AVICTA COMPLETE PAC EVALUATED ON A SILT LOAM SOIL INFESTED WITH NEMATODES

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Introduction

These studies detail experiments conducted in 2005 - 2007 and explore our ability to use GIS/GPS technique as aids for analyzing early season pest management problems in cotton. Avicta Complete Pac (ACP), fumigation with Telone II and variations in nitrogen and sulfur rates were included as test variables. Analysis of on-farm test data can produce erroneous experimental errors if standard interpretive statistical techniques are used. An alluvial test field infested with nematodes, located at the LSU Ag Center's Northeast Research Station, provided small plot test data and a larger on-farm test was also evaluated. Analysis using GIS methods illustrates performance strength and weakness for each individual treatment option and provides an introduction to using descriptive statistical technique suitable for analysis of thrips and nematode distributions and yield.

Seed treatments are conveniently popular but frequently require supplemental foliar treatments for insect pests or nematodes. Without adequate treatments for root knot and reniform nematodes annual losses would increase (Overstreet and McGawley, 1999; Overstreet and McGawley, 2000; Overstreet and McGawley, 2001; Overstreet et al., 2001). In cotton, nematodes are known to cause additional losses due to interactions with soil borne diseases and early insects like thrips (Burris et al., 1989; Burris et al., 1990; Colyer et al., 1991; Micinski et al., 1992; Micinski et al, 1993). In addition to the disease and insect complications caused by nematodes, recent research documents that cotton plants failed to adequately use nitrogen in the presence of high root-knot nematode population densities. There is scant data evaluating seed treatments and fumigant combinations. Telone II fumigation treatments are specific for nematode control and can be cost prohibitive when yields are not increased due to treatment. However, these test data suggest fumigation and seed treatment combinations may be helpful when attempting to remediate light soil infested with high to very high nematode populations. Numerous on-farm tests conducted since 2001, support the use of apparent electrical conductivity zones (EC_a) and soil sampling for nematodes as key methodology for obtaining optimum yield from site-specific applications of Telone II fumigation treatments (Burris et al., 2006; Overstreet et al., 2004; Overstreet et al., 2005; Wolcott et al., 2005; Wolcott et al., 2006).

Current N fertilizer recommendations for the Mississippi River alluvial areas in LA are usually made depending on soil type. For lighter textured soils such as silt loam, 60 to 80 lb nitrogen per acre (N/A) is recommended, and on clays the recommendation is 90 to 120 lb N/A. The response of cotton to N on these soils may also depend upon cropping history, cover crops, and other factors (Boquet, 2000). GIS studies conducted within the last three year period resulted in evidence that root-knot nematode can severely limit nitrogen utility (Burris et al., 2005) and indicated a need for follow-up studies. Therefore, low, medium and high nitrogen rate selections were included for evaluation with the ACP and Telone II fumigation treatments.

Materials and Methods

Multiple tests for evaluating Avicta Complete Pac (ACP) were conducted at the Northeast Research Station and on a farm located in Tensas Parish, LA. Soils targeted for testing included delta silt loams (Commerce or Dundee) infested with moderate – high population densities of root-knot nematode and very low populations of *reniform* nematode. In all tests, nematode population densities exceeded economic threshold. Variables used for comparative analysis of treatments included efficacy data for thrips insects, laboratory analysis for plant parasitic nematodes, plant phonology ratings, and yield. Treatments included in the tests were various combinations of ACP, standard nematicides, and selected rates of nitrogen (N). Nematicide treatment standards used for seed treatment comparisons included aldicarb in-furrow treatments applied at 0.75 lb AI/A and/or fumigant treatments of Telone II applied at 3 gallons of product per acre (GPA). Thrips species were used as an indicator to determine the efficacy of ACP's insecticide component thiomathoxam applied at the rate of .34 mgAI/seed. Plant samples of 5 plants per plot were collected at least one time per week from treated cotton between 7 and 60 days after emergence. Samples were processed with whole plant washing procedures (Burris et al., 1990). Plants collected from the field were immediately placed in 1 qt jars and transported to the laboratory for counting using a binocular microscope. Prior to counting, plants were thoroughly washed to dislodge insects which were collected on 300 mesh screens that were backwashed onto a Buchner funnel containing ruled filter paper. Nematode ratings were taken using a root rating system or laboratory counts to determine the efficacy of the nematicide component abamectrin applied at the rate of 0.15 mg AI/seed. Nematode population densities were monitored using 6 inch soil sample cores taken from each plot at mid-season. Nematode samples were processed for counting using elutriation, a centrifuge and sugar flotation.

Geographical Information Systems (GIS) and Geographical Positioning Systems were used in the analysis of data collected from small plots on the experiment station as follows: The soil type was Commerce silt loam. ACP was evaluated with and without Telone II for managing early season insect and nematode complexes. In addition, a low nitrogen strategy was included with the Telone II plus Avicta combination. Cotton seed were planted on 23 Apr. The seeding rate was 39,200 seed/acre. Deltapine 555 was used as the seed treatment standard and Deltapine 494 was used in the non-treated. The test area received fall-applied soil amendments which included 1 ton of lime, 100 lb of a complete fertilizer (0-0-60), and 45 lb of K-Mag per acre. A John Blue VR-2455 applicator was used to apply a sidedress application of a mixed liquid fertilizer (30-0-0-2) on 1 Jun. The ACP seed treatment plus Telone II plot was sidedressed with 24 gallons of fertilizer to supply 80 lb of actual nitrogen (N) and 5.34 lb of sulfur, and was considered a low N strategy. The ACP seed treatment and the non-treated plots were sidedressed with 37.2 gallons of fertilizer to supply 120 lb of actual N plus 8.0 lb of sulfur, and was a high N strategy. Plot size was thirty two rows (centered on 40 inches) by 50 feet. Thirty-two GPS sample points (replicates) were recorded per block and identified with bicycle flags placed 12 ft from the ends and between the fourth and fifth row of each eight row set, providing a total of 96 sample locations for the 3 treatments. Orthene 90S, 0.3 lb AI/A was applied as a foliar insecticide treatment for thrips on 26 Jun with a high clearance sprayer calibrated to deliver 6 gpa through Teejet TX-8 hollow cone nozzles (2/row). Insect treatment efficacy was determined by sampling 5 plants at each GPS point. Plant and soil samples were collected within a 15 ft radius of each GPS point to monitor insect and nematode populations. Thrips were quantified in the laboratory at the Northeast Research Station. The species and number of nematodes were determined at the Nematology laboratory in Baton Rouge, LA. Thrips and aphid counts were recorded 30 DAP, and 12 DAT 1. Plant stand counts were taken on 29 May and Greenseeker Normalized Difference Vegetative Index (NDVI) data was recorded on 15 Jun. Root-knot nematode counts and 1st square ratings were recorded on 11 Jun. Plots were harvested with a mechanical harvester equipped with a sacking attachment on 10-28-07. Economic treatment comparisons were calculated using costs of $45.00 / acre for Telone II, $18.81 / acre for ACP, $60.74 / acre for Deltapine 555 seed, $43.25 / acre for Deltapine 494 seed, $44.64 / acre for 24 gal of 30-0-0-2 fertilizer, and $66.96 / acre for 37.2 gal of fertilizer.

