2003 BELTWIDE COTTON CONFERENCES, NASHVILLE, TN – JANUARY 6-10

EFFECT OF AERIAL APPLICATION PARAMETERS SIMULATED ON A SPRAY TABLE ON INSECTICIDAL MORTALITY OF COTTON APHIDS AND STINK BUGS

Juan D. López Jr., M.A. Latheef, W.C. Hoffmann, and I.W. Kirk
USDA-ARS
Southern Plains Agricultural Research Center
Areawide Pest Management Research Unit
College Station, TX

Abstract

A spray table calibrated for spray rates of 2 and 5 gallons/acre (gpa) with 2 different nozzles was used to simulate aerial applications on cotton to determine effects on insecticidal mortality of cotton aphids, *Aphis gossypii* Glover, and southern green stink bugs, *Nezara viridula* (L.). Spray droplet characteristics for both spray rates were similar except for the number of droplets/cm^2. Acetamiprid (Intruder®) and dicrotophos (Bidrin®) at various active ingredient (ai) concentrations were evaluated for aphids and southern green stink bugs, respectively. Acetamiprid at 0.025, 0.038and 0.05 lb ai/acre (ai/ac) at 5 gpa significantly reduced aphid numbers per leaf compared to control by 3 days after treatment (DAT) and to essentially zero by 5, 7 and 14 DAT which indicates good residual activity. At 2 gpa, only the 0.038 and 0.05 ai rates significantly reduced aphid numbers by 3 DAT, but the decrease was significantly less than for all 3 ai rates at 5 gpa. A delayed effect for aphid control at 2 gpa was evident because by 5 DAT and thereafter, there were no significant differences in numbers of aphids/leaf at all rates for both 2 and 5 gpa; however, numbers were not essentially zero in the 2 gpa. Dicrotophos at 0.125, 0.25 and 0.375 lb ai/ac with exposures starting 1 DAT significantly reduced the percent of stink bugs alive compared to control by 2, 3 and 4 DAT for all ai rates at 5 gpa and all percentages alive were statistically equal except for 0.125 lb ai/ac at 2 DAT. For 2 gpa at 2 DAT, only the 0.375 ai rate significantly reduced the percentage alive and this was the only rate that reduced numbers to those not significantly different from all ai concentrations at 5 gpa. These results show that for both insecticides and pests, coverage is important for efficacy and that there is potential for using lower ai concentrations at 5 gpa to reduce control costs, but additional evaluations are needed.

Introduction

Cotton aphids, *Aphis gossypii* Glover, have been and continue to be important pests of cotton throughout the Cotton Belt. Stink bugs on the other hand, have only more recently become important cotton pests because of reduced broad spectrum insecticide use in areas of the Cotton Belt where boll weevils have been eradicated. Increased plantings of Bt cottons that typically require less insecticide use are also a factor contributing to emergence of new pest problems (Turnipseed et al. 1995; Greene et al. 1999; Roof and Arnette 2000; Emfinger et al. 2001; Karner and Goodson 2002). Control of both pests often requires intervention with insecticides. The list of recommended products has grown recently because new insecticides with distinct modes of action have come into the market (Moore et al. 2002). Many of these insecticides are applied with agricultural aircraft to insure timely application. There is a distinct lack of information on efficacy of these insecticides relative to aerial application parameters such as droplet-size spectrum, spray rate, and concentration of active ingredient. Typical of this type of studies are those reported by Wofford et. al. (1987), Kirk et al. (1993, 1994), Kirk and Esquivel (1998) and Esquivel and Kirk (1998). The critical aspects relative to cost of control are spray rate and concentration of active ingredient. Droplet-size spectrum, which is an important consideration in drift control is important not as much from a direct cost, but more from an efficacy standpoint. Because tremendous resources are needed to do these evaluations under field conditions, initial evaluations of the effect of aerial application parameters are better assessed by simulation using a spray table to reduce the number of treatments that will be taken to the field for verification of findings. The objective of this research was to determine the effect on efficacy of spray rate (2 and 5 gpa) and different active ingredient rates of acetamiprid (Intruder®) and dicrotophos (Bidrin®) for control of cotton aphids and southern green stink bug, *Nezara viridula* (L.), respectively, by simulating aerial applications on a spray table. Although evaluations reported here only include two of the recommended insecticides, the emphasis will be on using similar protocols to evaluate all recommended and commonly-used insecticides in the future.

