Determination of Residual Control of Commonly used Insecticides in Soybean and Cotton, 09-2021

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Background and Objectives

Due to increased costs of insecticides, particularly newer products, the most asked question by growers is length of control. This drives many decisions on product choice. For example, if product A is $10.00/Acre and provides 5 days of control, the grower is essentially spending $2.00/day for insect control compared to insecticide B that cost $15.00/Acre and provides 10 days of control. Product B is costing the grower $1.50/day for insect control and is a better investment. Most estimates of residual control with currently used insecticides are non-scientific best guesses and are generally wrong. This experiment will address true residual control (and examine systemic uptake) producers can expect in both soybean and cotton with commonly used insecticides targeting several key pests in each crop. This research will be jointly funded by both commodities.

Objective 1: Determine insecticidal residual of commonly used insecticides in soybean.

Objective 2: Systemic quantification of diamides in soybean

Objective 3: Validate mortality of systemic concentrations on mortality of Corn Earworm and Soybean Looper

Report of Progress/Activity

Objective 1:

All treatments out to 21 days after treatment (DAT) significantly reduced stink bug numbers below the untreated check (Table 1). Numerically, acephate + bifenthrin treatments reduced stink bugs more effectively than other treatments up to 14 DAT. Regarding detected chemical concentrations, clothianidin did not persist after 7 DAT (Table 2). While acephate concentrations were not detected at 28 DAT, bifenthrin was still present out to the same time interval. Rather than assuming insecticides provided long residual control, treatments possibly killed a large percentage of the initial population, and the perceived control was likely due to lack of reinfestation.

Objective 2:

Chlorantraniliprole concentrations in soybean flowerets have been quantified (Figure 1). Results from the chemical analysis showed concentrations in flowerets out to 14 DAT. Systemic movement of chlorantraniliprole into flowerets could be expected based on the results from this study. Concentrations discovered in the flower tissue was used to determine mortality of corn earworm based on bioassay data (results in objective 3). In soybean leaf tissue, chlorantraniliprole concentrations generally decreased when moving from the top to the bottom of the plant. Expectedly, these concentrations decrease over time measured out to 28 days after application (Table 3, 4). High morality of corn earworm was observed in soybean leaf bioassays. >87% mortality was achieved with all rates in the top of the plant (Table 5). Mortality ranging from 94 to 95% was recorded with 28 and 21 fl oz/A rates while a reduction in mortality, 88%, was noticed using the lowest rate, 7 fl oz./A. All rates except for 7 fl oz/A resulted in mortality >90% in the bottom of the plant.

Objective 3:

Results from the leaf bioassay indicated significant differences in mortality between the reduced rates of chlorantraniliprole (Figure 2). Mortality was similar with 5 PPB, 25 PPB, and the untreated control. When increasing from 25 to 75 PPB, a drastic increase in mortality was observed. The three highest concentrations (75, 100, 125 PPB) were not different and resulted in >50% mortality. This study confirmed some systemic movement into the flowerets could provide mortality of corn earworm up to 64%. In addition to the leaf bioassay, diet incorporated assays were conducted using comparable concentrations. Similar LC_{50} values were observed between field colony (LC_{50} = 30.1 PPB) and lab colony (LC_{50} = 30.0 PPB) corn earworms. Confidence intervals overlapped among the two populations and were considered not significantly different [Field Colony (8.9-56.03) and Lab Colony (10.8-56.80)]. Since no statistical differences in LC_{50} values were observed, there does not appear to be any apparent threat of resistance of corn earworm to chlorantraniliprole in Mississippi populations.

Impacts and Benefits to Mississippi Soybean Producers

With the increase cost of insecticides, the data in the study has allowed for a better understanding on insecticide residual and the approximate length of control targeting either stink bugs or corn earworm in Mississippi soybean production systems. With an average of two foliar insecticide applications annually targeting either stink bugs or corn earworm, this data will be applicable to all acres that might receive in insecticide application.

End Products–Completed or Forthcoming

Data has been presented at one local, one regional, and one national meeting in 2021 and has been presented at one regional meeting with plans to present at a second regional meeting in 2022.. In addition to data presentations at local, regional, and national meetings, there are plans to use this data for blog articles on the Mississippi State Crop Situation Blog. Currently, this data is being written up in a M.S. thesis and data chapters will be submitted to referred journals for publication.

