BELTWIDE NEMATODE RESEARCH AND EDUCATION COMMITTEE REPORT ON FIELD PERFORMANCE OF SEED AND SOIL-APPLIED NEMATICIDES, 2019

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Abstract

The 2019 National Cotton Council Nematode Research and Education Committee evaluated three seed-applied, two soil-applied, and one foliar-applied nematicide to manage *Meloidogyne incognita* or *Rotylenchulus reniformis* in cotton. The cotton cultivars Deltapine DP 1646 B2XF and Phytogen PHY 350 W3FE was used in this study. While both cultivars are susceptible to *R. reniformis*, PHY 350 W3FE is marked as being moderately resistant against *M. incognita*. All locations had a low or moderate population density of root-knot or reniform nematodes. None of the nematicides had a significant impact on seedling establishment or early season vigor. The treatment that included COPeO® Prime + Velum® Total (14 fl oz/A) + Propulse® 3.34 SC (13.6 fl oz/A, at bloom) had the lowest numeric percent of root system galled across all locations. While COPeO® Prime provided the best numeric suppression of *R. reniformis* reproduction recovered from soil samples across locations. Of the trails conducted in *M. incognita* infested fields, COPeO® Prime + Propulse® 3.34 SC (13.6 fl oz/A, in-furrow) had the greatest numeric impact on yield protection. Whereas CoPeO® Prime + Velum® Total (14 fl oz/A, in-furrow) had the greatest impact on yield protection in *R. reniformis* fields. These data suggest the combination of seed-applied + soil-applied nematicides in general provide more consistent seedling root and yield protection compared either single application method in fields infested with cotton nematodes.

Introduction

The southern root-knot nematode (*Meloidogyne incognita*) and reniform nematode (*Rotylenchulus reniformis*) continue to be among the most yield-limiting factors affecting cotton production across the U. S. Cotton Belt. For the past three years, estimates of yield loss by these two nematode species exceed more than 3% across the Cotton Belt (Lawrence et al., 2017; Lawrence et al., 2018; Lawrence et al., 2019). Though a few cotton cultivars with resistance to southern root-knot nematode are commercially available, none have resistance to *R. reniformis*. Nematicides are useful in an integrated pest management program and evaluating them across the Cotton Belt provides an understanding of their performance across production systems. Therefore, the objective of this study was to evaluate the relative impact of seed-applied and soil-applied nematicides at several locations across the U.S. Cotton Belt.

Materials and Methods

Cotton Cultivars

The upland cotton cultivar, Deltapine, DP 1646 B2XF and Phytogen, PHY 350 W3FE, were selected for this study because of their broad adaptation across the U.S. Cotton Belt. While both cultivars are susceptible to *R. reniformis*, PHY 350 W3FE is marketed as being moderately resistant to *M. incognita*.

Nematicide Treatments

All seed were treated with a base fungicide treatment of Allegiance® FL (metalaxyl) + EverGol® Prime (penflufen) + Spera™ 240FS (mycolobutanil) + Vortex® (ipconazole) at a rate of 0.75 + 0.33 + 1.8 + 0.08 oz/cwt, respectively, and a storage rate of Gaucho® 600 F (imidacloprid) at 4.6 oz/cwt. Seed-applied nematicides consisted of NemaStrike™ ST (tioxazafen) at rate of 0.75 mg ai/seed, BioST® Nematicide 100 (*Burkholderia rinojensis*, strain A396) at rate of 7.02 oz/cwt, and COPeO® Prime (fluopyram) + Gaucho® 600 F at a rate of 0.2 mg ai/seed + 4.6 oz/cwt, respectively. All seed were treated at the University of Tennessee at West Tennessee Research and Education Center in Jackson, TN. The soil applied nematicide, Velum® Total (fluopyram + imidacloprid) was applied in-furrow at planting at a rate of 14 fl oz/A. The soil applied fungicide/nematicide, Propulse® 3.34 SC (fluopyarm + prothioconazole) was applied in-furrow at planting at a rate of 13.6 fl oz/A. The soil-applied nematicides were applied with 5-6 gal of water/A using a flat fan nozzle oriented perpendicular to the seed furrow. Various combinations of seed-applied and in-furrow applied nematicides were evaluated in this multi-state trial (Table 1). Only the base fungicide treatment (non-nematicide control) and COPeO® Prime were used on PHY 350.