Materials and Methods

Deltapine 436RR grown in the greenhouse was used for testing.. For the test with cotton aphids, seed was planted in 18" DuraCotta plastic window boxes (BWI, Schulenburg, TX). The plants were thinned to 5 plants per box. After true leaves were present, plants were treated with PixPlus® at the rate of 2 fl oz/gal/acre to prevent excessive growth, spindly stems and long internodes. Tests with these plants were initiated after fruiting. For the test with stink bugs, seed was planted in 12"diameter plastic pots and the plants thinned to 3 per pot. The plants had been trimmed back to about the second node above the cotyledonary nodes and tests were conducted on the regrowth when the plants had started squaring again.

Cotton aphids used in the studies were a naturally-occurring infestation that developed in the greenhouse cotton in the fall of 2002. Plants with aphids were treated and returned to the greenhouse. Other untreated plants in the greenhouse were heavily infested and should have provided a good source for reinfestation of treated plants in the case that there was a reduction in the residual effects of the insecticides. Aphids were sampled pretreatment by collecting 6 leaves randomly from the plants in the trays preselected for testing. Treatment effects were determined by collecting 3 leaves from the plants in each tray which represented a replicate at 3, 5, 7 and 14 DAT. Both winged and wingless aphids were counted, but only the total counts are presented here.

Adult southern green stink bugs were captured in 40-watt blacklight traps (Hollingsworth and Hartstack 1972) operated in an intensively cropped area (cotton, corn, sorghum, soybeans and pecans) in the Brazos River Valley , Burleson County, about 12-15 miles southwest of College Station, TX. Catch containers in the blacklight traps originally designed to kill captured insects were replaced with inverted hardware screen catch containers from 30″diameter Texas cone pheromone traps (Hartstack et al. 1979). Pieces of crumpled paper bags were placed inside the canisters for captured insects to rest on. Capture containers were collected early each morning and placed in a walk-in refrigerated box maintained at 55°F for sorting. Southern green stink bugs were separated from the rest of the captured insects and both sexes were placed in screened Plexiglass™ boxes where they were fed green beans, *Phaseolis vulgaris* (L.), for 1 or more days. The green beans were washed and dried before feeding to remove any residual insecticide. Adults were kept in an environmental room with temperature at 80° F, RH > 60%, and a 14:10 h L:D photoperiod. For testing, 10 adults were randomly selected from the cages irrespective of sex and were confined on treated and control plants 1 DAT by placing a tube made of fine organdy over the pot and sealing the bottom with tape on the pot and the top with a rubber band after twisting it shut. The treated plants were kept in the greenhouse and were checked for live and dead stink bugs 2, 3 and 4 DAT.

Plants were treated on a spray table that had been calibrated to deliver 2 and 5 gpa spray rates from nozzles no. 650033 and 8002E, respectively, with similar droplet spectrums by using different combinations of pressure, speed and height of the nozzle above the plant canopy. Both nozzles were obtained from TeeJet Agricultural Spray Products, Spraying Systems Co. Two swaths, 8.375" wide on either side of a 7" strip directly under the nozzle, were marked on the spray table to identify the location that provided the desired spray pattern. The distance from the nozzle to the to top of the plants was adjusted to provide the best spray pattern. Plants were placed in the appropriate swath and each replicate was treated in a separate run of the spray table. A support stand with a clamp that held a piece of cardboard at plant height was placed in front of the plants and in the same position on the swath. A strip of water sensitive paper was placed on the cardboard for each run to insure proper treatment of the plants. Each strip was properly labeled and was stored after drying in a plastic holder. Table 1 shows the spray table setting, swaths and spray characteristics for the 2 and 5 gpa treatments.

Acetamiprid (Intruder®) was obtained from Aventis CropScience and was evaluated at rates of 0.025, 0.038, and 0.050 lb ai/ac. Dicrotophos (Bidrin® 8) was obtained from AMVAC Chemical Corporation and evaluated at rates of 0.125, 0.25, and 0.375 lb ai/ac. Silwet 77® (Loveland Industries) was added to both finished test sprays at a rate of 0.05% v:v.

Data were analyzed using the GLM procedure (SAS Institute 2001) and means separated using the Least Significant Difference means separation test with $\alpha= 0.05$.

Results and Discussion

As shown on Table 1, the actual treatment gpa of 2.15 and 4.93 were relatively close to the target of 2 and 5, respectively. The percentage of droplets less than 100 microns (% droplets <100microns) and volume median diameter (VMD) in microns show that droplet characteristics for both treatments were not very different. As expected, the major difference was in the no. of droplets per cm (# droplets/cm^2) in which there were about 10 times more droplets for the 5 than 2 gpa treatment.

