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Agronomy News

The University of Maryland Extension Agriculture and Food Systems and Environment and Natural Resources Focus Teams proudly present this publication for commercial field crops and livestock industries.

Volume 8 Issue 7 "Special Research Edition" October 27, 2017

Evaluating Impacts of Neonicotinoid Seed Treatments on Pests, Beneficial Arthropods, and Yield in Grain Crop Rotations

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Overview:
Background: Neonicotinoid seed treatments (NSTs) are a popular and economical way of protecting many crops from insect pests. Neonicotinoids have low mammalian toxicity and seed treatments are considered low-risk for applicators and the environment. However, neonicotinoids may have negative impacts on beneficial insects such as predators and parasitoids. Additionally, they may only provide yield benefits in areas with high early season pest pressure.

Methods: In this study, we examined the impact of two NSTs, Cruiser® and Gaucho®, in a three-year crop rotation of full-season soybean, winter wheat, double cropped soybean and corn. We evaluated the effects of seed treatments on pest and beneficial insects, as well as effects on plant growth parameters and yield.

Results & Conclusions: Pest pressure was very low throughout the 3-year study. While Cruiser® and Gaucho® did reduce the abundance of some early season pests, beneficial insects were also reduced. Cruiser® and Gaucho® use in soybean, wheat, and corn did not significantly impact yield. NSTs are useful in fields with high early season pest pressure. However, where pest levels are often low, such as much of the mid-Atlantic, they may not be economically beneficial.

Background: NSTs are one of the most widely used methods for protecting various crops from insect pests. Neonicotinoids have low mammalian toxicity, and applying insecticides as seed treatments reduces applicator exposure and off-site drift of the active ingredient. NSTs are used to control soil and seedling pests and play an important role in grain crop production, as they are used on the majority of corn and about half the soybean grown in the U.S.[1] Their usage is also increasing in wheat. In the Mid-Atlantic, these grain crops are typically grown in a crop rotation.

Previous studies have shown that NSTs may improve yield under high pest pressure; however, they only provide protection against early season pests for the first 4-6 weeks after planting. If insect pest pressure is low, using NSTs may not improve yield compared to seeds that have not been treated with an insecticide. Because treatment decisions are made before target pest populations are known, NSTs provide the highest economic benefit in fields with a history of early season insect pest problems.

In addition to providing inconsistent benefits, NSTs can have negative impacts on beneficial insects, primarily pollinators and natural enemies.[2] Repeated use of neonicotinoids could also lead to the development of insecticide resistance. Therefore, we conducted a three-year study to better understand both the benefits and risks of using two neonicotinoid seed treatments, Cruiser® 5FS (thiamethoxam, Syngenta) and Gaucho® 600 Flowable (imidacloprid, Bayer) in a 3-year grain crop rotation of full-season soybean, winter wheat, double-cropped soybean and corn.

Objectives: To determine the impact of NSTs on 1) arthropod pests, 2) beneficial arthropods, and 3) plant growth and yield. By looking at a 3-year rotation, we are also evaluating potential cumulative effects of the repeated use of NSTs over multiple years in the same location.

Methods: The study was conducted at two sites in Maryland (Beltsville and Queenstown). At each site, we planted four replicate plots of each of the following treatments using standard Mid-Atlantic production practices:

1. Control (bare seed)
2. Fungicide (fungicide seed treatment)
3. Cruiser + Fungicide (insecticide + fungicide seed treatment)
4. Gaucho + Fungicide (insecticide + fungicide seed treatment)

Figure 1: Insect sampling through visual counts (top left), sticky cards (top right), pitfall traps (bottom left), and litter sampling (bottom right).

At each site, the abundance and diversity of invertebrate communities were measured throughout the season. Insects on the plants were measured through visual scouting, sweep-net samples and sticky cards, while soil-dwelling insects were sampled with pitfall traps and litter samples (Figure 1). This allowed us to measure both the pest and beneficial arthropods present in the field. To determine whether seed treatments increase yield, either by reducing pest damage or increasing plant growth and establishment, we measured yield and growth parameters such as stand density and plant height.

Results: 2015 & 2016

Insect abundance:

It is important to note that overall pest pressure was low during this study. All the pests mentioned for soybean, corn and wheat were present at numbers well below treatment thresholds.

In **full-season soybeans**, the most abundant arthropod pests observed during early season (V5 stage) visual scouting were plant thrips and leafhoppers, while the most abundant beneficial insects were predatory thrips and minute pirate bugs. Both Cruiser® and Gaucho® reduced the abundance of these pests and beneficials.

Double cropped soybean was visually scouted twice, at the V2-V3 and R1 stages. Plant thrips and predatory thrips were the most abundant insects. Cruiser® reduced plant thrips on both dates, and predatory thrips on the first date. Gaucho® did not impact the abundance of pest or beneficial thrips.

In **winter wheat**, we conducted visual counts twice in the winter and three times in the spring (Feekes stages 1, 2, 6, 10 and 11). Aphids were the most abundant pest; cereal leaf beetle was also present in the spring, but in very low numbers. Natural enemies were not prevalent in wheat. In the winter, both Cruiser® and Gaucho® significantly decreased the numbers of aphids. However, by the spring there were no significant treatment effects on either aphid or cereal leaf beetle populations.