The test conducted on Helena plantation was planted in late April. Soils were Dundee silt loam transitioning into Tensas clay. Deltapine 164 was the farmer standard. Seeding rate was ca. 40,000 seed/acre planted with 12 row equipment. Seed treatment, Telone II and nitrogen treatments were included in the test. Telone II and ACP were main plots and nitrogen applied sidedress were sub-plots. A commercial blend of 30-0-0-2 was applied with the John Blue VR-2455 applicator at 24 GPA to supply 80 lb N/acre, 35.6 GPA to supply 115 lb N/acre and 41.8 GPA to supply 135 lb N/acre. Test plots were replicated three times. Aerial imagery was used to measure normalized vegetative index (NDVI) in early July and late August (Fig. 3). Yields were harvested using a John Deere picker equipped with a GS2 and yield monitor. Data were imported to Apex and exported as a shape file. Yield harvest data was cleaned using the USDA-ARS yield cleaner. From that analysis, raw point data was used in the GIS programs. Data analysis and mapping was accomplished using GeoStatistical tools in ArcGis 9.1 and GeoDa 0.9.

In the small plot tests treatments, data were subjected to ANOVA and means separated according to Fisher's protected least significant difference. Geo-referenced test points were also converted to centroids using SSTool Box and Geostatistical and GeoSpatial analysis was performed using ArcGis 9.1 and GeoDa 0.9 (Anslin, 2003a). The data was interpolated using Inverse Distance Weighting. Root Mean Square (RMS) and Standard Deviation (S.D.) obtained after the individual treatments were converted into test polygons was used to compare consistency of yield across treatments. GeoDa 0.9 was used to generate a spatial weights matrix, statistical graphs (histograms and scatter plots) and perform ordinary least squares regression analysis. Global spatial correlation was evaluated using Univariate Moran I scatter plots either in ArcGis 9.1 or GeoDa 0.9.

Results

Small plot tests indicated improved Thrips control for Cruiser seed treatment when the rate was increased to 0.34 mg/seed and further improvements when a nematicide component was included in the Avicta Complete PAC (ACP). Nymph efficacy for the seed treatments was numerically better on the initial observation dates, but appeared to release control earlier as compared to the efficacy provided by Temik 15G (Figs 1, 2 and 3). Thrips nymph numbers recorded 30 DAP were significantly higher in the ACP with 120 lbs N and ACP + Telone with 80 lbs N plots as compared to the non-treated plots. Thrips numbers taken 12 DAT-1 were significantly higher in the non-treated plots. Aphids were significantly higher in the non-treated at 30 DAP and 12 DAT-1 (Table 1).

Plant stand was significantly lower in the non-treated plots compared to the stand in the ACP and ACP + Telone II treated plots. The addition of Telone II significantly increased stand compared to the ACP alone treatment. Root-knot nematodes were significantly lower in the ACP and ACP + Telone plots compared to that in the non-treated plots. Use of IDW interpolation to create a surface of the plots provided maps of the thrips and nematode hot-spots that could be developed into prescriptions suitable for site-specific application (Fig. 5 and 6). The first fruiting node with a square was significantly lower in the ACP + Telone II plots compared to the other treatments. The NDVI recorded on 15 Jun was significantly higher in ACP plus Telone plots as compared to the other treatments. Lint yields were significantly increased with the ACP and ACP plus Telone II compared to the non-treated plots. The RMS value for yield was 61.27 and 56.58 and 215.6 for the ACP plus Telone, ACP and non-treated plots. The Standard Deviation (S.D.) was 63.70, 64.04, and 195.93 for the treatments. The RMS and S.D. values indicate more consistent lint yield in the ACP plus Telone II plus low N and ACP plus high N strategies and considerably more variability in the non-treated plots. Net income for the treatments was $76.92 for ACP plus Telone II plus 80 lb of actual N plots and $100.24 for ACP plus 120 lb of actual N plots. A net loss of $22.32 was incurred in the non-treated plots (Tables 1 and 2).

In the on-farm test, soil samples for nematodes, use of NDVI and testing over a three year period allowed researchers to isolate the nematodes to about 33 acres of a 105 acre field. Root-knot nematode infestations measured in 2005, 2006 and 2007 remained constant at levels of 5000-6000/ 500cc of soil despite one year rotation with corn. Analysis of the yield monitor data across the entire 33 acres indicated Morans I = 0.05 which supports spatial autocorrelation in the field and indicates high probability that site-specific treatments for soil issues and/or pests could be used effectively. Histogram analysis of the entire 33 acre field shows lint yield ranged from values of 480.1 – 1918.7 and the mean was 1315.7 (Fig. 7 and 8). There was a highly significant response to Telone II treatment and no significant differences in nitrogen rates (Fig.9).

