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TITLE: Reniform nematode management investigations – project report.

INVESTIGATORS:
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OBJECTIVE:
Our objectives are to: 1) to determine the effect of the new seed treatment nematicides on the rate of development of the reniform and root-knot nematodes over time in various soil types; 2) to determine the effect of poultry litter fertilizer applications on the efficacy of the new seed treatment nematicides for reniform nematodes in cotton; 3) screen current corn cultivars for host status to the reniform and root-knot nematodes; 4) identify summer and winter weed hosts of the reniform nematode and how these weeds affect nematode population during a corn rotation; and 5) determine the efficacy and economics of recommended and experimental nematicides and biologicals for management of the reniform nematode.

1) **What effect does the abermectin nematicide seed treatment have on the reniform nematode rate of development over time in various soil types?**
Greenhouse test examines the morphological development of the reniform nematode (*Rotylenchulus reniformis)* in cotton roots as affected by Avicta (abermectin). Cotton seeds were treated with either: 1) Avicta Complete Pak which consists of Avicta 4.17 FS (abermectin), Dynasty CST 125 FS, and Cruiser 5 FS; or 2) Dynasty CST 125 FS, and Cruiser 5 FS. Soil types consisted of a silt loam (BM) (72.4, 12.0, 15.6, S-S-C, 0.6% OM, 14.9 CEC, and pH 6.1) and a sandy loam (HUX) (72.4, 12.0, 15.6, S-S-C, 0.6% OM, 14.9 CEC, and pH 6.1). Root samples were processed at 3, 6, 9, 14, 19, 25, 35 and 45 days after inoculation (DAI) to determine life stage development, number of nematodes per gram of root and numbers of egg masses. Nematode development did not appear to be affected by soil type. Avicta Complete Pak reduced the numbers of *R. reniformis* in the roots at 3 and 6 DAI as compared to the Dynasty CST 125 FS plus Cruiser 5 FS seed treatment. A greater percentage of the total population of *R. reniformis* was observed in stage A (J2) and B (sausage-shaped juvenile with conical tail), at 6 DAI in the Avicta Complete Pak treatment as compared to the control. Gravid females with egg masses were observed at 19 DAI in the control verses 35 DAI in the Avicta Complete Pak treatments.

2) **Poultry litter, reduced tillage, and nematicide as a conservation system for** *R. reniformis* **management.** Evaluations were conducted in field plots to determine the effect of poultry litter, reduced tillage systems and nematicides on *R. reniformis* populations and seed cotton yields. The test was designed as a 3 x 3 x 2 factorial with four replications. Nematicide treatments consisted of either Avicta complete pak, Temik 5 G or Telone II. Tillage systems included conventional, strip or no tillage systems and poultry litter was compared to the standard inorganic fertilizer equivalent. Fertilizers were applied March 30 and Telone II was injected with a red ball applicator on April , 2006. Pots were planted the 9th of May and harvested Oct. 3rd. No interactions were observed between poultry litter, tillage, or nematicide for nematode populations throughout the season or seed cotton yields. Poultry litter produced an increased of seed cotton yield by 4% as compared to the inorganic fertilizer equivalent. Avicta complete pack produced

2156 lb/A of seed cotton with Temik 15 G and Telone II increasing yields by an additional 88 and 335 lb/A. *Rotylenchulus reniformis* vermiform nematode numbers were reduced 50% ($P \leq 0.05$) at planting by the Telone II nematicide treatment. The numbers of *R. reniformis* were 22% and 41% higher in the Temik 15 G and Avicta complete pak treatments as compared to the Telone II treatment at 30 DPA. Nematode numbers were not different between nematicides at mid season and harvest samples. Poultry litter and tillage did not affect the nematode populations at any time during the season. Previous greenhouse evaluations have confirmed that poultry litter has the potential to reduce *R. reniformis* numbers in cotton; however, field trials indicate that long-term evaluations with poultry litter should be conducted before recommendations are made.