Yield: Cruiser® and Gaucho® seed treatments did not impact yield in full-season soybean, double cropped soybean or winter wheat.

2017

Insect abundance:

In **field corn** at the V4 stage, we counted the number of plants that showed evidence below-ground pest pressure (white grubs and wireworms were present at both sites). At Beltsville seedling damage due to cutworms was also present and measured. **The Cruiser® and Gaucho® treatments did not have an impact on the number of plants affected by soil/seedling pests**.

The most abundant foliar insects early in the growing season (V7) were plant thrips (Figure 2). These were not significantly impacted by the neonicotinoid seed treatments (Figure 3). No beneficial insects were present in high numbers at this time.

Figure 2: Insects seen in V7 and R1 stages f corn. The primary pest insect was plant thrips (top left and right) and the primary beneficial insects were lacewing eggs (bottom left) and minute pirate bugs (bottom right).

Visual counts were repeated at the R1 stage. No pest insects were found in high numbers. The most numerous beneficial insects were minute pirate bugs and lacewing eggs (Figure 2); these were not impacted by the Cruiser® or Gaucho® treatments.

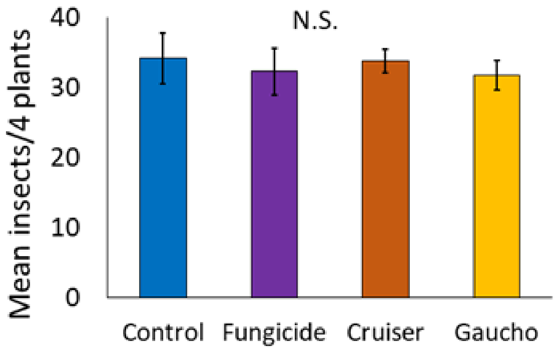

Figure 3: Mean number of plant thrips per four corn plants at V7 growth stage. Error bars represent standard error and N.S. = Not Significant.

Yield: Gaucho® and Cruiser® did not significantly impact corn yield (Figure 4).

Conclusions: These results indicate that NSTs provide limited pest protection, as they are only effective early in the growing season. When pest pressure is low, the use of NSTs may not increase yield relative to seeds not treated with insecticides [fungicide seed treatment only or bare seed (control)]. NSTs play an important role in grain crop production and can be a useful tool for insect pest management. When pest pressure is high, they provide a convenient and economical way to protect crops. However, our work demonstrates that the use of NSTs may not always be economically beneficial in the mid-Atlantic region. Producers can make the best use of NSTs where they regularly have high early season insect pest pressure.

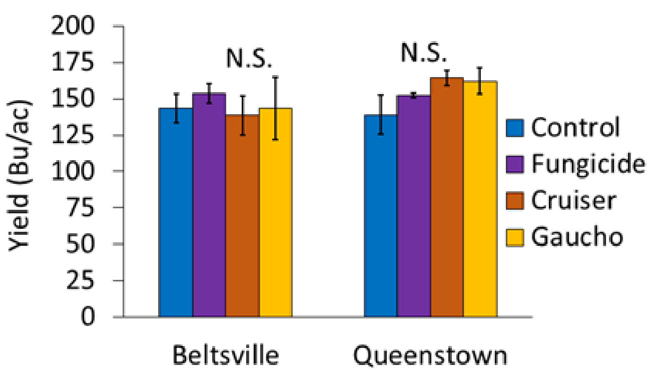

Figure 4: Corn yield in 2017. Corrected to 15.5% moisture. Error bars show standard error. N.S. = Not Significant.

Acknowledgements: Funding for this research was provided by the Maryland Grain Producers Utilization Board, the Maryland Soybean Board and by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2015-38640-23777 through the North East SARE program under sub-award number GNE16-11B-29994. We would like to thank Maggie Lewis, Terry Patton and all the technicians who worked on this project.

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A New Invasive Problem for Cucurbits in Our Area

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Sometime in early September I got a call from Bob Rouse asking me to look at a pumpkin field located at the Western Maryland REC in Keedysville. Something about the color of the yellow leaves had Bob worried that it could be something odd. By the time I got to the field the entire field had a yellow caste to it (fig. 1). However there were particular plants that had an odd yellow color to them in which some of the leaves were dead but there was little wilting (fig. 2). When I cut a cross section at the base of the stem on these particular plants the interior of the stem showed a distinct yellow-brown coloration of the phloem (fig. 3). This honey-colored phloem is one of the characteristics of a disease called Cucurbit yellow vine decline or disease (CYVD). The bacteria *Serratia marcescens*, the causal agent of CYVD, was recovered from the phloem of symptomatic plants.

Fig. 1 Pumpkin field in mid-September with many yellowing plants.

Fig. 2 Odd yellow-colored pumpkin plants that did not wilt.

Cucurbit yellow vine disease was first found in squash and pumpkins in Texas and Oklahoma in 1988. Three years later it was causing large scale losses of watermelons and cantaloupe in some areas of these two states. The disease has since been found in Arkansas, Colorado, Kansas, Nebraska, Missouri, Massachusetts, and Connecticut (odd sort of spread it seems). In areas