Typically, test evaluations of farm fields reveal several problem areas; maps of the lowest yields indicate ranges from 480.1 – 1162.8 and reveals several trouble spots for the field. The upper 1/3 of the field is a low EC_a zone and at least 2 nematode hot-spots, as defined by soil samples, contributed to low yields in that zone. A line of damage caused by irrigation poly pipe can also be seen. In the lower left corner a drainage problem occurred in the clay portion of the field. The mid-section of the field which transitions from Dundee silt loam into Tensas clay produced very high yield as indicated by the bluish color. Individual analysis of selected plots was easily accomplished using selection features in ArcGis 9.1. For example, plot 103 which was Telone II plus ACP with a medium N rate strategy had a mean yield of 1364 lbs lint throughout the plot. In contrast, the treatments in plot 301 which were Telone II plus ACP plus a low rate N strategy had a mean yield of 1294 lb lint (Fig. 10). The mean yield for the plots with and without Telone indicated there were no significant differences in N strategy when the data was analyzed across the entire 33 acre field (Fig. 9).

When the analysis was restricted to the lowest EC_a zone that contained nematode hot-spots, the combination of Telone II and ACP plus medium N strategy produced 1642 lbs of lint. That treatment combination increased yield more than 300 lbs of lint as compared to the next best treatment with Telone II, and more than 400 lbs of lint as compared to the ACP treatments without fumigation. The high N (135 lb nitrogen plus 8 lbs sulfur) treatment strategy produced 100 lbs more lint with the addition of Telone II. The low rate nitrogen treatments produced comparable amounts of lint with and without fumigation (Fig. 11).

Discussion

The choice to use seed treatments is popular and frequently made by farmers in Tensas Parish, LA. These tests were conducted to evaluate the strengths and weaknesses of selected options to include with seed treatments for improving lint yield in cotton grown on light soil infested with nematodes. GeoSpatial analysis of yield indicated highly significant spatial autocorrelation in both the small plot and on-farm test, suggesting variability due to soils and/or soil pests.

The GeoStatistical analysis features of ArcGis 9.1 provided Root Mean Square (RMS) and Standard Deviation Values which indicated increased consistency for a specific treatment combination. Treatments that included nematicide control as compared to the non-treated produced the least amounts of variability. Inverse Distance Weighting (IDW) interpolation was found to be a useful technique for defining and isolating thrips and nematode population hot-spots in small plots containing geospatial records.

Defining the appropriate nitrogen strategy to use in the presence of nematodes continues to be a complicated problem. However, selection of a low rate nitrogen strategy of 80 lb actual N with Telone II failed to produce the highest yield at the small plot and on-farm test and was consistent with previous test data. A disease interaction between nematodes plus *Fusarium* wilt was observed to limit top fruit production in the low N plots thus preventing optimum yield.

Other benefits of using GIS maps and data to analyze farm fields were observed. Low and high yielding areas of the field were easy to select for analysis. Such results provide practitioners a means of follow-up for correcting problems like drainage, or amending agronomic and pest control practices.

When analysis was restricted to the low EC_a zone with nematode hot-spots, Telone II plus ACP and a medium N rate strategy of 115 lb N was significantly better than all other treatments. The high N plots (135 lb N) generally were later maturing compared to others and had more fruit set in the top 1/3 of plants. Yield was lost when the farmer elected to harvest before the high N plots matured. Stormy weather in the gulf was the main reason for the decision and would not be uncommon.

