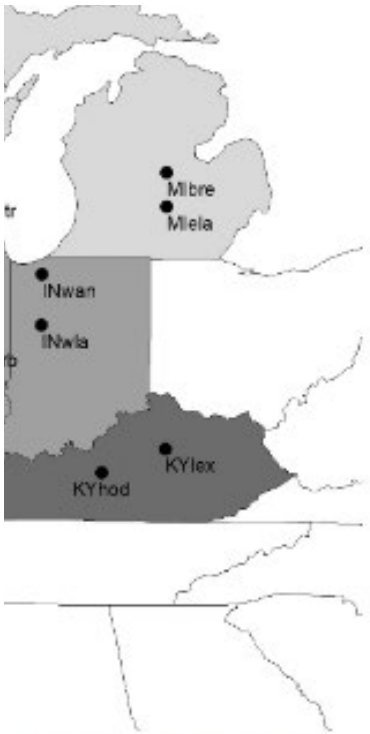
# “In each site-year both individual inputs and combination high-input (SOYA) management systems were tested.”*

**Table 3. Additional marginal costs for inputs over the standard practice for experiments in 2012, 2013, and 2014.**

| Input† | Additional cost, $ ha$^{-1}$‡ | |
|---|---|---|
| | 2012 | 2013, 2014 |
| Fungicide ST | 21.61 | 21.61 |
| Fungicide+Insecticide ST | 52.49 | 52.49 |
| Max ST | 59.90 | 59.90 |
| Defoliant | 44.73 | 44.73 |
| Nitrogen | 109.22 | 109.22 |
| Foliar fertilizer | 46.93 | 46.93 |
| N,N'-diformyl urea | 51.38 | 51.38 |
| Foliar Fungicide | 63.92 | 96.08 |
| Foliar Insecticide | 29.66 | 34.06 |
| Foliar Fungicide+Insecticide | 73.83 | 110.38 |
| SOYA | 341.26 | 377.81 |
| SOYA+D | 385.99 | 422.54 |
| SOYA-N | 232.03 | 268.59 |
| SOYA-FF | 277.33 | 281.73 |
| SOYA-FF and FI | 267.43 | 267.43 |

† ST, seed treatment; D, defoliant; F, foliar fertilizer; FF, foliar fungicide; FI, foliar insecticide; SOYA, combination high-yield management.

‡ Costs differ between 2012 and 2013, 2014 due to the use of different input products.




considered the South region, while states
sidered the North region.

*Orlowski et al. 2016

# A single application of an insecticide paid for itself 37%-93% of the time, fungicide-insecticide seed treatment did 0-29%.

Table 8. Relative yield change and break-even probabilities for inputs compared to the standard practice at multiple yield levels and soybean sale prices across all environments between 2012 and 2014.

