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TRIMAX (IMIDACLOPRID): A NEW FOLIAR INSECTICIDE FOR COTTON PEST MANAGEMENT, PLANT HEALTH IMPROVEMENT AND YIELD PROTECTION

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Abstract

TRIMAX™ Cotton Insecticide is a new imidacloprid product from Bayer CropScience registered specifically for use on cotton. TRIMAX contains 4.0 lb of imidacloprid per gallon in a soluble concentrate formulation. The product was introduced to cotton growers in most of the cotton-growing region of the United States in 2002. More than 10 years of testing and experience prior to market introduction confirmed that TRIMAX provides benefits over and above traditional insect control with unique technology that delivers *Pest Management, Plant Health, and Enhanced Yield*. Results from 2002 corroborate findings from previous years with emphasis on improved plant health and enhanced yield.

Introduction

Imidacloprid was discovered by Bayer in 1985 and was the first commercially introduced insecticide of the class chloronicotinyl insecticides (CNI, *syn. neonicotinoid*). TRIMAX™ Insecticide is a new imidacloprid product from Bayer CropScience registered specifically for use on cotton. TRIMAX has excellent translaminar properties and plant compatibility that allows spray applications at low rates with good residual activity. Extensive research and development efforts for more than 10 years have confirmed that TRIMAX provides benefits over and above traditional insect control with unique technology that delivers *Pest Management, Plant Health, and Enhanced Yield.*

Pest Management

TRIMAX provides excellent control of the major sucking/piercing insects in cotton (cotton aphid, cotton fleahopper, banded-winged whitefly, plant bugs (excluding *Lygus Hesperus*), green stink bug and southern green stink bug). It also has ovicidal effects on bollworm and tobacco budworm. In addition, TRIMAX has a strong anti-feeding effect providing excellent protection from damaging pests feeding on cotton. TRIMAX can be applied up to five times per growing season, allowing multiple applications in sustained pest pressure and multiple pest situations.

Plant Health

By both effectively controlling insects and by preventing pests from feeding, TRIMAX protects plants from insect damage and promotes plant health. The active ingredient in TRIMAX, imidacloprid, is the only insecticide in the nitroguanidine subclass of chloronicotinyl insecticides with a chloropyridine side chain. This distinguishing side chain is structurally related to compounds like nicotinimide and chloronicotinic acid (CNA) known as a systemic plant resistance inducer. Although not fully understood, these substances appear to help plants better tolerate environmental stress including drought, diseases and insect attack. Multiple applications of TRIMAX provide sustained and consistent levels of these beneficial effects.

Enhanced Yield

The pest management and plant health benefits of TRIMAX, especially when used in multiple-application spray programs beginning early to midseason, result in enhanced yields. Significant yield enhancement benefits have been observed even in situations without economic target insect infestations.

Materials and Methods

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 yield have been made. Data were summarized over 22 trials where multiple applica-

tions were used and yield data were reported between 1995 and 2001. Demonstrations and experiments with more than 60 cotton consultants and 60 university cooperators were conducted in 2002 to confirm the pest management, plant health and yield benefits of TRIMAX. Special emphasis was placed on obtaining data to support plant health and yield observations.

Results and Discussion

Pest Management

The unique chemistry of TRIMAX has a mode of action that incorporates insect mortality, ovicidal activity and behavioral changes. These properties work together for the ultimate goal of the cotton producer – maximum yield. TRIMAX controls insects by contact and ingestion exposure. Following foliar application, part of TRIMAX remains on the leaf surface providing contact activity. The remainder penetrates plant tissue and is distributed throughout the leaf providing activity by ingestion during insect feeding.

TRIMAX is absorbed into cotton leaves and moves within the leaves from the upper to the lower surface (translaminar) and towards the tip of the leaf (acropetal). Through this leaf transport TRIMAX is available to hidden pests. The water solubility of TRIMAX enables it to disperse throughout the leaf within 24 hours but not move away from the site of insect feeding. Effective residual activity is dependant on retention of active ingredient at the site of insect feeding. The optimal water solubility of TRIMAX also enables the active ingredient that has not been absorbed to be better retained on the leaf surface through continued wetting periods (rain and dew), improving rainfastness in comparison to highly water soluble products.