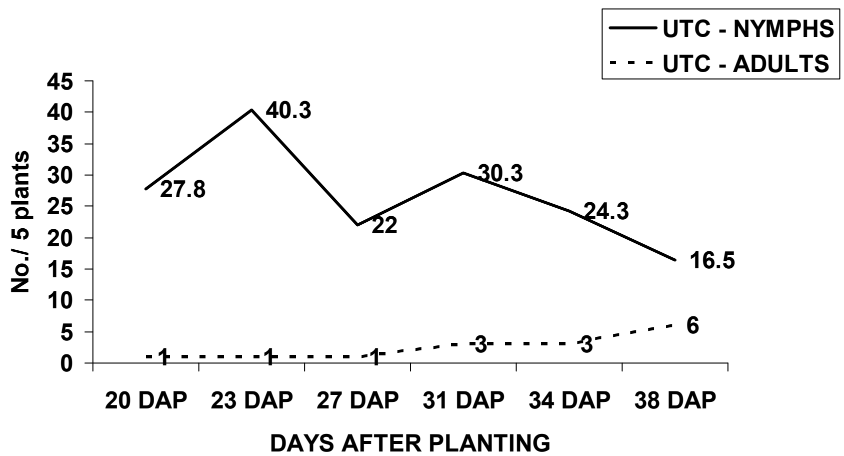

Fig.1 Thrips Occurrence In Untreated Plots

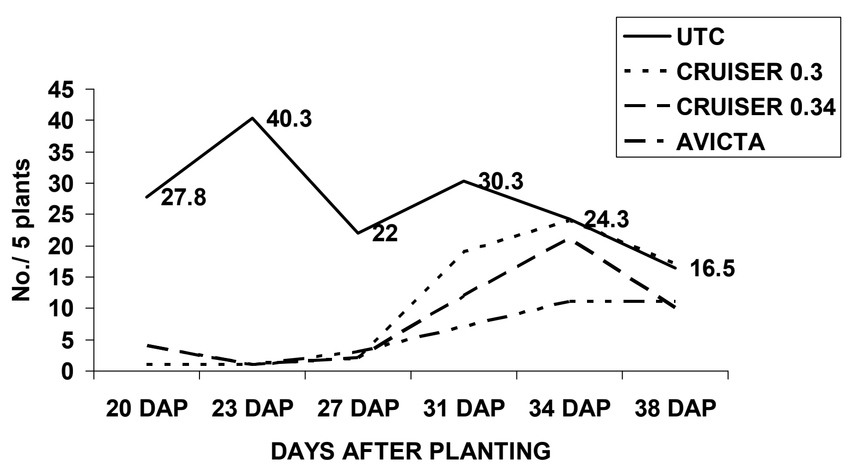

Fig. 2 Efficacy of Cruiser Rates and AVICTA Complete PAC

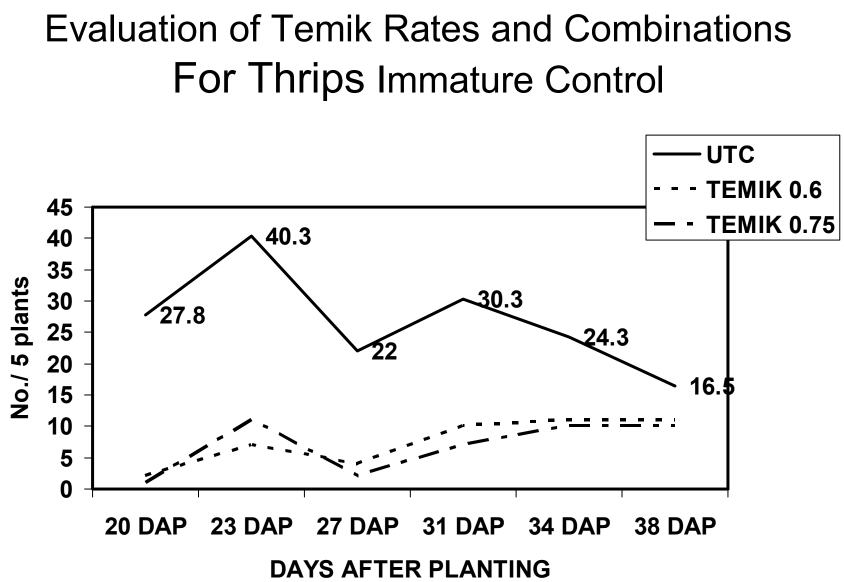

Fig. 3 Evaluation of Temik 15G for thrips nymph control

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Table 1. Treatment effects on early season thrips and aphids.

Treatment/formulation	Mg (AI)/seed	Thrips / 5 plants 30 DAP Nymphs	Thrips / 5 plants 12 DAT 1 Nymphs	Aphids /5 plants 30 DAP Adults	Aphids /5 plants 12 DAT 1 Adults
Non-treated + 37.2 GPA (32-0-0-2)		30.7b	8.5a	11.9a	70.6a
Avicta Complete Pac + 37.2 GPA (32-0-0-2)	0.52 Mg	112.5a	2.6c	0.8b	0.7b
Avicta Complete Pac + Telone II + 24 GPA (32-0-0-2)	0.52 Mg + 3 GPA	98.6a	4.8b	0.5b	0.8b
P>F		0.0001	0.0001	0.0001	0.0007

Means within columns followed by a common letter are not significantly different ($P \leq 0.05$, FPLSD).

Gal. product/acre.

Table 2. Treatment effects on Stand, Root-knot nematode, Node of 1st sq. and NDVI.

Treatment/formulation	Mg (AI)/seed	Plant Stand (No. / 25 ft)	Root-Knot nematode (No. / 500 cc soil)	Node of 1st Sq.	NDVI[a]
Non-treated + 37.2 gallons (32-0-0-2)b		40.1c	816.8a	6.4a	0.37b
Avicta Complete Pac + 37.2 Gal. (32-0-0-2)[b]	0.52 Mg	61.3b	320.6b	6.6a	0.41a
Avicta Complete Pac + Telone II + 24 Gal. (32-0-0-2)[b]	0.52 Mg + 3.0[b]	69.2a	141.8b	6.0b	0.55a
P>F		0.0001	0.0006	0.0013	0.0001

Means within columns followed by a common letter are not significantly different ($P \leq 0.05$, FPLSD).

[a]Normalized Difference Vegetation Index-

Gal. product/acre.