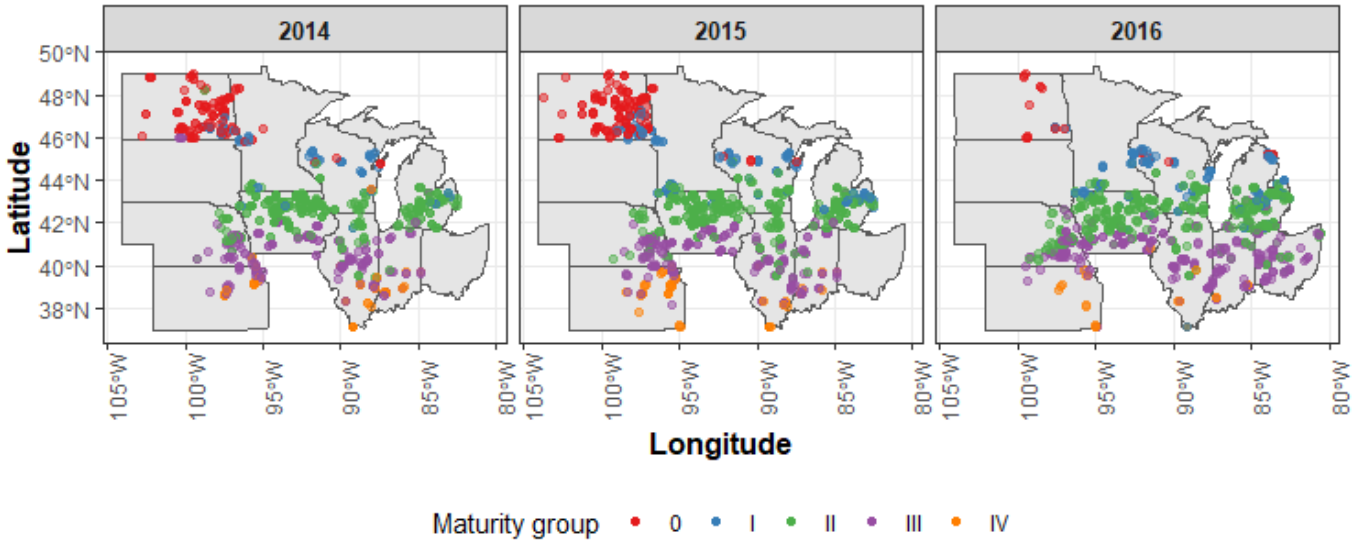
| | | Yield level, Mg ha$^{-1}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.0 | | | 4.0 | | | 5.0 | | |
| | | Soybean sale price, $ kg$^{-1}$ | | | | | | | | |
| Input† | RYC‡ | 0.33 | 0.44 | 0.55 | 0.33 | 0.44 | 0.55 | 0.33 | 0.44 | 0.55 |
| | % | % probability of break-even | | | | | | | | |
| Fungicide ST | −0.2 | 5 | 11 | 17 | 11 | 18 | 24 | 17 | 24 | 29 |
| Fungicide+Insecticide ST | 0.5 | 0 | 0 | 1 | 0 | 2 | 5 | 1 | 5 | 10 |
| Max ST | 1.7 | 0 | 2 | 11 | 2 | 15 | 31 | 11 | 31 | 48 |
| Foliar fertilizer | 0.7 | 0 | 2 | 6 | 2 | 8 | 17 | 6 | 17 | 27 |
| Defoliant | −2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Nitrogen | 1.7 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 7 |
| N,N'-diformyl urea | 0.5 | 0 | 0 | 2 | 0 | 3 | 8 | 2 | 8 | 15 |
| Foliar fungicide | 2.5 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 5 | 17 |
| Foliar insecticide | 2.7 | 37 | 64 | 78 | 64 | 81 | 88 | 78 | 88 | 93 |
| Foliar fungicide+Insecticide | 4.9 | 0 | 1 | 13 | 1 | 21 | 59 | 13 | 59 | 85 |
| SOYA | 1.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOYA+D | 4.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOYA-N | 5.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOYA-FF | 5.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOYA-FF+FI | 3.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

† ST, seed treatment; FF, foliar fungicide; FI, foliar insecticide; D, defoliant; SOYA, combination high-yield management.

‡ RYC, relative yield change vs. standard practice.

# “A Machine learning interpretation of the contribution of foliar fungicides to soybean yield in the north-central US. 2021. Shah et al.

