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ARTHROPOD MANAGEMENT

Evaluation of Toxicity of Selected Insecticides against Thrips on Cotton in Laboratory Bioassays

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ABSTRACT

Adult vial technique (AVT) and spray table bioassays were conducted to evaluate toxicity of selected insecticides against immature and adult thrips, *Frankliniella* spp. (Thysanoptera: Thripidae). In AVT, technical insecticides comprised of organophosphates (dicrotophos and methamidophos), spinosyn (spinosad) and neonicotinoids (thiamethoxam and imidacloprid) were used. The LC_{50} values for contact with the insecticides were all significantly different, with spinosad being most toxic and imidacloprid being least toxic to thrips. Spray table tests were conducted with formulated insecticides comprised of dicrotophos, methamidophos and spinosad on thrips-infested greenhouse-grown cotton plants. Multiple treatments of varying droplet sizes and densities were made at 19 L/ha (2 gpa), and thrips were sampled at 1, 3 and 7 days after treatment (DAT). Droplet characteristics (size and density) and DAT did not significantly influence post-treatment thrips densities on cotton plants. Average numbers of thrips/plant on methamidophos- and spinosad-treated cotton plants were significantly fewer than those on dicrotophos-treated and untreated plants. Spray table treatments were also made to examine effects of spray volume [19(2) and 47(5) L/ha(gpa)] and active ingredient (a.i.) rates of spinosad against thrips on cotton at 3, 5, 7 and 14 DAT. Averaged across DAT, increased spray volume rate 47 L/ha provided better control at lower spinosad a.i. rate indicating that improved coverage increased efficacy of spinosad concentrations below label rate.

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INTRODUCTION

Thrips, *Frankliniella* spp. (Thysanoptera: Thripidae) are a recognized pest in many plants including vegetables, roses, greenhouse grown plants, and cotton (Zhang et al., 2007, Boll et al., 2006). Thrips is known to be a vector of the tomato spotted wilt virus (Boonham et al., 2002), which is an economically important plant disease. Cloyd and Raymond (2000) reported that spinosad and acephate were effective at controlling thrips on greenhouse-grown plants.

Thrips is a serious pest on seedling cotton in Texas and other areas of the Cotton Belt (Williams 2006). The first sign of damage occurs on cotyledonary leaves which take on a silvery appearance. Damaged true leaves become ragged and crinkled with damaged areas becoming more apparent as leaves expand. In early season cotton, thrips cause significant leaf area destruction, delayed maturity and retarded plant growth (Sadras and Wilson 1998; Harp and Turner 1976; Hawkins et al. 1966). Severe damage causes loss of apical dominance and results in excessive branching with secondary terminals forming in leaf axils (Reed et al. 2001). In the Cotton Belt, early season thrips infested 91% of the US acreage in 2005 with 149,090 bales of cotton lost to this pest (Williams 2006). Williams (2006) also reported that during 2005 the greatest losses from thrips occurred in Virginia and Oklahoma with 3.66 and 3%, respectively. In Georgia, Ottens et al. (2004) reported that severe infestations can cause yield reduction as high as 50-60% if not controlled.

Traditionally, suppression of thrips in early season cotton is achieved by planting insecticide-treated seed or using in-furrow applied insecticides. However, such crop protection measures may have reduced effectiveness under severe thrips infestations, which would then require rescue treatments for suppression. Limited data are available for assessing insecticide toxicity to thrip species and describing application technology parameters that might influence efficacy of rescue treatments for controlling thrips on cotton. Development of such data will help in the judicious selection of insecticides for effective thrips management, monitoring of insecticidal

resistance, and in the selection of aerial application parameters for optimum insecticide efficacy.

Objectives of this study were to obtain data on relative toxicities of insecticides labeled for control of thrip species on cotton via bioassays using the adult vial technique (AVT). Furthermore, selected insecticides were evaluated under laboratory spray table conditions for efficacy against thrips on greenhouse-grown cotton plants. Finally, a single insecticide was evaluated at various active ingredient (a.i.) rates and spray volumes for efficacy against thrips on cotton.

