IMPACT OF SPRAY ADJUVANTS ON INSECTICIDE PERFORMANCE

D. R. Cook
J. Gore
Mississippi State University
Stoneville, MS
S. D. Stewart
University of Tennessee
Jackson, TN
G. M. Lorenz
University of Arkansas
Lonoke, AR
A. L. Catchot
Mississippi State University
Starkville, MS
D. L. Kerns
LSU AgCenter
Winnsboro, LA
G. Studebaker
University of Arkansas
Keiser, AR
F. R. Musser
Mississippi State University
Starkville, MS

Abstract

During 2012, trials were conducted to evaluate the impact of spray adjuvants on the performance of insecticides and miticides against thrips, spider mites, and tarnished plant bugs. None of the adjuvants tested significantly improved thrips control with acephate or Radiant. The addition of an adjuvant did not improve control of spider mites with Agri-Mek. The performance of Centric or Transform against tarnished plant bug was not significantly improved with the addition of any of the adjuvants tested. No rainfall occurred during these studies. Plant bug trials were also conducted with Centric, Transform, and acephate in which 1.2 in. of rainfall occurred within 2 to 2.5 hr after application. In these trials the addition of certain adjuvants significantly improved plant bug control compared to the insecticide applied alone. Of the three insecticides included in these trials, the greatest benefit was observed with acephate.

Introduction

Thrips are one of the first insect pests to infest cotton after emergence. Much of the cotton planted receives an insecticide seed treatment. In some cases, the seed treatments are supplemented with foliar insecticides. Under poor growing conditions and extended or severe thrips infestations, growers may apply more than one foliar application for thrips control.

Twospotted spider mite, *Tetranychus urticae* Koch, has historically been a late season pest of cotton in the mid-South. This trend has changed over the last ten years and spider mite infestations can be observed throughout the growing season. Traditional insecticides have limited activity on spider mites, and resistance to insecticides and acaricides can develop rapidly. There are a limited number of acaricides / miticides available, and these products tend to have activity only on spider mites and are quite expensive.

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is the major insect pest of cotton within the mid-South region. The tarnished plant bug is the target of more insecticide applications than any other insect pest in the mid-South (Williams 2012) with some growers making up to 15 foliar insecticide applications for plant bug control. Furthermore, tarnished plant bug is becoming resistant to many of the products currently used for their control, with few if any replacements expected in the near future (Hollingsworth et al. 1997, Holloway et al. 1998, Snodgrass and Scott 1988, Snodgrass 1994, Snodgrass and Elzen 1995, Snodgrass 2006). Currently, additional control measures are being investigated to help manage tarnished plant bug infestations.

There are numerous spray adjuvants available. Many of these substantially improve the performance of post emergence herbicides. The objective of these studies was to evaluate the impact of selected spray adjuvants representing different categories on the performance of insecticides and acaricides applied to manage thrips, twospotted spider mites, and tarnished plant bugs.

Materials and Methods

Across AR, MS, and TN trials were conducted during 2012 to evaluate the impact of spray adjuvants on insecticide and acaricide performance against thrips (two trials), spider mites (one trial), and tarnished plant bug (six trials). Trials were conducted on research stations and grower farms where sufficient infestation levels were encountered. The insecticides and acaricides included in these trials were Acephate 90S (0.15 lb AI/acre) and Radiant (1.5 oz/acre) for the thrips trials, Agi-Mek (4.27 oz/acre) for the spider mite trial, and Acephate 90S (0.75 lb/acre), Centric (1.25, 1.5, and 2 oz/acre), and Transform 50WG (1 and 1.5 oz /acre) for the plant bug trials. The adjuvants included in these trials represent several classes according to the Compendium of Herbicide Adjuvants (Young 2012) and are detailed in Table 1.

Table 1. List of adjuvants used as treatments, adjuvant category, and application rates.

