EFFECTS OF SOIL SYSTEMIC INSECTICIDES AND COTTON SEED VIGOR ON COTTON STANDS AND YIELDS

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Abstract

Results from previously published research, much of which is twenty to thirty years old, is quite varied in the effects that THIMET® and TEMIK® have on cotton plant stands and yields. Because of this lack of recent information and reports of phytotoxic responses, a three year study to evaluate the interaction effects of either THIMET or TEMIK and seed vigor was conducted. The systemic insecticides were placed in-furrow at a slightly exaggerated rate of 1.00 pound (AI) per acre on excellent seed (vigor index > 160) and on poor seed (vigor index < 120). Cotton treated with THIMET and TEMIK significantly increased yields an average of 91 pounds lint per acre over the untreated for the three years of testing. For the same time period, no differences were seen between THIMET or TEMIK in their effect on stand or yield. Seed vigor indexes were shown to have a high degree of correlation with final stands with the higher indexes producing the highest stands. The presence of systemic insecticides tended to increase final stands over the untreated check. Stands and yields were greatly influenced by the environmental conditions encountered.

Introduction

Cotton growers on the Texas High Plains use systemic insecticides such as THIMET® and TEMIK® for early season control of western flower thrips, *Frankliniella occidentalis* (Pergande). Research results from across the cotton growing regions vary widely as to the effect that early season insect control has on yields. Research in Arizona shows that when the growing season is at least 150 days long, cotton plants compensate for any early season fruit loss and do not result in yield loss (Terry 1992). In shorter growing season areas, such as the Texas High Plains, yield losses occurred due to reductions in early squares caused by thrips feeding (Leser 1986).

Much of the research dealing with the effects of THIMET and TEMIK on cotton stands and yields was conducted twenty to thirty years ago during the development of these products. At that time, early trials showed that cotton seed treated with systemic insecticides generally resulted in lower stand counts than corresponding same rate in-furrow applications (Davis et al. 1966). Differences were also seen between mechanical, flame, or acid delinted seed treated with systemic insecticides. Because of damaged seed coats, mechanically delinted seed reduced stands where flame or acid delinted seed did not (Parencia et al. 1958). The use of TEMIK applied in-furrow resulted in decreased plant stands compared to the untreated (Cowan and Davis 1967, Davis and Cowan 1972). Previous research that directly compared THIMET with TEMIK gave mixed results. In one study, THIMET decreased stands as compared to TEMIK (Hopkins and Taft 1965), while in another, TEMIK decreased stands and THIMET did not (Cowan et al. 1966). Other studies evaluating varying rates of TEMIK on different levels of seed vigor indicated that high rates of TEMIK reduced yields with poor vigor seed but not with good or excellent vigor seed (Hopper et al. 1990).

It appears from a review of past research that using systemic insecticides may cause stand reductions under some environmental conditions. Each year on the Texas High Plains, researchers, producers and agri-businessmen debate the relative safety of THIMET or TEMIK on the developing crop. Due to the lack of recent published information, a three year study was conducted to evaluate the interaction effects of THIMET or TEMIK and seed vigor.

Materials and Methods

Tests were conducted in 1994, 1995, and 1996 at the American Cyanamid Primary Research Site near Plainview, Texas. Soil type was a Pullman clay loam with 0-1% slope. Furrow irrigation was supplied as needed to the entire test area at the same time. PROWL® herbicide was incorporated each year at 1.20 pound (AI) per acre on flat land. Beds were constructed on 40 inch centers. Normal production practices for the area were observed on the entire test area. Soil tests for nematodes were not conducted since there had been no previous indication to suspect their presence.

Plainview Acid Delinting of Plainview, Texas, supplied two lots of Paymaster HS 200 cottonseed for each year's test. One seed lot was high vigor while the other was low vigor. Commercially delinted and treated Chembred 830 (F2 from hybrid) high vigor seed was included in each year's test. Samples of each seed were submitted each year to the Texas Department of Agriculture in Lubbock, Texas, for cool-warm vigor indexing as outlined in the Cotton Incorporated leaflet, *Seed Vigor Index* (Hopper et al. 1986).

Treatments were arranged in a randomized complete block design with four replications. Approximately 20 pounds per acre of each vigor seed were planted in plots 4 rows wide by 60 feet long with a Case IH model 900 plate-type planter. THIMET 20G® and TEMIK 15G® were applied directly into the seed furrow using Case IH granular applicators calibrated to deliver 1.00 pound (AI) per acre. This rate of application is two to three times the normal application rate

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of each chemical for insect control on the Texas High Plains but was chosen to increase the probability of differences occurring.

Stand counts for each plot were made approximately 50 days after planting and consisted of averages of two 0.001 acre locations from the center two rows of each plot. Yields were determined by hand harvesting and weighing 0.001 acre from the center two rows of each plot. Equal 0.75 pound samples from each of four replications for each treatment were composited into one sample for ginning. Percent lint turn out was calculated from the ginned composite samples and multiplied by the individual plot weights for each respective treatment to calculate lint yield. Composited samples were ginned at the Texas Agricultural Experiment Station at Lubbock, Texas.