MATERIALS AND METHODS

Test insects. Cotton plants (variety Deltapine 436RR [Delta and Pine Land Co., Scott, MS]) grown in the greenhouse were naturally infested with *Frankliniella* spp. These plants were maintained without insecticide use during their initial growth. All test procedures described in this report were conducted using the thrips maintained on greenhouse-grown cotton. The thrip infested plants were also used for the later spray table studies. Thrips were also collected from turnipweed, *Rapistrum rugosum* (C. Linnaeus) C. Allioni grown wild near farm areas in the Brazos Valley of Texas, for preliminary observations prior to conducting adult vial test (AVT) procedures.

AVT. Prior to conducting AVT procedures, we wanted to determine if a leaf tissue placed inside the scintillation vial would minimize natural mortality of thrips. We also wanted to assess if the mortality of thrips would be affected by closing the mouth of the vial either with a ball of cotton or a lid. Note that we observed the thrips were trapped in cotton fibers when the vials were closed with a ball of cotton. In order to accomplish this objective, we conducted a test comprised of 4 treatments. Treatment 1 consisted of a vial closed with a medium non-sterile ball of cotton [US Cotton (Canada) CO.], and without a leaf plug. Treatment 2 consisted of a vial closed similarly with a ball of cotton and containing a leaf plug. A leaf plug comprised of a 0.85cm^2 leaf area removed from a cotton leaf (variety, Deltapine 436RR) was placed inside the vial before introducing the thrips. Treatment 3 consisted of a vial closed with a lid and containing a leaf plug and Treatment 4 was a vial closed with a lid without a leaf plug. In each treatment, we introduced about 20-25 thrips, and assessed mortality 24 h thereafter. The thrips were introduced into the vial by tapping the flowers of turnipweed, into a funnel attached to the vial (see detailed descriptions later in the text).

Several authors have described techniques for conducting bioassays to assess resistance in thrips to insecticides. For instance, Eger et al. (1998) aspirated adult *Frankliniella* spp. into a 6-mm diameter glass tube and then emptied the thrips into a 35-ml diet cup containing a snap bean, *Phaseolus vulgaris* L. pod treated with spinosad. Martin et al. (2005) treated bean leaf discs with insecticides using a Potter spray tower and tapped the thrips from *Chrysanthemum* flowers into petri-dishes. Dağh and Tunç (2007) collected thrips using an aspirator, anaesthetized them with CO_2 and treated the bean leaf discs with insecticides using a Potter sprayer. The thrips were then tapped onto treated leaf discs placed over a plexiglass cell. Similarly, Thalavaisundaram et al. (2008) anaesthetized *Frankliniella* thrips with CO_2 and tipped the thrips onto a snap bean leaf disc embedded in an agar-bed before placing it inside a Potter sprayer. None of these studies utilized the traditional AVT technique, and we refrained from aspirating and anaesthetizing the thrips because we sought minimal handling of thrips before introducing them into insecticide-treated glass vials. Adult vial test procedures were similar to those described earlier for other cotton insect pests (Plapp et al. 1987; Snodgrass *1996*), but these had to be modified for use with thrips. Various concentrations of technical insecticides (ChemService® Inc, Westchester, PA) were prepared by weighing specific amounts using a Sartorius analytical balance (Model No. LA 120S) and mixed with acetone (assay 99.5%). The insecticides included organophosphates, dicrotophos and methamidophos; spinosyn: spinosad, and neonicotinoids, thiamethoxam and imidacloprid. One-half mL of each concentration was pipetted into 20-mL disposable glass scintillation vials. The vials were placed on a hot dog roller (heating elements removed) which was operated until all acetone was evaporated leaving behind insecticidal residues inside the vials. The vials containing various concentrations and an untreated check were placed in cardboard racks and transported to a greenhouse for testing. A leaf plug (0.85 cm^2) punched from leaves from untreated greenhouse-grown cotton was placed in each vial. The stem of a 10 cm diameter plastic funnel was fitted into a vial cap. This held insecticide-treated vials in position, while thrips from cotton plants were tapped into the funnel. After a sufficient number of adult and immature thrips (ca. 30) were observed in each vial, these were capped and placed inside the rack. Cardboard racks with vials were kept in an environmental room maintained at 26.7° C (80º F), RH >60% and a

photoperiod of 14:10 h L:D. Mortality was checked 24 h thereafter. To facilitate accurate counting of thrips, only dead thrips in each vial were counted and thereafter, a small amount of 75% ethyl alcohol (ca. 5 ml) was pipetted into each vial. The contents of the vial were emptied into a 50 X 90 mm plastic Petri dish. All enumerations were conducted under a dissecting microscope.

