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PHYSIOLOGICAL RESPONSES OF INSECTICIDAL USE ON COTTON

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Abstract

Maintaining profitability is key in any cropping system, causing producers to constantly strive to fine-tune management strategies to minimize inputs while optimizing yield. Because pesticides comprise a large portion of production inputs, reducing or enhancing their efficacy presents an avenue to increase profit. Pesticides containing both insecticidal and growth enhancing properties may be a viable option to increased profitability. In cotton (*Gossypium hirsutum* L.), early season applications of some insecticides have shown effects similar to those of plant growth regulators (PGRs). TRIMAX™ (imidacloprid) is one of these purported PGR insecticides. Centric® 40WG (thiamethoxam) a product similar to TRIMAX™, may also have like properties due to the fact that they are both in the nitroguanidine class of insecticides.

A field study was conducted at the Texas A&M Agricultural Experiment Station in Burleson County, Texas to assess the physiological effects of Centric® 40WG and TRIMAX™ on early season plant growth, rate of photosynthesis, yield and fiber quality. The statistical design consisted of a randomized complete block design with four replications. Treatments consisted of each of the insecticides being applied one, two, and three times at the 5-leaf stage, 5-leaf stage plus 10 days after initial treatment (DAIT), and 5-leaf stage plus 10 DAIT plus 20 DAIT. Rates consisted of TRIMAX™ and Centric® 40WG being applied at 1.5 and 1.33 oz/A, respectively. All possible combinations, including the untreated control, were applied for a total of seven treatments. Data was collected for plant height, total number of nodes, biomass partitioning, photosynthetic rate, mid-season plant mapping, end of season box-mapping, and yield and fiber quality analysis.

No significant differences in lint yield were observed between the treatments. The three treatments of Centric® 40WG all showed a numerical increase in yield over the untreated control. One application of TRIMAX™ was numerically greater in yield than the untreated control, whereas two and three applications were slightly lower than the untreated control. Height, node, and biomass partitioning data showed no significant differences at any time these measurements were made during the growing season. Due to the wide variation in the photosynthesis readings, no conclusive results were obtained. Additional studies to this one-year study are necessary to evaluate the physiological responses of TRIMAX™ and Centric® 40WG in cotton.

Introduction

Because maintaining profitability is key in any cropping system, producers are constantly striving to fine-tune management strategies to minimize inputs while optimizing yield. Pesticides comprise a large portion of production inputs; therefore, reducing or enhancing their efficacy presents an avenue to increase profit. Pesticides containing both insecticidal and growth enhancing properties may be a viable option to increased profitability. Bauer and Cothren (1990) stated that chlordimeform increased lint yields above yields expected from any pesticidal properties of the chemical. The systemic insecticide aldicarb has also shown enhanced cotton growth rates and promotion of root growth (Reddy et al., 1997). Pesticide chemistries that potentially offer this dual function could further increase profitability to the producer.

TRIMAX™ and Centric® 40WG, both nitroguanidines, have proven beneficial in controlling major sucking/piercing insects in cotton (Moore et al., 2003). Multiple applications of both chemicals can be made throughout the growing season. The active ingredient in TRIMAX™ is imidacloprid, which is similar to compounds such as nicotinamide and chloronicotinic acid that enable plants to tolerate stress elicited by drought, disease and insect infestation (Berglund, 1994).

Objective

The objective of this study was to evaluate the physiological responses of TRIMAX™ and Centric® 40WG through various parameters including plant growth, photosynthetic rate, yield, and fiber quality of cotton.