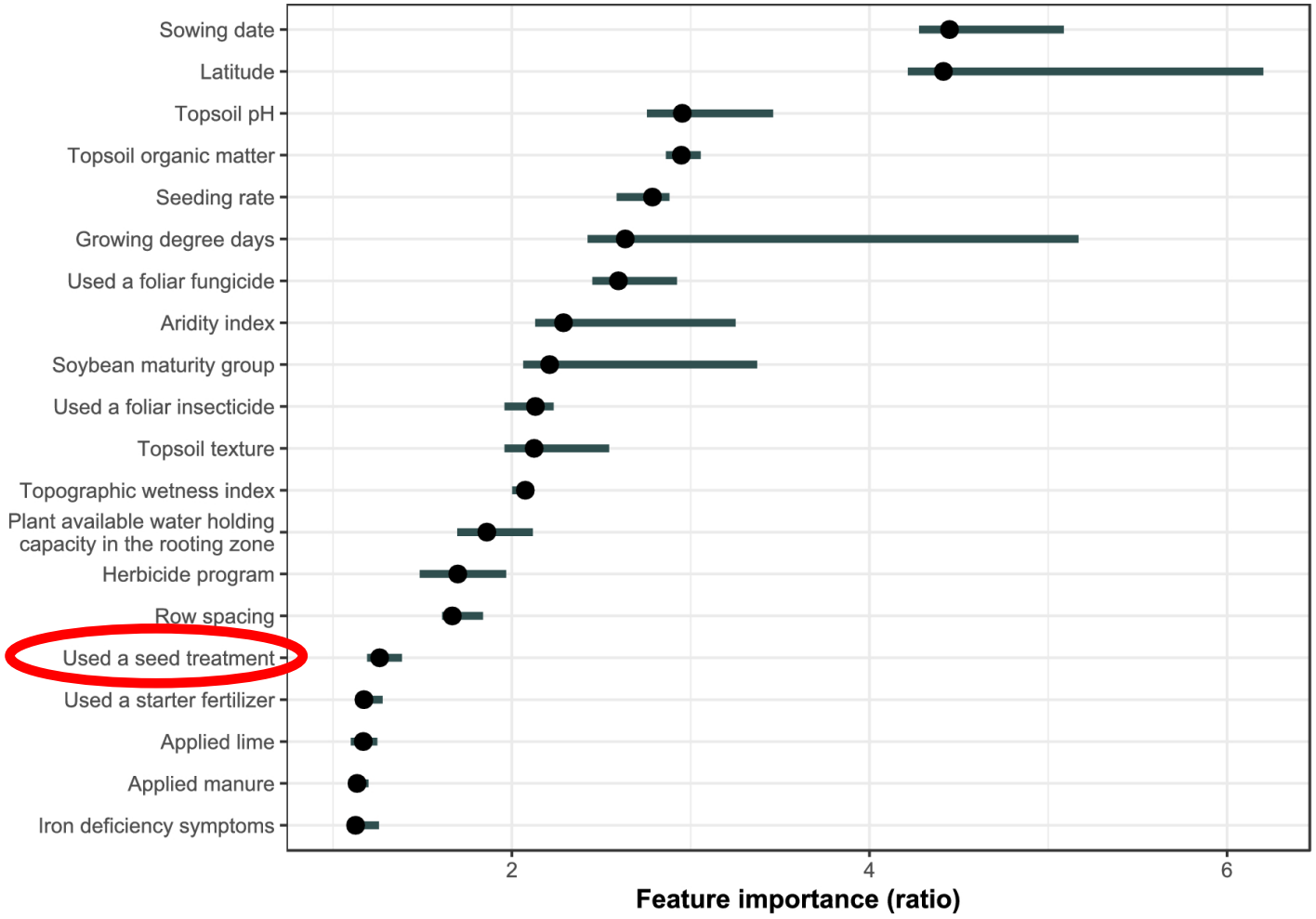
https://doi.org/10.1038/s41598-021-98230-2




Supplementary Figure S1. Locations of soybean fields for which surveyed growers supplied self-reported data on their management practices and yields, 2014 to 2016. Field locations are colored by soybean maturity group.

# “A Machine learning interpretation of the contribution of foliar fungicides to soybean yield in the north-central US. 2021. Shah et al.

**“Feature importance”** = how much does each factor help predict soybean yield.



# Insecticide evaluations continue…

IOWA STATE UNIVERSITY
Extension and Outreach

**2020**
**REPORT OF INSECTICIDE EVALUATION**

Department of Entomology
Ames, Iowa 50011-3140

Soybean Pest Investigated:

Soybean Aphid

Japanese Beetle

Soybean Gall Midge

Project Leader:
Erin Hodgson

Project Co-Leaders:
Greg VanNostrand
Ashley Dean
Mitchell Helton

CROP 3198 15 November 2020

https://store.extension.iastate.edu/product/16055

Seed treatment only

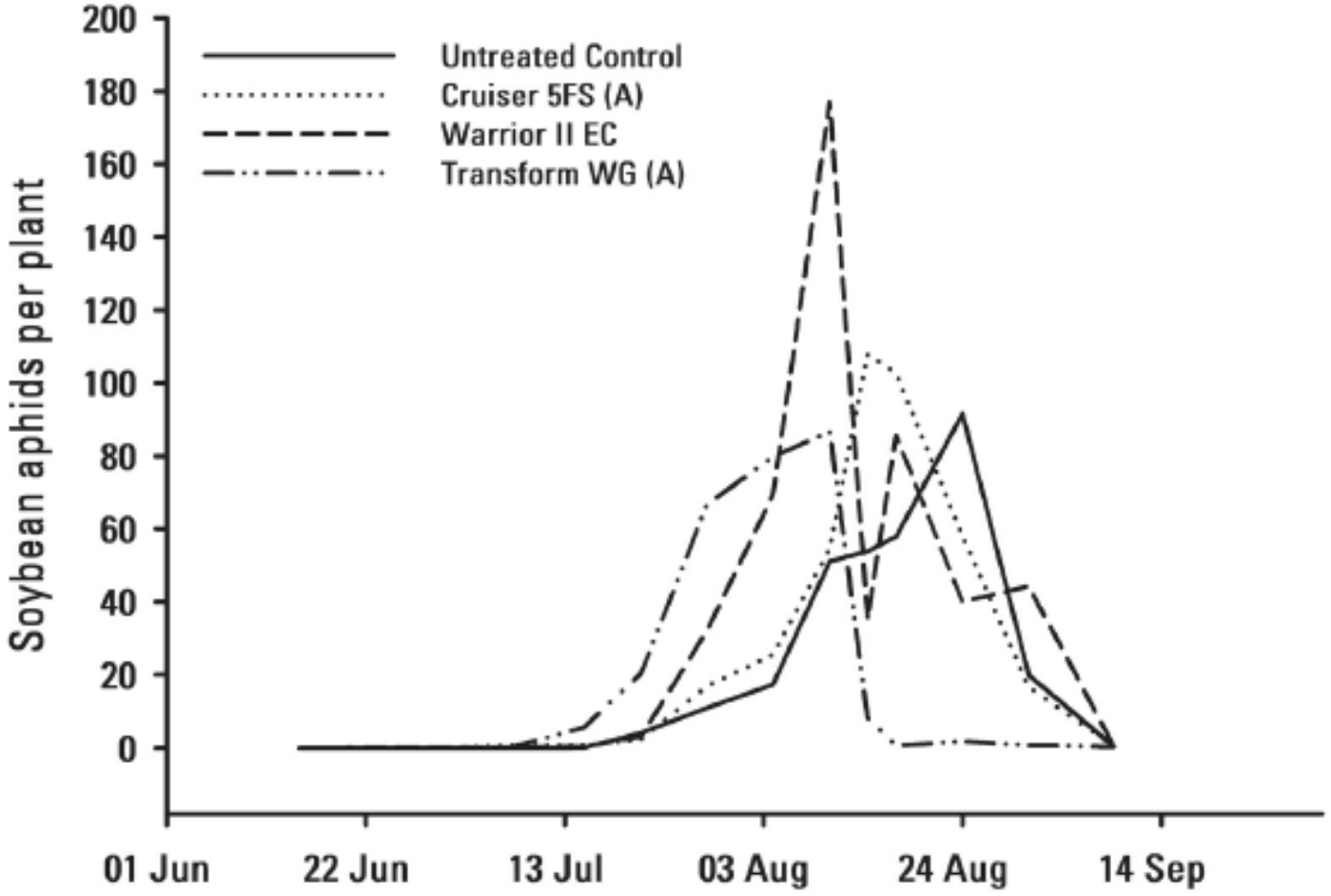
Seed treatment AND foliar-applied insecticide