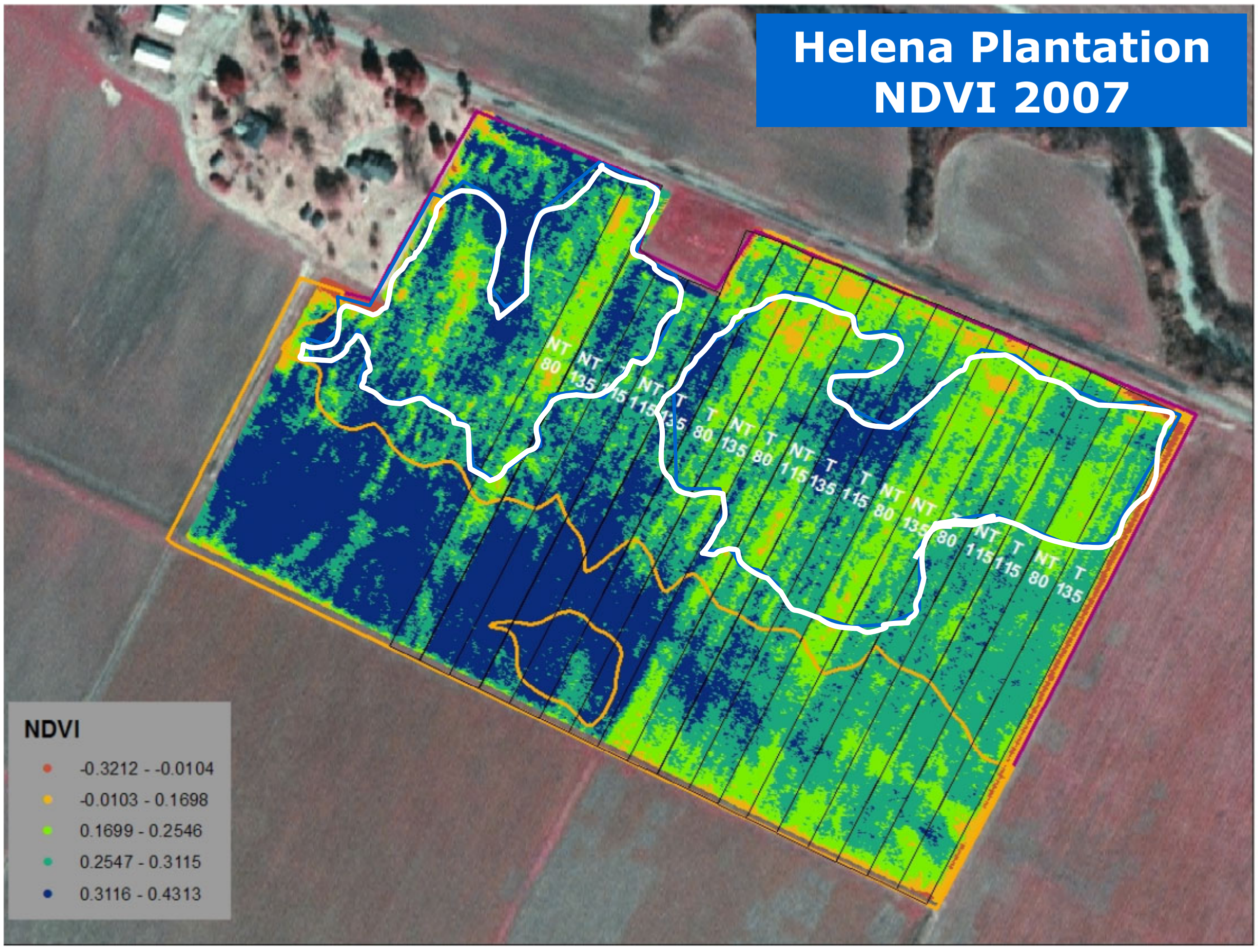


Fig. 4. A split plot design replicated 3 times consisting of Telone II, 3 GPA (T or NT) applied as main plots and low (80), medium (115) and high (135) rates of nitrogen (30-0-0-2) applied as sub-plots were used to evaluate a field on Helena Plantation. The test treatments were applied as strips and Avicta Complete PAC was used as a seed treatment on the entire field. White polygons are used to outline serious yield loss caused by nematodes in 2005. The test plots and polygons are layered over an NDVI picture taken in late August, 2007. Darker areas represent areas of higher plant bio-mass that aide in identifying treatment effects. The diagonal orange line was developed using Veris electrical conductivity and represents a transition from Dundee silt loam into a silty clay loam mix. The higher biomass readings in the lower left portion of the picture represent late cotton in a silty clay area of the field that was recovering from an early drainage problem.

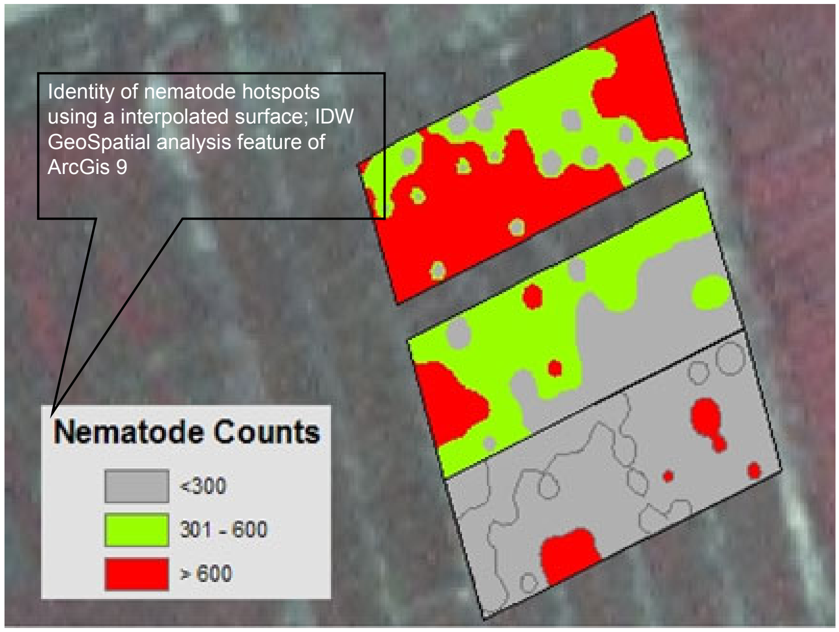


Fig. 5. Use of Inverse Distance Weighting in ArcGis 9.1 to identify nematode hot-spots in treatments that included Telone II (lower right plot) Avicta Complete Pac (middle plot) and a non-treated (top right). Soil samples for nematodes were taken from the drill on 11 June, 2007.

