Response of Cotton to Precision-Guided Cultivation and DSMA in a Dense Stand of Purple Nutsedge

Gary W. Thacker[1] *and William B. McCloskey*[2]
[1]*UA Cooperative Extension, Pima County, Tucson, Arizona*
[2]*Department of Plant Sciences, University of Arizona, Tucson, Arizona*

Abstract

Close cultivation (within 1.5 inches of the cotton drill row) accomplished with an electro-hydraulic machine guidance system and an early season application of the herbicide DSMA were evaluated for purple nutsedge suppression in cotton. There were no significant differences in the cotton plant mapping data collected mid-season except that there was significantly less boll retention on the second fruiting branch in the precision cultivator treatments that may have been caused by root pruning during the second precision cultivation that could have shocked the cotton. There were significant differences in seed cotton yield with the precision cultivator treatments yielding more than the standard cultivator treatments. There was an opposing yield trend with the use of DSMA; DSMA tending to be beneficial with the precision cultivator and detrimental with the standard cultivator. We cannot explain this opposing trend. We regard our results as preliminary until we gain more experience with precision-guided cultivators in dense stands of nutsedge.

Introduction

Purple nutsedge (*Cyperus rotundus*) and the related species, yellow nutsedge (*Cyperus esculentus*), are effective early season competitors with cotton because they propagate from tubers that contain much more stored food material than a cotton seed and utilize a photosynthetic process that is more efficient than that used by cotton. These advantages allow nutsedges to grow faster than cotton early in the season and utilize water and nutrients that would otherwise benefit cotton. Early season growth of nutsedges causes increased moisture stress in cotton seedlings and stunts the growth of young cotton plants (Moffett and McCloskey, 1996). Cotton yield losses of 15 to 35 percent have been documented in Arizona and California cotton fields with dense infestations of yellow and purple nutsedge (Keely and Thullen, 1975; Moffett et. al., 1995; Moffett and McCloskey, unpublished data).

Dense infestations of purple nutsedge are difficult to control using cultural practices such as mechanical cultivation or the herbicides that are currently registered for Arizona cotton. Growers with infestations begin cultivating as early in the season as possible and do it frequently in order to minimize the water stress imposed on developing cotton seedlings by purple nutsedge. The organic arsenical herbicides, DSMA and MSMA, are registered in cotton and are used to obtained early season suppression of nutsedges. However, they frequently retard the growth of cotton, especially when they are applied over-the-top of small cotton. A major impediment to the early season use of cultivation and herbicides has been the inability to accurately guide mechanical cultivators and post-direct herbicide application equipment close to cotton seed row. However, new electro-hydraulic machine guidance systems have been introduced which maintain very accurate implement positioning. These precision guidance systems allow closer cultivation and more accurate placement of herbicide sprays than would otherwise be possible.

The objectives of this study were to evaluate the use of a precision-guided cultivator that allowed early season close cultivation and the use of DSMA either with or without precision-guided cultivation for early season suppression of purple nutsedge in cotton. Our original intent was to accurately post-direct the DSMA at the base of the cotton plants thereby avoiding herbicide application to the terminal of the shoots. However, the purple nutsedge infestation was so severe that the cotton was stunted and too short to allow application of DSMA without contacting the cotton terminal so the herbicide was applied over-the-top of the cotton.

Materials and Methods

The test site was on the Buckelew Farm in Three Points, on Highway 86 (Ajo Way) about 20 miles west of Tucson. The plots were located in a dense purple nutsedge infestation of about 20 to 30 shoots/ft^2. Two types of cultivation were performed in the experimental plots, either precision-guided cultivation or standard cultivation as described below, and some plots were treated with DSMA. Thus, there were four treatments in this experiment; precision guided cultivation with and without DSMA and standard cultivation with and without DSMA. A randomized complete block experimental design with six blocks was used with all plots located within the heaviest infestations of purple nutsedge. Plots were 50 feet long by six 40-inch rows. Five plants from each plot were mapped on August 2, 1995 to measure cotton development and fruit retention. The data collected included plant height, node of the first fruiting branch, number of mainstem nodes, number of aborted or missing fruit, and whether the first and second fruiting positions retained a boll. Seed cotton yields were obtained by hand picking one 13.1-foot length of row (one thousandth of an acre) in each plot on October 18, 1995. Cotton plant height was also measured at this time.

The precision guidance system used in this study was a Buffalo Scout, an articulated quick hitch guidance system described elsewhere in this Cotton Report (Thacker and Coates, 1996a). Guidance systems of this type use sensing elements to detect and follow a furrow or crop row. In this study, part of the weed control strategy was to cultivate very close to the rows as soon as the cotton emerged. Since cotyledon cotton will not actuate a crop wand, it was essential to have an accurate reference furrow for the guidance system to follow. The cooperator made reference furrows by mounting a small shovel behind each gauge wheel of a John Deere Max-Emerge planter. These small marks in the bottoms of the gauge wheel furrows allowed the "furrow guidance weight" of the articulated guidance system to accurately position equipment with respect to the cotton seed row.