The speed and degree of TRIMAX absorption is more affected by lipophilicity than water solubility. Studies indicate rapid absorption and redistribution of imidacloprid into cotton leaves. Translaminar movement was demonstrated using cotton aphids (Aphis gossypii) caged on the underside of the first true leaf. Imidacloprid provided nearly 100% control for 12 days when aphids were caged on the lower leaf surface directly under the site of application (3 droplets each containing 2.5 micrograms a.i.). When aphids were caged under the leaf near the tip and insecticide applied to the upper surface near the stem (basal region), acropetal movement was demonstrated and attributed to water solubility. Aphid mortality at the distal portion of the leaf was 100% at 24 hours after application. The optimal water solubility of TRIMAX allows it to be maintained more uniformly for longer periods in the leaf as compared to products with higher water solubility.

Plant Health

Imidacloprid-based insecticides have led to a philosophical change in defining how insects are "controlled." Traditional "control" is thought of in terms of insect mortality when in reality the desired effect is a reduction in plant damage. TRIMAX controls insects and promotes plant health both by killing insects and by reducing insect damage to plants. The ultimate result of reduced plant damage may be dramatic even when actual insect mortality may falsely imply only modest levels of "control." The documented range of imidacloprid effects include: traditional insect mortality, cessation of insect feeding, reduced honeydew production from aphids and whiteflies, sustained control of pest populations through reduction of insect reproduction, residual plant protection from anti-feeding effects, direct and indirect effects on plant physiology.

TRIMAX results in pest management with an increase in plant health. Effects on plant health significantly greater than can be explained by insect mortality alone are frequently observed. This phenomenon causes traditional insect mortality ratings to inaccurately reflect the positive effects of TRIMAX on cotton. For example, the traditional scouting practice of counting live insects in cotton may misrepresent the impact of TRIMAX on plant bugs. Plant bug counts will not reflect the proportion of plant bugs that are neutralized due to feeding inhibition. Square retention and yield more accurately reflect pest management with TRIMAX. These sub-lethal effects may be slower acting yet longer lived than traditional "insecticidal" effects.

The anti-feeding effects of imidacloprid have been documented in cotton aphid (Nauen and Elbert, 1994) and green peach aphid (Nauen, 1995). Nauen's data indicate that the dose resulting in only 15% mortality will at the same time result in a 95% reduction in honeydew production. A similar response has also been observed in tarnished plant bug. Dr. Tina Teague (1996) of the Arkansas Agricultural Experiment Station began laboratory experiments in 1995 to evaluate anti-feeding effects of imidacloprid on tarnished plant bug. She observed similar effects as Nauen reported with green peach aphid. Dr. Teague concluded that tarnished plant bug feeding is reduced when individuals are fed low doses of imidacloprid. She also concluded that products such as TRIMAX with anti-feeding effects could result in live insects remaining in the field even though they no longer damage the crop.

Plant protection beyond insect mortality was first observed with imidacloprid in a field experiment conducted by Dr. Phil Tugwell of the University of Arkansas. Plant bug control was comparable for imidacloprid and fipronil; however, imidacloprid resulted in improved square retention.

Research has confirmed that retaining early-season squares is essential to producing a healthy, early-maturing, high-yielding cotton crop. Loss of early-season squares is often associated with plant bug damage. The use of TRIMAX Insecticide during the early-squaring period will protect small squares from plant bugs and other yield-robbing pests.

