Evaluation of Various PPO Inhibitors as Defoliants for Upland Cotton

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Abstract

This study was conducted in 2005 at the University of Arizona Maricopa Agricultural Center. The objective was to compare the performance of various PPO inhibitors [Aim (carfentrazone-ethyl), ET (pyraflufen-ethyl), Blizzard (fluthiacet-methyl) and Resource(flumiclorac)] as stand-alone defoliation treatments either as a single or sequential application, or tank mixed with Ginstar or CottonQuik. Plots were arranged in a randomized, complete block design with four replicates. Each plot was composed of four, 40 inch rows that measured 25 feet long. Delta and Pine variety DP 449BR was planted on 12 April 2005. Treatments included: Ginstar @ 6 oz/A, Ginstar @ 8 oz/A, Aim @ 1 oz/A, ET @ 1.5 oz/A, Resource @ 8 oz/A and Blizzard @ 0.5 oz/A, Aim followed by Aim, ET followed by ET, Blizzard followed by Blizzard, Resource followed by Resource, Ginstar @ 6 oz/A plus Aim, Ginstar plus ET, Ginstar plus Resource, Ginstar plus Blizzard, CottonQuik at 32 oz/A plus Aim, CottonQuik plus ET, CottonQuik plus Resource, and CottonQuik plus Blizzard. All treatments receiving a PPO inhibitor also contained a Crop Oil Concentrate at 1% v/v. None of the PPO inhibitors applied as a single application performed as well as Ginstar at either the 6 oz/A or 8 oz/A rates. At 14 days after treatment (DAT), both Aim and Blizzard achieved 74% defoliation, Resource 69% and ET 60%. For sequential applications at 14 DAT, Aim at 1.5 oz/A followed eight days later by a second application of Aim performed as well as the standalone applications of Ginstar at 6 oz/A and 8 oz/A. Two applications of Blizzard at 0.5 oz/A eight days apart defoliated as well as Ginstar at 6 oz/A. Tank mixing any of the four PPO inhibitors with Ginstar did not improve defoliation over Ginstar alone, at either rate nor did defoliation rates decrease as a result of the mixes. A mixture of Aim + CottonQuik (75%) defoliated as well as a standalone treatment of Ginstar (82%).

Introduction

Protoporphyrinogen oxidase (PPO) is an enzyme that occurs in plants and animals as well as some fungi and bacteria. In plants, this enzyme is crucial to the formation of chlorophyll, a pigment necessary for photosynthesis. When certain chemicals (called PPO inhibitors) prevent PPO activity, singlet oxygen accumulates within plant cells. Singlet oxygen is highly reactive and disrupts cell membranes, which causes rapid leaf dessication. Contact herbicides with the active ingredients carfentrazone-ethyl, pyraflufen-ethyl, flumiclorac and fluthiacet-methyl are PPO inhibitors and use this membrane-disruption mechanism to destroy leaf tissue.

In addition to their usefulness as contact herbicides, PPO inhibitors are emerging as competitively priced cotton harvest aids. In Central Arizona, chemical defoliants are usually applied to Upland cotton to expedite the natural senescence process of leaf abscission. This study compared the performance of various PPO inhibitors [Aim (carfentrazone-ethyl), ET (pyraflufen-ethyl), Blizzard (fluthiacet-methyl) and Resource(flumiclorac)] as stand-alone defoliation treatments either as a single or sequential , or as tank mixes with Ginstar or CottonQuik.

Materials and Methods

Plots were arranged in a randomized, complete block design with four replicates. Each plot was composed of four, 40 inch rows that measured 25 feet long. Delta and Pine variety DP 449BR was planted on 12 April 2005. Standard management practices in regard to irrigation, fertilization and pest control were carried out throughout the season. Final irrigation occurred on 05 August 2005**,** when nodes above white flower (NAWF) < 5.

There were six standalone treatments: Ginstar @ 6 oz/A, Ginstar @ 8 oz/A, Aim @ 1 oz/A, ET @ 1.5 oz/A, Resource @ 8 oz/A and Blizzard @ 0.5 oz/A. Sequential or follow-up treatments using the four PPO inhibitors (Aim, ET, Blizzard and Resources) were applied eight days apart. Four tank mix treatments included Ginstar @ 6 oz/A plus a PPO inhibitor: Aim@ 1oz/A, ET @ 1.5 oz/A, Resource @ 8oz/A or Blizzard @ 0.5 oz/A. Four tank mix treatments included CottonQuik at 32 oz/A plus PPO inhibitors at the previously mentioned rates.