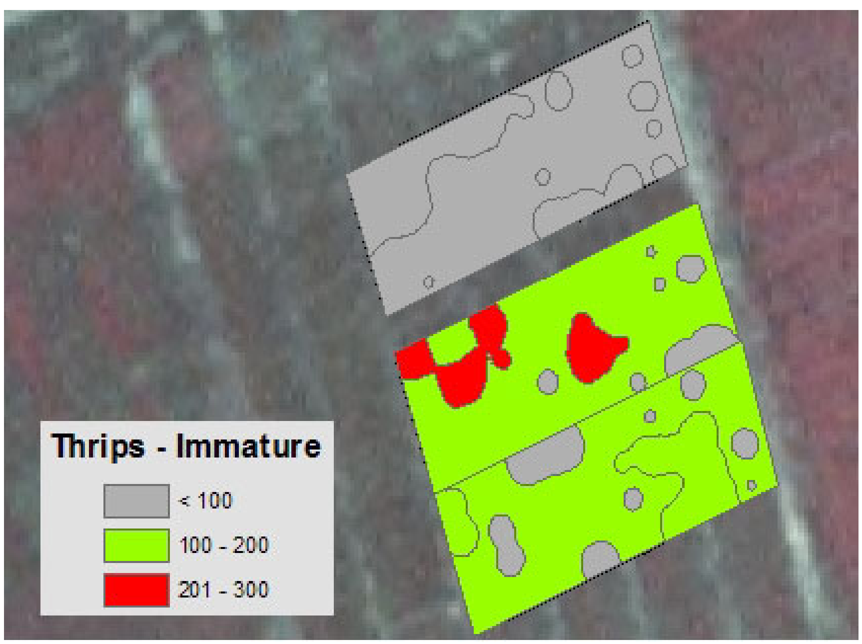
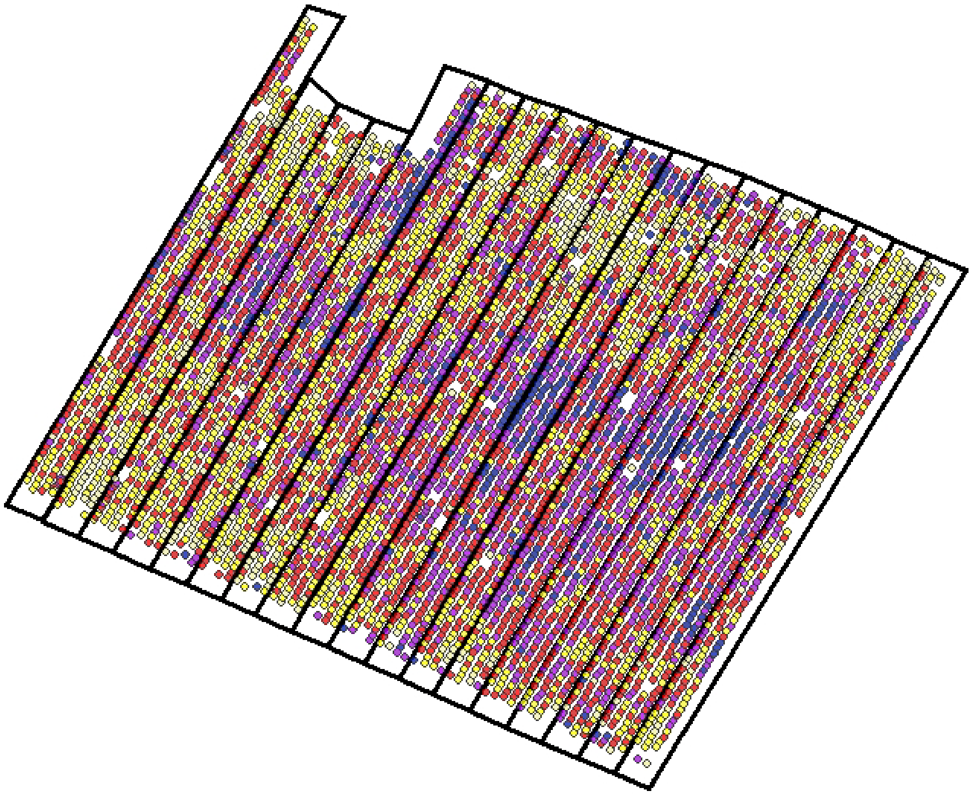


Fig. 6. Use of Inverse Distance Weighting in ArcGis 9.1 to identify thrips hot-spots in treatments that included Telone II (lower right plot) Avicta Complete Pac (middle plot) and a non-treated (top right). Thrips counts of the nymph stages of the insects were made at 30 days after planting.



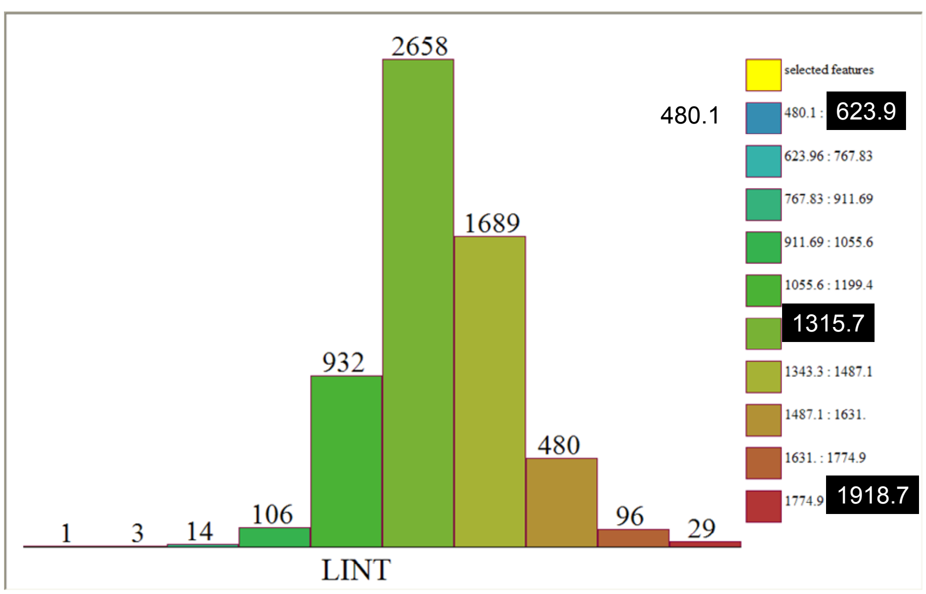
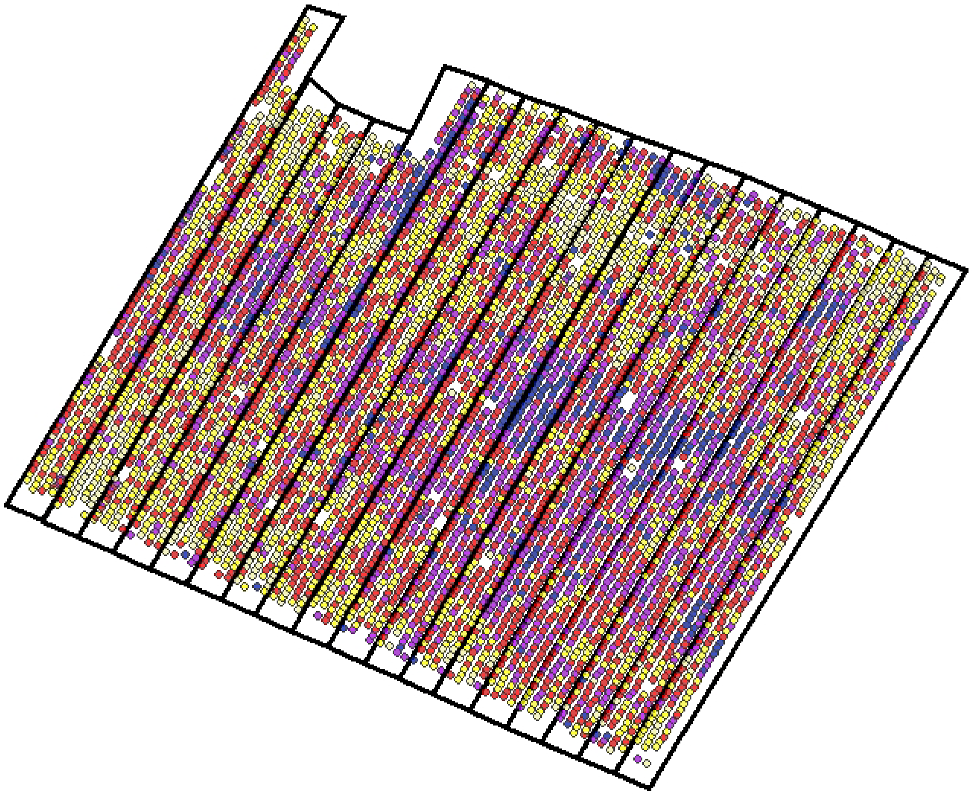