Adjuvant	Adjuvant Category	Rate (%v/v)
Agri-Dex	Crop Oil Concentrate	1%
Penetrator Plus	Crop Oil Concentrate + Deposition Agent + Buffering Agent	1%
Induce	Nonionic Surfactant	0.25%
Dyne-Amic	Methylated Seed Oil + Organo-Silicone Surfactant + Nonionic Surfactant	0.5%
Kinetic	Organo-Silicone Surfactant	0.25%
Dyna-Pak	Nonionic Surfactant + Nitrogen Source	1%
Hyper-Active	Deposition, Retention, and Wetting Agent	0.25%
Cohere	Nonionic Spreader-Sticker	0.125%
Cide-Winder	High Surfactant Oil Concentrate	0.5%
Liberate	Nonionic Surfactant + Deposition Agent + Methylated Seed Oil	0.5%
LI-700	Nonionic Surfactant + Buffering Agent	0.25%
Interlock	Deposition Agent	6 oz/acre
Preference	Nonionic Surfactant	0.5%
Supermax AMS	Buffering Agent + Deposition Agent	0.5%
SuperFact	Nonionic Surfactant	0.25%

In each trial, one insecticide / acaricide (acephate, Radiant, Agri-Mek, Centric, or Transform) was applied at a standard rate with all or selected adjuvants listed in Table 1. The insecticide was also applied alone and a non-treated control was included. Treatments were applied with high clearance sprayers calibrated to deliver 8-10 GPA, except at the second Arkansas location (AR No. 2). Application volume in trials (one thrips and one plant bug trial) conducted at this location was 3 GPA. Thrips densities were determined at 3 to 6 days after treatment (DAT) by sampling five plants from the center two rows of each plot using a whole plant washing procedure described by Burris et al. (1990) or a similar procedure. Spider mite densities were determined by counting all mites on 1 sq in. of leaf surface from 10 leaves per plot. Leaves were chosen from the top third of the canopy of randomly selected plants. Densities of tarnished plant bugs were determined by sampling 10 row feet from the center two rows with a black drop cloth at 2 to 14 DAT. Plant bug densities are expressed as number of insects per 5 row ft. Data were subjected to ANOVA procedures, with means separated according to Fisher's Protected LSD. No rainfall occurred during the thrips trials, the spider mite trial, or the plant bug trials conducted in AR or TN. Rainfall of 1.2 in occurred within 2.5, 2.25, and 2 hrs after application in the Transform, Centric, and acephate trials, respectively, conducted in MS.

Results

In the thrips trial conducted in TN, all of the insecticide treatments significantly reduced thrips densities compared to the non-treated control (Figure 1). The addition of a spray adjuvant did not significantly impact the efficacy of acephate against thrips. In the thrips trial conducted in AR, no significant differences among treatments were observed for thrips densities at 3 or 6 DAT (Table 2). The addition of a spray adjuvant did not significantly improve spider mite control with Agri-Mek at 5 or 9 DAT (Figure 2). Also, none of the acaricide treatments significantly

reduced spider mite densities compared to the non-treated control.