## Table 1. List of treatments and rates for soybean aphid at the Northwest Research Farm in 2020

| | Treatment and Formulation | Group[a] | Active Ingredient(s)[b] | Rate[c] | Timing |
|---|---|---|---|---|---|
| | 1. Untreated Control | — | — | — | — |
| | 2. Warrior II CS | 3A | lambda-cyhalothrin | 1.92 fl oz | 11 Aug |
| | 3. Sniper EC | 3A | bifenthrin | 4.0 fl oz | 11 Aug |
| X | 4. Cruiser 5FS (A) | 4A | thiamethoxam (ST) | 0.0756 mg ai/seed | — |
| X | 5. Cruiser 5FS (B) | 4A | thiamethoxam (ST) | 0.1512 mg ai/seed | — |
| | 6. Transform WG (A) | 4C | sulfoxaflor | 0.66 oz | 11 Aug |
| | 7. Transform WG (B) | 4C | sulfoxaflor | 0.794 oz | 11 Aug |
| | 8. Pyrifluquinazon SC (A) | 9B | pyrifluquinazon | 0.8 fl oz | 11 Aug |
| | 9. Pyrifluquinazon SC (B) | 9B | pyrifluquinazon | 1.2 fl oz | 11 Aug |
| | 10. Pyrifluquinazon SC (C) | 9B | pyrifluquinazon | 1.6 fl oz | 11 Aug |
| | 11. Sefina DC | 9D | afidopyropen | 3.0 fl oz | 11 Aug |
| X | 12. Cruiser 5FS and Warrior II CS (A) | 4A<br>3A | thiamethoxam (ST) lambda-cyhalothrin | 0.0756 mg ai/seed<br>1.92 fl oz | —<br>11 Aug |
| X | 13. Cruiser 5FS and Warrior II CS (B) | 4A<br>3A | thiamethoxam (ST)lambda-cyhalothrin | 0.1512 mg ai/seed<br>1.92 fl oz | —<br>11 Aug |
| X | 14. Leverage 360 SC | 4A + 3A | imidacloprid + beta-cyfluthrin | 2.8 fl oz | 11 Aug |
| X | 15. Endigo ZCX (A) | 3A + 4A | lambda-cyhalothrin + thiamethoxam | 3.5 fl oz | 11 Aug |
| X | 16. Endigo ZCX (B) | 3A + 4A | lambda-cyhalothrin + thiamethoxam | 4.5 fl oz | 11 Aug |
| X | 17. CruiserMaxx Vibrance + Saltro FS | 4A + 7[d] | thiamethoxam + pydiflumetofen (ST) | 0.1695 mg ai/seed | — |
| X | 18. CruiserMaxx Vibrance FS + Saltro FS and Warrior II CS | 4A + 7[d]<br>3A | thiamethoxam + pydiflumetofen (ST)<br>lambda-cyhalothrin | 0.1695 mg ai/seed<br>1.92 fl oz | —<br>11 Aug |

