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CONCURRENT EVALUATION OF RENIFORM NEMATODE AND EARLY SEASON INSECT POPULATIONS AS INFLUENCED BY ENHANCED DEGRADATION OF ALDICARB

Taylor V. Boozer
Auburn University
Auburn, AL
K. S. Lawrence
Auburn University
Auburn, AL
C. H. Burmester
Auburn University
Auburn, AL
Y. Feng
Auburn University
Auburn, AL
B. L. Freeman
Auburn University
Auburn, AL
E. Van Santan
Auburn, AL

ABSTRACT

Observations in upland cotton (*Gossypium hirsutum*), production indicate that when aldicarb degrades rapidly reniform nematode (R*otylenchulus reniformis*), and early season insect populations increase. We assessed nematode and insect populations in eight cotton fields in northern Alabama and concurrently evaluated the degradation of aldicarb in those fields. Treatments consisted of aldicarb (Temik 15G) applied as a granular in-furrow at planting, avermectin (Avicta) seed treatment, and thiamethoxam (Cruiser) seed treatment. All treatments were arranged in a randomized complete block design and replicated three times with plot widths of 4 to 12 rows and rows lengths of 1,000 feet. High-performance liquid chromatography (HPLC) was used to measure the degradation of aldicarb and it's metabolites. Reniform population levels were determined monthly fore each plot at each location. Plots were also evaluated for thrips, aphids, and mites at 3, 4, and 5 weeks after planting. HPLC indicated aldicarb degraded within 10 days in four of the eight soils. In all eight locations, reniform populations were not reduced ($P \leq 0.05$) by aldicarb or avermectin as compared to the thiamethoxam treatment. Thrip numbers varied between treatments and location as well. Total thrip adults and larvae numbers were similar in the thiamethoxam and aldicarb treatments. Averaged over all locations, Avicta produced 2048.75 lb/A of seed cotton compared to 1973.33 lb/A in the Temik 15G treatment. The Cruiser control plots averaged 1946.25 lb/A.

INTRODUCTION

A loss of efficacy of Temik 15G to the reniform and root-knot nematodes has been reported in Alabama, Arkansas, Louisiana, and Mississippi. Enhanced microbial degradation of aldicarb and it's metabolites has been confirmed for two cotton fields in Alabama and one in Mississippi, thus explaining the loss of efficacy in these locations. Concurrently, many cotton producers in the mid south and southeast have opted to include insecticidal seed treatments for thrip control in their production systems. These insecticides have no activity on nematodes but streamline planting operations by eliminating the need for the granular pesticide applicator use at planting. Seed treatments simplify the planting process and reduce producer's exposure to pesticides. The objective of this study was to determine the efficacy of Avicta and Temik15G on insects and nematodes in fields with and without aldicarb degradation to determine the optimal fit of each nematicide.

MATERIALS AND METHODS

Tests were established to determine the efficacy of Temik 15G and Avicta for nematode and insect management in cotton fields in north Alabama. Treatments consisted of: 1) Temik 15G (aldicarb) applied at 5 lb/A; 2) Cruiser (thiamethoxam) treated seed; and 3) Avicta (Abamectin) treated seed. The manufacturer applied Avicta and Cruiser seed treatments. Aldicarb was applied at planting in the seed furrow with chemical granular applicators attached to the planter. All treatments were arranged in a randomized complete block design and replicated three

times with plot widths of 4 to 12 rows and rows lengths of 1,000 feet. Yields were determined by weighing the seed cotton produced in the plot area in a boll buggy.

Insect populations

All plots were evaluated for early season insect populations. Five seedlings were randomly selected from each plot on the sampling date. The seedlings were rinsed in 70% ethyl alcohol, the contents were filtered, and the insects were counted using a stereoscope. Adult and larval thrips were tallied separately. One larval thrip is the most commonly accepted threshold.

Reniform populations

Plots were sampled for reniform populations at planting, at 30 and 60 days after planting, and at harvest. Twenty soil cores, 2.5 cm in diameter and 20 cm in deep, were collected from both rows in a plot using a systematic sampling pattern. Composite soil samples were sealed in plastic bags and stored in a cooled ice chest as they were collected then transferred to a 5°C refrigerator for storage prior to extraction. Nematodes was extracted from a 150cm^3 sub-sample by gravity screening and sucrose centrifugal flotation and then enumerated

