2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

TRIMAXTM: ASSISTING COTTON GROWERS IN YIELD MAXIMIZATION

J. Alan Hopkins
Bayer CropScience
Greenbrier, AR
Keith Vodrazka
Bayer CropScience
Lakeland, TN
Richard Rudolph
Bayer CropScience
Molino, FL
John Bell
Bayer CropScience
RTP, NC

Abstract

TRIMAX™ Insecticide is a product from Bayer CropScience containing 4.0 lbs. of imidacloprid per gallon in a suspension concentrate formulation. Field and laboratory experiments as well as consultant demonstrations were conducted 2002-2004. Data from these trials support previous observation for effective control of important insects, improved plant health and enhanced yield following TRIMAX applications. A summary of results from several sources is presented in this paper with a focus on the positive influence of TRIMAX for yield maximization in cotton.

Introduction

Imidacloprid was discovered by Bayer in 1985 and was the first commercially introduced insecticide of the class chloronicotinyl insecticides (CNI, *syn. neonicotinoid*). TRIMAX contains 4.0 lbs. of imidacloprid per gallon in a suspension concentrate formulation. The product was introduced to cotton growers in most of the cotton-growing region of the United States in 2002. TRIMAX provides effective control of several important insects in cotton, including aphids (*Aphis gossypii*), tarnished plant bugs (*Lygus lineolaris*), and cotton fleahoppers (*Pseudatomoscelis seriatus*).

Private and public researchers have conducted small-plot and large-plot testing since the early 1990's. Observations for insect control, plant growth and development, and improved yield have been made. Prior to market introduction, data were summarized for 22 trials where multiple applications were used and yield data were reported between 1995 and 2001. These results indicated excellent yield response with 7.4% increase following one application, 11% increase following 2 applications and 14.5% increase following three applications. Several of the trials in the summary reported very low or no insect infestations which supports the hypothesis that TRIMAX may have plant physiological effects in addition to insecticidal properties.

Subsequent to the product launch, Bayer initiated an ambitious testing schedule with cotton entomologists, extension specialists, plant physiologists and consultants. In all trials special emphasis was placed on obtaining data to verify plant health and yield observations.

Results and Discussion

Entomology Trials

Yield data from University of Arkansas entomologist's trials averaged over three years (2002-2004) indicate improved cotton yield where TRIMAX was compared to untreated controls. Since tarnished plant bug was the primary pest targeted in these trials, the efficacy of TRIMAX against this pest is evident by the increase in yield (Table 1). Other insecticides active against the target pests also improved cotton yield compared to the untreated. Trials were also conducted by other universities but yield data were not available at this writing.

Cotton Physiology Trials

Data developed by Dr. Derrick Oosterhuis and his cotton physiology team at the University of Arkansas were particularly interesting since they represent some of the first attempts to elucidate the plant physiological and biochemical effects of TRIMAX on cotton.

In 2002, Oosterhuis and Brown observed effects on plant growth and development and reported an increase in cotton yield where TRIMAX was evaluated at two locations in Arkansas (Fayetteville and Clarkedale). They also reported significant differences in specific leaf weight, chlorophyll, and canopy temperature following TRIMAX applications. Significantly lower levels of the antioxidant enzyme, glutathione reductase, were observed in TRIMAX-treated plants compared to untreated plants. According to Oosterhuis and Brown, glutathione reductase may be induced by stress. Therefore, lower levels of this enzyme may indicate less stress in TRIMAX-treated plants. In 2003, Oosterhuis, Gonias and Brown did not observe the same change in glutathione reductase levels but did observe changes in other antioxidant enzymes. Due to the complexity of enzymatic systems in cotton plants, the significance of these findings is not completely understood. However, the fact that TRIMAX has significantly altered the levels of certain antioxidant enzymes is certainly intriguing and supports the hypothesis that the product may influence the physiology of cotton plants. In addition to changes in enzyme levels, Oosterhuis also observed significant changes in carbohydrates and polyols in 2003 as measured by these sugars: fructose, glucose, sucrose and myo-inositol (polyol). According to Dr. Oosterhuis, "Sugar alcohols (polyols) stabilize the native conformation of proteins, counteracting the detrimental effects of desiccation and temperature extremes. Polyols are a mechanism which improves the plant's ability to withstand stress." Oosterhuis and his students also measured membrane leakage in leaf cells and observed significantly more leakage (less membrane integrity) in untreated plants compared to TRIMAX-treated plants. Experiments in 2002 and 2003 indicated improved plant development and yield where TRIMAX was used in water-stressed plants compared to untreated plots in the same water-deficit regime. Data from 2003 under these two water regimes with pre-flowering applications in Clarkedale and post-bloom applications in Fayetteville are shown in Table 2. These results point to the possibility that TRIMAX may improve plant health under certain environmental stresses such as drought. A positive yield trend was observed in all trials conducted by Oosterhuis and students in 2002-2004 (Table 3). Dr. Oosterhuis hypothesized that lack of significant differences in 2004 may be attributed to much less natural stress and observed that production fields set record high yields in 2004 under this low-stress environment. More detailed information from the University of Arkansas physiology studies may be obtained from Beltwide manuscripts referenced below as well as papers presented by Oosterhuis and Gonias at the 2005 Beltwide Cotton Conferences.