Pretreatment count for the aphid test with acetamiprid was a mean (±SD) of 205 (64.4) of total aphids (both winged and wingless) per leaf; therefore, aphid populations on test plants were high (Table 2). At 3 DAT, all active ingredient rates at 5 gpa dramatically reduced aphid numbers compared to control. Essentially no aphids were found on the treated plants up to 14 DAT, although there was a significant decrease in the number of aphids after 3 DAT in the control. For all active ingredient rates at 2gpa, there were significant decreases in aphid numbers at 3 DAT, but the decrease was significantly greater for the 0.038 and 0.05 lb ai/ac rates than for the 0.025 rate. At all active ingredient rates at 2 gpa and 3 DAT, the decrease was not as great as compared to 5 gpa. Starting 5 DAT and thereafter, there were no significant differences in aphid numbers for all active ingredient rates at both 2 and 5 gpa, but numerically there were still some aphids found in the 2 gpa treatments. These results show that coverage is an important component of efficacy for acetamiprid as emphasized in the label and that there is a delayed effect at 2 gpa. Also, acetamiprid appears to show very good residual activity. Additional evaluations of this insecticide are needed for lower than recommended rates at 5 gpa and the effect of different droplet sizes on efficacy with emphasis on the larger droplet sizes to reduce drift.

For dicrotophos, the lowest recommended rate for stink bugs on the label is 0.25 lb ai/ac and the recommended rate for green stink bugs in Southern, Eastern and Blackland areas of Texas is 0.5 lb ai/ac (Moore et al. 2002). Therefore, the rates evaluated are at the lower end. There were no significant differences in survival of the controls over the 3 day test period (Table 3). Overall, the highest mortality was obtained with the 0.25 and 0.375 lb ai/ac rates at 5 gpa. At 0.125 lb ai/ac and 5 gpa, initial mortality at 2 DAT was significantly lower than at the other rates; however, at 3 and 4 DAT, the differences were not significant. At 2 gpa and 2 DAT, only the 0.375 lb ai/ac rate significantly decreased survival and by 3 and 4 DAT, mortality for this rate was not significantly different from all ai rates at 5 gpa. As with acetamiprid, dicrotophos is more effective when applied at higher spray rates; therefore, lower active ingredient rates at higher spray rates may be effective so additional evaluations are needed. Determining the effect of larger droplet sizes is also important for drift reduction.

With both insecticides evaluated for cotton aphids and southern green stink bugs, 5 gpa for all active ingredient rates tested provided the best efficacy and there is potential for use of reduced rates with the higher spray volumes to decrease the cost of control. The effect of increased droplet size spectra on efficacy is also an important consideration for future studies to determine drift reduction potential.

Acknowledgments

The help of Charlie Harris in calibrating the spray table and Chris Parker in conducting the tests is gratefully acknowledged.

Disclaimer

Mention of a commercial or proprietary product does not constitute an endorsement for its use by the U.S. Department of Agriculture.

References

Emfinger, K., B. R. Leonard, J. Gore and D. Cook. 2001. Insecticide toxicity to southern green, *Nezara viridula* (L.) and brown, *Euchistus servus* (Say), stink bugs. Proc. Beltwide Cotton Prod. Res. Conf. 2: 1159-1161.

Esquivel, J. F. and I. W. Kirk. 1998. Efficacy of aerially applied Tracer™ on cotton foliage. Proc. Beltwide Cotton Prod. Res. Conf. 2:1276-1277.

Greene, J. K., S. G. Turnipseed, M. J. Sullivan and G. A. Herzog. 1999. Boll damage by southern green stink bug (Hemiptera: Pentatomidae) and tarnished plant bug (Hemiptera: Miridae) caged on transgenic *Bacillus thuringiensis* cotton. J. Econ. Entomol. 92: 941-944.

Hartstack, A. W., J. A. Witz and D. R. Buck. 1979. Moth traps for the tobacco budworm. J. Econ. Entomol. 72: 519-522.

Hollingsworth, J. P. and A. W. Hartstack, Jr. 1972. Effects of components on insect light trap performance. Trans. ASAE 15: 924-927.

Karner, M. and J. Goodson. 2002. Stink bugs - An emerging pest in Oklahoma cotton fields. 3 pp. Proc. Beltwide Cotton Prod. Res. Conf.

Kirk, I. W. and J. F. Esquivel. 1998. Field evaluation of aerially applied Tracer™ - spray rate and droplet size. Proc. Beltwide Cotton Prod. Res. Conf. 2:1277-1278.

Kirk, I. W., L. F. Bouse, M. A. Latheef, and J. B. Carlton. 1994. Spary deposition by different aerial delivery systems for control of sweetpotato whitefly in cotton. Proc. Beltwide Cotton Prod. Res. Conf. 1:546-548.