All treated plots were sprayed on 01 September 2005 with a high clearance research sprayer calibrated to deliver 20 gallons/A. Crop oil concentrate was added to all ET, Aim, Resource and Blizzard treatments at the rate of 1% v/v. See Table 1 for treatment information. Plots that received a sequential application were sprayed 8 days later on 09 September 2005.

Results

Defoliation provided by Aim, ET, Blizzard and Resource, as standalone treatments, tankmixed with either Ginstar or CottonQuik or used as sequential applications were compared to single applications of Ginstar alone at 6 oz/A and 8 oz/A. Differences in mean defoliation (expressed as a percent) were analyzed using an analysis of variance.

None of the PPO inhibitors applied as a single application performed as well as Ginstar at either the 6 oz/A or 8 oz/A rates (see Figure 1). At 14 days after treatment (DAT), both Aim and Blizzard achieved 74% defoliation, Resource 69% and ET 60%. For sequential applications at 14 DAT, Aim at 1.5 oz/A followed eight days later by a second application of Aim at the same rate performed as well as the single applications of Ginstar at 6 oz/A and 8 oz/A (Figure 2). Two applications of Blizzard at 0.5 oz/A eight days apart defoliated as well as Ginstar at 6 oz/A. Repeated applications of Resource (74%) and ET (75%) provided significantly less defoliation than the other follow-up treatments or Ginstar alone at either rate.

Tank mixing any of the four PPO inhibitors with Ginstar did not improve defoliation over Ginstar alone at either rate nor did defoliation rates decrease as a result of the mixes (Figure 3). There were some statistically significant differences using CottonQuik as the tank mix partner (Figure 4). A mixture of Aim + CottonQuik (75%) defoliated statistically as well as a standalone treatment of Ginstar (82%).

Table 1. Application rates and active ingredients of harvest aids applied to Upland cotton in 2005.

	Rate	Active Ingredient
Standalone	Ginstar @ 6 oz/A Ginstar @ 8 oz/A Aim @ 1 oz[a] ET @ 1.5 oz/A Resource @ 8 oz/A Blizzard @ 0.5 oz/A	thidiazuron + diuron carfentrazone-ethyl pyraflufen-ethyl Flumiclorac fluthiacet-methyl
Tankmix	Aim @1 oz + Ginstar @ 6 oz ET @ 1.5 oz + Ginstar @ 6 oz Resource @ 8 oz + Ginstar @ 6 oz Blizzard @ 0.5 oz + Ginstar @ 6 oz	
	Aim @1 oz + CottonQuik @ 32 oz ET @ 1.5 oz + CottonQuik @ 32 oz Resource @ 8 oz + CottonQuik @ 32 oz Blizzard @ 0.5 oz + CottonQuik @ 32 oz	CottonQuik = AMADS + ethephon
Follow-up	Aim @ 1 oz fb Aim @ 1 oz ET @1.5 oz fb ET @ 1.5 oz Resource@ 8 oz fb Resource @ 8 oz Blizzard @ 0.5 oz fb Blizzard @ 0.5 oz	

[a]Crop oil concentrate was added at the recommended rate of 1% v/v to all treatments containing ET, Aim, Resource or Blizzard.

