MANAGEMENT OF FUSARIUM WILT AND ROOT KNOT NEMATODE WITH VELUMTOTAL AND PROPULSE

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Abstract

Trials were conducted in two Fusarium wilt (race 1) fields that were also infested with root-knot nematode. The trials consisted of at-plant, infurrow nematicide products (none, Velum Total [14 oz/a], and Propulse [13.6 oz/a]) and seed treated with or without Nemastrike. At the Gaines county site, plant stands declined sharply between 20th of June and 9th of July due to Fusarium wilt. Root galls were reduced by Propulse (0.7 galls/root) compared to no infurrow product (7.3 galls/root). Transformed (LOG10) root-knot nematode density also was lower for plots treated with Propulse (2.87) compared to no infurrow product (3.59). Final stands were not affected by nematicide products and lint yield was also not significantly affected by product, though did trend higher for plots treated with Propulse. The seed treatment Nemastrike did not affect any measured parameters at Gaines County. At the Hall county site, there was less Fusarium wilt overall. Plots treated with Propulse had lower plant stands initially and at the end of the season compared with no infurrow product. Neither nematicide or infurrow product significantly reduced root galling, but plants treated with these products did at least trend with lower root galling and higher yields than the no infurrow treatment. The spatial variability of Fusarium wilt made it challenging to show significant treatment differences. Seed treated with Nemastrike did have lower yields than seed with no nematicide treatment. These tests did not confirm that Propulse, as an at-plant infurrow nematicide, controls Fusarium wilt effectively but did suggest that this product had some benefits in terms of reduced nematode damage and increased yields in Fusarium wilt fields.

Introduction

Fusarium wilt of cotton caused by the complex of *Fusarium oxysporum* pv. *vasinfectum* and root-knot nematode (*Meloidogyne incognita*) can cause devastating losses in cotton (Atkinson, 1892). Fusarium wilt races which interact with root-knot nematode can be at least partially managed by controlling root-knot nematode. Colyer et al. (1997) demonstrated that aldicarb could increase yield and reduce root-knot nematode gall ratings and wilt ratings in Fusarium wilt fields. More recently the nematicide/fungicide fluopyram has been used to manage root-knot nematode (Faske and Hurd, 2015; Ji et al., 2019). The product Velum Total (Bayer CropScience) contains fluopyram and is used as an at-plant infurrow applied nematicide. The product Propulse (Bayer CropScience) also contains fluopyram and another product prothioconazole. Prothioconzaole is a fungicide and has been shown to reduce Fusarium wilt in watermelon (Everts et al., 2014; Miller et al., 2020; Petkar et al., 2018). The objective of this research project was to determine if infurrow applications of Velum Total or Propulse would affect the severity of Fusarium wilt of cotton, and what secondary effect the chemicals had in managing root-knot nematode.

Materials and Methods

Tests were conducted in fields with a history of Fusarium wilt in Gaines and Hall counties. *Fusarium oxysporum* pv. *vasinfectum* was identified as race 1 (Dr. Cecilia Monclova-Santana, personal communication) in both fields. The experiment consisted of three at-plant, infurrow treatments (none, Propulse at 13.6 oz/acre and Velum Total at 14 oz/acre) as the main plots, and two subplot seed treatments (no nematicide and Nemastrike (active ingredient is tioxazafen) treated seed). There were four replications of each treatment combination. The variety was the Fusarium wilt/root-knot nematode susceptible DP 1820 B3XF. The plot size was two-rows wide with 40-inch centers, and 36 feet in length. The seed was planted using a cone planter, with 4 seed planted/foot of row. The infurrow applications were made with microtubing using a disc to apply a stream of liquid in the furrow before row closure. The application rate was 5 gal/acre and was metered with a CO_2 system set at 30 PSI. The application speed was 2.5 mph. At the Gaines county site, planting occurred on 17 May, and stand counts were taken on 1, 12, and 20 June, 9 July, and at harvest (15 November). Ten roots/plot were dug on 20 June and galls were counted and averaged per plant in each plot. Soil samples were taken on 7 October and assayed for second-stage juveniles (200 cm^3 soil) with a modified baerman pie-pan assay (Thistlethwayte, 1970). Eggs were obtained by putting 500 cm^3 soil in 3 L water, stirring and then allowing the soil to settle for 15 second. The organic matter/roots in the water

were poured through a 60-mesh sieve. Eggs were extracted with NaOCl (0.5%) for 5 min. and then caught on a 500-mesh sieve (Hussey and Barker, 1973). The plots were harvested on 15 November. The Hall county site was planted on 29 May. Stand counts were taken on 11 June and at harvest. Roots (10 plants/plot) were dug on 11 July and galls were counted and averaged/plant for each plot. Soil samples were not taken at this site. Plots were harvested on 5 November. Analysis for all measured parameters were done with a mixed model analysis for a split plot design, using SAS version 9.4. Soil temperature and soil moisture sensors were placed in each field and attached to a data logger to monitor conditions throughout the growing season at a 5-inch depth.