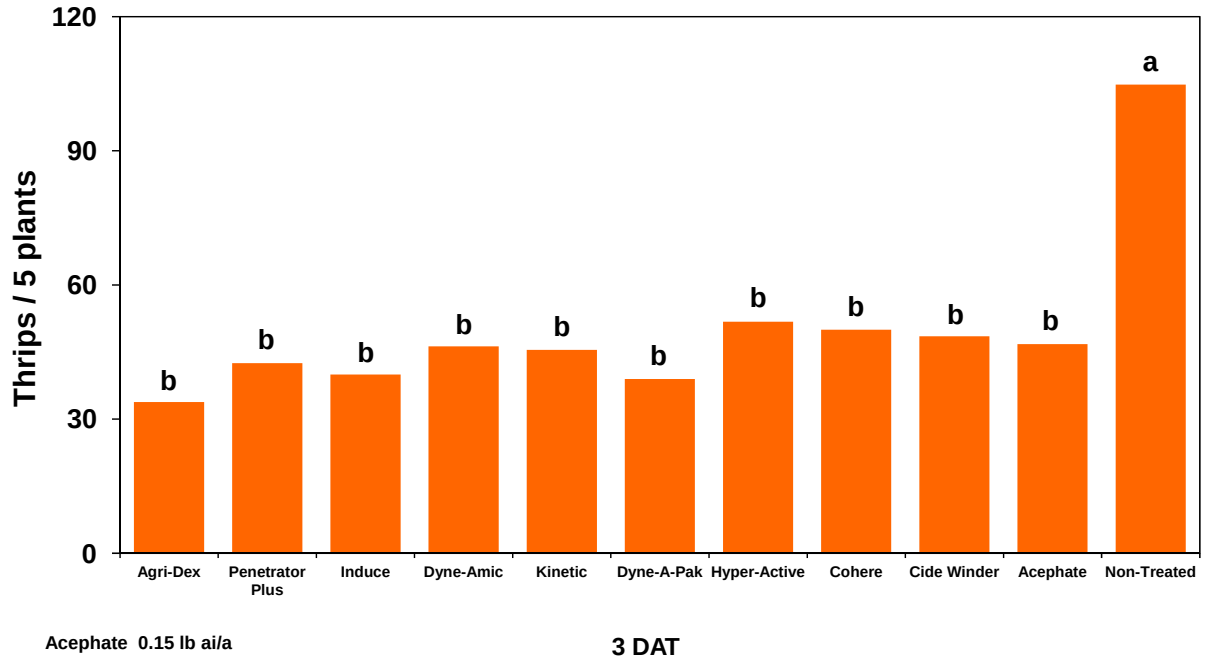

Figure 1. Impact of selected adjuvants on the performance of acephate against thrips at 3 DAT, 2012 TN.

Table 2. Impact of selected adjuvants on the performance of Radiant against western flower thrips at 3 and 6 DAT, 2012 AR No.2.

		Western Flower Thrips / 5 plants	
Treatment	Rate/acre	3 DAT	6 DAT
Radiant + Agri-Dex	1.5[1] + 1[2]	3.5	9.0
Radiant + Penetrator Plus	1.5[1] + 1[2]	3.8	6.3
Radiant + Induce	1.5[1] + 0.25[2]	2.5	6.0
Radiant + Dyne-Amic	1.5[1] + 0.5[2]	2.8	6.5
Radiant + Kinetic	1.5[1] + 0.25[2]	2.0	3.5
Radiant + Dyne-A-Pak	1.5[1] + 1[2]	2.5	4.3
Radiant + Hyper Active	1.5[1] + 0.25[2]	0.3	5.8
Radiant + Cohere	1.5[1] + 0.125[2]	3.3	10.3
Radiant + Cide Winder	1.5[1] + 0.5[2]	2.0	4.0
Radiant	1.5[1]	2.3	8.8
Radiant	3.0[1]	2.5	7.8
Non-Treated	-	8.0	13.5
P>F		0.19	0.15

Means within columns followed by a common letter are not significantly different (Fisher's Protected LSD, *P*=0.05).
[1]oz product / acre.
[2]%volume / volume.

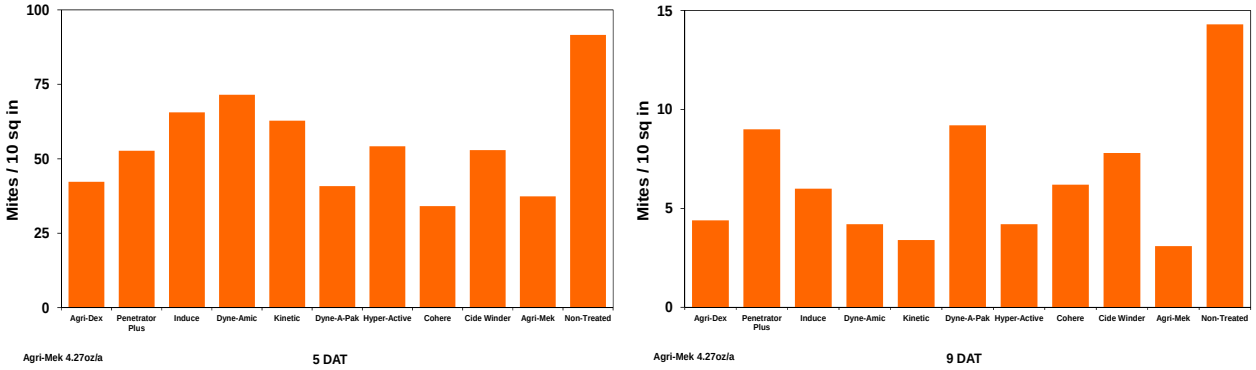

Figure 2. Impact of selected adjuvants on the performance of Agri-Mek against spider mites at 5 and 9 DAT, 2012 TN.

In the plant bug trial conducted in TN, all of the treatments that included Centric significantly reduced densities of tarnished plant bug nymphs compared to the non-treated control (Figure 3). However, the addition of an adjuvant did not improve plant bug control compared to Centric alone. No rainfall occurred during this trial.