The SAS PROC GLM (SAS Institute, 1992) procedure was used to perform the Analysis of Variance (ANOVA) for all data. Since stand counts varied widely both within and between years, counts were transformed by the log 10 (count + 1) transformation to stabilize the variance before the analyses were performed. Actual treatment and cultivar stand means are presented in Tables 2 and 3. No transformation was performed on cotton yields. Year, treatment, and seed vigor effects were tested for significance at the 5% level. Interaction terms were tested for significance at the 10% level. Since the insecticide treatment by vigor interaction was found not significant, it was removed from the ANOVA for both stand and yield. Multiple comparisons were performed using the F Least Significant Difference procedure based on the least square means. Linear correlation coefficients were calculated for vigor index and final stand using the product-moment method with significance tested by predetermined probability tables.

Results and Discussion

Stand Counts

Near ideal growing conditions were encountered on the High Plains during the 1994 and 1996 seasons. Cotton emerged quickly with a minimum of rainfall and cool temperatures until after the crop had become well established. Although thrips numbers were not recorded, visual observations of thrips feeding damage in untreated cotton indicated low to moderate thrips damage to cotton plants in 1994 and 1996. The 1995 test received both rainfall and cool temperatures shortly after emergence. Visual observations of thrips feeding was also much more severe than in 1994 or 1996.

As defined by Hopper et al. (1986), seed with vigor indexes of 160 or greater are rated “excellent” while those of 120 or less are rated “poor.” Seed vigor indexes for one lot of Paymaster HS 200 and Chembred 830 seed were excellent while the other lot of Paymaster HS 200 was rated poor for each year tested. Correlation coefficients calculated from the vigor index and the resulting stands exceeded 95% for each year (Table 1). However, due to the small number of comparisons, the only significant correlation occurred in 1994. Although the correlation was significant in only one year, there appears to be a strong relationship between the seed vigor index and final stands. Correlation coefficients for combined years were not calculated because environmental conditions greatly reduced stand counts in 1995 compared to 1994 and 1996, even with similar vigor indexes.

Since the ANOVA for the combined data indicated that year, year by treatment, and year by seed vigor were significant, an ANOVA by year was performed. Multiple comparison of means showed there were no stand differences due to insecticide treatments in 1994 or 1996 (Table 2). Near ideal growing conditions with low to moderate thrips pressure were encountered in both 1994 and 1996. In 1995, a year which had adverse growing conditions and high thrips pressure, TEMIK treatments resulted in significantly higher stands than either THIMET or the untreated check. THIMET treated stands were not different from the untreated check. The use of systemic insecticides resulted in numerically higher stand counts each year. Combining the three years of tests indicated that TEMIK increased plant stands over the untreated check. Stands treated with THIMET were not different from those of TEMIK or the untreated check. From these data it appears the systemic insecticides reduced thrips feeding stress and allowed the plants to better cope with environmental stresses resulting in higher plant stand counts in all years of testing.

Both excellent vigor level cultivar selections resulted in higher stands than the poor vigor seed in each of the three years of testing (Table 3). However, in 1995 Chembred 830 also produced higher stands than the Paymaster HS 200 of similar vigor. Combining data from three years of testing indicated the excellent vigor CB 830 produced higher stands than either the excellent or poor vigor HS 200 seed. Excellent vigor HS 200 also produced higher stands than the poor vigor HS 200 seed. These differences in established stands between cultivar selections may have been due to residual hybrid vigor of the Chembred 830 seed or possibly to differences in seed size that may have resulted in more seed being planted.

Yield

Since the ANOVA resulting from combining yields from the three years indicated significant year, year by treatment, and year by seed vigor differences, an ANOVA by year was performed. The insecticide treatment by cultivar interaction was not significant and was taken out of the final model. There were no differences between treatment yields in 1994 (Table 4). However, in 1995, both THIMET and TEMIK produced higher yields than the untreated check but were not different from each other. In 1996, TEMIK resulted in significantly higher yields than THIMET but was not different from the untreated. THIMET yields were not different from the untreated. The combined three year analysis showed that both THIMET and TEMIK treatments resulted in significantly higher cotton yields than the untreated check, averaging 91 pounds more cotton per acre. Again, there were no yield differences between the THIMET and TEMIK treatments. These results are consistent with previous data showing yield increases with the use of systemic insecticides (Leser 1986).