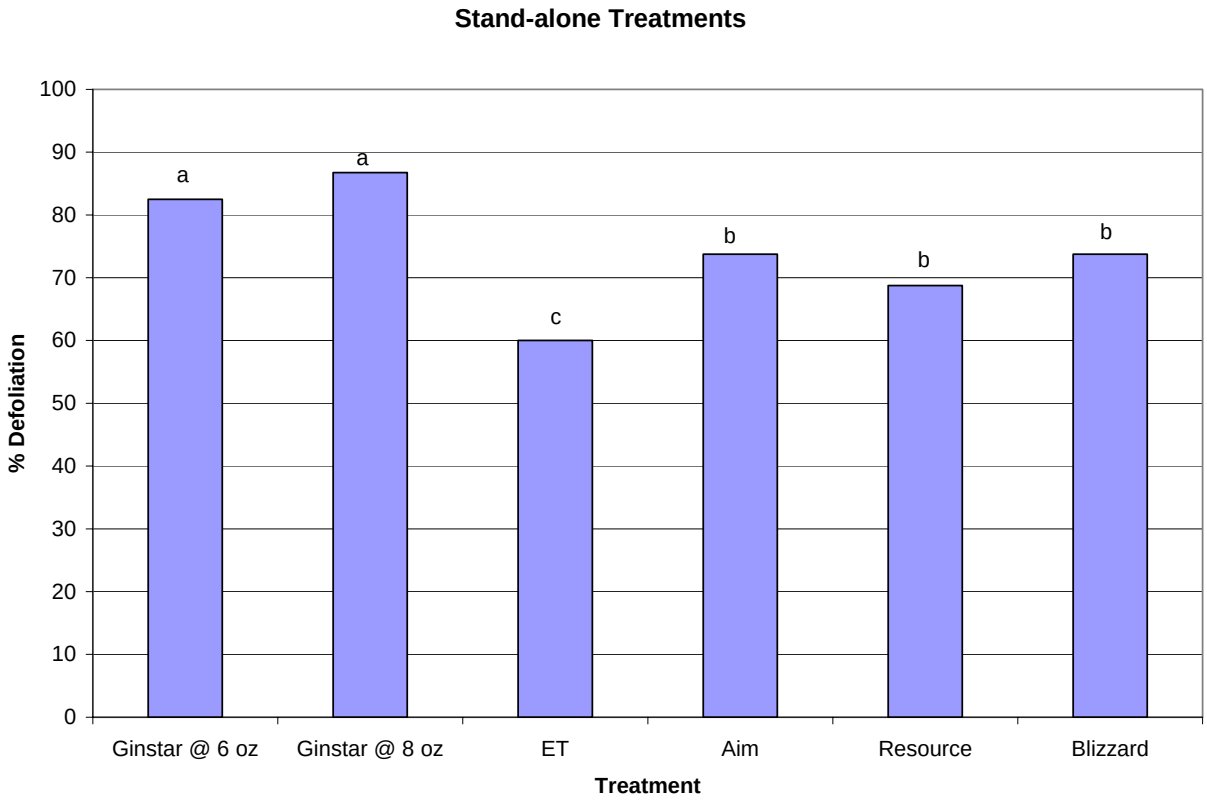

Figure 1. Single application of Ginstar at 6 oz/A and 8 oz/A compared to single applications of PPO inhibitors for Upland defoliation at Maricopa, Arizona in 2005. Bars accompanied by different letters have mean defoliation percentages that are significantly different ($p < 0.05$).