In the trial conducted in AR (AR No. 1), all of the insecticide treatments, except Transform 1 oz/acre, Transform plus Dyne-Amic, and Transform plus Cide-Winder, resulted in significantly fewer tarnished plant bug nymphs compared to the non-treated control at 3 DAT1 (Table 3). The addition of an adjuvant did not significantly improve plant bug control over Transform 1 oz/acre alone, and only Transform (1.5 oz/acre) alone reduced plant bug densities below treatment threshold (3 plant bugs / 5 row ft.). At 6 DAT1, all of the insecticide treatments significantly reduced densities of tarnished plant bug nymphs compared to the non-treated control. There were no significant differences between Transform alone and Transform plus any of the spray adjuvants. All of the treatments that included Transform resulted in significantly fewer plant bug nymphs compared to the non-treated control at 4 DAT2. Plots treated with Transform (1 oz/acre) plus Agri-Dex had significantly fewer plant bug nymphs compared to plots treated with Transform (1 oz/acre) plus Induce, Dyne-Amic, Dyne-A-Pak, Hyper-Active, or Cide-Winder, or Transform (1 and 1.5 oz/acre) alone. At 7 DAT2, all of the insecticide treatment significantly reduced plant bug densities compared to the non-treated control. Transform (1 oz/acre) plus Penetrator Plus, Induce, Dyne-Amic, or Kinetic resulted in significantly fewer plant bug nymphs compared to Transform (1 oz/acre) plus Dyne-A-Pak, Hyper Active, or Transform (1 oz/acre) alone. All of the insecticide treatments significantly reduced plant bug densities compared to the non-treated control at 14 DAT2. Plots treated with Transform (1 oz/acre) plus Penetrator Plus had significantly fewer plant bug nymphs compared to all of the insecticide treated plots, except those treated with Transform (1 oz/acre) plus Agri-Dex, Induce, Dyne-Amic, or Transform (1.5 oz/acre) alone. Across all sample dates, all of the insecticide treatments significantly reduced plant bug densities compared to the non-treated control. The addition of an adjuvant did not significantly improve plant bug control compared to Transform (1 oz/acre) alone. Also across sample dates, none of the insecticide treatments maintained plant bug densities below treatment threshold level. No rainfall occurred during this trial. In the second trial conducted in AR (AR No. 2), no significant differences among treatments were observed for numbers of plant bug nymphs at 3 or 6 DAT1 or at 3 DAT2 (Table 4). At 8 DAT2, all of the insecticide treatments, except Centric plus Hyper-Active, significantly reduced plant bug nymphs compared to the non-treated control. The addition of an adjuvant did not improve plant bug control compared to Centric alone.