Field Experiments

Field efficacy of seed-applied and soil-applied nematicides were assessed in eight *M. incognita* infested fields in Alabama, Arizona, Arkansas, Georgia, North Carolina, South Carolina, Texas, and Virginia, while four experiments were conducted in *R. reniformis* infested fields in Florida, Louisiana, Mississippi, and Texas. The experimental design was a randomized complete block design with four to five replicates per treatment. Individual plots consisted of two to four rows, 25 to 60-ft-long, spaced either 36 to 40-in apart separated by a 3-ft fallow alley. Plant stand counts were taken on 14 to 30 days after planting (DAP) as number of pants per 10 ft of row. Vigor ratings were based on a six point scale with 0 = poor vigor and 5 = best and sampled at 14 to 30 DAP. Population densities of root-knot and reniform nematodes were sampled at 30 to 60 DAP by collecting a representative soil subsample from each plot. Samples were collected near the existing stand of cotton. Root-knot nematode infection was determined at 30 to 60 DAP from 5 to 10 root systems based on gall counts per root system, rating system (six or ten point scale) or estimating percent of root system with galls. All data were converted to percent root system with galls for analysis. Seed cotton yield was collected at harvest.

Statistics

Nematode infection, soil sampled data and yield were transformed using an inverse distribution function to normalize for analysis and non-transformed data are reported (Timpleton, 2001). Data were analyzed using a factorial ANOVA in the general linear mixed model procedure with location and nematicides as fixed variables and block as a random variable. Additionally, data were analyzed in a general linear mixed model procedure with nematode threshold and application method as fixed variables and block as a random variable. Data with two cultivars were analyzed similarly with cultivar as a fixed variable. Using SPSS 25.0 (SPSS INC. Chicago, IL). Means were separated at $\alpha = 0.05$ by Tukey's Honest Significant Difference test.

Results and Discussion

In *M. incognita* infested fields, there was no cultivar by nematicide and no nematicide by location interaction ($P \geq 0.20$) for, vigor, percent root system galled, nematode population density or yield, thus only the main effects are reported (Table 1). There was no effect of nematicide treatment for seedling population density (stand), seedling vigor, or nematode population density (soil samples). Cotton cultivars did differ in nematode infection with a lower ($P = 0.038$) percent root system galled at 0.64% on PHY 350 than 1.6% on DP 1646. However, there was no difference between seed cotton yield from PHY 350 (2,712 lb./A) and DP 1646 (2,770 lb./A). All nematicides performed similarly in regards to suppressing root-knot nematode infection (Table 1). Overall, galling was low with an average percent root system galled of 1.2% across locations. Most locations (FL, GA, NC, SC, and VA) had a low action threshold of root-knot nematodes in the field. A lower ($P = 0.05$) seed cotton yield was observed with COPeO® Prime + Velum® Total + Propulse® (foliar) compared to COPeO® Prime + Propulse®; however, neither differed from the non-nematicide control.

There was no application method by nematode threshold interaction in the *M. incognita* field trials. On average, all nematicide application methods contributed to a numerically lower percent of root system galled compared to the non-nematicide control (1.6%). The average percent root-system galled for seed-applied, soil-applied and combination treatments was 1.2%. Similarly, seed cotton yield averages were numerically greater with seed-applied (3,207 lb./A), soil-applied (3,165 lb./A) and combination treatments (3,284 lb./A) compared to the non-nematicide control (2,992 lb./A).

Table 1. Effect seed-applied and in-furrow applied nematicides in *Meloidogyne incognita* infested fields.

	Stand[z]	Vigor[y]	*Meloidogyne incognita*[x]		Seed cotton (lb./A)
Treatment and rate	14-30 DAP	14-30 DAP	Soil	% Galling	
Non-nematicide control[w]	24.0	4.0	76	1.6	2,934 ab[v]
COPeO® Prime (0.20 mg ai/seed)	24.7	4.2	90	1.4	3,192 ab
BioST® Nematicide 100 (7.02 oz/cwt)	24.4	4.2	129	0.9	2,963 ab
NemaStrike™ ST (0.75 mg ai/seed)	25.5	4.2	109	1.2	3,127 ab
Velum® Total (14 fl oz/A)	25.3	4.3	117	1.3	3,144 ab
Propulse® 3.34 CE (13.6 fl oz/A)	26.3	4.2	91	1.2	2,818 ab
CoPeO® Prime + Velum Total (14 fl oz/A)	25.3	4.2	137	1.3	3,164 ab
COPeO® Prime + Propulse® 3.34 SC (13.6 fl oz/A)	26.6	4.2	125	1.1	3,434 b
Velum Total (14 oz/A) + Propulse® 3.34 SC (13.6 fl oz/A)	23.1	4.2	113	1.2	2,950 ab
COPeO® Prime + Velum® Total (14 fl oz/A) + Propulse® 3.34 SC (13.6 fl oz/A)	24.5	4.4	95	0.8	2,680 a
$P > F$	0.43	0.15	0.99	0.57	0.05