Materials and Methods

A field study was established on the Texas A&M Agricultural Experiment Station in Burleson County, Texas. Cotton, cv. Delta and PineLand 20B, was seeded at 48,000 plants/A with a John Deere Max-Emerge planter on May 7, 2003. Plots consisted of 4 rows x 32 feet in length on raised beds spread 40 inches apart. Statistical design was a randomized complete block, consisting of seven treatments with four replications. Plots were managed using linear irrigation and pest management practices common to the region. Two insecticides, Trimax™ and Centric® 40WG, were applied to evaluate growth regulator properties and the rate responses of the crop to different treatments. One, two, and three applications of Trimax™, an imidacloprid, were applied at a rate of 1.5 oz/A. Timings of these applications occurred at the 5-leaf stage, 5-leaf stage plus 10 days after treatment (DAIT), and 5-leaf stage plus 10 DAIT plus 20 DAIT. Also one, two, and three applications of Centric® 40WG, a thiamethoxam, were applied at a rate of 1.33 oz/A. Timings of these applications occurred at the 5-leaf stage, 5-leaf stage plus 10 DAIT, and 5-leaf stage plus 10 DAIT plus 20 DAIT. All possible combinations including the untreated control were applied for a total of seven treatments. Initial data for determining uniformity across plots was collected 37 days after planting (5-leaf stage). Ten plants were tagged in each plot for collection of height and node data throughout the season. Four one-meter sections were tagged in each plot for removal of plants after each foliar application for biomass partitioning. Heights, nodes, leaf weight, stem weight, and leaf area were recorded seven days after each PGR insecticidal application. These observations were again collected at 61 days after initial treatment. Photosynthetic rate was measured using a portable LI-6400. The CO2 exchange rate was determined for the third leaf below the apex. The rate of photosynthesis was recorded after each chemical application and prior to the subsequent application. Readings were again taken 46 days after initial treatment to record the photosynthetic rate. At harvest, five plants per plot were box-mapped for yield distribution. Yield and fiber characteristics were also observed. Lint samples were sent to the International Textile Center in Lubbock, Texas for fiber quality analysis.

Statistical Analysis

Data was analyzed using PROC GLM in SAS and means were separated using Fisher's LSD with the $\alpha = 0.05$.

Results and Discussion

No significant differences in treatments were observed for lint yield (Fig. 1). The actual and percent gain or loss in lint yield between the treatments and the untreated control is depicted in Figure 2. AGR (Absolute Growth Rate), RGR (Relative Growth Rate), LAR (Leaf Area Ratio), and NAR (Net Assimilation Rate) were calculated using the appropriate parameters. Initial results indicated limited treatment responses in these variables. All three treatments of Centric® 40WG numerically increased yield over the untreated control. For TRIMAX™, however, one application numerically increased yield over the untreated control, whereas two and three applications were slightly lower than the untreated control. No differences in height, node, LAI, or biomass partitioning (total versus individual observations for stem, leaf, and fruiting structures) were observed during the growing season. Wide variation in the photosynthetic readings from the LI-6400 minimized conclusions that could be made from this data (data not shown). No significant differences were obtained for lint quality; however, all results for fiber characteristics were within acceptable ranges.

Boll retention at first and second position, on the lower nodes (6-10), was numerically higher than the untreated control in treatments that received only one application of insecticide (Fig. 3). This higher retention in the first and second positions may partially explain the numerical increase in percent of lint yield in PGR treatments over the untreated control, with the exception of TRIMAX™ at two applications (Fig. 4).

Treatments with lower numerical yields had more total bolls than the higher yielding treatments, but the distributions of these bolls were in third and fourth positions and in nodal proximity to the apex. An explanation for greater boll numbers at these positions was not apparent. However, the plant can compensate for early fruit loss due to stress by setting bolls in the upper nodes and vegetative branches (Sadras, 1995).

Conclusions

Initial year data indicates that there were no significant differences observed between the treatments for:

Plant Height	Photosynthetic Rate
Total Nodes	Lint Yield
Biomass Partitioning	Lint Quality

Additional research is needed to examine the PGR properties of Centric® 40WG and TRIMAX™.

Future Research

These data represent results from one year of research. The study will be repeated again during the 2004 growing season to expand the data base. Additional studies are necessary to evaluate the physiological responses of TRIMAX™ and Centric® 40WG in cotton.

References

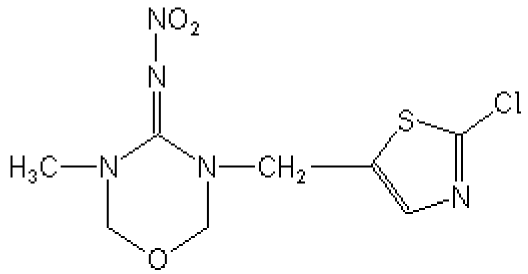
Bauer, P.J. and Cothren, J.T. 1990. Growth-promoting activity of chlordimeform. Agron. J. 82:73-75.
Berglund, T. 1994. Nicotinamide, a missing link in the early stress-response in eukaryotic cells – a hypothesis with special reference to oxidative stress in plants. FEBS Lett 351:145-149.

Moore, G.C., Parker, R.D., Fromme, D.D., Knutson, A.E. 2003. Suggested Insecticides for Managing Cotton Insects in the Southern, Eastern and Blackland Areas of Texas-2003. Bull. E-5A. Texas Cooperative Extension.

