

Evaluation of Contact Herbicides as a Follow-up Defoliation Treatment in Upland Cotton

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Abstract

Studies were conducted in 2002, 2004, and 2005 at the University of Arizona Maricopa Agricultural Center located near Maricopa, Arizona. Objectives of the study were to evaluate the efficacy of contact herbicides for defoliation as a second application and evaluate any potential improvement in lint return (gin turnout), fiber quality and overall lint value. In 2002, Delta and Pine cultivar 458 BR was planted on 17 April. In 2004 and 2005 Delta and Pine cultivar 449 BR was planted on 13 May and 12 April respectively. In all years, plots were 13.33 ft wide and 25 ft long and treatments were arranged in a randomized complete block with four replications. Irrigation was terminated at cutout (NAWF=5) and defoliation treatments were initiated 22 days later. All plots received an initial defoliation treatment of thidiazuron plus diuron (Ginstar) at 8 oz/A. In 2002 and 2004, follow-up applications occurred seven days after initial defoliation, and included the following treatments: paraquat (Gramoxone Max) at 10.7 oz/A plus nonionic surfactant at 0.25%v/v, flumiclorac (Resource) at 8 oz/A plus crop oil concentrate (COC) at 1% v/v, pyraflufen (ET) at 1.5 oz/A plus COC at 1% v/v or carfentrazone (Aim) at 1.0 oz/A plus COC at 1% v/v. In 2005, follow-up application occurred eight days after initial defoliation and included the same treatments as 2002 and 2004 with the addition of fluthiacet-methyl (Blizzard) at 0.5 oz/A plus COC at 1% v/v and an adjustment of the Gramoxone Max rate to 20 oz/A. For comparison purposes, in all years, one treatment did not receive a follow-up application. In 2002 and 2004, percent defoliation was significantly higher in treatments that received an application of Ginstar followed by Aim, Resource, ET or Gramoxone Max compared with a single application of Ginstar. However, follow-up treatment with Gramoxone Max at 10.7 oz/A provided significantly less defoliation than Aim or ET treatments. In 2005, defoliation was significantly increased by follow-up application with all of the contact herbicides evaluated. No significant differences were observed in gin turnout, lint yield or loan value in the years these variables were evaluated.

Introduction

Defoliation, or leaf abscission is a naturally occurring physiological phenomenon in cotton and accompanies boll opening, fiber maturity and other processes associated with senescence. Defoliation is induced in cultivated cotton in order to facilitate mechanical harvest and to reduce the “trash” contamination of lint (Ayala & Silvertooth, 2001). Successful defoliation is dependent upon a number of factors, in particular: weather conditions, plant water status, N fertilization status, honeydew accumulation due to whitefly feeding and the use of chemical defoliant (Silvertooth 2001).

Although leaf abscission is always a hormonal process, chemical defoliation of cotton may employ one of two mechanisms:

1. The hormonal mechanism increases leaf ethylene production and inhibits auxin transport which leads to production of an abscission layer (Jost & Brown 2003),
2. The abscission layer is formed by a herbicidal mechanism where cell membranes are disrupted, causing leaf ethylene concentrations to rise.

Several defoliant and herbicides (desiccants) are available to Central Arizona producers. In general, defoliant utilizing the hormonal mechanism, such as those containing tribufos or thidiazuron are used for the initial application and may be tank mixed with herbicides. Five years of research evaluating defoliant/herbicide combinations have shown only occasional benefits of the combination, compared with defoliant applied alone. Herbicides such as paraquat, sodium chlorate, carfentrazone or pyruflufen are sometimes applied as a follow-up treatment to Upland cotton in Arizona to “clean up” crops already treated with a chemical defoliant. Support for this practice comes from the perception that higher levels of defoliation lead to greater gin turn-out/yield, fiber quality (color and leaf grade) and overall value. This study, conducted over the course of three years, evaluates the efficacy of various contact herbicides as follow-up treatments after the application of an initial chemical defoliant on Upland cotton in Central Arizona. The objectives of this study were to: 1.) Evaluate the efficacy of contact herbicides for defoliation as a second application and 2.) Evaluate any potential improvement in lint return (gin turnout), fiber quality and overall lint value.