[z] Cotton seedlings per 10 ft. of row.
[y] Seedling vigor based on 0-5 scale where 5 = most vigorous seedling growth.
[x] Population density of *Meloidogyne incognita* per 100 cm^3 soil and percent of root system galled 30-60 DAP.
[w] All seed were treated with a premium fungicide base and storage rate of Gaucho® 600 F.
[v] Different letters indicate a significant difference at $\alpha = 0.05$ according to Tukey's HSD test.

In the *R. reniformis* infested fields, there was no cultivar by nematicide by location or cultivar by nematicide location interaction ($P \geq 0.20$) for stand, vigor, nematode population density or yield, thus only main effects are reported (Table 2). There was no effect of nematicide treatment for seedling population density (stand), seedling vigor, or nematode population density (soil samples). Cotton cultivars had similar nematode population density ($P = 0.11$) and yield ($P = 0.19$) with an average of 1,366 RN/100 cm^3 soil and 2,852 lb./A seed cotton, respectively.

There was no interaction between application method and nematode threshold for nematode population density or yield. Of the application methods, only the soil-applied and seed-applied + soil-applied treatments contributed to a numerically lower *R. reniformis* population density than the non-nematicide control. The seed-applied (2,792 lb./A)

combination treatments (2,992 lb./A) contributed to a greater numeric yield over the soil-applied (2,671 lb./A) and non-nematicide control (2,756 lb./A).

Table 2. Effect of seed-applied and in-furrow applied nematicides in *Rotylenchulus reniformis* infested fields.

Treatment and rate	Stand[z] 14-30 DAP	Vigor[y] 14-30 DAP	*Rotylenchulus reniformis*[x] 30-60 DAP	Seed cotton (lb./A)
Non-nematicide control[w]	26.0	2.9	1,752	2,250
COPeO® Prime (0.20 mg ai/seed)	27.6	3.0	749	2,226
BioST® Nematicide 100 (7.02 oz/cwt)	26.1	2.9	2,566	2,416
NemaStrike™ ST (0.75 mg ai/seed)	26.6	2.9	2,147	2,357
Velum® Total (14 fl oz/A)	26.9	3.0	1,105	2,404
Propulse® 3.34 CE (13.6 fl oz/A)	25.4	3.0	1,037	2,126
CoPeO® Prime + Velum® Total (14 fl oz/A)	27.2	3.1	1,060	2,533
COPeO® Prime + Propulse® 3.34 SC (13.6 fl oz/A)	25.6	3.1	209	2,557
Velum® Total (14 oz/A) + Propulse® 3.34 SC (13.6 fl oz/A)	27.6	3.0	1,866	2,423
COPeO® Prime + Velum® Total (14 fl oz/A) + Propulse® 3.34 SC (13.6 fl oz/A)	28.7	3.0	1,030	2,408
P > F	0.62	0.96	0.23	0.22

[z] Cotton seedlings per 10 ft. of row.
[y] Seedling vigor based on 0-5 scale where 5 = most vigorous seedling growth.
[x] Population density of *Rotylenchulus reniformis* per 100 cm^3 soil.
[w] All seed were treated with a premium fungicide base and storage rate of Gaucho® 600 F.

Summary

The seed-applied nematicides were variable in their suppression of cotton nematode infection reproduction and yield protection. Soil-applied Velum® Total and Propulse® provided a similar magnitude of nematode suppression and yield protection. Similarly, COPeO® Prime + Propulse® and COPeO® + Velum® Total had a similar response in nematode suppression and yield protection. The addition of a foliar application had no benefit over the comparable treatments without a foliar application. Overall, the combination of seed-applied + soil-applied nematicide treatments contributed to a greater numeric seed cotton yield than the non-nematicide control or solo seed-applied nematicides or soil-applied nematicides.

Disclaimer

This paper reports the result of research only. Mention of a pesticide in this paper does not constitute a recommendation by the University of Arkansas, Division of Agriculture nor does it imply product registration within each state. This work was supported by a grant from Bayer CropScience.

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