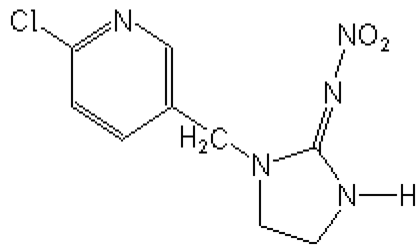
Reddy, V.R., Wang, Z., Reddy, K.R. 1997. Growth responses of cotton to aldicarb and temperature. Environ. Exp. Bot. 38:39-48.

Sadras, V.O. 1995. Compensatory growth in cotton after loss of reproductive organs. Field Crops Res. 40 1–18.

Chemical Structures



Thiamethoxam



Imidacloprid

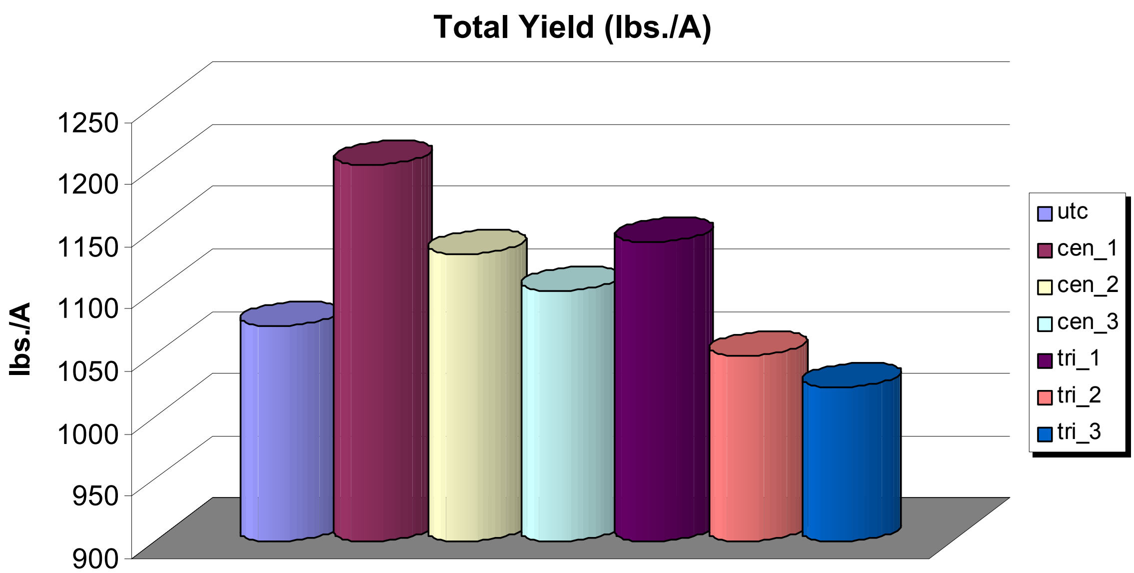


Figure 1. Insecticidal treatment effect on total lint yield.

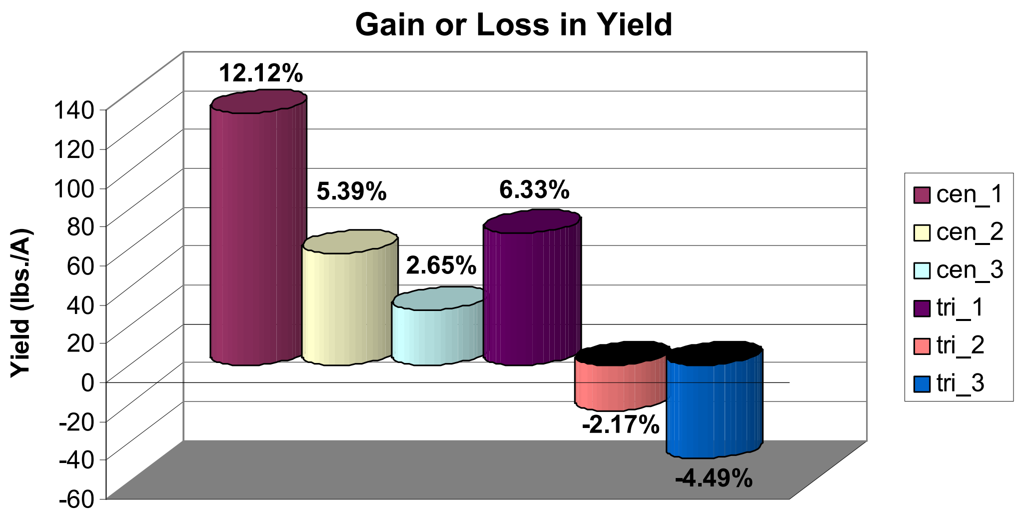


Figure 2. Insecticidal effect on gain or loss of total lint yield.