The cotton was planted to moisture April 23, 1995 and a dry soil mulch cap was placed over the seed row to conserve soil moisture. Usually, when the cap is removed, the field is left in an essentially flat condition with essentially no furrows. Thus, we had to design a precision de-capper to remove the cap without destroying the reference furrow that would guide the cultivator through small cotton. A precision de-capper was assembled by mounting planter clod pushers on a six-row tool frame. Small sections of truck tire snow chains were mounted and dragged behind the clod pushers. The de-capper proved to be very precise and effective with the tire chains leaving a fine mulch of soil over the drill rows that prevented the scrapped soil surface from forming a hard dry crust. The de-capper was mounted on the Buffalo Scout and the furrow guidance weight was used to accurately guide the de-capper using the reference furrow left by the planter. To renew the reference furrow, we mounted the same small shovels used on the planter on the rear of the de-capper. The dry soil mulch cap was removed on April 28, 1995 and cotton emerged a few days later.

The first precision cultivation was performed on May 10, 1995 using the Buffalo Scout guidance system and a 6-row Buffalo 6100 cultivator. The furrow guidance weight followed the reference furrow left by the de-capper allowing the guidance system to accurately steer the cultivator through cotton at the cotyledon to 2 true leaf growth stage. The first soil-engaging tools on the cultivator were disks that cut away soil to within 1.5-inches of the drill row leaving a 3-inch band of undisturbed soil centered on the drill row. The next set of tools on the cultivator were crescent hoes positioned behind the disks to cut soil from the shoulders of the beds. Following the crescent hoes were disk coulters that were positioned in the centers of the furrows to give the cultivator the "directionality" or lateral stability required to allow an implement to respond well to an articulated guidance system (Thacker and Coates, 1996a). Directly behind each disk coulter were 14-inch Alabama sweeps that cleaned out the furrows and reshaped the beds. The cooperator performed the first standard cultivation treatment on May 11, 1995 using a 6-row International Harvester Danish tine row crop cultivator. The sweeps on the Danish tines were positioned 4-inches from each side of the drill row leaving an 8 inch band of undisturbed soil.

Two nozzles per crop row were used to apply DSMA to the appropriate plots in 15-inch band over-the-top of the cotton in both cultivator treatments on May 17, 1995. The rate was 3.6 pounds of active ingredient per acre in the treated band. It is preferable to apply organic arsenical herbicides as a directed spray to the base of cotton plants and we attempted to do this by spraying with two nozzles per crop row. However, the purple nutsedge significantly stunted the cotton making it nearly impossible keep from spraying the shoot terminal of most cotton plants in the standard cultivation plots and some plants in the precision cultivated plots.

The cooperator performed the second set of cultivations on May 30, 1995. The precision cultivation was performed using the crop wand of the Buffalo Scout to sense the crop rows and guide the Buffalo 6100 cultivator. The tool setup on the precision cultivator was the same as described above for the first cultivation. The standard cultivation was performed using International Harvester Danish tine cultivator as described above. A precision cultivation was planned for June, however, the combination of irrigations at the test site and the schedule of statewide precision guidance system demonstrations prevented us from returning with the precision-guided cultivator until July. Therefore, all plots were cultivated for a third time on June 15, 1995 with the International Harvester Danish tine cultivator. The final cultivation treatments were conducted after layby herbicide was applied using floodjet nozzles mounted on a 6-row Lilliston rolling cultivator. The standard cultivation treatments were cultivated with the International Harvester Danish tine cultivator on July 14, 1995 and the precision cultivator treatments were cultivated on July 15, 1995 with the Buffalo Scout guidance system and Buffalo 6100 cultivator. To perform a precision cultivation in large cotton, the tooling on the Buffalo cultivator was re-arranged as described in an accompanying Cotton Report article (Thacker and Coates, 1996b). The tool rearrangement involved moving the disks further away from the seed rows and turning the crescent hoes inward toward the seed row to maintain a 3-inch gap at the level of the soil-engaging tools while having a larger gap at the level of the cotton canopy to avoid injuring the cotton. Bezzerides torsion weeders positioned behind the crescent hoes provided additional close-to-the-row weeding action.

Results and Discussion

Precision cultivation resulted in a narrower band of undisturbed soil centered on the seed row than the standard cultivation so that immediately after a cultivation there were fewer purple nutsedge shoots competing with the cotton in the precision cultivation treatments. However, within a short time after cultivation, purple nutsedge reinfested the cultivated soil on the beds so that there was little apparent difference between cultivations treatments. As is typical for organic arsenical herbicide applications on cotton, the DSMA reddened and slightly stunted the cotton in all treatments. DSMA did suppress the growth of purple nutsedge for a period of several weeks, however, it did not appear that cotton was released from competition, primarily competition for moisture, by the DSMA application.