Aldicarb degradation

To determine if enhanced microbial degradation was occurring in each field a bulk soil sample was collected. One half of the soil from each location was sterilized by autoclaving at 121˚ C and 103.4 kPa for two hours on two consecutive days. The remaining soil was not autoclaved. Temik 15 G was incorporated at 5 lb/A into the top 5 cm of soil in each pot in both natural and sterile soils for all locations. Pots were placed in the greenhouse in a randomized complete block design with two replications. After 10 days the entire soil volume from each pot was collected for analysis. Soil weight and moisture content at collection were ascertained. The soil samples were thoroughly mixed, sealed in plastic bags, and placed at -20 C. Aldicarb and it's two metabolites, aldicarb sulfoxide and aldicarb sulfone were extracted from the soil samples according to the Standard Operating Procedure 90013 developed by Rhone-Poulenc Ag Company. Briefly, a soil sample (100g wet weight) was weighed into a 250 ml glass jar and 100 ml of distilled water was added. The glass jar was tightly capped, vigorously shaken for 30 seconds and allowed to stand for 30 minutes. This procedure was repeated two additional times. The soil suspension was centrifuged at 6233 x g for 15 minutes. The supernatant was filtered through a 0.45 µm membrane and concentrated using a H2O-Phobic DVB solid phase extraction column (J. T. Baker, Phillipsburg, NJ) according to manufacturer's specifications. HPLC analysis was used to determine aldicarb, aldicarb sulfoxide, and aldicarb sulfone concentrations. Samples were analyzed using a Waters Alliance 2690 system (Waters Corporation, Milford, MA) consisting of a Supelcosil LC-18-DB column (Supelco, Bellefonte, PA) and a dual wavelength UV detector set at 220 and 247 nm. The mobile phase at a flow rate of 1 ml/min was a mixture of component A containing 1/1/18 acetonitrile/methanol/water (v/v/v) and component B containing 2/2/1 acetonitrile/methanol/water (v/v/v). The initial mobile phase composition of 100% A was first brought to 60/40 A/B within 20 min, then brought to 100% B by 25 min, and held at that composition for 2 min. The samples injection volume was 50 µL.

Data analysis

Count data were analyzed using generalized mixed models Nelder and Wedderburn, (1972) implemented in the SAS® procedure GLIMMIX (http://support.sas.com/rnd/app/papers/ glimmix.pdf). The negative binomial distribution with a log link function was used as the underlying distribution for vermiform counts in order to account for over dispersion. Cotton yield data were analyzed using mixed models methodology as implemented in SAS® procedure MIXED (http://support.sas.com/onlinedoc/913). In all cases location, treatment, and their interaction were considered to be fixed effects and blocks (location) was a random effect.

RESULTS AND DISCUSSION

Aldicarb degradation

Enhanced aldicarb degradation occurred in four of the eight fields selected. Aldicarb and it's metabolites were not detected by HPLC analysis in the natural soils from the Hargrave, Lee, Murphy, or Thorton locations (Fig. 1).

Aldicarb was detected in these four locations when the soil was autoclaved (sterilized) before aldicarb addition. Aldicarb and aldicarb metabolites were present in the Hamilton, Jennings, Shaw and Whitehead sites in both the natural and autoclaved soils.

Insect populations

The tobacco thrip, *Frankliniella fusca*, was the predominated species of thrip commonly found in the cotton fields. The effect of location and nematicide was significant at P=0.02 consequently insect counts were combined over time. The Shaw, Murphy, and Thornton fields encountered the highest levels of insect infestations. The Murphy location was the only site where Temik 15G reduced ($P \leq 0.05$) thrip numbers to lower levels than the Avicta and Cruiser treatments.

Reniform populations

Average reniform nematode populations varied widely through out the season samples. The effect of location, nematicide, and time was significant at P=0.003 (Fig. 2). The locations Hargrave, Lee, Murphy, and Thorton, which exhibited enhanced microbial degradation of aldicarb, did not have higher numbers ($P \leq 0.05$) of reniform nematodes in the Temik 15 G plots compared to Avicta or Cruiser at any sample data. The number of nematodes would have been expected to be similar between the Cruiser and Temik 15 G treatments since Cruiser is an insecticide without nematicidal activity and enhance degradation of Temik 15 G occurred in these locations. However, Avicta did not reduce reniform number to lower levels than the Cruiser and Temik 15 G treatments. Nematode numbers were similar in the Hamilton, Jennings, Shaw, and Whitehead locations. No differences ($P \leq 0.05$) in nematode numbers were observed between the three nematicide/insecticide treatments.

