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INSECTICIDE EFFICACY AGAINST COTTON INSECT PESTS USING AIR INDUCTION AND HOLLOW CONE NOZZLES

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Abstract

Air induction (low-drift) nozzles have been effective in herbicide applications while reducing off-target drift of sprays. Hollow cone nozzles are highly effective in insecticide applications, but generally produce a droplet spectrum that is prone to drift off-target. For the purpose of convenience, cotton producers have recently opted to use air induction spray nozzles while applying insecticides. This study compares efficacy of insecticides applied using air induction and hollow cone nozzles against selected insect pests. The results consistently show that insecticide efficacy levels are lower using air induction nozzles compared to that for hollow cone nozzles.

Introduction

Chemical control strategies rely heavily on the capacity of the application system to properly deliver the insecticide to the target site. Pesticide application technologies are constantly being improved, and a recent change has been to modify nozzles, primarily to reduce phytotoxicity from non-target drift of contact herbicides. Air induction (low-drift) or venturi-type nozzles introduce air into the nozzle body resulting in larger droplets and reduced drift potential of sprays. These types of nozzles are effective in herbicide applications (Baumann and Smith 2000). However, air induction nozzles used for insecticide applications are not as effective as other nozzle types for insecticide applications to horticultural crops (Lesnik 2005). Most cotton producers are using air induction nozzles on tractor-mounted spraying systems to reduce off-target drift of herbicides. Hollow cone and flat-fan nozzles have historically been used for insecticide applications (McDowell et al. 1991). However, hollow cone nozzles typically produce a droplet spectrum (200 – 280 microns) prone to off-target drift (Anonymous 1996, Griffin et al. 2003). Consequently, producers, for the purpose of convenience, have recently opted to utilize air induction nozzles for co-application of herbicides and insecticides. During 2005, producers and consultants reported unsatisfactory control of several insect pests when co-applying insecticides with the herbicide, glyphosate, using air induction nozzles. The objective of this study was to compare insecticide efficacy for treatments applied through air induction and hollow cone nozzles against common cotton and soybean insect pests.

Materials and Methods

Site Locations and Production Practices

Field experiments were conducted at the Macon Ridge Research Station (MRRS) near Winnsboro, Louisiana and at the United States Department of Agriculture–Agricultural Research Service–Southern Insect Management Research Unit (USDA-ARS-SIMRU) near Stoneville, Mississippi in 2005. All treatments were applied with ground-based application systems. Test areas were planted to recommended varieties of cotton and soybean, and maintained with optimum production practices.

MRRS

Field experiments at the Macon Ridge Research Station were conducted using a non-randomized experimental design with four replications. Plots in all studies consisted of 3 rows (centered on 40 inches) x 50 feet. TeeJet® (Spraying Systems Co., Mobile Systems Division, Wheaton, IL 60189-7900) TX-6 hollow cone and TeeJet® AI110015 air induction nozzle tips were used in each experiment. All insecticides were applied to cotton with a PTO-driven, compressed air spraying system calibrated to deliver 10 gpa through AI110015 nozzles at 30 psi and

TX-6 nozzles at 40 psi while traveling 3 mph. Data for all experiments were subjected to analysis of variance, and selected treatment means (air induction vs. hollow cone) were compared for significant differences ($P < 0.05$) (SAS Institute 1998).

Cottonseed (Stoneville 5599BR) for thrips studies was planted into a Gigger-Gilbert silt loam soil on 11 Apr. Bidrin 8EC at rates of 0.1, 0.2, and 0.3 lb AI/acre were applied on 19 May. Thrips (Thysanoptera), primarily *Franklinella spp.*, infestation levels were quantified 3 days after treatment (DAT) and 7 DAT by removing 10 plants per plot, soaking the plants in a 10% hypochlorite solution for approximately 10 minutes, and rinsing insects through a No. 30 (0.0234 in.) testing sieve and into a No. 325 (0.0017 in.) testing sieve. Thrips were then subjected to an ethanol (90%) rinse on filter paper, where excessive moisture was removed with a vacuum pump, and observed microscopically. Total number of insects per 10 plants was used to determine percent control.
Cottonseed (Stoneville 5599BR) for cotton aphid, *Aphis gossypii* (Glover), studies was planted into a Gigger-Gilbert silt loam soil on 11 Apr. Bidrin 8EC (0.2 lb AI/acre) and Intruder 50WP (0.067 lb AI/acre) were applied on 20 Jun. Cotton aphid densities were quantified 3 DAT and 8 DAT in a similar manner as described previously for thrips with the exception of the use of 10 upper-most, fully-expanded terminal leaves. Total numbers of insects per 10 leaves was used to determine percent control.