Fig. 7 Histogram analysis (frequency of occurrence lb lint per acre) of the clean yield monitor data from Helena Plantation, 2007. The analysis represents yield occurrence across the entire 33 acre field. Lint yields ranged from 480.1- 1918.7 lb lint/A.



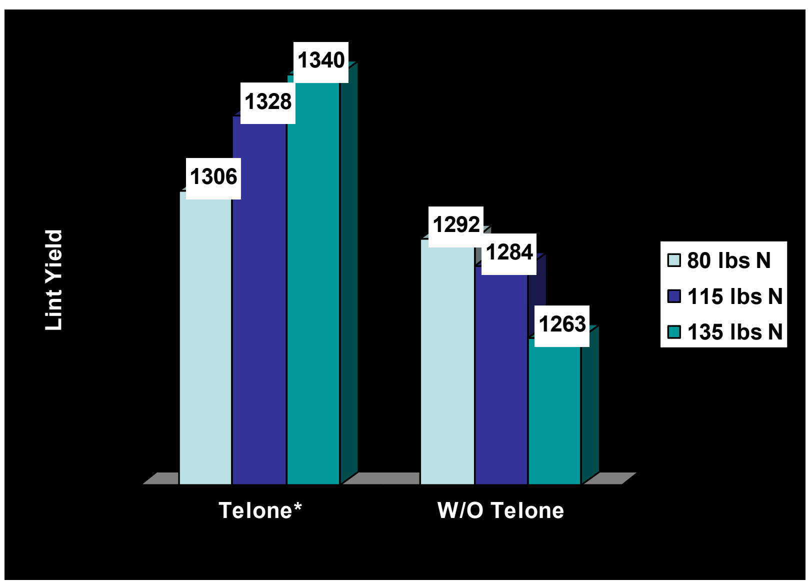


Fig. 8. Analysis of yield across the 33 acre test on Helena indicated treatment with Telone II was significant. However, there were no significant differences for the low, medium or high nitrogen management strategies. Means were extracted using ArcGis 9.1 and then subjected to Ordinary Least Squares analysis using GeoDa 0.9