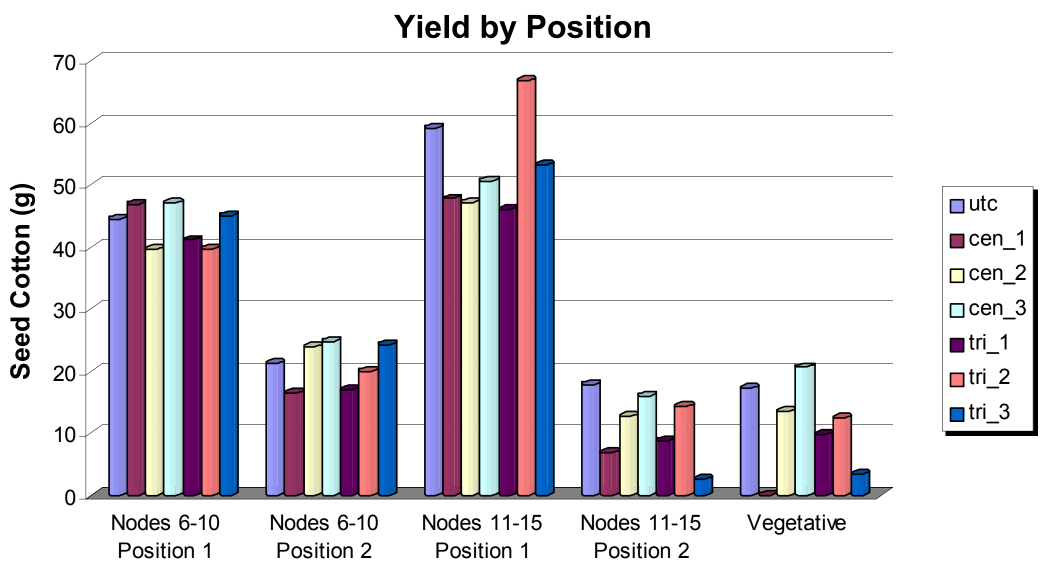


Figure 3. Insecticidal effect on distribution of total yield by position.

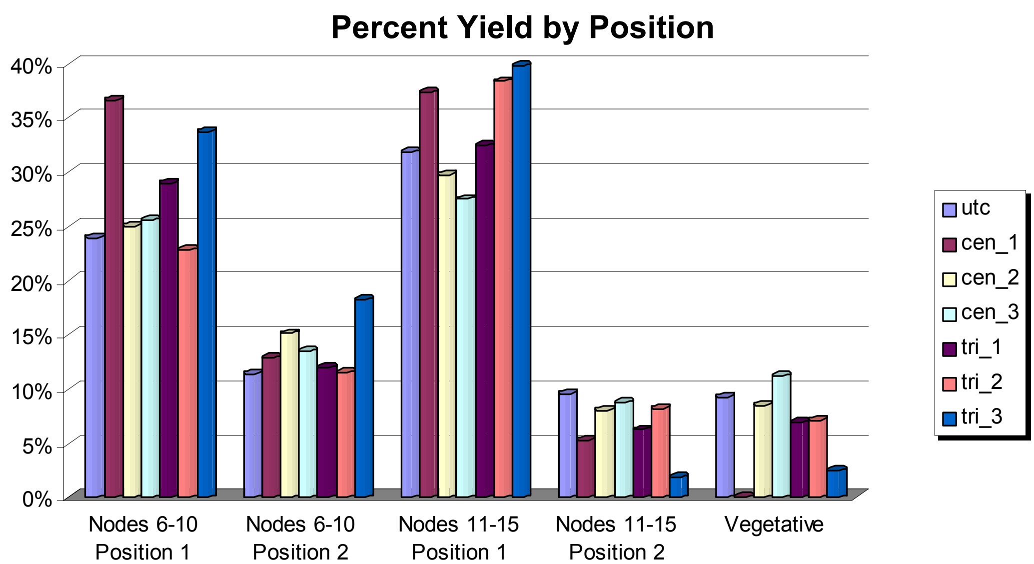


Figure 4. Insecticidal effect on distribution of percent yield by position.