Materials and Methods

Field trials were conducted in 2002, 2004 and 2005 at the University of Arizona Maricopa Agricultural Center. In 2002, Delta and Pine cultivar 458 BR was planted on 17 April (Table 1). In 2004 and 2005 Delta and Pine cultivar 449 BR was planted on 13 May and 12 April, respectively, with conventional tillage on a Casa Grande sandy clay loam soil. Fertilization, irrigation, insect and weed management was based on current extension recommendations. In all years, plots were 13.33 ft wide and 25 ft long and treatments were arranged in a randomized complete block with four replications. Irrigation was terminated at cutout (nodes above white flower of 5 or less) and defoliation treatments were initiated 22 days later. In 2002, all chemical applications were made using a CO₂ backpack sprayer with a carrier volume of 20 gallons per acre (GPA). In 2004 and 2005, a high clearance sprayer with compressed air was used to make the chemical applications at a spray volume of 20 GPA. All plots received an initial defoliation treatment of thidiazuron plus diuron (Ginstar) at 8 oz/A (Table 2).

In 2002 and 2004, follow-up applications occurred seven days after initial defoliation, and included the following treatments: paraquat (Gramoxone Max) at 10.7 oz/A plus nonionic surfactant at 0.25% v/v, flumiclorac (Resource) at 8 oz/A plus crop oil concentrate (COC) at 1% v/v, pyraflufen (ET) at 1.5 oz/A plus COC at 1% v/v or carfentrazone (Aim) at 1.0 oz/A plus COC at 1% v/v. In 2005, follow-up application occurred eight days after initial defoliation and included the same treatments as 2002 and 2004 with the addition of fluthiacet-methyl (Blizzard) at 0.5 oz/A plus COC at 1% v/v and an adjustment of the Gramoxone Max rate to 20 oz/A. For comparison purposes, in all years, one treatment did not receive a follow-up application.

At 14 and 21 days after initial application, each plot was rated to determine percent defoliation using a visual rating system with zero equal to no defoliation and 100 equal to complete defoliation. In 2004 and 2005, gin turnout, lint yield and fiber quality were analyzed post-harvest. Cotton fiber samples were evaluated using High Volume Instrumentation (HVI) analysis (color, leaf, micronaire, length, strength, bark levels and uniformity) at the USDA-AMS Cotton Classing Laboratory in Phoenix, AZ. Cotton loan values were calculated using the Cotton Loan Evaluation Program (Falconer and Reeves 2005). Studies were analyzed across years (factorial analysis of variance) and a year by treatment interaction was observed. Due to the interaction, years are presented separately and means were separated using Duncan's New Multiple Range Test.

Results

Cotton Defoliation

In 2002, percent defoliation was significantly higher in treatments that received an application of Ginstar followed by Aim (95%), Resource (96%), ET (96%) or Gramoxone Max (85%) compared with a single application of Ginstar (80%) (Table 3). However, follow-up treatment with Gramoxone Max at 10.7 oz/A provided significantly less defoliation than the other follow-up treatments.

In 2004, defoliation percentage was significantly higher in treatments that received any of the follow-up herbicide application over those that only received a one-time application of Ginstar at 8 oz/A. The highest rate of defoliation was achieved using a follow-up application of Aim at 1 oz/A plus crop oil concentrate (88%) and was greater than Resource or Gramoxone Max.

In 2005, the rate of Gramoxone Max was adjusted to 20 oz/A. All treatments containing a follow-up application provided at least 91% defoliation and were significantly greater than a single application of Ginstar (84%).

Gin turnout, Lint Yield, and Lint Value

Although defoliation was significantly increased by follow-up application of all of the contact herbicides evaluated, no significant differences were observed in gin turnout, lint yield or loan value (Table 4).

Conclusions

Ginstar at 8 oz/A provided less defoliation in 2004 (53%) compared with other years of the study. In 2004, temperatures at the time of application and the two weeks following were much lower than at the application timings for 2002 and 2005. Producers will typically increase the rate of Ginstar to 10 oz/A when heat unit accumulations for the two weeks following application are expected to be in the 200 to 300 range (86/55 model). Regardless of defoliation level achieved with Ginstar, all follow-up treatments in all years significantly improved cotton defoliation level at harvest. Gramoxone Max applied at 10.7 oz/A did not provide equivalent defoliation to Aim or ET, however increasing the rate to 20 oz/A in 2005 resulted in defoliation levels comparable to other follow-up treatments. Surprisingly, gin turn-out, lint yield, and lint value were not impacted by the level of defoliation achieved from either the single application or multiple applications. Future work needs to be conducted on a larger scale in Arizona to determine what defoliation levels are adequate to provide maximum yield and fiber quality.

Acknowledgments

We acknowledge the help from the staff at the Maricopa Agricultural Center and the financial support of Bayer, Chemtura, Dupont, FMC, Nichino, Syngenta and Valent.