Consultant Demonstrations

Demonstrations were established with cotton consultants in 2002-2004. Consultants were asked to compare TRIMAX to another standard recommendation and make observations for insect control, plant health and yield. Most data were from mid-south locations and all trials with yield data are represented in this paper.

Eight trials compared TRIMAX to no insecticide treatment. It is important to point out that in these situations, insect populations were very low and "no treatment" was the consultant's standard recommendation. TRIMAX resulted in higher cotton yields in all eight demonstrations. Yield increase ranged from 2.4% to 21.3% with a mean yield advantage of 7.4% in favor of TRIMAX. Seventeen consultant demonstrations compared TRIMAX to Centric™ (thiamethoxam) Insecticide. In these trials, TRIMAX resulted in higher cotton yield from 14 of 17 locations. Yield increase ranged from -1.3% to 11.6% in favor of TRIMAX with an average yield advantage of 4.5%. Eight trials compared TRIMAX to Orthene® (acephate) Insecticide. TRIMAX resulted in a yield advantage in 7 of 8 trials ranging from -.02 to 9.83% with a mean yield advantage of 3.7% in favor of TRIMAX (Figures 1-3). Other demonstrations included comparisons to Vydate C-LV™ (oxamyl), Bidrin™ (dicrotophos) and Intruder™ (acetamiprid) and showed a similar trend for improved yield with TRIMAX compared to these standard insecticides.

Conclusions

Results from University of Arkansas entomology and plant physiology trials and mid-south consultant demonstrations demonstrate improved cotton yield where TRIMAX was used compared to untreated controls and other standard insecticides. In entomology trials and several of the consultant demonstrations where TRIMAX was used against targeted pests, the positive yield response was primarily attributed to insect control. However, in the physiology trials and in some of the consultant demonstrations, insect pressure was nonexistent to well below economic thresholds and

positive yield response was attributed to the documented changes in plant physiology. Although the changes in plant physiology are not fully understood, most of the observations are related to the mitigation of moderate plant stress imposed by drought and/or high temperatures. These data support the insecticidal and plant physiological properties of TRIMAX and confirm the benefits of TRIMAX to assist cotton growers in yield maximization.

References

Gonias, E.D., Derrick M. Oosterhuis, and Robert S. Brown. 2004. Effects Effects of Trimax™ on the Physiology, Growth, and Yield of Cotton. Proc. Beltwide Cotton Prod. Conf. National Cotton Council of America, Memphis, TN

Hopkins, Alan, Richard Rudolph, Amy Wyman, Robert Steffens, David Rogers, Herb Young and Keith Vodrazka. 2003. TRIMAX™ (Imidacloprid): A New Foliar Insecticide for Cotton Pest Management, Plant Health Improvement and Yield Protection. Proc. Beltwide Cotton Prod. Conf. National Cotton Council of America, Memphis, TN

Oosterhuis, D.M. and Brown, R.S. 2002. Effects of Trimax™ on the Physiology, Growth, and Yield of Cotton. Summaries of Cotton Research 2002. Research Series 507: 209-214.

Oosterhuis, D.M. and R.S. Brown. 2003. Effects of Trimax™ on the Physiology, Growth, and Yield of Cotton. Proc. Beltwide Cotton Prod. Conf. National Cotton Council of America, Memphis, TN

Table 1. Influence of TRIMAX on cotton yield (lb lint/A) in University of Arkansas Entomology Trials.