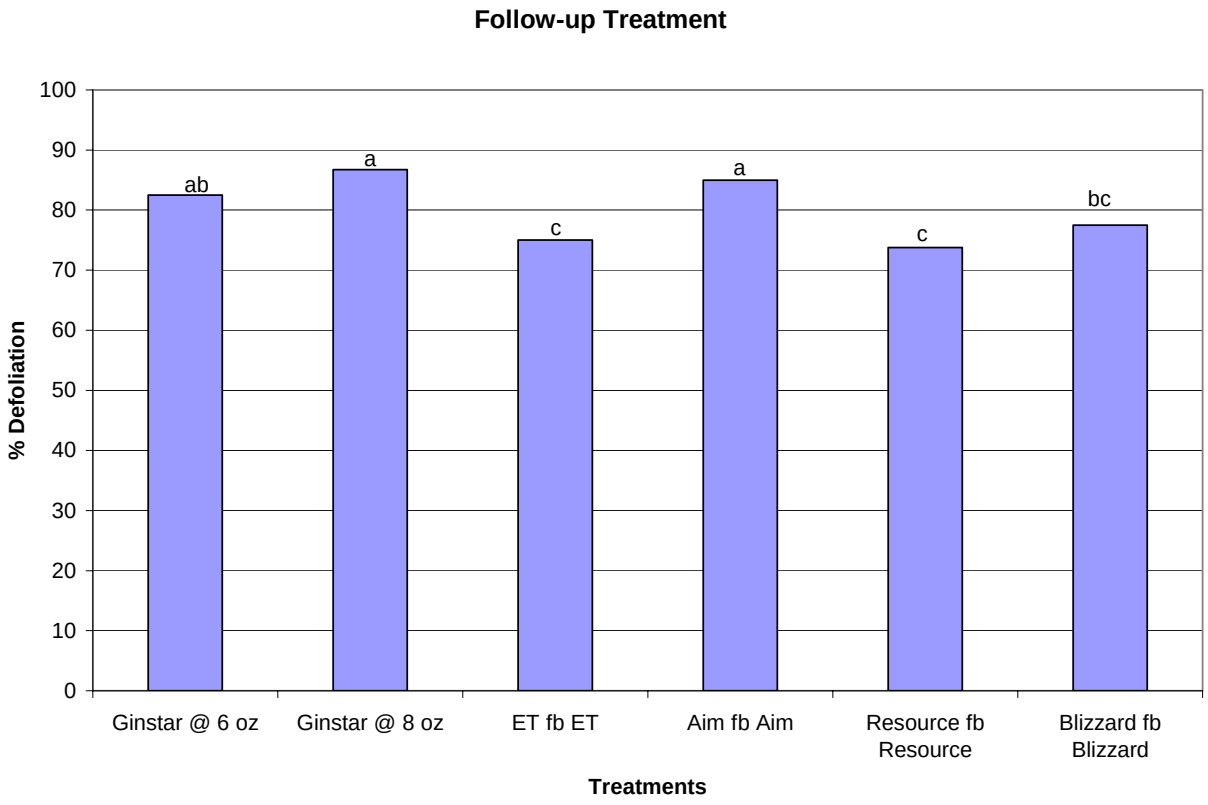

Figure 2. Single application of Ginstar at 6 oz/A and 8 oz/A compared to sequential applications of PPO inhibitors for Upland cotton defoliation at Maricopa, Arizona in 2005. Bars accompanied by different letters have mean defoliation percentages that are significantly different ($p < 0.05$).

