INFLUENCE OF HARPIN PROTEIN SEED AND FOLIAR TREATMENTS ON ESTABLISHMENT AND GROWTH OF COTTON

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Abstract

A study consisting of replicated field trials located across the southern United States was initiated to evaluate the influence of N-Hibit® Gold CST seed treatment and ProAct™ foliar treatment on cotton produced in fields infested with nematodes. Field trials were conducted by independent agricultural scientists. Nine trial locations with eight replicates per location were completed in four different states. Trials with ProAct included a base application of Temik® or AVICTA® Complete Pak; N-Hibit Gold CST was assessed with other seed treatment products. Plant establishment, growth, and yield measurements were recorded. Treatment with N-Hibit Gold CST or ProAct resulted in lint yield increases and increased net crop value.

Introduction

$Harpin_{Ea}$ and $harpin_{\alpha\beta}$ are proteins from a group of naturally occurring compounds first isolated from *Erwinia amylovora* (Wei et al. 1992). Harpin proteins activate signaling receptors present in virtually all plants. After plant receptors detect the presence of harpin proteins, plants are signaled that a pathogen is attacking the plant. The outcome of this signaling is the expression of genes involved in the hypersensitive response and plant growth enhancement and activation of an induced systemic defense response (Wei & Beer 1996). Commercial products containing harpin proteins, such as N-Hibit and ProAct, have been granted registration by the Environmental Protection Agency. Harp-N-Tek® is the brand for technologies originating from harpin proteins. The mode of action of Harp-N-Tek products is unique among plant health and protection products. A natural "inside-out" growth and defense response is activated by Harp-N-Tek products. This inside-out mode of action complements other plant protection products that have either an outside-only (non-systemic) or an outside-in (systemic) mode of action.

Reniform nematode, *Rotylenchulus reniformis* (Linford & Olivera) and root-knot nematode, *Meloidogyne incognita* (Kofoid & White) Chitwood, are significant pests of cotton (Thomas & Kirkpatrick 2002; Lawrence & McLean 2002). Compared with untreated cotton, seed and foliar treatment of cotton with harpin resulted in fewer *R. reniformis* and *M. incognita* eggs per gram of root weight in well-controlled greenhouse trials (Kirkpatrick et al. 2005, Kirkpatrick et al. 2006). Likewise, seed and foliar application of harpin in cotton fields infested with a significant *M. incognita* or *R. reniformis* population resulted in improved seed cotton yield (French et al. 2006). In previous research, cotton lint yields have been improved with foliar applications of harpin (French & Atkins 2006, Guy et al. 2006, Smith et al. 2006).

The primary objective of this study was to investigate the influence of harpin seed treatment (N-Hibit Gold CST) and foliar treatment (ProAct) in combination with other nematode management tools on cotton growth and yield in cotton fields infested with nematodes. Findings from that research are reported.

Materials and Methods

Design. During 2007, 9 tests were conducted by independent agricultural scientists located in AR, LA, NC, and TN (Table 1). Each test was arranged in a completely random design with 8 replications per treatment. If blocking factors were identified, then the design was adjusted to randomized complete block. Plots contained two to four treated rows of cotton (generally 12.6 ft wide, 50 ft long) planted on 30 to 38 inch row spacing. Each plot included a buffer of 10 ft between blocks and at least 2 rows between adjacent plots. Cooperators selected test sites with a reasonably uniform soil that was known to be infested with nematodes. Cottonseed was obtained by each cooperator, and each site was planted with a locally adapted variety that was tolerant to glyphosate and expressed *Bacillus thuringiensis* protein. Plant growth inputs, insects, mites, and weeds were managed according to locally accepted practices, and all plots within each trial were treated identically. Weather and production inputs such as fertility program, pesticide use, and defoliants were documented. Results from one trial location were not included in data analysis due to an extremely low lint yield of less than 300 lbs per acre.