Spray Table Applications. The cotton plants used for the spray table applications (Deltapine 436RR) were those grown in the greenhouse in 46-cm (18 in.) long plastic window boxes (DuraCotta®, BWI, Schulenburg, TX) thinned to 5 plants per box. After true leaves were present, plants were treated with Pix® Plus (mepiquat chloride; BASF, Research Triangle Park, NC) at 0.146 L a. i./ha to regulate excessive vegetative growth. Tests were conducted in a spray table when test plants reached 4 to 6 true leaf stages. As mentioned previously, these plants were maintained in the greenhouse with no insecticides and were naturally infested with thrips. The spray table is computer-controlled utilizing air pressure and a rodless, pneumatic cylinder to vary the speed of spray nozzle assembly on which different individual nozzles and air pressures can be used to simulate an unlimited number of deposition combinations (unpublished data).

Two spray table studies were conducted. The first spray table study examined the effects of droplet size, droplet densities and percentage area coverage in controlling thrips on cotton. Using two flat fan nozzles, 6503 and 650033 (Spraying System Co., Wheaton, IL), we produced two different droplet spectra comprised of droplet sizes, droplet densities and percentage area coverage. Droplet characteristic data were determined using water-sensitive paper (WSP) cards placed near the potted plants in line with the top of the cotton plant canopy. Deposition on WSP cards was analyzed using the WRK DropletScan™ software system (Whitney and Gardisser 2003). Three insecticides, dicrotophos (Bidrin® 8, Amvac Chemical Corp., Newport Beach, CA), methamidophos (Monitor®, Valent Corp., Walnut Creek, CA) and spinosad (Tracer®, Dow AgroScience, Indianopolis, IN), from the AVT bioassays were selected. Spinosad was selected because of its low LC_{50} and environmental compatibility. Dicrotophos and methamidophos were selected to determine whether the tenfold difference in LC_{50}s from the AVT was present under application conditions. All insecticides were applied at the lowest label recommended a.i. rate (dicrotophos - 0.056, spinosad - 0.075 and methamidophos - 0.112 kg/ha) and at a spray volume of 19 L/ha. Each treatment consisted of a chemical and nozzle type replicated five times by exposing one window box (5 cotton plants/box) at a time with each replicate of the treatments being applied with a separate run of the spray nozzle assembly.

The second spray table study examined the effects of spray volume on efficacy at varying a.i. rates. Spinosad was selected for this portion of the study due to low LC_{50} value in the AVT study. Spray volumes of 19(2) and 47(5) L/ha(gpa) were used. The a.i. rates used were 0.0187, 0.0281, 0.0375, 0.0751 and 0.0874 kg/ha. Each treatment consisted of a specific combination of spray volume and a.i. rate. Each treatment was replicated three times, with a replicate consisting of a window box with five plants. All treatment effects in the first and the second spray table studies were compared with an untreated check (no insecticides) using 5 and 3 replications, respectively.

Experimental Design. In the first spray table study, the experimental design conformed to a split-split plot design. The insecticides were the main plot, the nozzle types were the sub-plot, and the DAT comprised the sub-sub plot. Devoid of DAT, the study relative to spray deposit on WSP cards conformed to a split-plot design in which the insecticides were the main plot and the nozzle type was the sub-plot. The second spray table study conformed to a split plot design in which the a. i. rate was the main plot and DAT was the sub-plot. Each a. i. rate was randomly assigned to each window box of 5 cotton plants. In 19 L/ha spray volume treatment, the a. i. rate, 0.0375 kg/ha and the untreated control were assigned twice to the assemblage of whole plot treatments, which gave a total of 96 observations. Similarly, in 47 L/ha spray volume treatment, the a. i. rate, 0.0375 kg/ha and the untreated control were assigned twice to the assemblage of whole plot treatments. However, the 14 DAT measurement was dropped in the untreated control which gave a total of 93 observations.