One aspect of improved plant health that is not fully understood is related to 6-chloronicotinic acid, an active metabolite of imidacloprid. When TRIMAX is applied to cotton plants, the active ingredient, imidacloprid, is absorbed into the leaf and distributed throughout the leaf. Imidacloprid is slowly metabolized by the plant to produce 6-chloronicotinic acid (6-CNA). The breakdown to 6-CNA is a result of the unique chloropyridine side chain of imidacloprid. 6-CNA is structurally related to nicotinamide-based compounds known as systemic plant resistance inducers. These compounds are believed to trigger physiological changes in the plant to assist the plant in protection from environmental stress (drought and UV stress), disease, and insect attack. Since 6-CNA is a degradation product of imidacloprid, additional benefits of enhanced plant health can occur. To achieve maximum plant health benefits, TRIMAX should be used in a program with multiple applications.

Enhanced Yield

Yield benefits can be expected to result from effective pest management and improved plant health. Research has shown a positive yield response following TRIMAX applications on cotton. In research conducted at the University of Arkansas, Dr. Charles Allen, observed significantly higher square retention and yield when imidacloprid was applied three times starting at pin-head square. Dr. Allen also observed increased yield in this trial for imidacloprid treatment (1304 lb. lint/A) compared to the untreated (1067 lb. lint/A). In 2002, Dr. Jeremy Greene, at the University of Arkansas, conducted a similar study with TRIMAX applied three times under severe plant bug infestation. He observed significant increase in cotton yield following TRIMAX at 1 or 1.5 oz/A compared to the untreated or standard-treated plots (884, 810, 492 and 445 lb lint/A for the four treatments, respectively).

In a trial conducted at the Bayer Research Station near Benoit, MS, 1, 2, or 3 foliar applications of TRIMAX followed an in-furrow application of Temik at 3.5 lbs/A. Although only low numbers of thrips were observed in this trial, each TRIMAX application provided a yield increase (Almand).

Yield data clearly confirm the benefits of multiple applications of TRIMAX. Data from 16 locations in the mid-south where tarnished plant bug was the primary pest, indicate cotton yield increases following multiple applications of TRIMAX. Data from 22 trials with varying combinations of treatments were compared to the non-imidacloprid control. Of these trials, tarnished plant bug infestations were moderate to very low in 12 trials and high in 4 trials. The remaining trials reported varying degrees of tobacco thrips, cotton aphid or cotton bollworm infestations. Results indicate a strong trend toward increasing yield benefits with each additional application.

Related papers published in the Proceedings of the 2003 Beltwide Cotton Conferences include:

Cotton Physiology Conference:

EFFECTS OF TRIMAX INSECTICIDE ON THE PHYSIOLOGY, GROWTH AND YIELD OF COTTON- Derrick Oosterhuis and Scott Brown, University of Arkansas, Fayetteville, AR

POTENTIAL OF TRIMAX TO ENHANCE COTTON FRUIT RETENTION IN AN INSECT-FREE ENVIRONMENT- A.M. Stewart and B.M. Guillory, Louisiana State University Agricultural Center, Alexandria, LA

Insect Control Conference:

PLANT GROWTH AND YIELD RESPONSE TO TRIMAX INSECTICIDE IN GEORGIA- Herb Young, Bayer CropScience, Tifton, GA, and Jay Holder, Ashburn, GA

PLANT GROWTH AND YIELD RESPONSE TO TRIMAX INSECTICIDE IN THE EAST MISSISSIPPI DELTA- Keith Vodrazka, Bayer CropScience, Lakeland, TN, Ben Meriweather, Bayer CropScience, Tupelo, MS, and Brian Sweeden, Bayer CropScience, Leland, MS

PLANT GROWTH AND YIELD RESPONSE TO TRIMAX INSECTICIDE IN THE WEST MISSISSIPPI DELTA- Alan Hopkins, Bayer CropScience, Greenbriar, AR, Ross Bell, Bayer CropScience, Monroe, LA, and Roger Bowman, Bayer CropScience, Leachville, AR

PLANT GROWTH AND YIELD RESPONSE TO TRIMAX INSECTICIDE IN TEXAS AND OKLAHOMA- Drew Palrang, Bayer CropScience, Austin, TX, and John Cagle, Bayer CropScience, Mill Creek, OK

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