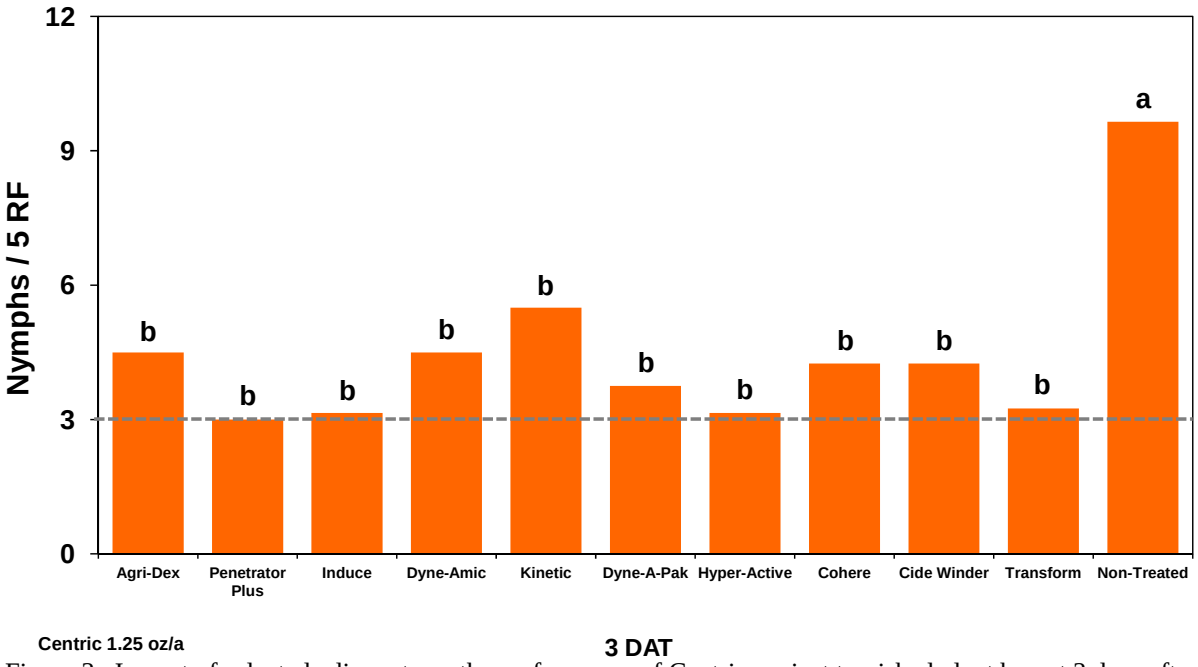

Figure 3. Impact of selected adjuvants on the performance of Centric against tarnished plant bug at 3 days after treatment, 2012 TN.

Table 3. Impact of selected adjuvants on the performance of Transform against tarnished plant bug at 3 and 6 DAT1, 4, 7, and 14 DAT2, and across sampling dates, 2012 AR No. 1.

		Tarnished Plant Bug Nymphs / 5 Row ft					
Treatment	Rate/acre	3 DAT1	6 DAT1	4 DAT2	7 DAT2	14 DAT2	Season mean
Transform + Agri-Dex	1[1] + 1[2]	3.1c	3.5b	0.4e	5.1bcd	13.2bcd	5.4cde
Transform + Penetrator Plus	1[1] + 1[2]	3.4bc	3.6b	1.0cde	2.8de	8.9d	4.1e
Transform + Induce	1[1] + 0.25[2]	4.2bc	4.9b	1.2cd	2.9de	12.6bcd	5.8cde
Transform + Dyne-Amic	1[1] + 0.5[2]	6.1ab	6.8b	1.4cd	3.0de	13.2bcd	6.4b-e
Transform + Kinetic	1[1] + 0.25[2]	4.0bc	4.9b	0.7de	2.3e	17.4bc	6.0cde
Transform + Dyne-A-Pak	1[1] + 1[2]	4.4bc	5.3b	1.8bc	7.0bc	21.1b	8.1bcd
Transform + Hyper Active	1[1] + 0.25[2]	3.1c	3.6b	2.8b	9.6b	19.5bc	8.4bc
Transform + Cohere	1[1] + 0.125[2]	4.2bc	5.0b	1.1cde	4.9cd	18.3bc	7.1b-e
Transform + Cide Winder	1[1] + 0.5[2]	5.3abc	6.1b	1.5cd	8.2bc	22.4b	9.9b
Transform	1[1]	4.9abc	5.5b	1.8bc	6.8bc	14.5bc	7.3b-e
Transform	1.5[1]	2.9c	4.0b	1.2cd	2.7de	11.2cd	4.7de
Non-Treated	-	9.0a	11.4a	20.3a	43.5a	47.1a	27.6a
P>*F*		0.04	<0.01	<0.01	<0.01	<0.01	<0.01

Means within columns followed by a common letter are not significantly different (Fisher's Protected LSD, *P*=0.05).

DAT1 = Days after treatment 1; DAT2 = Days after treatment 2; Season Mean = Mean across all sampling dates.

[1]oz product / acre.

[2]%volume / volume.

Table 4. Impact of selected adjuvants on the performance of Centric against tarnished plant bug at 3 and 6 DAT1, and 3 and 8 DAT2, 2012 AR No. 2.

		Tarnished Plant Bug Nymphs / 5 Row ft			
Treatment	Rate/acre	3 DAT1	6 DAT1	3 DAT2	8 DAT2
Centric + Agri-Dex	1.5[1] + 1[2]	1.9	0.8	6.1	3.3bc
Centric + Penetrator Plus	1.5[1] + 1[2]	2.0	1.0	4.9	4.0bc
Centric + Induce	1.5[1] + 0.25[2]	3.5	0.3	4.6	3.3bc
Centric + Dyne-Amic	1.5[1] + 0.5[2]	1.1	0.3	6.3	3.6bc
Centric + Kinetic	1.5[1] + 0.25[2]	2.0	0.6	5.0	2.8c
Centric + Dyne-A-Pak	1.5[1] + 1[2]	3.1	0.9	6.8	2.8c
Centric + Hyper Active	1.5[1] + 0.25[2]	1.9	0.3	5.8	4.9ab
Centric + Cohere	1.5[1] + 0.125[2]	2.3	0.6	4.5	2.6c
Centric + Cide Winder	1.5[1] + 0.5[2]	2.1	1.3	4.4	3.8bc
Centric	1.5[1]	1.9	0.6	4.6	4bc
Centric	2.5[1]	1.6	0.0	4.1	2.4c
Non-Treated	-	2.5	0.9	6.0	6.3a
P>F		0.09	0.84	0.83	<0.01