3) Screen current corn hybrids for host status to the reniform and root-knot nematodes. Corn hybrids were evaluated in the greenhouse for host status to both *R. reniformis* and *Meloidogyne incognita* nematodes. Ninety-two transgenic and non-transgenic corn hybrids were evaluated for host suitability to both *R. reniformis* and *M. incognita* race 3 nematodes and compared to a cotton susceptible standard DPL 555 BG/RR. Separate evaluations were conducted for each nematode species. *Rotylenchulus reniformis* and *M. incognita* were increased on cotton (ST 5599BG/RR and DPL 555BG/RR, respectively) in the greenhouse. Each nematode species was extracted from the soil by combined gravity screening and sucrose centrifugal floatation. Nematode eggs were collected from the root systems by shaking the excised root systems for 4 minutes in 0.6% NaOCl and sieving. Both nematode species were standardized to 1000 juveniles or vermiform life stage and eggs per 2 ml of water for inoculation. Corn hybrids were grown in 150cm^3 conetainer® filled with a loamy sand soil (72.5% sad, 25% silt, 2.5% clay, ph 6.4). The soil was autoclaved twice at 121°C and 103.4 kPa for two hours on two consecutive days. Seeds were planted and allowed to germinate after which the hybrids were inoculated with the standardized solutions of each nematode species. Tests were arranged in a randomized complete block design with five replications and each test was conducted twice. Sixty days after inoculation, nematodes were extracted from the soil, and eggs were removed from the roots as previously described. After enumeration of *R. reniformis* vermiform and egg populations, reproductive factor values (Rf = final population / initial population) were determined. Any RF values over 1 would indicate the nematode species is increasing in population numbers. Nematodes are not reproducing when the RF values are less than 1. Gall ratings were also determined on the *M. incognita* infested roots utilizing a rating scale of 0 to 5 with 0 equivalent to no galls and 5 as more than 100 galls on the root system. All data was analyzed using general linear model procedures (GLM) of SAS. Means were separated with Fisher's protected least significant difference test ($P \leq 0.05$).
Of the corn hybrids screened, none exhibit any resistance to *M. incognita*. All appeared to be extremely susceptible to *M. incognita* and serve as good hosts to the nematode. All corn hybrids were as susceptible to *M. incognita* as was the DPL 555BG/RR cotton. All the corn hybrids screened for resistance to *R. reniformis* are resistant to the nematode and did not allow for reproduction of this nematode species. Thus corn should serve as an excellent rotation crop for fields infested with *R. reniformis* and nematode populations should decline. However, *M. incognita* populations should increase if corn is rotated with cotton in root-knot infested fields. This data has been published in the Alabama Agricultural Experiment Station Timely Information sheets PP617.
http://www.aces.edu/timelyinfo/PlantPathology/2006/December/pp617.pdf

4. **Determine the host suitability of various summer and winter weeds for the reniform nematode**. Summer and winter weed species common to Alabama cotton production systems were evaluated for *R. reniformis* host status in the greenhouse. Corn and individual weed species were grow as composites for the second seasons a microplot study to determine if *R. reniformis* populations would

increase under a mix host status. A field trial was also repeated in a field naturally infested with *R. reniformis* in Huxford, Alabama. Corn was grown under different herbicide regimes to simulate various weed densities to determine if *R. reniformis* populations will increase in the field on weed hosts associated with the cotton-corn rotation system.

Twenty-eight weed species were evaluated in the greenhouse. Black Medic, Blue Fescue, Coffee Senna, Coffee Weed, Common Ragweed, Common Waterhemp, Hemp Sesbania, Ivy Leaf Morningglory, Lambsquarter, Moringglory (*I. nil*), Mornigglory (*I. tricolor*), Musk Thistle, Pale Smartweed, Pitted Morningglory, Redrood Pigweed, Tall Mornigglory, Teaweed, Velvetleaf, and Wild Buckwheat Sicklepod, Velvetleaf, and the Morningglory species tested, all serve as excellent hosts for the reniform nematode. Thus, these weeds which are common to cotton corn rotation systems, could potentially increase reniform nematode populations if weed populations are high. Noxious weeds that did not increase reniform nematode numbers include: Cogongrass, Corn Spurry, Curly Dock, Field Bindweed, Jimson Weed, Kochia, Purple Nutsedge, and Wild Mustard. Microplot studies conducted in 2005-2006 indicated *R. reniformis* populations were higher ($P \leq 0.05$) throughout the season in the cotton treatments compared to corn and the corn plus noxious weed combinations. Sicklepod or mixed Morningglory species growing in combination with corn increased *R. reniformis* nematode populations ($P \leq 0.05$) as compared to monoculture corn at 60 and 120 days after planting. Populations of *R. reniformis* were always greater ($P \leq 0.05$) in the cotton treatment as compared to the corn weed species combination. Sicklepod and mixed Morningglory species served as good hosts for *R. reniformis* allowing the nematode population to increase in the corn cycle of the cotton corn rotation system.