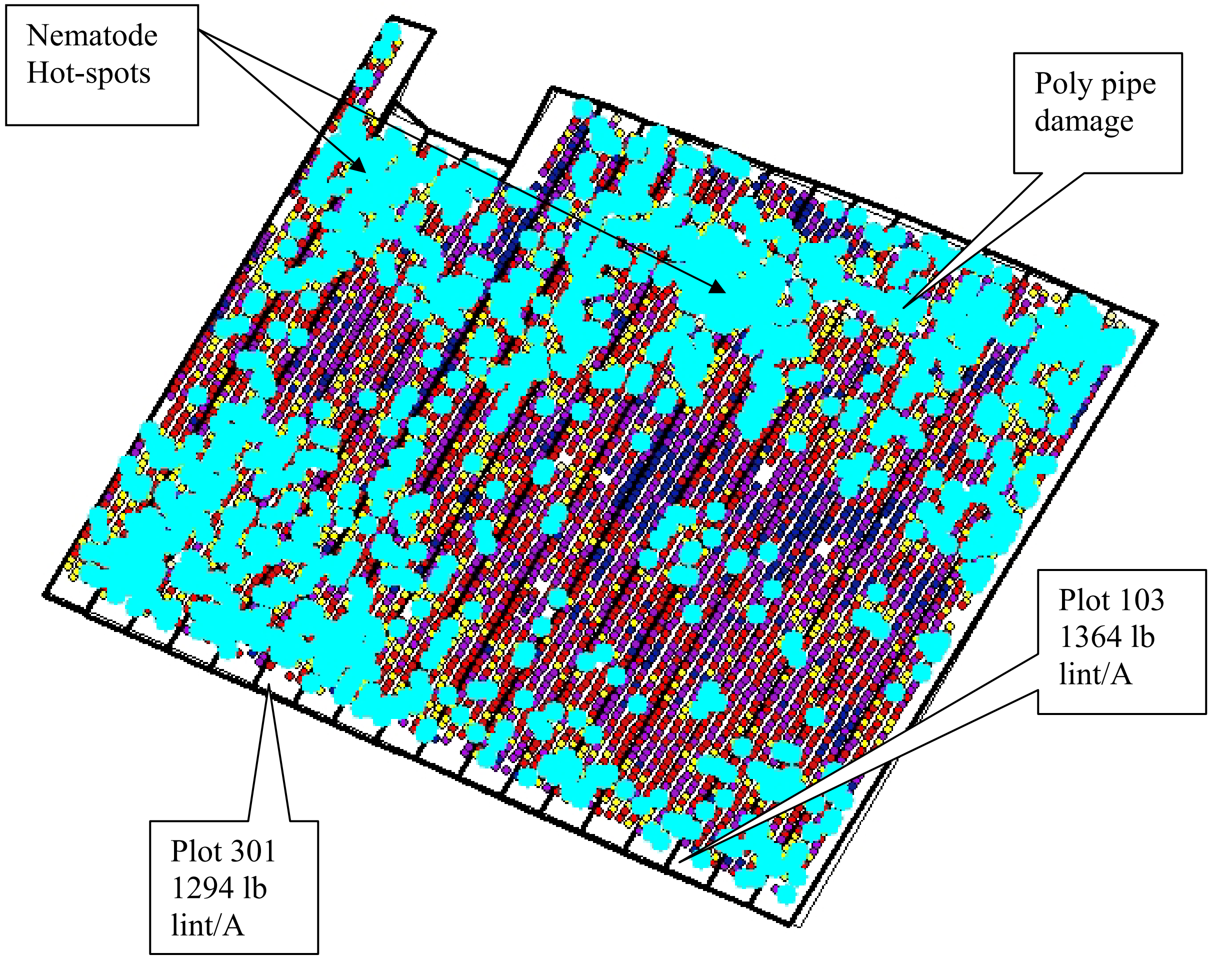


Fig. 9. Low lint yield data points are isolated using a Histogram created in ArcGis 9.1. These points represent yield that was generally less than 1000 lbs of lint. The upper 1/3 of the test is within a low EC_a zone and at least 2 nematode hot-spots as defined by soil samples can be seen. A line of damage caused by irrigation poly pipe can also be seen. In the lower left corner a drainage problem occurred. The mid-section of the field which transitions from Dundee silt loam into Tensas clay produced very high yield as indicated by the bluish color. Also plot 103 which was Telone II plus ACP with a medium N rate strategy indicates high (1364 lb lint/A) yield throughout the plot. In contrast, plot 301 indicates lower (1294 lb lint/A) yield. The treatments in 301 were Telone II plus ACP plus a low rate N strategy. These results indicate that GIS technique was useful in helping to isolate field problems and/or low yielding areas of a field and that testing in this manner could help fine tune N management strategies in the presence of root-knot nematode infestations.

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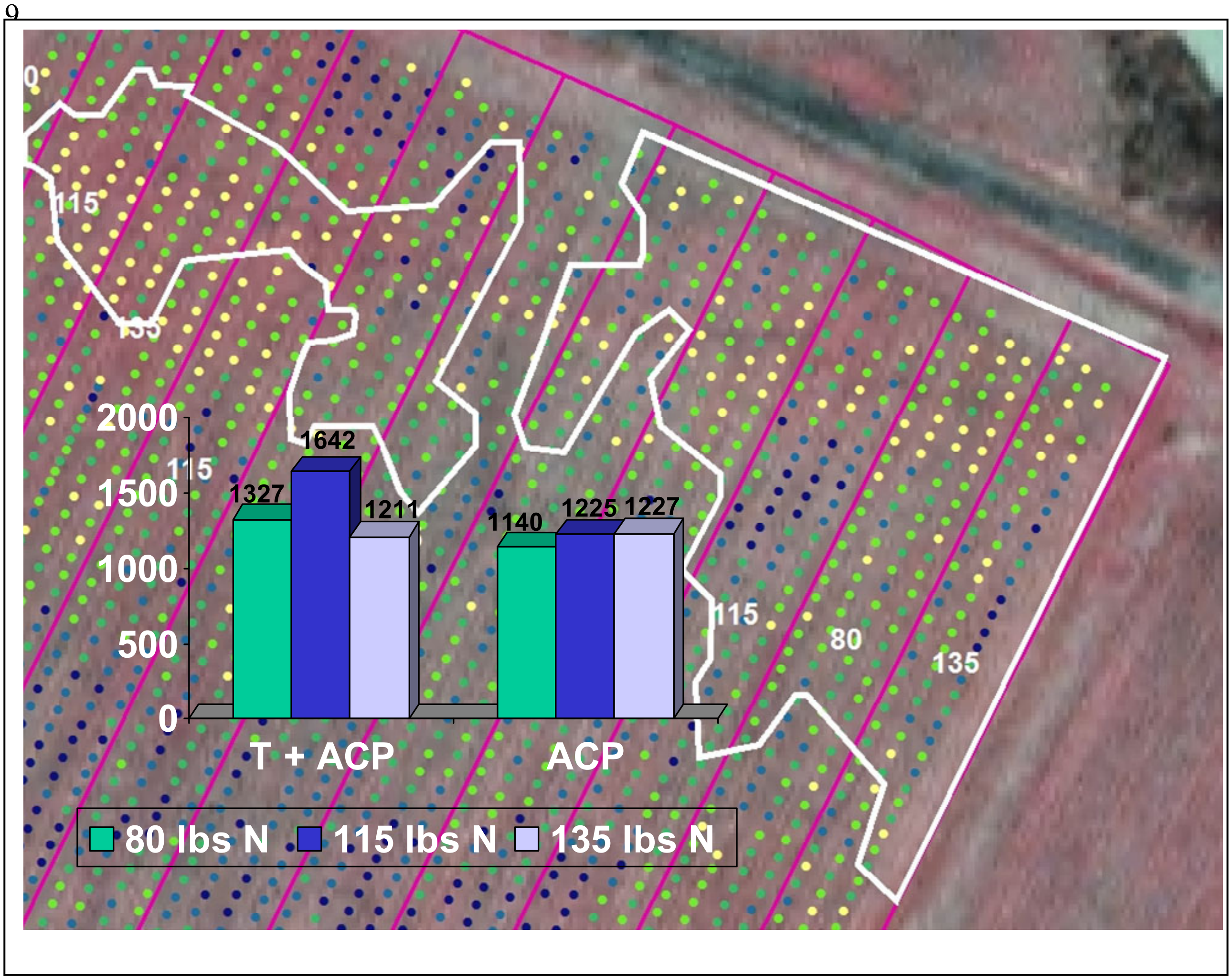

Fig. 10. A graph of lint yield for Telone plus Avicta Complete Pac (T plus ACP), ACP and low, medium and high nitrogen strategies is overlaid on clean yield point data. Yield responses to treatments represent results that were obtained for a problem area in a Dundee silt loam soil type. The areas identified by white polygons represent a zone of low EC_a. Soil samples taken within the zone also indicated high root-knot population densities.

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