Means within columns followed by a common letter are not significantly different (Fisher's Protected LSD, *P*=0.05).
DAT1 = Days after treatment 1; DAT2 = Days after treatment 2.
[1]oz product / acre.
[2]%volume / volume.

Three plant bug trials were conducted in MS. The treatments in these trials were applied from 2 to 2.5 hrs prior to a 1.2 in. rainfall event. In the first trial, all of the insecticide treatments (Transform and Transform plus adjuvants) significantly reduced tarnished plant bug nymphs compared to the non-treated control at 3 DAT (Figure 4). Also, plant bug densities in the treated plots were reduced below the treatment threshold of 3 plant bugs / 5 row ft. In this trial, the addition of Cohere significantly improved plant bug control compared to Transform alone.

In the second trial, all of the insecticide treatments (Centric and Centric plus adjuvants) significantly reduced densities of plant bug nymphs compared to the non-treated control at 3 DAT (Figure 5). Also, all of the insecticide treatments reduced plant bug densities below the treatment threshold. Plots treated with Centric plus Kinetic or Dyne-Amic had significantly fewer plant bug nymphs compared to plots treated with Centric alone.

In the third trial, all of the insecticide treatments (acephate and acephate plus adjuvants) resulted in significantly fewer plant bug nymphs compared to the non-treated control at 2 DAT (Figure 6). All of the acephate adjuvant treatments reduced plant bug densities below treatment threshold and resulted in significantly fewer plant bug nymphs compared to acephate alone. At 3 DAT all of the insecticide treatments, except acephate alone, significantly reduced plant bug densities compared to the non-treated control. Only acephate plus LI-700, SuperFact, or Hyper-Active reduced plant bug densities below treatment threshold, and plots that received these treatments had significantly fewer plant bug nymphs compared to acephate alone.