In field plots, *R. reniformis* populations increased ($P \leq 0.05$) in the corn plots with minimal herbicide applications increase as compared to the weed-free treatments. At harvest, the minimal pre-emergence and no post-emergence herbicide plots, supported greater *R. reniformis* populations than the routine pre-emergence herbicide application followed by one roundup application. This population response would be expected, due to the time required for population growth of the nematode

5. **Determine the efficacy and economics of recommended and experimental nematicides for the management of the reniform nematode.** Eighteen trials were conducted in 2006 to determine the efficacy of recommended and experimental nematicides. Tests were established in naturally infested fields located either adjacent to the Auburn University, Tennessee Valley Research and Extension Center, in Belle Mina; at the E. V. Smith Research Station in Tallassee; or in a producer's field near Huxford, AL. Avicta complete pak, Aeris, Temik 15 G, Vydate C-LV and various experimental compounds were examined at variable rates and application timings. All treatments were planted in 2 - 4 row plots, 25 feet long with a 36 - 40 inch row spacing, and replicated 4 – 6 times. Avicta and experimental compounds were applied to the seed by the manufacturer. Temik 15 G (5.0 lb/A) was applied at planting in the seed furrow with chemical granular applicators attached to the planter. Vydate C-LV was applied as a foliar spray at the 4 - 6 true leaf plant growth stage with a two row CO_2 charged back pack sprayer. Nematode population development was determined at monthly intervals. Plots were rated at 4 weeks to determine seedling emergence and uniformity. Cotton was harvested utilizing a two-row cotton picker to determine the effects of each treatment on cotton yield.

Reniform nematode and seedling disease pressure was moderate in 2006. Most areas of the state suffered a drought beginning in mid May that lasted throughout the season. Avicta complete pak, Temik 15 G and Curiser treatments were present in six tests in the two locations. For a general summary of 2006, seed cotton yields in north Alabama were averaged across all tests and Temik 15 G and Avicta complete pak produced 12.6

and 9.5 percent more seed cotton than the Cruiser control treatment. In south Alabama, Avicta complete pak produced 2.3 percent more seed cotton than the Cruiser control, however, Temik 15 G did not increase yields.

Avicta, Temik 15G, and Vydate CLV were evaluated in both north and south Alabama. Reniform nematode numbers at planting averaged 3353 vermiform life stages per 150 cc of soil at planting in the north Alabama field (Table 1). Cotton seedling stand was not affected by the nematicide treatments. At 28 DAP, the Avicta treatment had the lowest reniform numbers although no nematicide treatment was statistically lower than the untreated control ($P \leq 0.05$). At mid season and at harvest reniform numbers had not increased due to the drought and no differences ($P \leq 0.05$) in population numbers were observed between any treatments. Seed cotton yields varied by 555 kg/ha from the highest to lowest yielding plots with an average of 2646 kg/ha of seed cotton produced over all nematicides. Yields averaged 2715 kg/ha over the Gaucho Grande treatments followed by 2697 kg/ha in the Temik 15G treatments and 2688 kg/ha in the Avicta treatments. The addition of Vydate produced an average yield of 2647 kg/ha. All nematicide treatments increase yields as compared to the non treated control under these drought conditions in north Alabama.

Table 1. Effect of Avicta complete pak, Temik 15G, and Vydate CLV on stand, reniform nematode numbers, and seed cotton yields in northern Alabama.