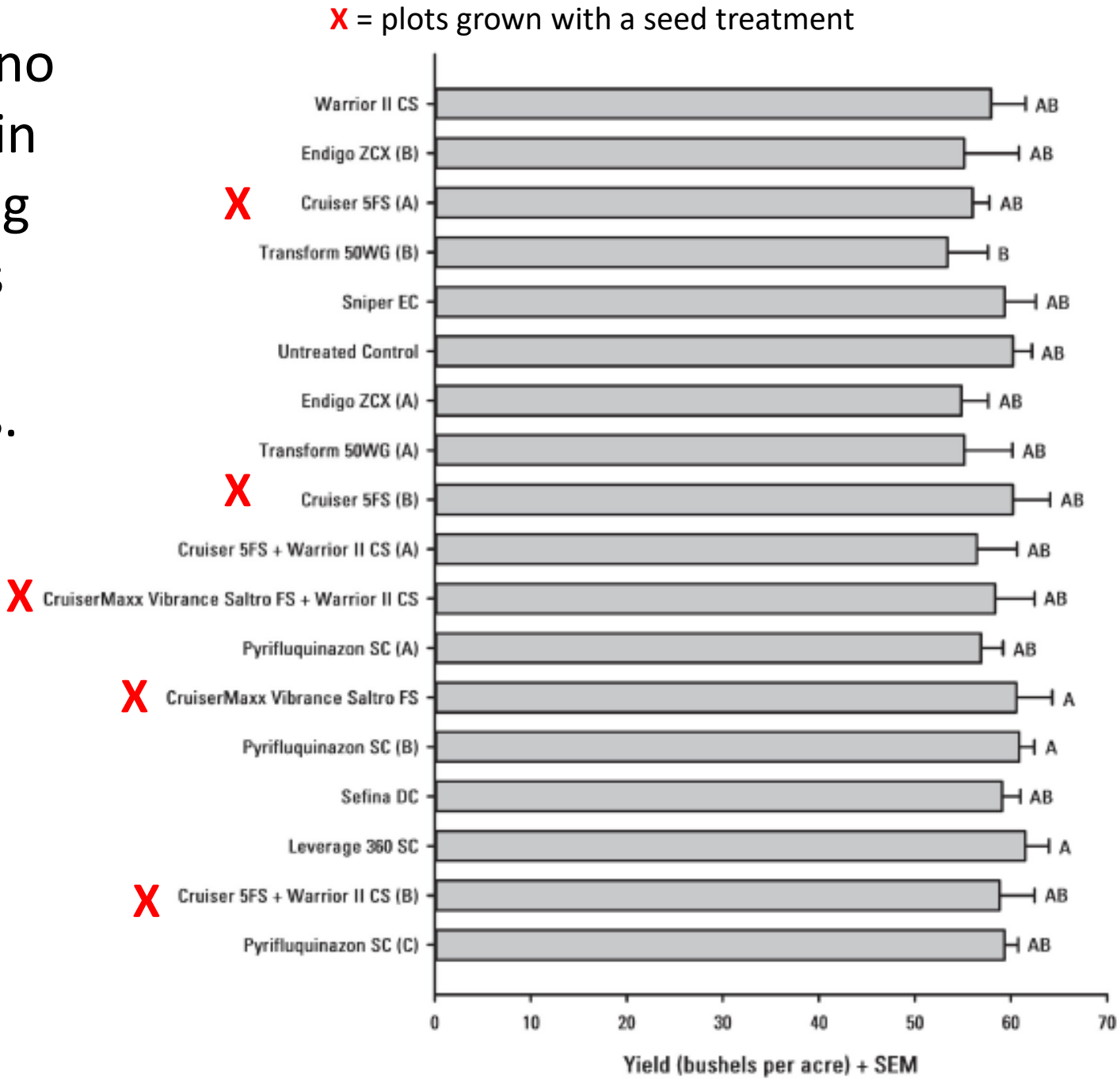
# Aphid populations low in 2020*.