Thrips Sampling. For the two spray table studies, thrips were sampled from individual cotton plants at 1, 3 and 7 DAT for the first spray table study and 3, 5, 7 and 14 DAT for the second spray table study. Each sample consisted of an individual cotton plant cut at soil level from each window box in each treatment in each replicate. Each plant was placed in a 15.2 x 15.2 cm (6x6 in.) clear flat polyethylene bags with zipper seals. Each plant sample bag had 10-ml of 95% ethyl alcohol added using an automatic pipetting machine (Brewer® Model 40). Thrips were dislodged from

the cotton plants by vigorous shaking. The contents of each bag were emptied into a 16.5 cm Schwartz ® isotropic milk filter mounted in a titration flask. Thrips were then counted by examining the milk filter under a dissecting microscope. All counts were based on total number of thrips per plant (adults and immatures).

Data Analyses. Dosage mortality equations [lethal concentrations (LCs)] and associated statistics were computed using POLO-PC (LeOra software 1987) for AVT. Significance of regression coefficients conforming to dose-response equations was tested using the *t* ratio and the χ^2 value, which tested how well the data approximated the probit model (Robertson and Preisler 1991). Statistical differences between LCs were determined using the presence or absence of overlap in the 95% confidence limits (CLs). Variance analyses of deposition and insect efficacy data were conducted using PROC GLM procedure (SAS Version 9.1; SAS 2003). When *F*-values were significant at the 5 % level, means were separated using Duncan's Multiple Range Test (DMRT) at the 5% level. Interaction effects were separated using the Least square means with adjust (Tukey option).

RESULTS AND DISCUSSION

Adult Vial Tests. Table 1 shows that mortality of thrips inside the scintillation vial with a leaf plug and capped with a lid was significantly less compared to its counterpart without a leaf plug (F = 25.31; df = 3, 36; P <0.0001). Also, mortality of thrips inside the vial with a leaf plug and closed with a ball of cotton was comparable to its counterpart without a leaf plug. This study demonstrated that a leaf plug placed inside the vial and capped with a lid appears to be the best procedure to minimize natural mortality of thrips in AVT procedures.

Table 1. Mean mortality of thrips ± SEM inside scintillation vials with or without a leaf plug

Treatment	N*	% mortality
Vial closed with a cotton ball and without a leaf plug	100	79.9 ± 7.6a
Vial closed with a cotton ball and with a leaf plug	198	76.2 ± 7.5a
Vial closed with a lid and without a leaf plug	80	65.1 ± 10.6a
Vial closed with a lid and with a leaf plug	191	6.6 ± 3.7b

***Number of thrips used.**

Within column means followed by the same lower case letter are not significantly different (P>0.05).

With the exception of methamidophos, mortality data for dicrotophos, spinosad, thiamethoxam and imidacloprid approximated the probit model with the χ^2 values less than the tabular values for the appropriate degrees of freedom (P>0.05; Table 2). The *t* ratios for all insecticides evaluated showed significant dose-response equations (P<0.05). The LC_{50} values (µg a.i./vial) for dicrotophos and methamidophos were 6.675 (95% CLs=5.863-7.536) and 0.652 (0.443-0.923), respectively. The LC_{50} for spinosad was 0.08 (0.073-0.087) µg/vial. The LC_{50} values for thiamethoxam and imidacloprid were 2.163 (1.899-2.448) and 51.533 (38.804-62.436) µg/vial. All of these LC_{50} values were significantly different. Imidacloprid was the least toxic while spinosad, was the most toxic insecticide to thrips. It is important to note that AVT for the neonicotinoids, thiamethoxam and imidacloprid, measures primarily contact toxicity and not translaminar toxicity which both of these insecticides are known to possess. The significant difference in contact toxicity between thiamethoxam and imidacloprid may be an important consideration relative to field efficacy.

Spray Table Studies

Deposition. Variance analysis of the first spray table study revealed that insecticides did not significantly influence $D_{v0.5}$, µm (F = 0.11; df = 2, 8; P > 0.897), drops/cm^2 (F = 0.56; df = 2, 8; P > 0.590) or percentage area coverage (F = 0.03; df = 2, 8; P > 0.975). Nozzle type was the predominant source of variation for $D_{v0.5}$, µm (F = 214.43; df = 1, 12; P<0.0001), for drops/cm^2 (F = 91.46; df = 1, 12; P<0.0001), and for percentage area coverage (F = 13.79; df = 1, 12; P<0.005). Also, there was no significant interaction between insecticides and nozzle type for $D_{v0.5}$, µm (F = 1.78; df = 2, 12; P > 0.210) and for drops/cm^2 (F = 2.41; df = 2, 12; P > 0.132). However, significant interaction between nozzle type and insecticides on percent area coverage was evident (F = 5.19; df = 2, 12; P < 0.025). Table 3 shows the deposition characteristics of insecticides by nozzle type. The 6503 nozzle produced significantly greater spray droplet size, drops/cm^2, and percent area coverage on WSP cards compared with those for 650033 nozzle (Table 3). However, percentage area coverage produced by 6503 nozzle for methamidophos was significantly less compared with that for 650033 nozzle. There was no significant difference in deposition characteristics between insecticides for either nozzle.