Results and Discussion

The Gaines county site developed substantial Fusarium wilt. Plant stands declined by an average of 47% at this site. The initial decline in stand counts occurred between 12th and 20th of June, but a substantial decline occurred between 20 June and 9 July (Table 1). Stands did not appear to decline further after 9 July. On 1 June, plots treated with Propulse had lower initial stands than plots treated with Velum Total. These differences persisted through 12 June. However, as plants began to die, the stand differences between infurrow treatments disappeared. There was no significant impact of Nemastrike on plant stands. Galls/plant were lower for plots treated with Propulse than with no infurrow product. Seed treatment had no effect on root galls. Transformed (LOG_{10}) root-knot nematode density (J2 + eggs/500 cm^3 soil) were lower in the Propulse treated plots than in the no-infurrow plots. Seed treatment did not affect root-knot nematode density. Yield was not significantly affected by treatments, however trended higher for Propulse treated plots. The field was center pivot deficit irrigated, but after a rain occurred on 22 July, it did not appear to receive any irrigation or substantial showers after that date (Fig. 1). Thus, plants with healthier roots had insufficient water to obtain higher yield.

Table 1. Effect of infurrow nematicide treatments at Gaines county site on cotton and nematode parameters.

	Plants/ft of row							Lint
	1 June	12 June	20 June	9 July	15 Nov.			Yield
Infurrow						Galls	LRK[2]	(lbs./a)
None	2.54 ab[1]	2.66 ab	2.45	1.22	1.33	7.3 a	3.59 a	284
Propulse	2.31 b	2.65 b	2.44	1.56	1.64	0.7 b	2.87 b	367
Velum Total	2.89 a	3.08 a	2.82	1.57	1.48	4.1 ab	3.34 ab	277

[1]Least square means with the same letters are not significantly different at P=0.10, based on t-tests.
[2]LRK are LOG10(root-knot nematode density+1)/500 cm^3 soil.

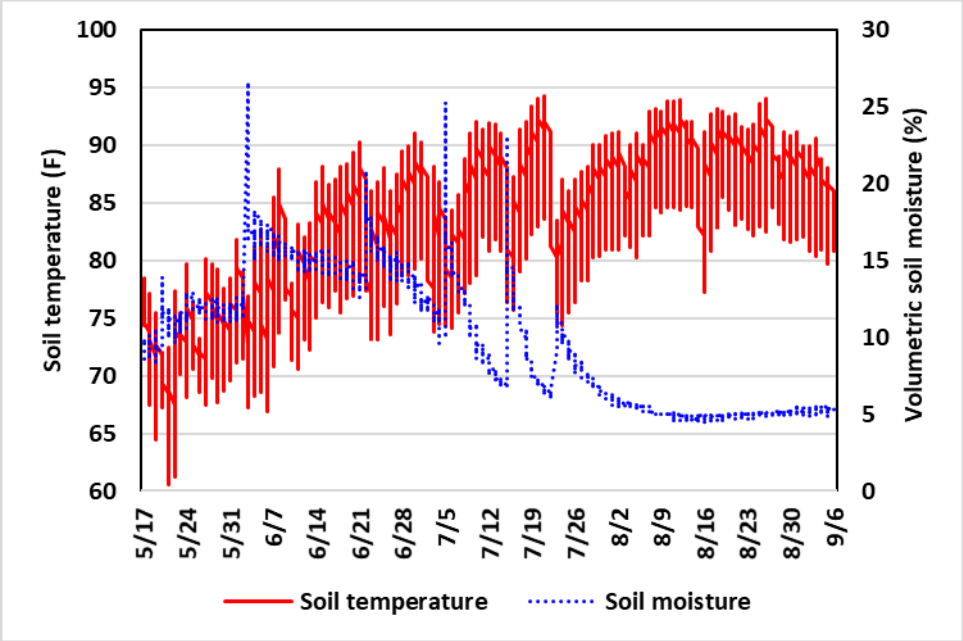

Figure 1. Soil moisture and soil temperature at a 5-inch depth for the Gaines county site.

There was less Fusarium wilt overall at the Hall county site. Stands declined an average of only 10% at this site. Plots treated with Propulse had lower stands both initially and final stand counts, than the plots with no infurrow applied (Table 2). Plots treated with Velum Total did not appear to lose any stand over the course of the season, while stand counts did drop by 15% between initial and final stand counts for Propulse and no infurrow product. Galls/plant and yield did not appear to be affected by infurrow application, though yield did trend higher for Propulse than the no infurrow treatment. Seed treatment did not affect plant stand or galls/plant but did affect final yield. Plots treated with Nemastrike had lower (2,100 lbs. of lint/acre) yield than no nematicide seed treatment (2,274 lbs. of lint/acre). The Hall county site was irrigated frequently, starting in July and continuing until the end of August (Fig. 2).