Averaged over all locations, Avicta produced 2048.75 lb/A of seed cotton compared to 1973.33 lb/A in the Temik 15G treatment. The Cruiser control plots averaged 1946.25 lb/A. Hargrave, Lee, Murphy, and Thorton locations which exhibited enhanced microbial degradation of aldicarb, produced similar seed cotton yields in the Avicta treatment as compared to the Temik 15G treatment. In all four locations there were no differences ($P \leq 0.05$) in yield between the Avicta, Temik 15G, and Cruiser treatments. The Hamilton, Jennings, Shaw, and Whitehead locations produced comparable results. In these locations, yields were not different ($P \leq 0.05$) between the three treatments. In the Hamilton and Whitehead sites, cotton yields were very low. Hamilton's low yields were due to dry weather in August and September. The Whitehead site cut-out after hurricane Katrina and did not develop a top crop. The lack of response to nematicide treatment at both sites was greatly affected by the environment. The Lee site had the lowest reniform population throughout the season and also produced the highest yield of all the tests.

Nelder, J.A. and R.W.M. Wedderburn. 1972. Generalized linear models. J. Royal Statistical Society (A) 135: 370-384.

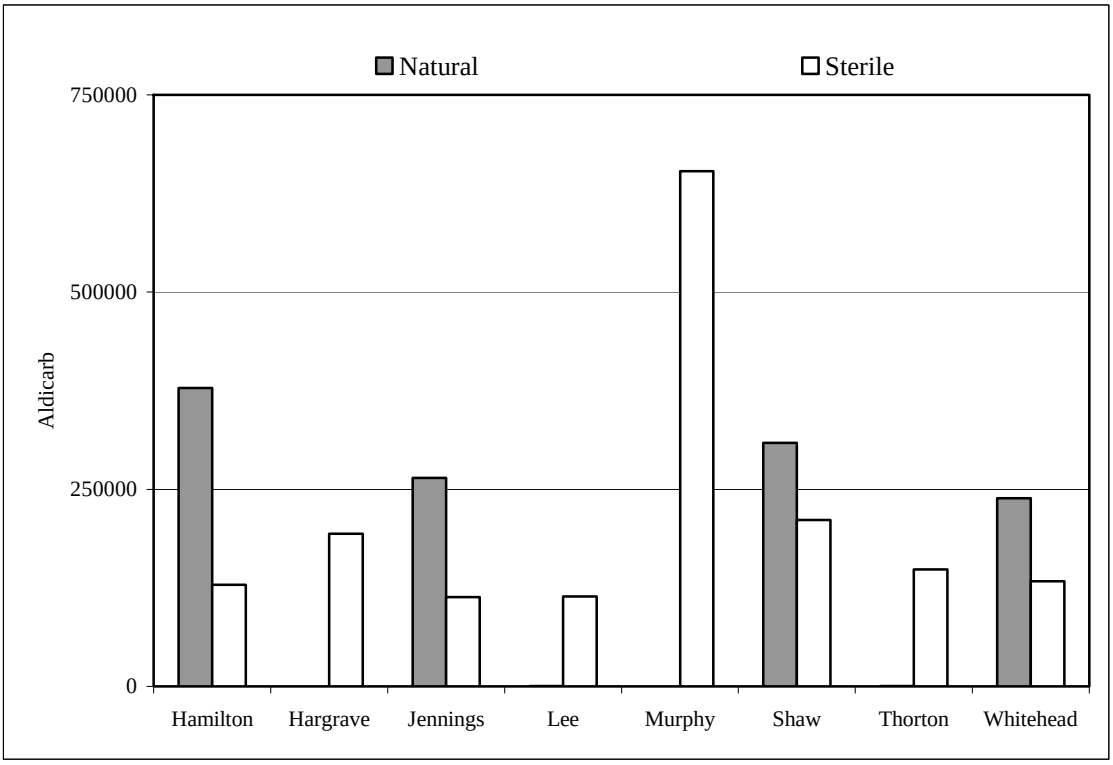


Fig. 1. Peak values of aldicab and it's metabolites in natural and autoclaved (sterile) soils for the eight on-farm trials in Alabama.