No yield differences were observed among the three seed vigor cultivars in 1994 (Table 5). Both excellent vigor seeds resulted in higher yields than the poor vigor seeds in 1995 when thrips were a problem. This difference was probably due to poorer stands achieved with the poor vigor seed in 1995 but was also probably influenced by stress from thrips feeding. In 1996, both the excellent and poor vigor Paymaster HS 200 yielded significantly more than the excellent vigor Chembred 830 seed. Combined year analysis of the yield data showed the excellent vigor Paymaster HS 200 to have yielded significantly more than the Chembred 830 cultivar but was not different from the poor vigor Paymaster HS 200. These data suggest that in good cotton growing years that cultivar selection has more influence on yield than the vigor of the planting seed as long as minimum uniform plant stands are achieved. However, in poor growing years, planting seed vigor is much more important than cultivar selection.

Conclusions

Significant yield differences were seen with THIMET and TEMIK treatments averaging 91 pounds lint per acre more than the untreated check during the course of this three year study. No differences in yield were seen between THIMET and TEMIK treatments. Yields were also affected by the vigor index level but only when poor stands resulted. Paymaster HS 200 appears to be better adapted to the High Plains growing area than Chembred 830 by producing higher yields, especially in good cotton production years. Final plant stand appears to be highly correlated with the cool/warm vigor index in a given year. High vigor (excellent) seed always produced significantly higher stands than the low vigor (poor) seed, regardless of environmental conditions or cultivar. There appears to be some differences in plant stand with the Chembred 830 seed that is not accounted for in the vigor index. This may be due to hybrid vigor of the Chembred 830 seed or possibly differences in seed size that cannot be confirmed from this study. THIMET and TEMIK treatments produced numerically higher plant stands compared to the untreated check in all years. TEMIK and THIMET plant stands were different from each other only in the 1995 test, although this difference was not reflected in final yields. Since environmental conditions during stand establishment can be highly variable from year to year, planting seed vigor is much more important in stand establishment than the choice of systemic insecticide. However, once a stand is established, systemic insecticides are very important in reducing thrips feeding and protecting yield potential. Knowledge of the planting seed vigor should be the primary consideration on which other management decisions are made for stand establishment and top yield.

Acknowledgments

THIMET® is a registered trademark of American Cyanamid Company for phorate insecticide.

TEMIK® is a registered trademark of Rhone-Poulenc Ag Company for aldicarb insecticide.

PROWL® is a registered trademark of American Cyanamid Company for pendimethalin herbicide.

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Table 1. Seed vigor index and resulting final stands. Plainview, TX.

	1994		1995		1996	
Cultivar	Vigor Index [1]	Stand	Vigor Index	Stand	Vigor Index	Stand
HS 200	172	71,200	161	29,500	175	70,100
HS 200	83	31,500	58	11,700	95	49,300
CB 830	178	73,500	165	37,500	161	73,600
	r = 0.9999		r = 0.9623		r = 0.9558	
	Significant @ 5%		NS		NS	

Significance determined by product-moment method for the coefficient of linear correlation ($P \leq 0.05$).

[1] Vigor index > 160 = Excellent, Vigor index < 120 = Poor

Table 2. Cotton stands resulting from systemic insecticide treatments. Plainview, TX.

	Stand (Plants/Acre)			
Treatment	1994	1995	1996	3-Year Average
TEMIK	59,333a	29,375a	65,250a	51,319a
THIMET	57,818a	26,500b	64,333a	49,314ab
Untreated	57,958a	22,792b	63,417a	48,056b

Means followed by the same letter in each column are not significantly different by LSMEANS procedure ($P \leq 0.05$).

Table 3. Cotton stands resulting from planting "Excellent" and "Poor" vigor indexed seed. Plainview, TX.

		Stand (Plants/Acre)			
Cultivar	Vigor Rating	1994	1995	1996	3-Year Average
CB 830	Excellent	73,500a	37,458a	73,583a	61,514a
HS 200	Excellent	71,227a	29,541b	70,083a	56,543b
HS 200	Poor	31,500b	11,667c	49,333b	30,833c

Means followed by the same letter in each column are not significantly different by LSMEANS procedure ($P \leq 0.05$).

Table 4. Cotton yields resulting from treatments with THIMET and TEMIK insecticides. Plainview, TX.

	Lint Yield (Lbs/Acre)			
Treatment	1994	1995	1996	3-Year Average
TEMIK	1251a	922a	1548a	1240a
THIMET	1306a	873a	1451b	1207a
Untreated	1260a	640b	1499ab	1133b

Means followed by the same letter in each column are not significantly different by LSMEANS procedure ($P \leq 0.05$).

Table 5. Cotton yields resulting from planting "Excellent" and "Poor" vigor indexed seed. Plainview, TX.

		Lint Yield (Lbs/Acre)			
Cultivar	Vigor Rating	1994	1995	1996	3-Year Average
CB 830	Excellent	1229a	847a	1418b	1176b
HS 200	Excellent	1295a	848a	1537a	1225a
HS 200	Poor	1290a	740b	1544a	1191ab

Means followed by the same letter in each column are not significantly different by LSMEANS procedure ($P \leq 0.05$).