Treatments and Application in ProAct Trials. In one series of trials with ProAct, Temik was applied at 5 lbs per acre in-furrow at planting. In a second series of trials with ProAct, all cottonseed was commercially treated with AVICTA Complete Pak. ProAct at 1 oz per acre was applied at the 8-leaf stage, and Vydate® C-LV at 17 oz per acre was applied at the 4-leaf stage. Cooperators were requested to apply foliar treatments with properly calibrated ground equipment utilizing a four-row shielded spray boom with two spray nozzles per row and to apply each plot as single pass. Water was used as the carrier, and treatments were applied at a finished spray volume of 10 gpa. Spray equipment was carefully rinsed prior to each application. Sprays were made on a day and at a time when the plants were actively growing. To minimize any confounding effects of early season insects, all plots were oversprayed at 3-leaf stage with flonicamid 2.8 oz per acre.

Table 1. Summary of trial locations investigating ProAct™ and N-Hibit® Gold CST in replicated cotton field trials, 2007.

Trial No.	Trial Focus	Cotton Variety	Planting Date	Harvest Date	State
207020	ProAct™ with Temik® base	DP 445 BR	5-11-04	10-4-07	AR
207021		DP 445 BR	5-24-07	10-12-07	AR
207022		DP 164 B2RF	6-6-07	10-16-07	LA
207023	ProAct™ with AVICTA® Complete Pak base	DP 161 2RF	5-11-07	10-4-07	AR
207024		DP 444 BR	5-18-07	11-2-07	TN
204025		DP 449 BR	5-11-07	10-1-07	NC
204026	N-Hibit® Gold CST and other seed treatments	DP 444 BR	5-26-07	11-2-07	AR
204027		DP 164 B2RF	6-6-07	10-16-07	LA
204028		DP 449 BR	5-12-07	10-1-07	NC

Treatments and Application in N-Hibit Gold CST Trials. Before planting, seed treatments were preapplied by the seed company or applied by the cooperator. Treatments included various combinations of N-Hibit Gold CST at 2 oz per cwt, AVICTA Complete Pak (commercially treated), Temik at 5 lbs per acre in-furrow, and Dynasty™ at a rate equivalent to the fungicide component supplied with AVICTA Complete Pak. To minimize any confounding effects of thrips, all plots were oversprayed at 2-leaf stage for thrips management.

Field Observations and Data Analysis. Measurements from the center two rows included plant stand, phytotoxicity, machine-harvested seed cotton, turnout, and lint yield. In the N-Hibit Gold CST trials, numbers of leaves and nodes were recorded at the four-leaf stage. Because no phytotoxicity or adverse effects were observed, results will not be further discussed. Analysis of variance was conducted for each trial, and means were compared by protected LSD (P=0.1).

Results and Discussion

A nematode management program of Temik followed by ProAct yielded 12% or 132 lbs lint per acre more than Temik alone (Figure 1). Likewise, a program of AVICTA Complete Pak followed by ProAct averaged a yield increase of 6% or 64 lb lint per acre greater than AVICTA Complete Pak alone (Figure 2). The addition of ProAct

to Temik or AVICTA Complete Pak provided an increase in net value per acre of $35 to $79 per acre (Table 2 and 3). Increases in yield and crop value with ProAct exceeded results observed for Vydate.