Graphics/Tables

Table 1 Impact of selected insecticides on mean (SEM) number of stink bugs per 25 sweeps at the Delta Research and Extension Center in Stoneville, MS and the R.R. Foil Plant and Soil Sciences Research Center in Starkville, MS in 2020.

Treatment	**3 DAT[1]**	**7 DAT**	**14 DAT**	**21 DAT**	**28 DAT**
			Mean (± S.E.)[2]		
Untreated	5.8a (1.7)	5.2a (0.8)	10.5a (1.9)	18.6a (2.5)	13.3a (2.5)
Clothianidin	1.9b (0.5)	2.4b (0.6)	5.1b (0.8)	7.7b (1.3)	11.2a (2.8)
Bifenthrin	2.2b (0.7)	2.7b (0.7)	5.6b (1.7)	8.3b (1.5)	7.2a (1.5)
Acephate	0.6b (0.2)	2.2b (0.6)	4.7b (1.0)	12.2b (1.4)	13.7a (2.9)
Acephate + Bifenthrin	0.8b (0.2)	1.3b (0.4)	3.0b (0.6)	8.1b (1.4)	8.4a (1.5)
F	5.7	5.1	5.3	7.2	1.9
d.f	4, 44	4, 113	4, 113	4, 93	4, 93
P>F	<0.01	<0.01	<0.01	<0.01	0.11

Means within a column followed by a common letter are not significantly different (FPLSD 0.05)
[1]DAT= Days after treatment
[2]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD (α=0.05).

Table 2 Mean (SEM) of concentrations of selected insecticides in soybean leaf tissue to determine chemical concentrations for study conducted at the Delta Research and Extension Center in Stoneville, MS in 2021.

Treatment	**4 DAT[1]**	**7 DAT**	**10DAT**	**14 DAT**	**21 DAT**	**28 DAT**
			Mean (± S.E.)[2,3]			
Untreated	0.0b	0.0a	0.0b	0.0b	0.0b	0.0b
Clothianidin	463.0b (210)	9.7ab (5)	0.0b	0.0b	0.0b	0.0b
Bifenthrin	4195.0ab (2146)	2290.0b (1108)	1797.7ab (1048)	2416.6a (1219)	1236.9a (662)	1470.0a (709)
Acephate	24,023.3a (9021)	9778.3a (5767)	3059.0a (1048)	293.7b (163)	24.5b (14)	0.0b
F	7.2	2.8	2.6	5.0	3.5	4.3
d.f	3, 6	3, 6	3, 7.8	3, 7.9	3, 6	3, 8
P>F	0.02	0.13	0.12	0.03	0.09	0.04

[1]DAT= Days after treatment
[2]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD (α=0.05).
[3]Means and standard errors are expressed as concentrations of active ingredient in parts per billion (PPB). (P≥0.05, Fisher's PLSD)