Table 2. Statistics from dosage mortality data analyses and calculated lethal concentrations to kill 50% of tested insects (LC_{50}) (µg a.i./vial) for contact toxicity of technical insecticides to thrips, *Frankliniella* spp.

Insecticides	N	χ^2 (df)	t ratio	LC_{50}	95% CL
Organophosphates					
Dicrotophos	999	1.29 (2)[z]	13.28[y]	6.675b	5.863-7.536
Methamidophos	2920	25.75 (5)**	22.57[y]	0.652d	0.443-0.923
Spinosyn					
Spinosad	2783	3.76 (4)[z]	20.06[y]	0.08e	0.073-0.087
Neonicotinoids					
Thiamethoxam	2143	1.39 (2)[z]	17.33[y]	2.163c	1.899-2.448
Imidacloprid	1444	0.44 (1)[z]	6.63[y]	51.533a	38.804-62.436

Within column LC_{50} values followed by the same letter are not significantly different based on 95% confidence limits (CLs) (P>0.05).

[z] χ^2 is not significant (P>0.05); df in parenthesis.

[y] Ratio is significant (P<0.05).

****- significant (P<0.01).**

Table 3. Deposition characteristics of 6503 and 650033 spray nozzles when dicrotophos, spinosad and methamidophos were sprayed on cotton at 19 L/ha (Mean ± SEM).

Insecticides	Nozzle	
	650033	6503
	$D_{v0.5}$	
Dicrotophos	177.4 ± 6.0 aB	365.2 ± 24.3aA
Methamidophos	195.2 ± 4.6 aB	334.4 ± 13.2aA
Spinosad	193.2 ± 2.7aB	345.0 ± 16.6aA
	Drops/cm^2	
Dicrotophos	180.5 ± 20.3aA	43.5 ± 30.8aB
Methamidophos	221.4 ± 26.8aA	14.5 ± 3.1aB
Spinosad	155.5 ± 36.2aA	30.0 ± 7.0aB
	% area coverage	
Dicrotophos	7.4 ± 1.3aA	7.1 ± 1.9aA
Methamidophos	9.8 ± 1.0aA	4.5 ± 0.5aB
Spinosad	7.8 ± 0.9aA	6.1 ± 1.1aA

Within column means for each response variable followed by the same lower case letter are not significantly different (P>0.05). Means within each row followed by the same upper case letter are not significantly different (P>0.05).

Efficacy. Analysis of variance of efficacy data for the first spray table study showed that insecticide was the only significant source of variation (F = 24.00; df = 3, 12; P < 0.0001). Neither nozzle type (F = 4.10; df = 1, 16; P > 0.06) nor DAT (F = 0.43; df = 2, 64; P > 0.65) significantly influenced thrip numbers on cotton. Note that the nozzle type, however, significantly influenced efficacy at the 10% level. No significant interactions were evident between any of the variables tested (F = 0.49; df = 3, 16; P > 0.69 for insecticide X nozzle type; F = 0.33; df = 6, 64; P > 0.92 for insecticide X DAT; F = 0.21; df = 2, 64; P > 0.81 for nozzle type X DAT; F = 0.15; df = 6, 64; P > 0.99 for insecticide X nozzle type X DAT). The mean number of thrips per plant was averaged over DAT but was separated by nozzle type (Table 4). The number of thrips per plant in all treatments was significantly less than the untreated control. Spinosad and methamidophos treatments, which were not significantly different, had significantly fewer thrips per plant than dicrotophos at the rates tested. These results relate well to toxicity assessments made via AVT.

Table 4. Mean number of thrips per plant ± SEM on cotton comparing 2 nozzles (6503 and 650033) on a spray table at 19 L/ha (2gpa). See deposition parameters from each nozzle in the text.