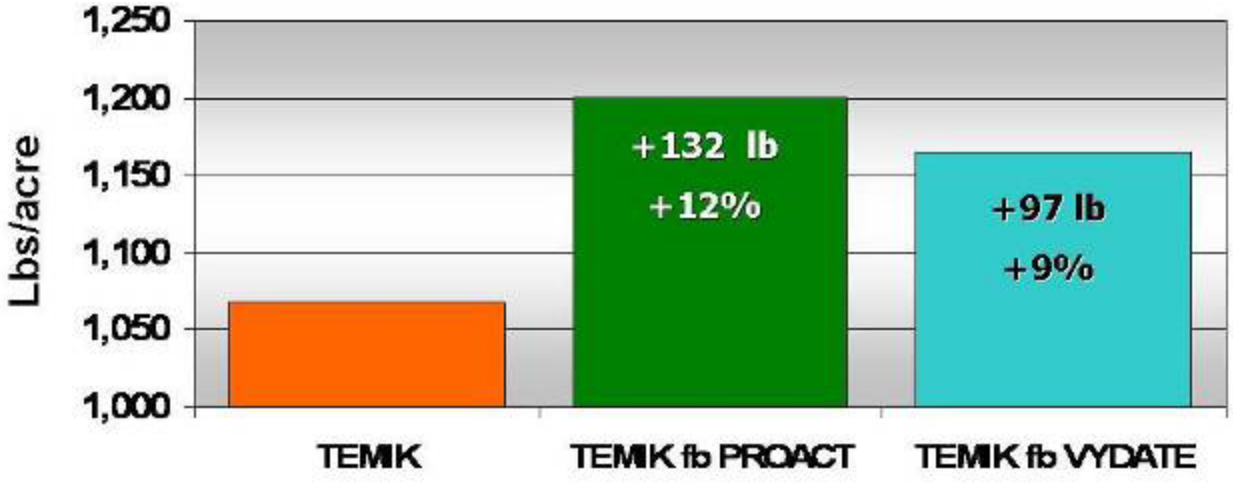

Figure 1. Influence of ProAct™ on cotton yield across three replicated field trials treated with Temik®, 2007. Temik applied in-furrow at 5 lb/A, ProAct 1 oz/A at 8-leaf and Vydate® 17 oz/A at 4-leaf; oversprayed at 3-leaf stage with flonicamid 2.8 oz/A.

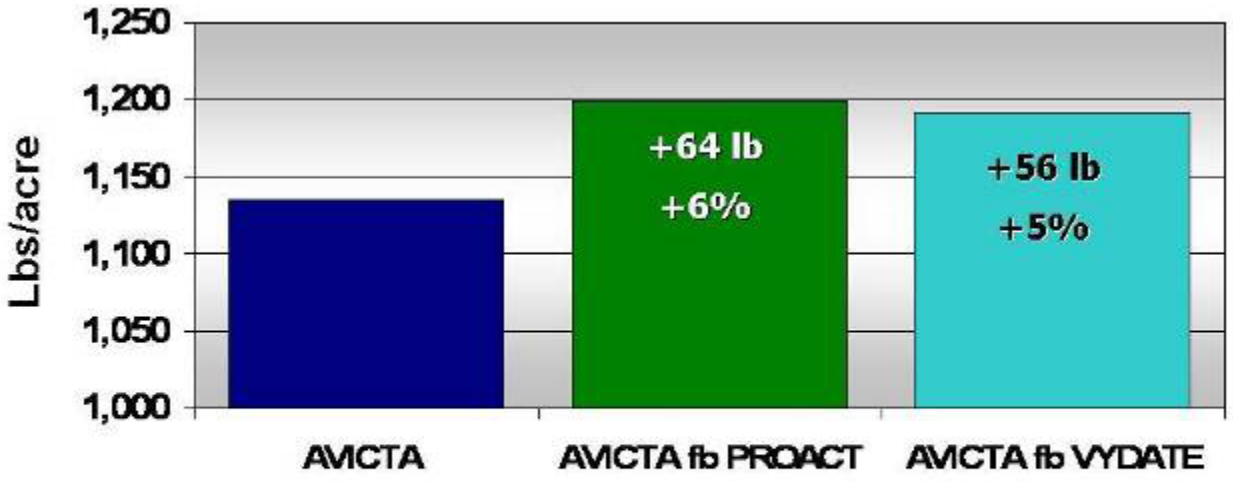

Figure 2. Influence of ProAct™ on cotton yield across replicated field trials treated with AVICTA® Complete Pak, 2007. ProAct 1 oz/A at 8-leaf and Vydate® 17 oz/A at 4-leaf; oversprayed at 3-leaf stage with flonicamid 2.8 oz/A; AVICTA = AVICTA Complete Pak.

Table 2. Influence of ProAct™ on cotton yield value and net value across three replicated field trials treated with Temik®, 2007.

Treatment	Gross Value ($) per Acre	Net Value ($) after Treatment Cost per Acre	Difference in Net Value ($) per Acre
Temik at 5 lb/ac followed by ProAct	$780	$773	$79
Temik at 5 lb/ac followed by Vydate®	$757	$748	$54
Temik at 5 lb/ac	$694	$694	n/a

Across trial analysis; 8 replicates per trial location; ProAct 1 oz/A at 8-leaf and Vydate 17 oz/A at 4-leaf; oversprayed at 3-leaf stage with flonicamid 2.8 oz/A; calculated using $0.65/lb.

Table 3. Influence of ProAct™ on cotton yield value and net value across three replicated field trials pretreated with AVICTA® Complete Pak, 2007.