**Figure 1. Mean number of aphids per plant in 2020 at the Northwest Research Farm.**

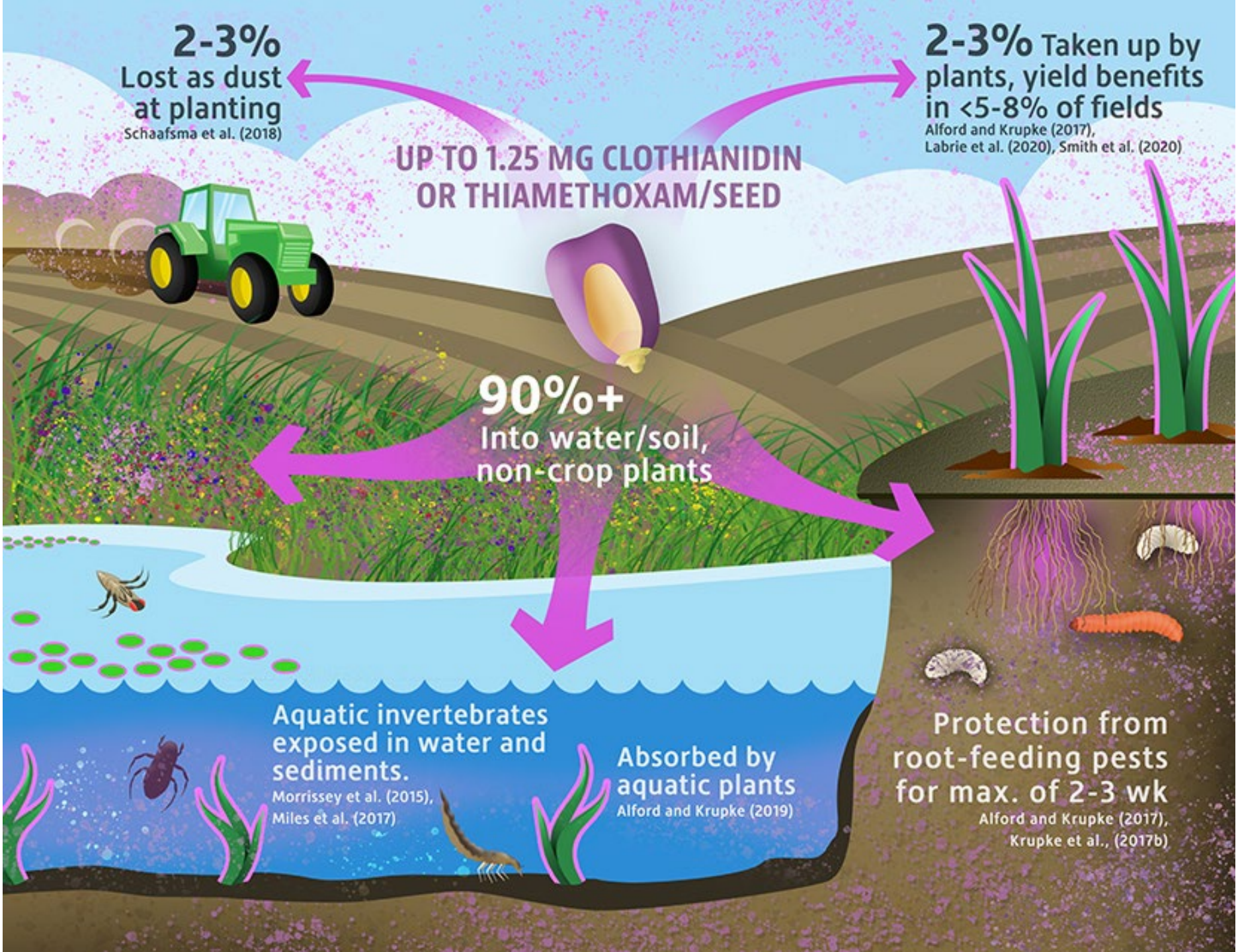



***and even lower in 2021 and 2022***

Limited to no difference in yield among the various insecticide treatments.