Treatment	Greene 2002	Studebaker 2002	Greene 2003 (I)	Greene 2003 (IV)	Studebaker 2003	Luttrell 2003	Greene 2004 (I)	Greene 2004 (IV)
Untreated	492	940	931	988	450	1012	988	1082
TRIMAX* (1 oz/A)	844	964	1201	1265	717	1019	-	-
TRIMAX (1.5 oz/A)	810	972	-	1132	811	1168	1163	1411

* TRIMAX 4 SC applied 1 to 3 times.

Table 2. Influence of TRIMAX on cotton yield (lb lint/A) under two water regimes (well-watered and dry) at two locations at the University of Arkansas, 2003.

Treatment	Clarkedale, AR Applications made during squaring	Fayetteville, AR Applications made during peak bloom
TRIMAX* – Water	426 [X]	1154 [X]
Control – Water	334	955
TRIMAX – Dry	597 [X]	920
Control – Dry	400	850

* TRIMAX 4 SC: 3 applications beginning at pin-head square in Clarkedale, AR and 3 applications beginning after first flower in Fayetteville, AR.
[X] Significant at $p \leq 0.05$ for the paired treatments.

Table 3. Influence of TRIMAX on cotton yield (lb lint/A) in University of Arkansas Physiology Trials, 2002-2004.

Treatment	Clarkedale 2002	Fayetteville 2002	Clarkedale 2003	Clarkedale2 003	Fayetteville 2003	Clarkedale 2004	Average
Untreated	712	953	948	930	1245	1346	1022

TRIMAX* (1.5 oz/A)	774	1123	1068	1124	1457	1443	1165
Increase	+62	+170	+120	+194	+212	+97	+143

* TRIMAX 4 SC applied 3 times.
Data from Oosterhuis, Brown, and Gonias, University of Arkansas.

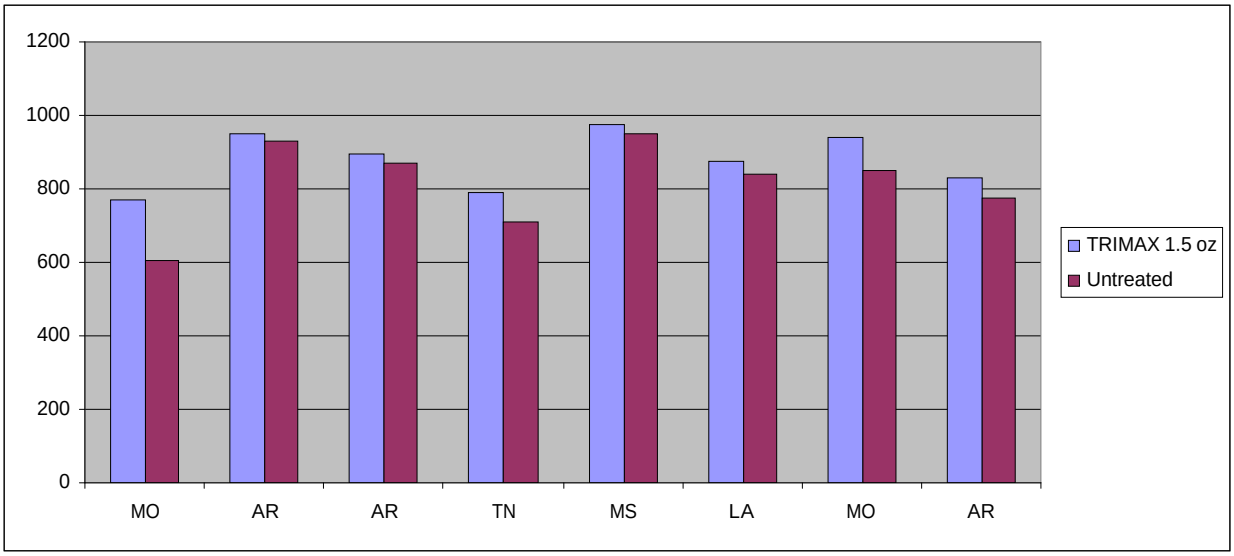

Figure 1. Consultant demonstrations comparing cotton yield (lb lint/A) for TRIMAX and no insecticide treatment at 8 mid-south locations.