Literature Cited

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Table 1. Planting and application dates, variety and temperature information for follow-up defoliation trials in 2002, 2004, and 2005 at Maricopa, AZ.

	2002	2004	2005
Planting Date	17-Apr-2002	13-May-2004	12-Apr-2005
Variety	DP 458 BR	DP 449 BR	DP 449 BR
Initial Defoliation Date	20-Sep-2002	24-Sep-2004	1-Sep-2005
Air Temperature at Time of Initial Defoliation	70.8°F	62.8°F	82.2°F
Follow-up Treatment Date	27-Sep-2002	1-Oct-2004	9-Sep-2005
Air Temperature at Time of Follow-up Treatment	74.9°F	62.4°F	82.6°F

Table 2. Product names and rates used for initial defoliation and follow-up treatments in 2002, 2004, and 2005 at Maricopa, AZ.

	2002	2004	2005
Initial Defoliation Product and Rate	Ginstar @ 8 oz/A	Ginstar @ 8 oz/A	Ginstar @ 8 oz/A
Follow-up Treatment Products and Rates	Gramoxone Max @ 10.7 oz/A + NIS ¹ Resource @ 8 oz/A + COC ² ET @ 1.5 oz/A + COC Aim @ 1.0 oz/A + COC	Gramoxone Max @ 10.7 oz/A + NIS Resource @ 8 oz/A + COC ET @ 1.5 oz/A + COC Aim @ 1.0 oz/A + COC	Gramoxone Max @ 20 oz/A + NIS Resource @ 8 oz/A + COC ET @ 1.5 oz/A + COC Aim @ 1.0 oz/A + COC Blizzard @ 0.5 oz/A + COC

¹NIS-non-ionic surfactant

²COC-crop oil concentrate

Table 3. Cotton Defoliation (%) in 2002, 2004 and 2005 at Maricopa, AZ.

Treatments	Defoliation %		
	2002	2004	2005
Ginstar at 8 oz/A fb Aim ¹ at 1.0 oz/A	95a ³	88a	92a
Ginstar at 8 oz/A fb ET at 1.5 oz/A	96a	85ab	91a
Ginstar at 8 oz/A fb Gramoxone Max ²	85b	72c	94a
Ginstar at 8 oz/A fb Resource at 8 oz/A	96a	78bc	93a
Ginstar at 8 oz/A fb Blizzard at 0.5 oz/A	---	---	95a
Ginstar at 8 oz/A	80c	53d	84b
LSD (0.05) ⁴	4	9	7
Treatment Probability (F)	0.0001	0.0001	0.0355

¹Recommended adjuvant and rates were used with all follow-up treatments

²Gramoxone Max applied at 10.7oz/A in 2002 and 2004 and 20 oz/A in 2005.

³Means in the same column with different letters significantly different (P = 0.05, Duncan's New MRT).

⁴LSD: Least Significant Difference

Table 4 Gin Turnout and Lint Yield for 2004 and 2005 at Maricopa, AZ.

Treatments	Mean Gin Turnout (% lint)		Lint Yield (lbs/A)		Loan Value (\$/A)	
	2004	2005	2004	2005	2004	2005
Ginstar at 8 oz/A fb Aim ¹ at 1.0 oz/A	32.27a ³	30.63a	\$621.99a	\$587.13a	1139.23a	1043.45a
Ginstar at 8 oz/A fb ET at 1.5 oz/A	32.30a	36.80a	\$589.47a	\$719.57a	1085.94a	1287.13a
Ginstar at 8 oz/A fb Gramoxone Max ²	32.17a	34.91a	\$630.53a	\$706.17a	1174.52a	1299.90a
Ginstar at 8 oz/A fb Resource at 8 oz/A	32.03a	34.97a	\$618.12a	\$735.68a	1133.47a	1330.10a
Ginstar at 8 oz/A fb Blizzard at 0.5 oz/A	---	34.96a	---	\$727.91a	---	1291.94a
Ginstar at 8 oz/A	32.80a	33.84a	\$668.11a	\$708.25a	1229.02a	1279.48a
LSD ⁴	0.83	5.28	\$49.06	\$140.61	102.19	219.91
Treatment Probability (F)	0.3502	0.2925	0.0624	0.2798	0.0949	0.1247

¹Recommended adjuvants and rates were used with all follow-up treatments

²Gramoxone Max applied at 10.7oz/A in 2002 and 2004 and 20 oz/A in 2005.

³Means in the same column with different superscripts are significantly different (P = 0.05, Duncan's New MRT).

⁴LSD: Least Significant Difference