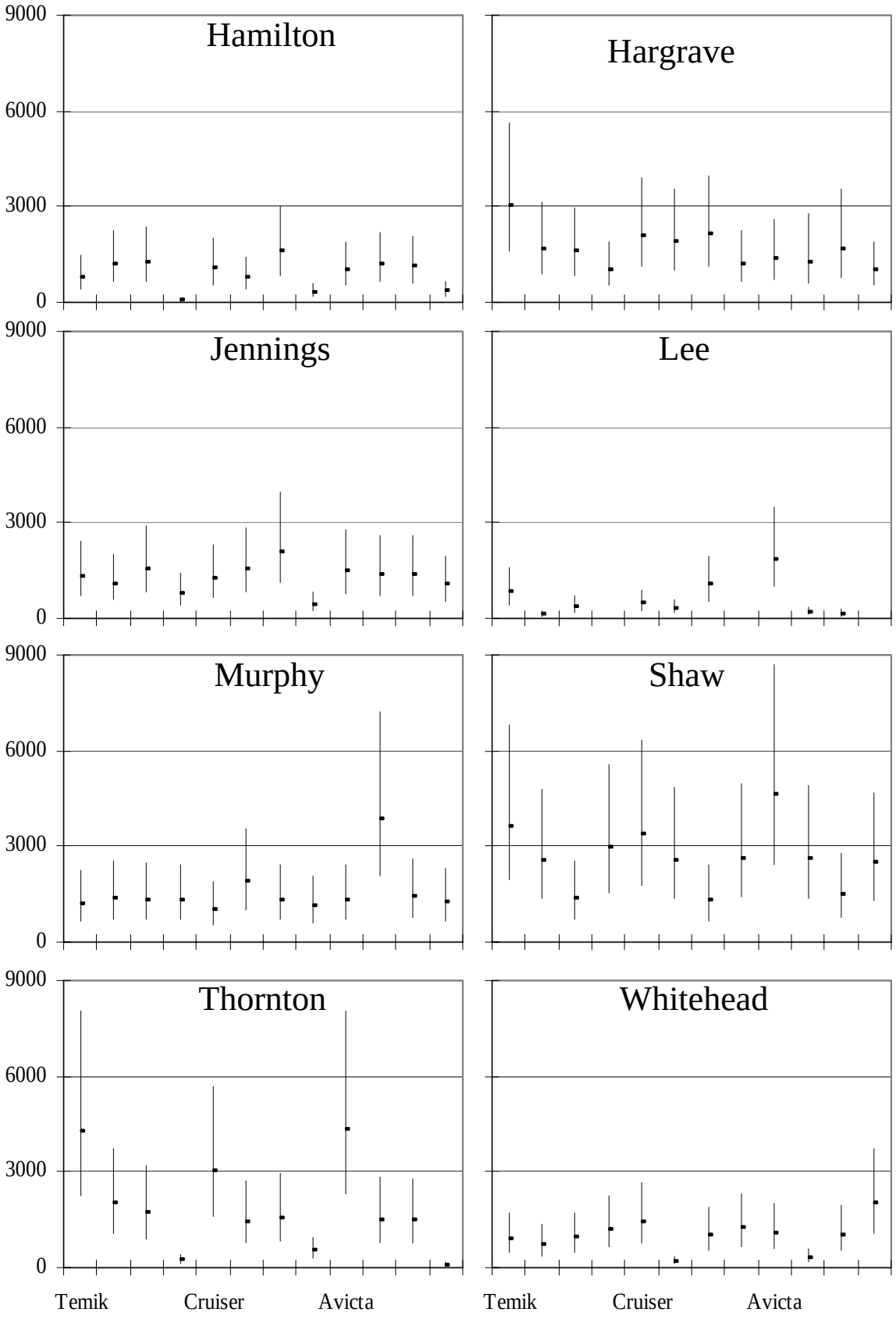
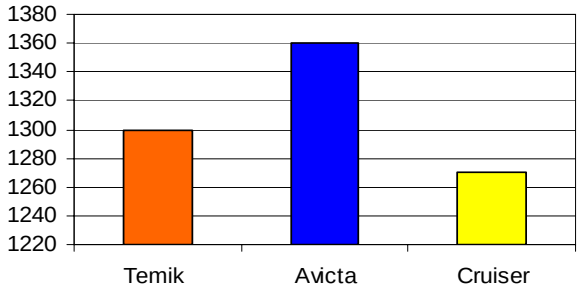
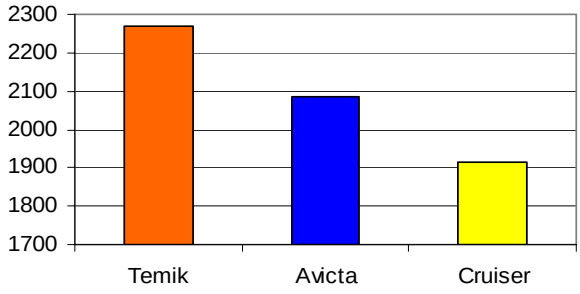

Hamilton
Hargrave
Jennings
Lee
Murphy
Shaw
Thornton
Whitehead
9000
6000
3000
0
Temik
Cruiser
Avicta

Fig. 2. Vermiform nematode numbers (count per 500 cc soil) for eight on-farm trials in Alabama in response to three nematicides. Location x treatment x month interaction was significant at $P = 0.003$. The main effect of treatment was not significant at $P = 0.10$. Within each nematicide group the bars represent counts for May, June, July, and October. Horizontal bars represent mean counts and vertical bars the 95% confidence intervals.