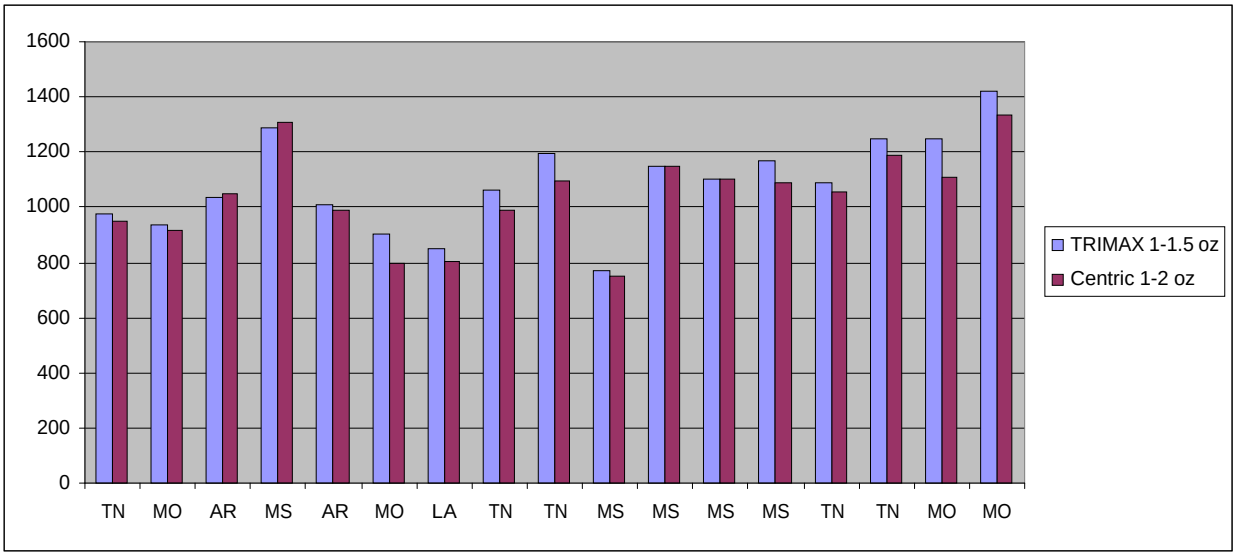

Figure 2. Consultant demonstrations comparing cotton yield (lb lint/A) for TRIMAX and Centric at 17 mid-south locations.

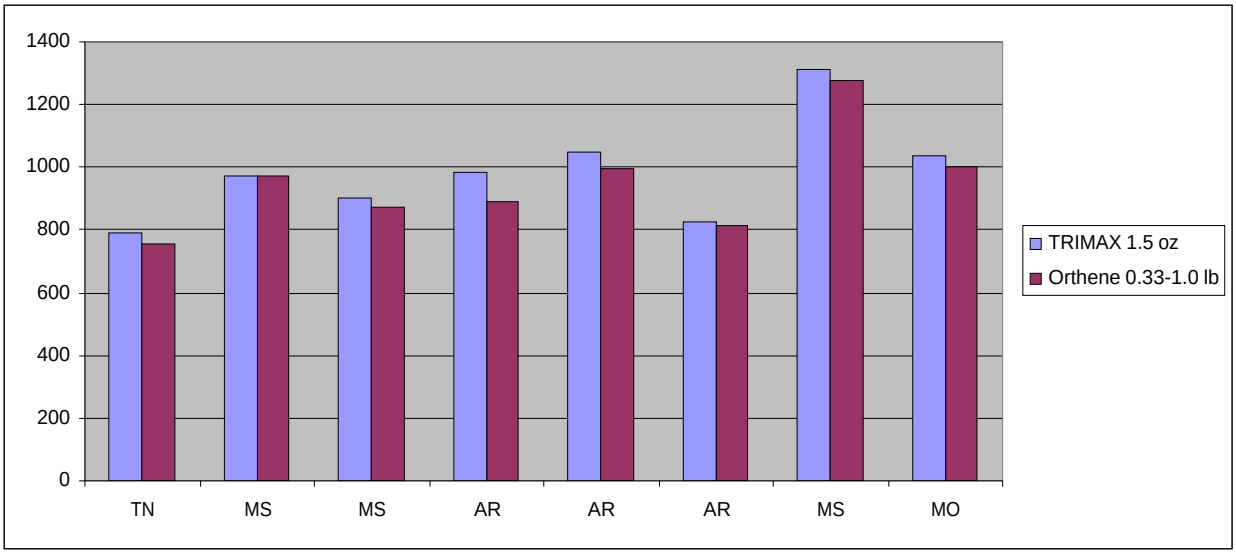

Figure 3. Consultant demonstrations comparing cotton yield (lb lint/A) for TRIMAX and Orthene at 8 mid-south locations.