Table 2. Affect of infurrow fungicides on plant stand, galls/root, and yield at the Hall County site.

	Plants/foot row			Lint
	11 June	5 Nov.		Yield
Infurrow			Galls	(lbs/acre)
None	3.15 a[1]	2.69 a	21.3	2,128
Propulse	2.44 b	2.07 b	15.5	2,270
Velum Total	2.79 ab	2.81 a	14.3	2,163
Prob>F	0.03	0.01	0.68	0.55

[1]Least square means with the same letters are not significantly different at *P*=0.10, based on t-tests.

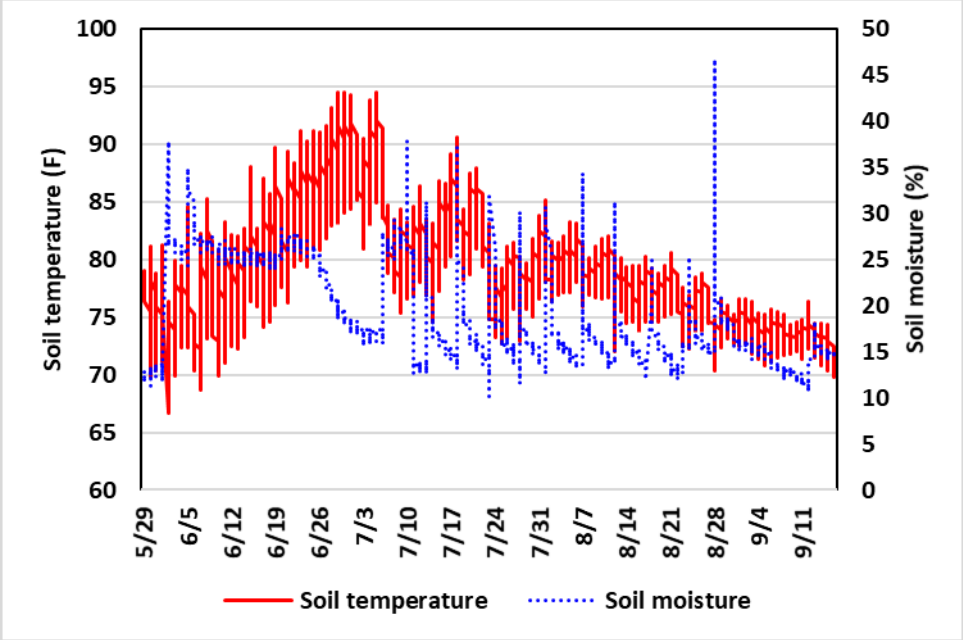

Figure 2. Soil moisture and soil temperature at a 5-inch depth at the Hall county site.

The product Propulse did reduce root-knot nematode density and galling at the Gaines county site, but not at the Hall county site. At both sites, yield did at least trend higher with Propulse compared to the no infurrow treatment. The erratic nature of the disease does make it challenging to get consistency within the treatments. The seed treatment Nemastrike did not improve nematode control or yield at either site. We are still trying to understand the conditions (soil moisture?) that result in better product activity and environmental conditions that trigger more severe disease conditions. Both sites had a history of severe Fusarium wilt certain years. The Gaines county site did experience good soil moisture (for that site) starting about 2 weeks before symptoms started, and the rain or irrigation events continued though the duration that plants were mostly dying (until 1st week in July). The Hall county site did show some plant death due to Fusarium wilt by 3 July (similar time frame as Gaines county), but

there was a drying down of the soil that occurred for two weeks or so before that date as well as a strong increase in soil temperature. Possibly the high soil temperatures during the end of June inhibited Fusarium wilt from taking off as much in Hall county. Chemical control can be used to reduce damage in Fusarium wilt/root-knot nematode fields, but overall the control is still insufficient to allow plants to survive the infection.

Summary

It was determined that Propulse given at the recommended rate, initially reduced plant stands in Seminole relative to VelumTotal, and in Turkey, relative to the check. In Seminole, stands were similar across all treatments by harvest as the Fusarium Wilt killed the plants across all treatments. Gall count was significantly reduced by Propulse compared to the check at Seminole and was at least lower numerically in Turkey, confirming the trend. Transformed root-knot nematode density was significantly reduced by Propulse by the end of the season, relative to checks at Seminole, and was not measured in Turkey. Yield was not significantly ($P< 0.05$) affected by in-furrow products at either site, however it did trend higher for Propulse at both sites. Further testing will include a repeat of protocol measurements and a repeat of the fungicides and nematicides used or similar chemicals if some are no longer commercially used. Future test sites may change due to producers' opinions, however more sites will include lands that have historically been affected by Fusarium Wilt and root-knot nematodes.

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