Cottonseed (DP 432RR) for the tobacco budworm, *Heliothis virescens* (F.), study was planted into a Gigger-Gilbert silt loam soil on 28 Jun. Tracer 4SC at a rate of 0.063 lb AI/acre was applied for tobacco budworm on 29 Aug. Insecticide efficacy was quantified by harvesting 10 squares per plot approximately 1 hour (H) after application. Squares were then infested with tobacco budworm larvae (3-4 d old) and mortality was determined at 3 DAT and 4 DAT. Percent mortality was used to compare insecticide efficacy between nozzle types.

USDA-ARS-SIMRU
Treatments in all experiments at the USDA-ARS-SIMRU were placed in a RBD with four replications. Cottonseed (DPL 424) was planted into a silt loam soil on 27 Apr. Soybeans (group IV) were planted during June. Plots in all studies consisted of 4 rows (centered on 40 inches) x 60 feet with the exception of the thrips test, which was 2 rows x 30 feet. All insecticides were applied using a CO_2-charged spraying system calibrated to deliver 9.4 gpa at 40 psi and 5 mph. TeeJet® TX-12 hollow cone and AI11002 nozzle tips were used in each experiment. Data in all experiments were analyzed using paired *t*-tests ($P < 0.05$).

The insecticide applied for thrips was Orthene 90SP at a rate of 0.25 lb AI/acre. Thrips densities were quantified 1 DAT where total numbers of insects per 10 plants were counted and converted to percent control. Insecticides applied for tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) included: Orthene 90SP (0.5 lb AI/acre), Centric 40WG (2.0 oz form/acre), and Karate 2.08SC (0.033 lb AI/acre). Tarnished plant bugs were caged on the plants 1 HAT, and mortality was determined 2 DAT. A total of 15 insects were used per treatment per replication.

The insecticide applied for bollworm, *Helicoverpa zea* (Boddie), was Karate 2.08SC (0.033 lb AI/acre). Insecticide efficacy was quantified by harvesting 10 leaves per plot approximately 1 HAT. Leaves were placed in Petri dishes, infested with 5 neonate stage bollworm larvae, and mortality was determined 2 DAT. Orthene 90SP (1.0 lb AI/acre) was applied for brown stink bug, *Euchistus servus* (Say). Stink bugs were caged on the plants 1 HAT, and mortality was determined 2 DAT. A total of 15 insects were used per treatment per replication.

Results and Discussion

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Control of thrips 3 DAT with Bidrin 8EC (0.1, 0.2, and 0.3 lb AI/acre) with air induction nozzles ranged from 43.7 to 50.6 percent, compared to hollow cone nozzles, which provided control ranging from 62.2 to 72.9 percent (Table 1). Similarly, control of thrips 7 DAT with air induction nozzles was less (8.0 to 31.2 percent) than control with hollow cone nozzles (20.3 to 59.5 percent). At 3 and 7 DAT Bidrin 8EC (0.3 lb AI/acre) was significantly more effective when applied with hollow cone nozzles compared to air induction nozzles.

Bidrin 8EC and Intruder 40WP applied through air induction nozzles provided less control (54 and 71.0 percent) of cotton aphid 3 DAT, compared to hollow cone nozzles, which provided 69.1 and 96.1 percent control. Similar trends were observed for air induction nozzles 8 DAT (57.8 and 64.3 percent control) compared to hollow cone nozzles (67.2 and 91.1 percent control). Performance of both insecticides was significantly greater with hollow cone nozzles compared to air induction nozzles 3 DAT.