Treatment	Gross Value ($) per Acre	Net Value ($) after Treatment Cost per Acre	Difference in Net Value ($) per Acre
AVICTA followed by ProAct	$780	$773	+$35
AVICTA followed by Vydate®	$774	$766	+$28
AVICTA	$738	$738	n/a

Across trial analysis; 8 replicates per trial location; AVICTA = AVICTA Complete Pak; ProAct 1 oz/A at 8-leaf and Vydate 17 oz/A at 4-leaf; oversprayed at 3-leaf stage with flonicamid 2.8 oz/A; value calculated using $0.65/lb.

The addition of N-Hibit Gold CST benefited at-planting nematode management programs of AVICTA Complete Pak, Temik, and AVICTA Complete Pak combined with Temik. Where seed had been treated with N-Hibit Gold CST, plants averaged more nodes per acre compared with treated controls (Figure 3).

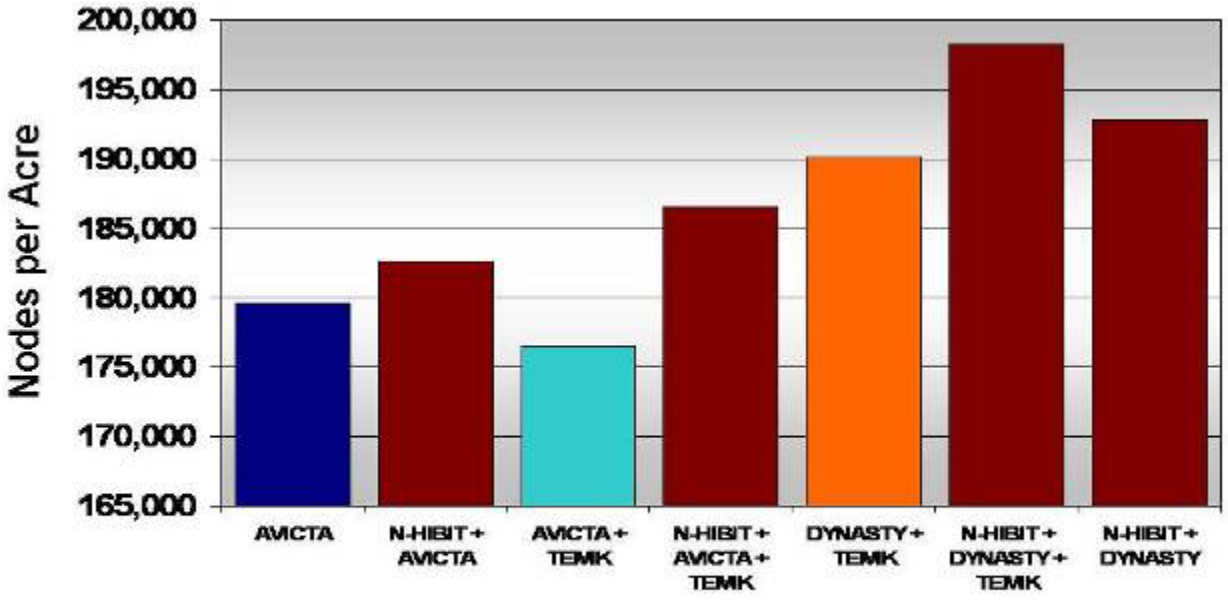

Figure 3. Influence of N-Hibit® Gold CST on plant growth, as cotton nodes per acre during early season, across three replicated field trials, 2007. Oversprayed at 2-leaf stage for thrips management; AVICTA = Avicta® Complete Pak.