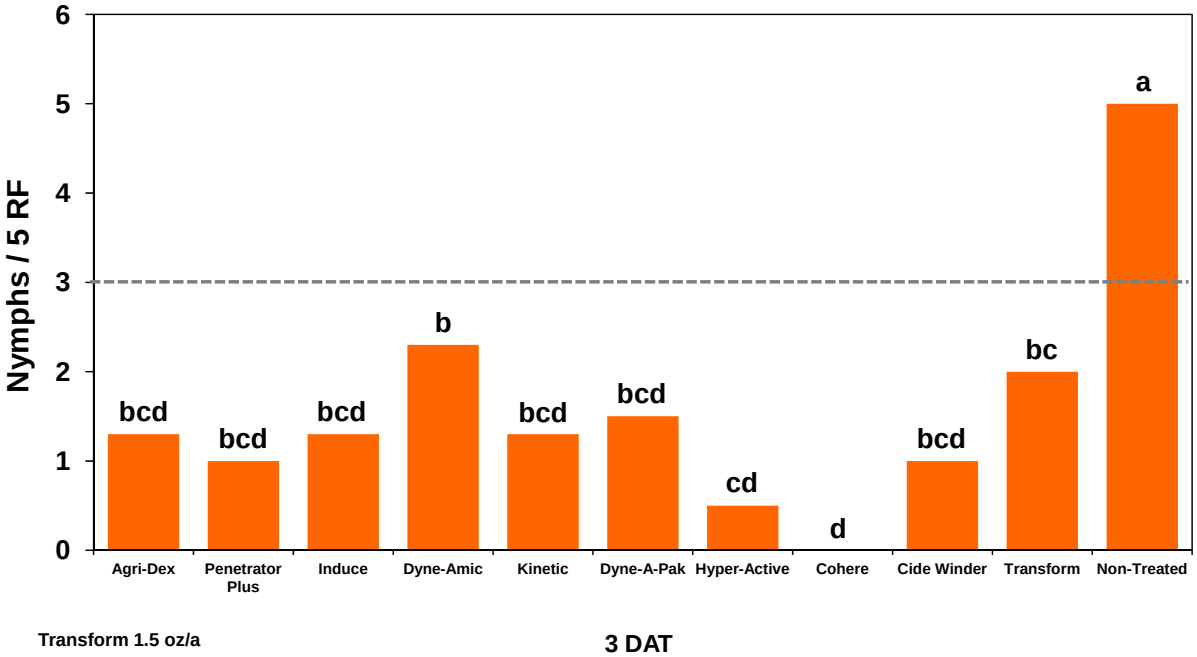

Figure 4. Impact of selected adjuvants on the performance of Transform against tarnished plant bug at 3 DAT, 2012 MS. Rainfall event (1.2 in.) occurred 2.5 hrs after application.

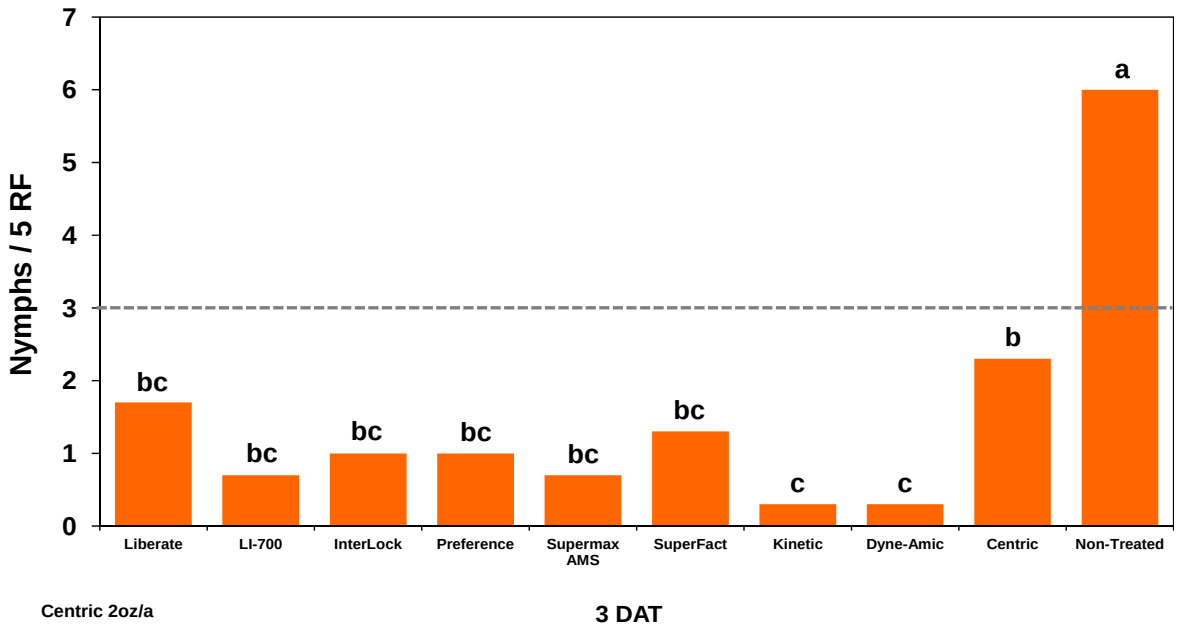

Figure 5. Impact of selected adjuvants on the performance of Centric against tarnished plant bug at 3 DAT, 2012 MS. Rainfall event (1.2 in.) occurred 2.25 hrs after application.