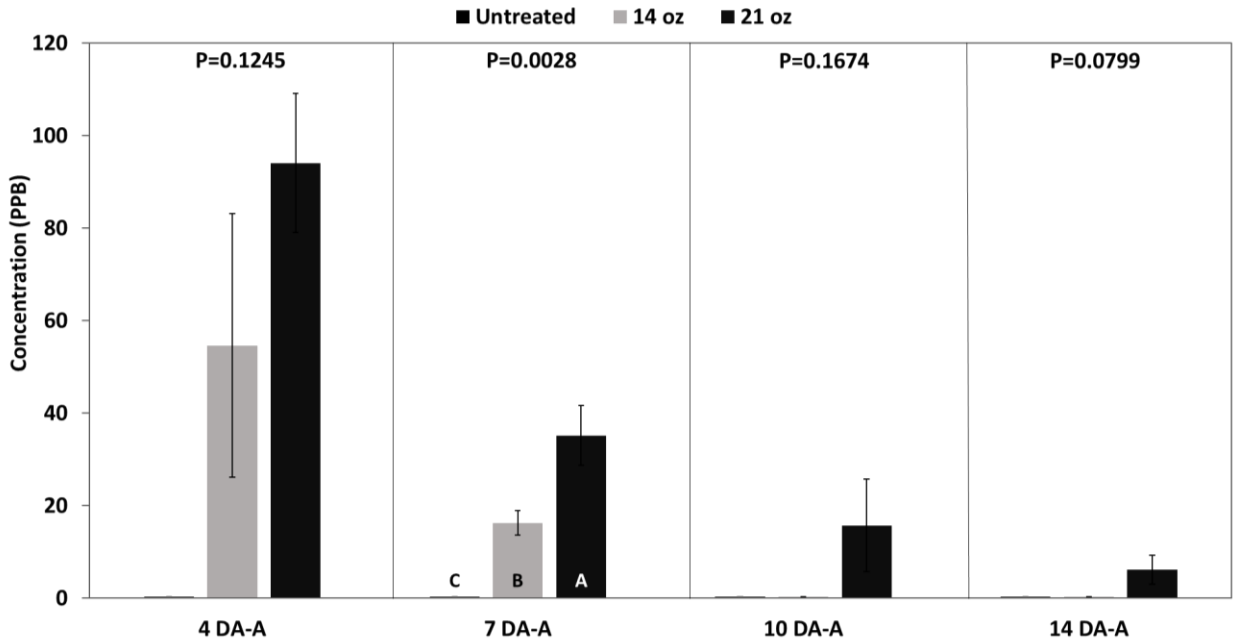

Figure 1: Systemic concentrations of chlorantraniliprole in soybean flowerets (P≥0.05, Fisher's PLSD)

Table 3 Mean (SEM) of chlorantraniliprole concentrations (PPB) by rate and zone in soybean leaves to determine the residual activity throughout the canopy in 2020 study.

[1]Rate of chlorantraniliprole expressed in kg ai ha^{-1}.

Rate[1]	**Zone[2]**	**1 DAT[3]**	**7 DAT**
		Mean (± S.E.)[4,5]	
0.028	Top	5696.0def (1899)	481.6cd (39)
0.028	Middle	3403.3efg (1125)	376.3cd (59)
0.028	Bottom	376.3fg (53)	163.7d (20)
0.053	Top	7814.3cde (3631)	2481.3bc (1231)
0.053	Middle	6410.0cde (885)	580.0cd (57)
0.053	Bottom	448.0efg (70)	230.5cd (43)
0.078	Top	15,413b (4208)	6406.7a (804)
0.078	Middle	9690.0cd (2544)	3583.3b (1052)
0.078	Bottom	3086.7defg (1647)	667.0cd (328)
0.103	Top	22,633.0a (2225)	7583.3a (587)
0.103	Middle	11,667.0bc (1319)	3440.3b (1406)
0.103	Bottom	1164.0efg (558)	505.0cd (138)
Untreated	Top	16.8g (2)[6]	2.5d (1)
Untreated	Middle	15.7g (3)	3.0d (2)
Untreated	Bottom	14.7g (3)	9.2d (4)
F		4.45	6.48
d.f.		8, 28	8, 26.1
P>F		<0.01	<0.01

[2]Plants were partitioned into three "zones" consisting of leaves from a top (18th node), middle (13th node), and bottom (9th node) zone.

[3]DAT= Days after treatment.

[4]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD (α=0.05).

[5]Means and standard errors are expressed as concentrations (PPB) of chlorantraniliprole.

[6]Trace amounts of drift was detected in untreated check plots.

Table 4 Mean (SEM) of chlorantraniliprole concentrations (PPB) by rate and zone in soybean leaves to determine the residual activity throughout the canopy in 2020 study.

Rate[1]	**14 DAT[2]**	**21 DAT**	**28 DAT**
		Mean (± S.E.)[3,4]	
0.028	269.5b (44)	177.2c (29)	142.9b (23)
0.053	617.8b (132)	819.9bc (418)	798.1b (417)
0.078	2472.1a (684)	1400.8ab (552)	852.0b (203)
0.103	2389.5a (655)	2096.0a (745)	2458.6a (203)
Untreated	2.3b (1)	1.7c (.7)	1.7b (.8)
F	17.3	5.4	9.2
d.f.	4, 28	4, 28	4, 28
P>F	<0.01	<0.01	0.02
Zone[5]			
Top	1749.5a (501)	1576.8a (550)	1419.4a (475)
Middle	1316.8a (473)	945.4ab (330)	740.3ab (293)
Bottom	384.5b (113)	174.6b (39)	392.3b (206)
F	17.9	5.9	4.4
d.f.	2, 28	2, 28	2, 28
P>F	<0.01	<0.01	0.02