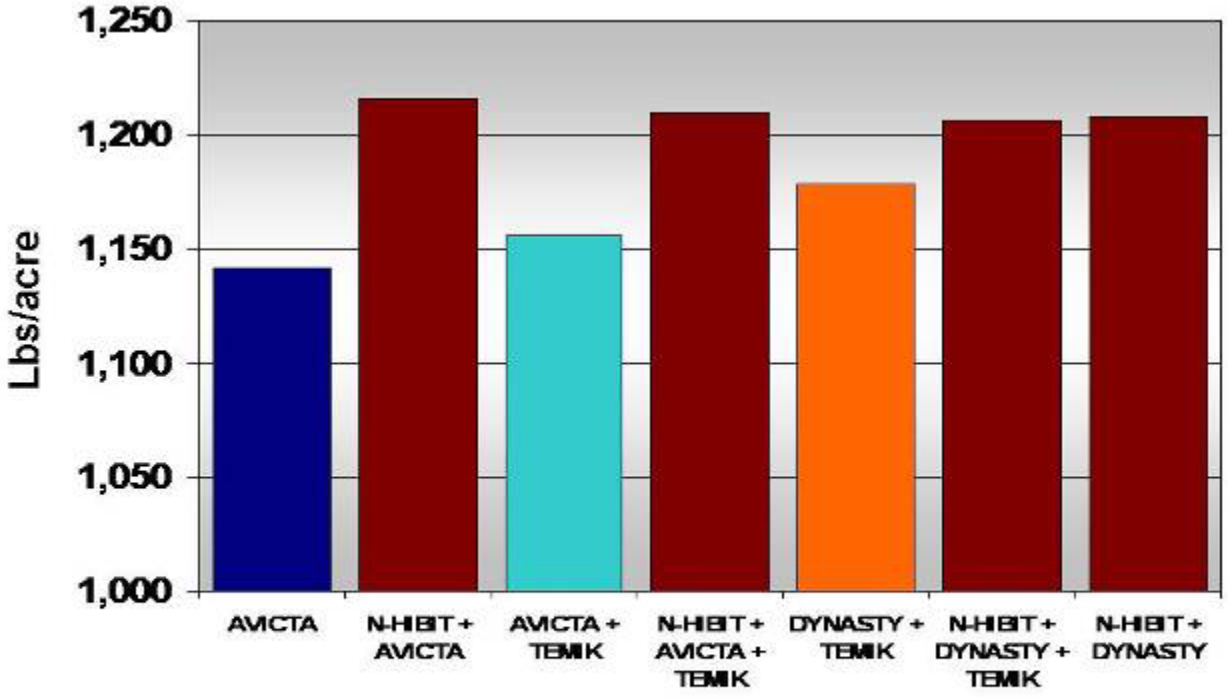

Figure 4. Influence of N-Hibit® Gold CST on cotton yield across three replicated field trials, 2007. Oversprayed at 2-leaf stage for thrips management; AVICTA = Avicta® Complete Pak.

Table 4. Influence of N-Hibit® Gold CST Seed Treatment on cotton yield value and net value across three replicated field trials, 2007.

Treatment	Gross Value ($) per Acre	Net Value ($) after Treatment Cost per Acre	Net Value Rank
N-Hibit + Dynasty™	$785	$776	1
N-Hibit + AVICTA®	$790	$768	2
N-Hibit + Dynasty + Temik®	$784	$759	3
N-Hibit + AVICTA + Temik	$786	$749	4
Dynasty + Temik	$766	$746	5
AVICTA	$742	$725	6
AVICTA + Temik	$752	$719	7

Across trial analysis; 8 replicates per trial location; AVICTA = Avicta® Complete Pak; Temik® at 5 lb/A; oversprayed at 2-leaf stage for thrips management; value calculated using $0.65/lb.

Increases in nodes per acre indicates improved plant establishment and early-season plant growth, and these gains probably contributed to the yield increases observed with N-Hibit Gold CST. Of the seven treatment combinations evaluated in these field trials, each of the four combinations that included N-Hibit Gold CST averaged the highest yield with all exceeding 1,200 lbs lint per acre (Figure 4), and the highest net value per acre (Table 4).

Conclusions

Previous research has shown that harpin seed treatments and foliar applications increase cotton lint yield. Results from 2007 field trials with N-Hibit Gold CST or ProAct paired with at-planting programs of AVICTA Complete Pak or Temik demonstrated a consistent benefit of increased cotton lint yield and improved net value per acre. Average yield increases with ProAct or N-Hibit Gold CST ranged from approximately 30 to 130 lbs of lint per acre, and net crop values per acre were favorable.

Acknowledgment

I wish to gratefully acknowledge the participation and efforts of the field trial cooperators who conducted the trials presented in this manuscript and to give special thanks to G. Lewis, M. Cloutier, R. Rice, and Z. Wei for critically reviewing the manuscript.

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