Tracer 4SC applied through air induction nozzles provided 15.0 and 42.5 percent control 3 and 4 DAT, respectively. Hollow cone nozzles provided significantly greater control of tobacco budworm 3 and 4 DAT, with respective mortality rates of 40.0 and 67.5 percent.

USDA-ARS-SIMRU

Control of thrips with Orthene 90SP applied through air induction nozzles was significantly less than hollow cone nozzles at 24 percent and 36 percent, respectively (Table 2).

Hollow cone nozzles provided 21, 65, and 96.4 percent control of tarnished plant bug for Karate 2.08SC, Orthene 90SP, and Centric 40WG, respectively. Air induction nozzles provided significantly less control (14, 49, and 75.8 percent) with the same products.

Control of bollworm with Karate 2.08SC through air induction nozzles was 27 percent. Control with hollow cone nozzles was significantly higher (54 percent) than that with air induction nozzles.

Orthene 90SP produced significantly higher mortality of brown stink bug when applied through hollow cone nozzles (100 percent) compared to air induction nozzles (77 percent).

Summary

Air induction nozzles are an effective means of delivering herbicides and reducing off-target drift, while hollow cone nozzles have been proven effective when used with insecticides. Producers are utilizing air induction nozzles to co-apply herbicides and insecticides for the purpose of convenience. Results of these studies consistently show hollow cone nozzles to be more efficacious than air induction nozzles in controlling various insect pests in cotton and soybean. This information and subsequent research should aid agricultural producers and consultants in future insect pest management decisions.

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Table 1. Insect control at Macon Ridge Research Station with air induction (AI) and hollow cone (HC) nozzles.

Insecticide	Nozzle	Rate(lbAI/A)	3DAT	DAT[y]
Thrips				
Bidrin	AI	0.1	41.1a	8.0a
Bidrin	HC	0.1	60.6a	20.3a
Bidrin	AI	0.2	50.6a	15.7a
Bidrin	HC	0.2	65.8a	37.3a
Bidrin	AI	0.3	49.8b	31.2b
Bidrin	HC	0.3	72.9a	59.5a
Cotton aphids				
Bidrin	AI	0.2	54.0b	57.8a
Bidrin	HC	0.2	69.1a	67.2a
Intruder	AI	1.07 [x]	71.0b	64.3a
Intruder	HC	1.07 [x]	96.1a	91.1a
Tobacco budworm				
Tracer	AI	0.063	15.0b	42.5b
Tracer	HC	0.063	40.0a	67.5a

Column means for each pest and insecticide rate combination followed by the same letter are not significantly different (DMRT, $P < 0.05$).
[x] oz formulation/acre
[y] The second thrips observation was 7 DAT, for cotton aphid 8 DAT, and for tobacco budworm 4 DAT.

Table 2. Insect control at USDA-ARS-SIMRU with air induction (AI) and hollow cone (HC) nozzles.

Insecticide	Nozzle	Rate(lb AI/A)	DAT[y]
Thrips			
Orthene	AI	0.25	24b
Orthene	HC	0.25	36a
Tarnished plant bug			
Orthene	AI	0.5	49b
Orthene	HC	0.5	65a
Karate	AI	0.033	14b
Karate	HC	0.033	21a
Centric	AI	2.0 [x]	75.8b
Centric	HC	2.0 [x]	96.4a
Bollworm			
Karate	AI	0.033	27b
Karate	HC	0.033	54a
Brown stink bug			
Orthene	AI	1.0	77b
Orthene	HC	1.0	100a

Column means for each pest and insecticide rate combination followed by the same letter are not significantly different (*t*-test, $\underline{P} < 0.05$).

[x] oz formulation/acre

[y] Data for thrips were collected 1 DAT, while tarnished plant bug, bollworm, and brown stink bug data were collected 2 DAT.