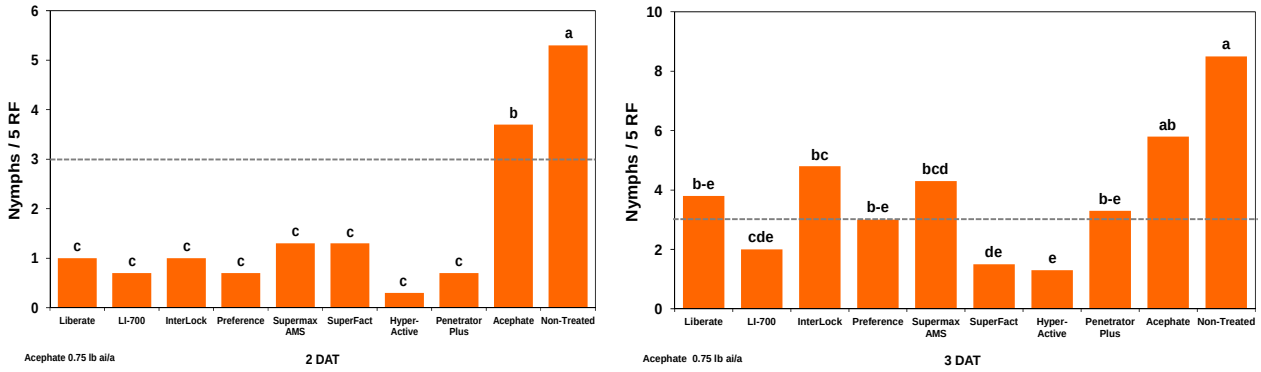

Figure 6. Impact of selected adjuvants on the performance of acephate against tarnished plant bug at 2 and 3 DAT, 2012 MS. Rainfall event (1.2 in.) occurred 2 hrs after application.

Cook et al. (2009) reported that the addition of Dyne-Amic to Radiant significantly improved thrips control. However, Cook et al. (2012) reported the addition of an adjuvant to Bidrin or Acephate did not significantly improve thrips control. Similarly, the addition of adjuvants to Bidrin or Transform did not significantly improve plant bug control. In the current studies the addition of an adjuvant did not improve thrips control with acephate or Radiant, spider mite control with Agri-Mek, or plant bug control with Centric in the absence of rainfall. At some sampling dates, the addition of some adjuvants significantly improved plant bug control with Transform in the absence of rainfall, but no consistent trends were observed. When rainfall occurred within 2.5 hrs of application, the addition of some adjuvants significantly improved plant bug control with Transform, Centric, and acephate. The greatest impact on efficacy was observed with acephate. These studies indicate that the addition of an adjuvant may be beneficial in maintaining insecticide efficacy if rainfall occurs soon after application.

Acknowledgements

The authors wish to thank the technicians and summer employees at the participating institutions and the cooperating growers for their assistance with these studies.

References

Burris, E., A. M. Pavloff, B. R. Leonard, J. B. Graves, and G. Church. 1990. Evaluation of two procedures for monitoring populations of early season insect pests (Thysanoptera: Thripidae and Homoptera: Aphididae) in cotton under selected management strategies. J. Econ. Entomol. 83:1064-1068.

Cook, D. R., A. L. Catchot, and J. F. Smith. 2009. Efficacy of selected foliar treatments against thrips on cotton, 2008. Arthropod Management Tests 34:F22, doi: 10.4182/amt.2009.F22.

Cook, D. R., J. Gore, S. D. Stewart, G. M. Lorenz, A. L. Catchot, B. R. Leonard, D. S. Akin, G. Studebaker, and F. Musser. 2012. Impact of spray adjuvants on insecticide performance, pp. 1115-1120. *In* Proc. 2012 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.

Hollingsworth, R. G., D. C. Steinkraus, and N. P. Tugwell. 1997. Response of Arkansas populations of tarnished plant bugs (Heteroptera: Miridae) to insecticides, and tolerance differences between nymphs and adults. J. Econ. Entomol. 90: 21-26.

Holloway, J. W., B. R. Leonard, J. A. Ottea, J. H. Pankey, J. B. Graves and G. Snodgrass. 1998. Insecticide resistance and syngersim of pyrethroid toxicity in the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), pp. 947-949. *In* Proc. 1998 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.

Snodgrass, G. L., and W. P. Scott. 1988. Tolerance of the tarnished plant bug to dimethoate and acephate in different areas of the Mississippi Delta, pp. 294-295. *In* Proc. 1988 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.

Snodgrass, G. L. 1994. Pyrethroid resistance in a field population of the tarnished plant bug in cotton in the Mississippi Delta, pp. 1186-1187. *In* Proc. 1994 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.

Snodgrass, G. L., and G. W. Elzen. 1995. Insecticide resistance in a tarnished plant bug population in cotton in the Mississippi Delta. Southwestern Entomol. 20: 317-323.

Snodgrass, G. L. 2006. Status of resistance in tarnished plant bug, pp. 1633-1638. *In* Proc. 2006 Beltwide Cotton Conf., National Cotton Council, Memphis, TN

Young, B. 2012. Compendium of Herbicide Adjuvants. http://www.herbicide-adjuvants.com/.

Williams, M. R. 2012. Cotton insect losses, 2011, pp. 1013 - 1057. *In* Proc. 2012 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.