			Stand	*Rotylenchulus reniformis*/150 cm[z]			Seed cotton
Treatment	Rate	Application	8 m[y]	28 DAP	77 DAP	133 DAP	kg/ha
Goucho Grande	0.375mgai/seed	seed	82.6	3229 ab	2142	556.2 c	2771 a
Goucho Grande + Vydate	0.375mgai/seed + 2 l/ha	seed + 2-5 leaf	69.8	5840 a	1854	695.3 bc	2659 a
Avicta	32 g/100kgseed + 0.34 + 0.15 mg/seed	seed	84.2	1916 b	2503	509.9 c	2832 a
Avicta + Vydate	32 g/100kgseed + 0.34 + 0.15 mg/seed + 2 l/ha	seed + 2-5 leaf	85.2	3461 ab	3461	1622.3 ab	2552 ab
Avicta + Temik + Vydate	32 g/100kgseed + 0.34 + 0.15 mg/seed + 7.8 kg/ha +2 l/ha	seed + IF + 2-5 leaf	83.8	3955 ab	2936	1684.1 a	2681 a
Temik 15G	7.8 kg/ha	IF	75.0	3600 ab	3863	1869.5 a	2698 a
Temik 15G + Vydate	7.8 kg/ha +2 l/ha	IF +2-5 leaf	84.2	3893 ab	2518	1097.0 a	2698 a
Untreated	- -		74.6	3940 ab	2894	973.4 abc	2277 b
LSD P=0.05			16.1	3221	3369	986.9	330

In the south Alabama field reniform nematode numbers were lower at planting averaging 940 vermiform life stages per 150 cc of soil at planting. As in the northern location, cotton seedling stand was similar between all treatments (Table 2). Reniform numbers in Avicta at 40 DAP were numerically lower than all other treatments although there were no significant differences ($P \leq 0.05$) between the treatments. By mid season, no differences ($P \leq 0.05$) were observed in nematode numbers between the treatments. The Avicta + Temik + Vydate combination treatment had the lowest reniform numbers by harvest. Seed cotton yields varied by 136 kg/ha at harvest with an average of 1714 kg/ha of seed cotton produced over all nematicides. Yields averaged 1753 kg/ha over the Gaucho Grande treatments followed by 1702 in the Temik 15G treatments and 1697 in the Avicta treatments. No nematicide treatment increase yields ($P \leq 0.05$) as compared to the non treated control under these drought conditions. The lack of rainfall for several weeks following planting most probably attributed to the lack of response from the nematicide treatments

Table 2. Effect of Avicta complete pac, Temik 15G, and Vydate CLV on stand, reniform nematode numbers, and seed cotton yields in southern Alabama.							
			Stand/ 8 m [y]	*Rotylenchulus reniformis*/150 cm [z]			Seed cotton
Treatment	Rate	Application		40 DAP	84 DAP	135 DAP	kg/ha
Gaucho Grande	0.375mgai/seed	seed	82.6	2060	6180	1390 a	1721.9
Gaucho Grande + Vydate	0.375mgai/seed + 2 l/ha	seed + 2-5 leaf	69.8	1583	5974	1437 a	1783.5
Avicta	32 g/100kgseed + 0.34 + 0.15 mg/seed	seed		952	4532	897 ab	1746.8
Avicta + Vydate	32 g/100kgseed + 0.34 + 0.15 mg/seed + 2 l/ha	seed + 2-5 leaf	85.2	1892	5330	742 ab	1654.9
Avicta + Temik + Vydate	32 g/100kgseed + 0.34 + 0.15 mg/seed + 5.7 g/ha +2 l/ha	seed + IF + 2-5 leaf	83.8	1248	4287	540 b	1688.6
Temik 15G	5.7 g/ha	IF	75	1648	3348	1180 ab	1646.9
Temik 15G + Vydate	5.7 g/ha +2 l/ha	IF +2-5 leaf	84.2	2008	3760	961 ab	1756.2
Untreated	- -		74.6	1545	3438	1098 ab	1740.8
LSD P=0.05			16.1	1455	2891	808	306.4

The new Bayer seed treatments were evaluated in both locations in the state. Treatment 6 Gaucho Grande FS + exp 3 applied at 0.375 mgai + 500 gai/100 kg is the rate that will be marketed as Aeris (Table 3). Cotton seedling stand was not affected by the Bayer seed treatments. Throughout the season no treatment reduced reniform numbers ($P \leq 0.05$) as compared to the untreated control. Seed cotton yields varied by 495 kg/ha at harvest with an average of increase of 300 kg/ha of seed cotton produced over all nematicides. The application of Temik 15 G increased yield by 495 kg/ha. The Gaucho Grande FS + exp 3 over all three rates increased yield by 300 kg/ha. The Gaucho Grande FS + GB 126 seed treatment yield was similar to all the Gaucho Grande FS + exp 3 and Temik 15 G nematicide treatments. All nematicide treatments numerically increased yields as compared to the non treated control under these drought conditions in north Alabama.