Kirk, I. W., V. S. House, and L. F. Bouse. 1993. Ovicide formulation and aerial application parameters influence control of tobacco budworm. *In* B. N. Devisetty, D. G. Chasin, and P. D. Berger eds. Pesticide Formulations and Application Systems. ASTM STP 1146, 12:319-333.

Moore, G. C., R. D. Parker, D. D. Fromme and A. E. Knutson. 2002. Suggested insecticides for managing cotton insects in the Southern, Eastern and Blackland areas of Texas. pp 8. Texas Cooperative Extension, TX A&M Univ., Publication no. E-5A, 3-02.

Roof, M. E. and F. Arnette. 2000. Monitoring stink bugs in cotton in South Carolina. Proc. Beltwide Cotton Prod. Res. Conf. 2: 1122-1123.

SAS Institute. 2001. PC SAS, Version 8, SAS Institute, Cary, NC.

Turnipseed, S. G., M. J. Sullivan, J. E. Mann and M. E. Roof. 1995. Secondary pests in transgenic Bt cotton in South Carolina. Proc. Beltwide Cotton Prod. Res. Conf. 2: 768-769.

Wofford, J. T., R. G. Luttrell, and D. B. Smith. 1987. Relative effect of dosage, droplet size, deposit density, and droplet concentration on mortality of *Heliothis virescens* (Lepidoptera:Noctuidae) larvae treated with vegetable-oil and water sprays containing permethrin. J. Econ. Entomol. 80:460-464.

Table 1. Nozzle and spray information for the 2 and 5 gpa spray rates simulated on a spray table for tests to evaluate effect on efficacy of insecticides recommended for control of cotton aphids and southern green stink bugs.

							Droplet Characteristics			
Treatment gpa	**Nozzle No.**	**Pressure psi**	**Height in**	**Swath No.**	**Speed mph**	**Flow Rate gpa**	**%<100 microns**	**VMD microns**	**Relative Span**	**#Drops /cm^2**
2	650033	20	45.0	2	8.5	2.15	0.632	183.92	0.39	8.74
5	8002E	30	25.5	3	4.5	4.93	3.614	240.28	1.01	78.17

Table 2. Mean no. (±SD) of total cotton aphids (both winged and wingless) per leaf after treatment with acetamiprid (Intruder®) at 3 different active ingredient rates and at 2 and 5 gpa simulated on a spray table.

	Mean no. aphids per leaf for indicated gpa and rate (lb ai/ac)							
	2 gal/ac				5 gal/ac			
DAT	**Control**	**0.025**	**0.038**	**0.050**	**Control**	**0.025**	**0.038**	**0.050**
3	201.1Aa	97.8Ba	54.1Ca	62.8Ca	199.3Aa	4.9Da	14.6Da	17.1Da
	(93.7)	(50.1)	(20.2)	(30.8)	(69.2)	(4.3)	(9.3)	(8.5)
5	122.8Ab	18.7Bb	9.9Bb	21.7Bb	111.4Ab	0.0Ba	0.0Ba	0.0Ba
	(57.1)	(28.4)	(4.6)	(14.7)	(102.3)	(0.0)	(0.0)	(0.0)
7	128.2Ab	24.8Bb	0.6Bb	1.4Bb	128.0Ab	0.1Ba	0.3Ba	0.0Ba
	(39.12)	(33.0)	(0.7)	(1.3)	(49.0)	(0.3)	(0.7)	(0.0)
14	116.7Ab	19.6Bb	7.2Bb	4.4Bb	112.7Ab	0.2Ba	0.0Ba	0.7Ba
	(60.1)	(21.7)	(5.8)	(4.6)	(41.2)	(0.6)	(0.0)	(1.7)

$LSD_{0.05}$=31.3. Means in the same row followed by different capital letters and means in the same column followed by different small letters are significantly different.

Table 3. Mean percent of adult southern green stink bugs alive at 2, 3 and 4 DAT on cotton plants treated with dicrotophos (Bidrin®) at various active ingredient rates at 2 and 5 gpa simulated on a spray table. Adults were confined on treated plants 1 DAT.

	Mean percent of adult stinkbugs alive for indicated gpa and insecticide rate (lb ai/ac)							
	2 gpa				5 gpa			
DAT	**Control**	**0.125**	**0.25**	**0.375**	**Control**	**0.125**	**0.25**	**0.375**
2	97Aa	97Aa	78Aa	37Ba	93Aa	34Ba	10Ca	7Ca
3	94Aa	90Aab	52Bb	14Cb	90Aa	27Ca	10Ca	7Ca
4	94Aa	70Bb	30Cc	14CDb	83ABa	27CDa	10CDa	7Da

$LSD_{0.05}$ = 21.8%. Means in the same row followed by different capital letters and in the same column followed by different small letters are significantly different.