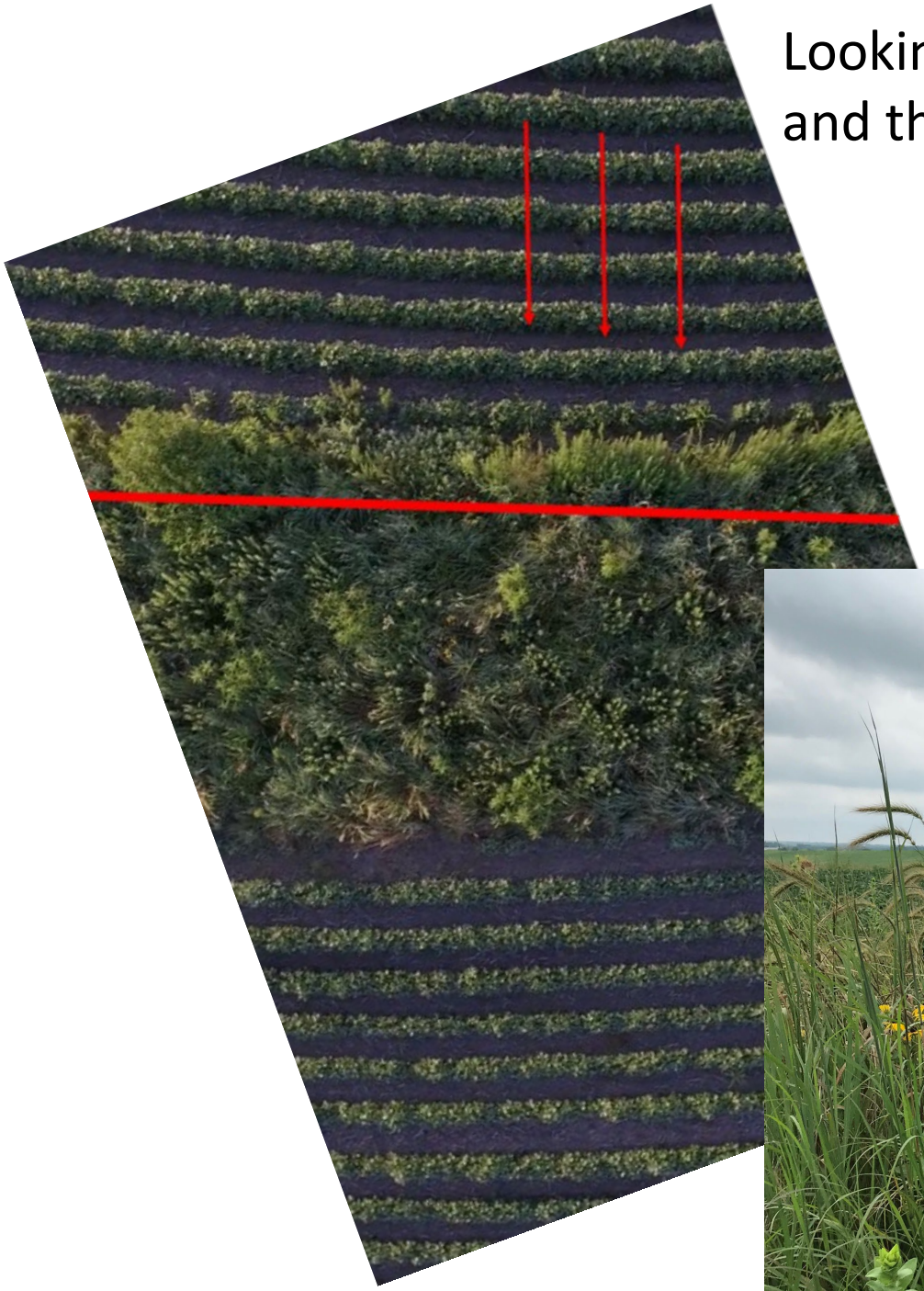
“Beyond the Headlines: The influence of insurance pest management on an unseen silent entomological majority.” 2020. Krupke and Tooker.
https://doi.org/10.3389/fsufs.2020.595855


2-3%
Lost as dust at planting
Schaafsma et al. (2018)
2-3% Taken up by plants, yield benefits in <5-8% of fields
Alford and Krupke (2017), Labrie et al. (2020), Smith et al. (2020)
UP TO 1.25 MG CLOTHIANIDIN OR THIAMETHOXAM/SEED
90%+
Into water/soil, non-crop plants
Aquatic invertebrates exposed in water and sediments.
Morrissey et al. (2015), Miles et al. (2017)
Absorbed by aquatic plants
Alford and Krupke (2019)
Protection from root-feeding pests for max. of 2-3 wk
Alford and Krupke (2017), Krupke et al., (2017b)

Agriculture, Ecosystems & Environment
Volume 325, 28 February 2022, 107723


# Quantifying neonicotinoid insecticide residues in milkweed and other forbs sampled from prairie strips established in maize and soybean fields

Maura J. Hall [a, b], Ge Zhang [a, 1], Matthew E. O'Neal [a], Steven P. Bradbury [a, b, c], Joel R. Coats [a, b]



Looking for  clothianidin, imidacloprid, and thiamethoxam in soil, leaf and bees.

| Location | % detects of neonicotinoids | Limits of quantification (ng/g) |
|---|---|---|
| Soil* | 100% | 0.07-0.9 |
| plant tissue* | 80% | 0.1-0.3 |
| Nectar** | 15.5% | 0.09-0.2 |
| Pollen** | 2.45% | 0.5 |
| Nurse worker bees** | 0.12% | 0.5-1 |

*Hall et al. 2022
**Hall et al. In preparation

# Conclusions from Hall et al.

- Neonics found in prairie strips, soil, plants, pollen and nectar. (Hall et al. 2022 and in prep)
- Frequency and concentrations declines from soil to nectar. (Hall et al. 2022 and in prep)
- Concentrations are orders of magnitude below the $LC_{10}$ for monarch larvae. (Hall et al. 2022)
- We observed no honey bee colony deaths in the 3 years of this study. (Zhang et al. in review)