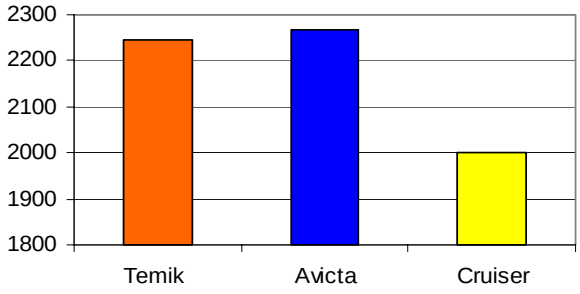
Hamilton



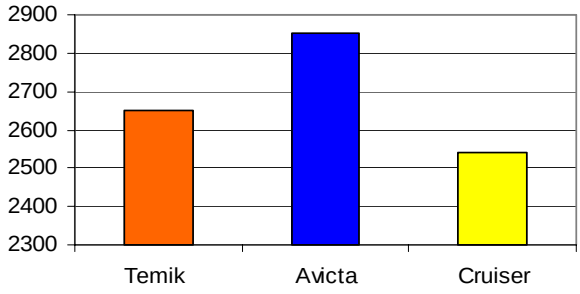
Hargrave



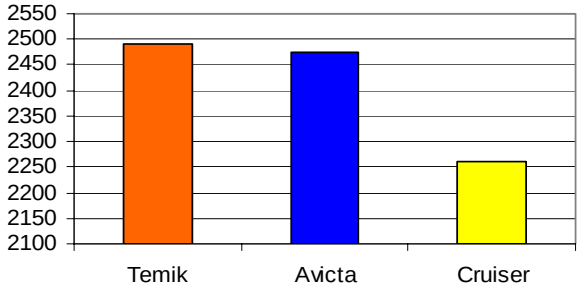
Jennings



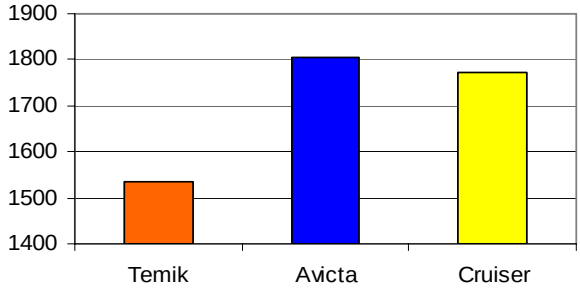
Lee



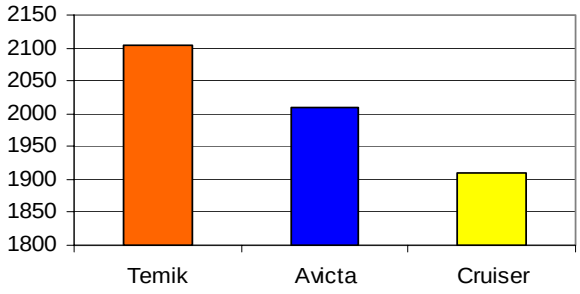
Murphy



SHAW



Thorton



Whitehead

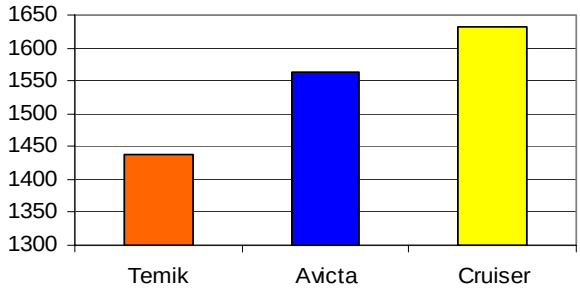


Fig. 3. Seed cotton yield for eight on-farm trials in Alabama in response to the Temik 15G, Avicta, and Cruiser treatments. Location x treatment interaction was not significant at $P = 0.1626$ although data is presented separately to show variation between sites. The main effect of treatment was not significant at $P = 0.10$.