Table 3. Effect of Gaucho Grande and Bayer experimentals on stand, reniform nematode numbers, and seed cotton yields in northern Alabama.

		Stand	*Rotylenchulus reniformis*/150 cm			Seed cotton
Treatment	Rate	25' row	28 DAP	77 DAP	133 DAP	kg/ha
1. Untreated		95	2132 ab	587 ab	185.4	2395 bc
2. Gaucho Grande FS	0.375 mgai	96	711 ab	309 b	154.5	2646 abc
3. Gaucho Grande FS + GB126	0.375 mgai	100	1097ab	232 b	231.8	2721 abc
4. Gaucho Grande FS + exp 3	0.375 mgai+ 350 gai/100 kg	93	556 b	603 ab	170.0	2630 abc
5. Gaucho Grande FS + exp 3	0.375 mgai+ 375 gai/100 kg	101	1267 ab	680 ab	170.0	2699 abc
6. Gaucho Grande FS + exp 3	0.375 mgai+ 500 gai/100 kg	92	819 ab	773 ab	195.7	2762 ab
7. **BCSTON02100602+L1505A**	0.34 +0.15 mgai	98	2997 a	1035 a	262.7	2521 bc
8. Temik 15G	840 g ai/ha (7lb/a)	93	1174 ab	556 ab	432.6	2890 a
LSD (0.05)		13	2305	623	286	329

In southern Alabama, reniform nematode numbers at planting averaged 1159 vermiform life stages per 150 cc of soil (Table 4). Reniform nematode numbers were not different ($P \leq 0.05$) from the untreated control at any sample date through the season. The seed treatments Gaucho Grande FS + GB 126 and BCSTON 02100602 + L1505A had fewer nematodes ($P \leq 0.05$) as compared to Gaucho Grande FS + exp 3 at the mid rate. By 84 DAP, reniform numbers increased in all plots; however, BCSTON 02100602 + L1505A and Temik 15 G ($P \leq 0.05$) supported lower levels of reniform than the Gaucho

Grande FS + exp 3 at the high rate. All reniform numbers had dropped to below at plant populations by 133 DAP. Seed cotton yields varied by 284 kg/ha at harvest with an average of 2035 kg/ha for the Gaucho Grande FS + exp 3 over all rates. No nematicide treatment increase yields as compared to the non treated control under these drought conditions. However, yields in the BCSTON 02100602 + L1505A treatment were greater than those in the Gaucho Grande FS + GB 126 and Temik 15 G plots.

Table 4. Effect of Gaucho Grande and Bayer experimentals on stand, reniform nematode numbers, and seed cotton yields in southern Alabama.

Treatment	rate/ seed or ha	Applied	*Rotylenchulus reniformis*/ 150 cm 40 DAP	85 DAP	133 DAP	Seed cotton kg/ha
1. Untreated			1365 ab	7377 ab	798	1944.9 ab
2. Gaucho Grande FS	0.375 mgai	seed	1481 ab	5455 ab	571	2117.0 ab
3. Gaucho Grande FS + GB 126	0.375 mgai	seed	1172 b	5356 ab	571	1921.2 b
4. Gaucho Grande FS + exp 3	0.375 mgai+250 gai/100kg	seed	1687 ab	6674 ab	713	1960.0 ab
5. Gaucho Grande FS + exp 3	0.375 mgai+375 gai/100 kg	seed	2253 a	5601 ab	481	2124.8 ab
6. Gaucho Grande FS + exp 3	0.375 mgai+500 gai/100 kg	seed	1558 ab	9918 a	790	2021.7 ab
7. BCSTON 02100602 + L1505A	0.34 +0.15 mgai	seed	876 b	3558 b	691	2229.3 a
8. Temik 15G	840 g ai/ha (7lb/a)	infurrow	1378 ab	2600 b	687	1890.4 b
LSD (0.05)			1073	5087	430	304