Insecticide	Mean Number of Thrips per Plant for indicated Nozzle	
	6503 ($D_{v0.5}$, µm =348.2)	650033 ($D_{v0.5}$, µm =188.6)
Untreated Control	63.3 ± 4.4a	60.9 ± 10.6 a
Dicrotophos	35.7 ± 3.6 b	28.0 ± 3.9b
Spinosad	13.3 ± 1.6c	9.3 ± 2.1 c
Methamidophos	6.4 ± 1.5c	5.7 ± 0.9 c

Means within columns followed by the same letter are not significantly different (P > 0.05). Means were averaged over 1, 3 and 7 DAT.

Analysis of results from the second spray table test showed that spinosad a.i. rate was the only significant source of variation for both spray volumes (F = 18.61; df = 5, 10; P<0.0001 for 19 L/ha and F = 79.90; df = 5, 10; P<0.0001 for 47 L/ha). Days after treatment did not significantly influence number of thrips between treated and untreated cotton for either spray volumes (F = 1.06; df = 3, 60; P > 0.37 for 19 L/ha and F = 0.88; df = 3, 57; P > 0.46 for 47 L/ha). Additionally, there were no significant interaction effects between DAT and a.i. rate for either spray volumes (F = 1.06; df = 15, 60; P > 0.41 for 19 L/ha and F = 1.61; df = 15, 57; P > 0.10 for 47 L/ha). The mean number of thrips per plant was averaged over DAT (Table 5). At a spray rate of 19 L/ha, the numbers of thrips per plant in the untreated control and 0.0187 and 0.0281 kg/ha a.i. rates were significantly higher than plants sprayed at or above 0.0375 kg/ha a.i. rate. However, at 47 L/ha, greater thrips control was found at lower a.i. rates as compared to 19 L/ha. Although this effect was statistically significant for only one a.i. concentration, there are obvious numerical trends. These results reflect the importance of evaluating insecticides at a.i. rates that provide marginal control to identify optimum deposition parameters for insecticide efficacy.

Table 5. Mean number of thrips per plant ± SEM on cotton sprayed with spinosad using 2 nozzles at 19 (2) and 47 (5) L/ha (gpa) on a spray table.

	Spray Volume (L/ha)	
	19	47
A.I. Rate (kg/ha)	Mean Number of Thrips per Plant	Mean Number of Thrips per Plant
Untreated Control	49.4 ± 5.4a	56.5 ± 4.1a
0.0187	34.7 ± 5.0ab	20.6 ± 4.2b
0.0281	42.6 ± 5.5a	12.0 ± 1.7bc
0.0375	23.8 ± 3.1bc	14.7 ± 2.5bc
0.0751	5.7 ± 1.3d	7.4 ± 1.0c
0.0874	9.4 ± 1.7cd	6.2 ± 1.2c

Means within columns followed by the same letter are not significantly different (P > 0.05). Means were averaged over 3, 5, 7 and 14 days after treatment.

SUMMARY AND CONCLUSIONS

Conclusions from the study were that all technical insecticides tested in the AVT had significantly different LC_{50}s, with spinosad and methamidophos being the most toxic to thrips. Thiamethoxam had significantly greater contact activity than imidacloprid in AVT. Imidacloprid was the least toxic in AVT bioassays which specifically evaluate contact toxicity; however, both neonicotinoids, imidacloprid and thiamethoxam, evaluated possess translaminar activity which AVT does not assess. Both spinosad and methamidophos at the lowest recommended label field rates provided significantly better control of thrips on cotton plants as compared to dicrotophos and untreated control under spray table application conditions. These results related well with toxicity assessments made via AVT. Spinosad and methamidophos provided the same level of control of thrips on cotton plants in spray table applications. Droplet size and density at a 19(2) L/ha(gpa) spray volume for spinosad, methamidaphos and dicrotophos did not have a statistically significant effect on control of thrips in the spray table. Spray table applications of spinosad provided significantly greater control of thrips on cotton plants at lower a.i. rates with increased spray volume [47 (5) compared to 19 (2) L/ha (gpa)] which indicated that coverage was important for this insecticide. Results of these laboratory studies will be used as a basis for selection of aerial application treatments to validate efficacy of different insecticides and aerial application parameters for control of thrips on producer-grown cotton and actual aerial field applications.

DISCLAIMER

Mention of a trademark, vendor, or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

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