[1]Rate of chlorantraniliprole expressed in kg ai ha^{-1}.
[2]DAT= Days after treatment.
[3]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD (α=0.05).
[4]Means and standard errors are expressed as concentrations (PPB) of chlorantraniliprole.
[5]Plants were partitioned into three "zones" consisting of leaves from a top (18^{th} node), middle (13^{th} node), and bottom (9^{th} node) zone

Table 5 Mean (SEM) percent mortality of corn earworm in leaf bioassays conducted in 2020 to determine mortality on soybean leaves throughout the canopy.

	Percent Mortality (± S.E.)[1,2]						
Zone[3]	**Rate**[4]						
	0.028	0.053	0.078	0.103	F	d.f	P>F
Top	87.8a (2.9)	92.7a (3.0)	92.5a (2.9)	92.9a (2.9)	3	72.0	0.12
Middle	88.1b (2.6)	91.0ab (2.4)	94.9a (1.7)	95.2a (1.7)	3	73.0	0.04
Bottom	84.6b (2.5)	91.5a (2.4)	94.1a (1.4)	92.0a (2.2)	3	69.1	<0.01

[1]Means within a row followed by the same letter are not significantly different according to Fisher's Protected LSD (α=0.05

[2]Means and standard errors are expressed percent mortality of corn earworm

[3]Plants were partitioned into three "zones" consisting of leaves from a top (18th node), middle (13th node), and bottom (9th node) zone.

[4]Rate of chlorantraniliprole expressed in kg ai ha^{-1}.

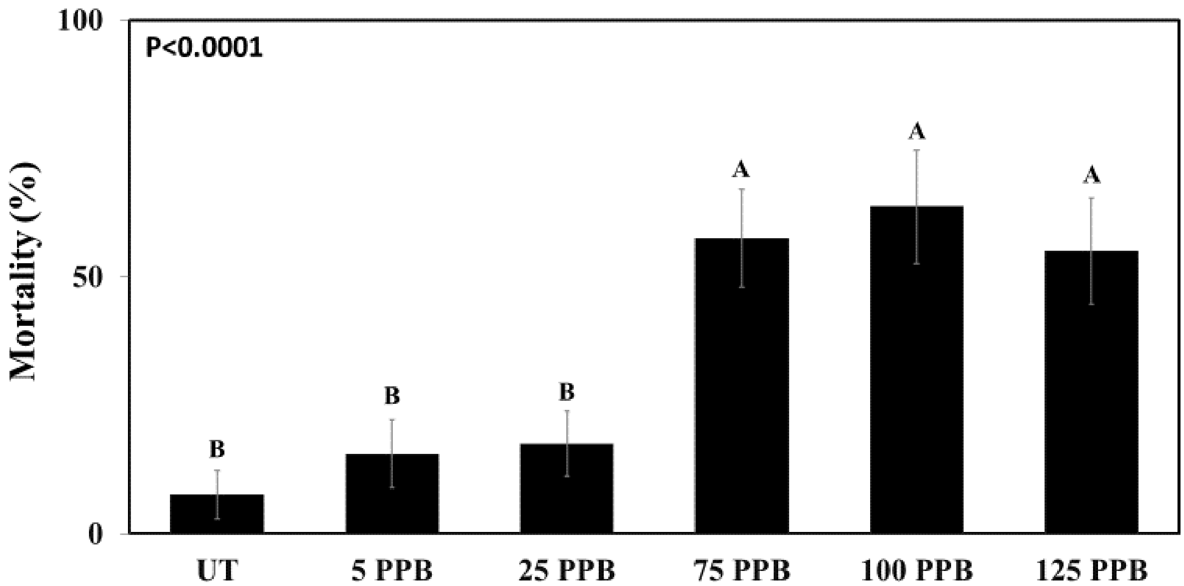

Figure 2 Mean (SEM) percent mortality of corn earworm in 2021 bioassay study to determine susceptibility of corn earworm to concentrations of chlorantraniliprole found in soybean floweret chemical analysis study. Means with like letters do not differ significantly according to Fisher's Protected LSD (α=0.05).