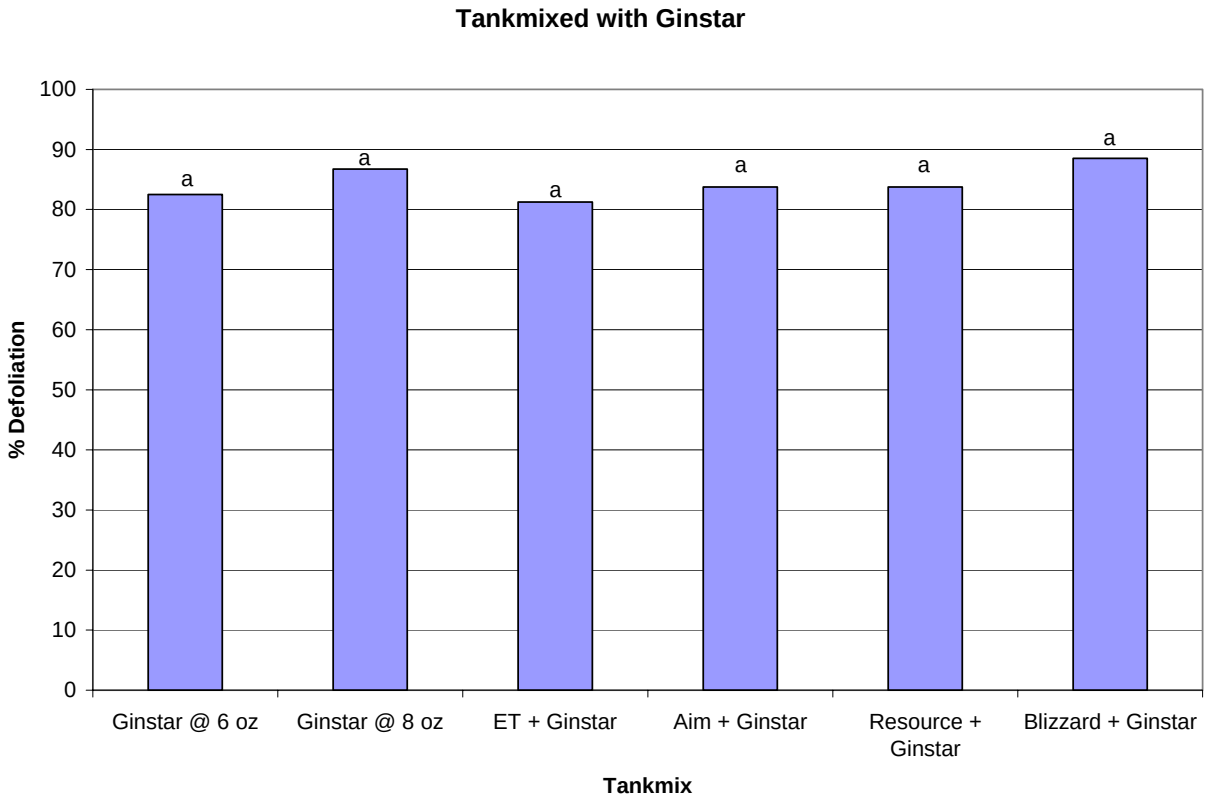

Figure 3. Single application of Ginstar at 6 oz/A and 8 oz/A compared to tank mixes of Ginstar + PPO inhibitors for Upland cotton defoliation at Maricopa, Arizona in 2005. Bars accompanied by different letters have mean defoliation percentages that are significantly different ($p < 0.05$).

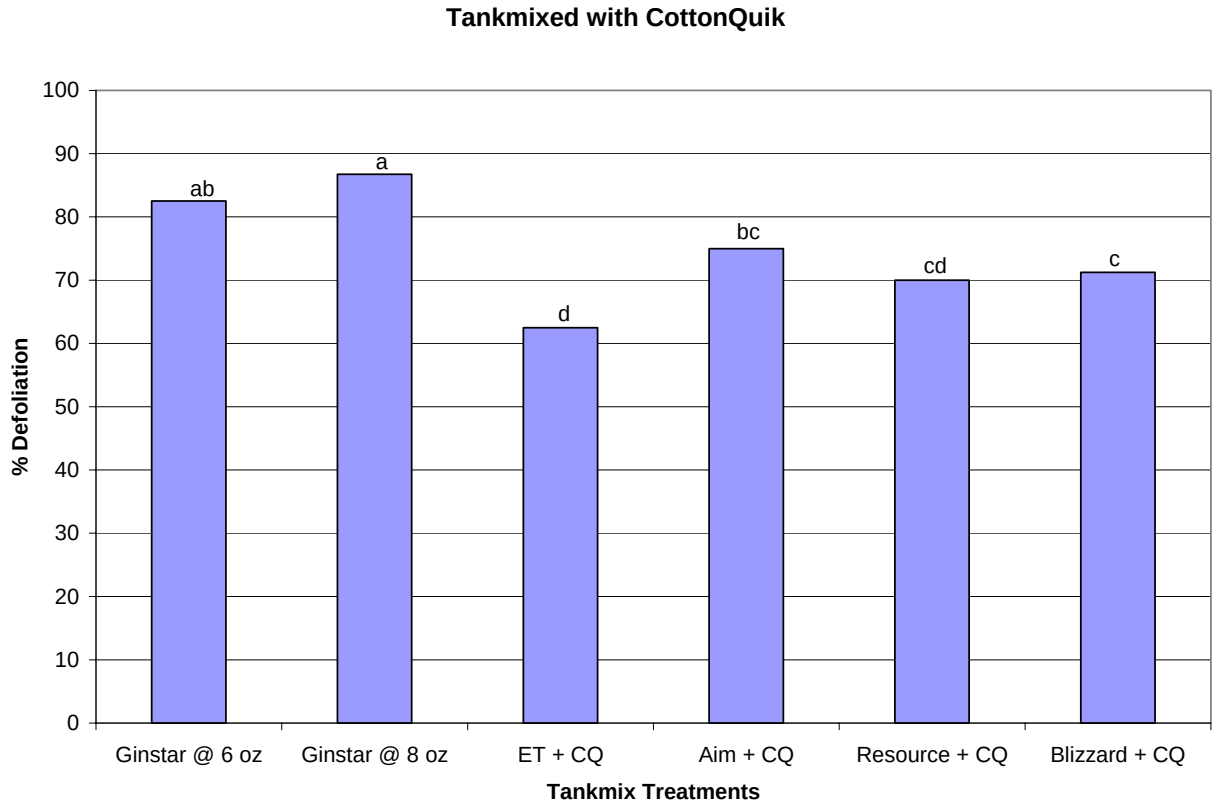

Figure 4. Single application of Ginstar at 6 oz/A and 8 oz/A compared to tank mixes of CottonQuik + PPO inhibitors for Upland cotton defoliation at Maricopa, Arizona in 2005. Bars accompanied by different letters have mean defoliation percentages that are significantly different ($p < 0.05$).