Purple nutsedge competition with cotton frequently delays the initiation of reproductive growth and this delay is reflected in the height or node of the first fruiting branch. A difference of 2 nodes in the position of the first fruiting branch between cotton growing in dense nutsedge infestations and cotton growing in the absence of purple nutsedge are common. In this study, precision cultivation or DSMA applications did not alleviate purple nutsedge competition enough to result in any differences in the initiation of reproductive growth as evidenced by the position of the first fruiting branch (Table 1). Differences in the intensity of competition between cotton and purple nutsedge may also be reflected in the percent fruit retention at the first two fruiting positions of the first and second fruiting branches. There were no significant differences in percent fruit retention on the first fruiting branch. On the second fruiting branch, fruit retention was significantly lower for the precision cultivator with DSMA treatment, and was slightly lower for the precision cultivator treatment without DSMA treatment compared to the standard cultivator treatments (Table 1). The May 30th cultivations were made at about the time the cotton was at eight to nine nodes and the close cultivation probably caused some cotton root pruning that shocked or stressed the cotton. This stress in combination with the stunting caused by DSMA may explain the differences in percent boll retention at the first and second positions on the second fruiting branch evident in the plant mapping data.

Despite the fact that there were no obvious differences between treatments for most of the season (Table 1) and in plant height at harvest (Table 1), there were significant differences in seed cotton yield (Table 2). The overall trend was for the precision cultivator treatments to yield more than the standard cultivator treatments. While the use of DSMA did not make a significant difference within cultivator treatments, there was a trend for the DSMA to be detrimental with the standard cultivator and to be beneficial with the precision cultivator. We cannot explain why such opposing trends for

DSMA exist between the cultivator treatments. The fact that percent fruit retention on the second fruiting branch was lower for the precision cultivator treatments and seed cotton yields ranked in an opposite manner probably reflects the ability of cotton to compensate for brief periods of stress with later growth. However, the conflicting effects of DSMA and the lack of obvious differences between cultivator treatments causes us to regard our data as preliminary. Hopefully, the causes of the effects documented in this study will be elucidated in future studies and as we gain more experience with precision-guided cultivators in dense stands of nutsedge.

Acknowledgments

This project was supported by a grant from the U.S. Environmental Protection Agency through the Arizona Department of Environmental Quality. The authors also appreciate the cooperation and support of Nick Buckelew, Fleischer Manufacturing, Inc., Bezzerides Brothers, Inc. and Marwald West Equipment, Inc.

References

Keeley, P.E. and Thullen, R.J. 1975. Influence of yellow nutsedge competition on furrow-irrigated cotton. Weed Sci. 23:171-175.

Moffett, J.E. and W.B. McCloskey. 1996. Effects of irrigation and yellow nutsedge (*Cyperus esculentus*) density on cotton (*Gossypium hirsutum*). Weed Sci: submitted.

Moffett, J.E., W.B. McCloskey, S.H. Husman, and G.L. Dixon. 1995. The interaction and effects of soil moisture regime and yellow nutsedge (*Cyperus esculentus*) density on cotton (*Gossypium hirsutum*) growth. Cotton, A College of Agriculture Report. Cotton, A College of Agriculture Report. Series P-99, University of Arizona, College of Agriculture, Tucson, AZ. p. 217-223.

Thacker, G.W. and W.E. Coates. 1996a. How the Quick Hitch Guidance Systems Work and Their Practical Applications. In this issue of Cotton, A College of Agriculture Report.

Thacker, G.W. and W.E. Coates. 1996b. How to Mechanically Remove Weeds From the Row. In this issue of Cotton, A College of Agriculture Report.

Table 1. Plant mapping data collected on August 2, 1995.

Treatment	Node of 1ST Fruiting Branch	Percent Boll Retention 1ST Fruiting Branch	Percent Boll Retention 2ND Fruiting Branch	Percent Total Boll Retention	Height-to-Node Ratio
Standard Cultivator w/o DSMA	7.2 a*	83.3 a	83.3 a	84.2 a	1.28 a
Standard Cultivator w/ DSMA	7.9 a	70.0 a	83.3 a	86.8 a	1.35 a
Precision Cultivator w/o DSMA	7.3 a	76.7 a	63.3 ab	83.0 a	1.31 a
Precision Cultivator w/ DSMA	7.0 a	60.0 a	43.3 b	81.5 a	1.33 a
CV	8.5%	30.9%	25.1%	5.6%	5.2%
P Value	0.117	0.348	0.003	0.291	0.351
LSD	0.764	0.275	21.1	5.81	0.084

* Means within a column and followed by the same letter are not significantly different at the 95% confidence level.

Table 2. Plant height and seed cotton yield on October 18, 1995.

Treatment	Plant Height (inches)	Seed Cotton Yield (lb./Acre)
Standard Cultivator w/o DSMA	55.7 a*	2674 bc
Standard Cultivator w/ DSMA	54.8 a	2340 c
Precision Cultivator w/o DSMA	52.5 a	3015 ab
Precision Cultivator w/ DSMA	50.7 a	3502 a
Coefficient of Variation	7.9%	13.7%
P Value	0.202	0.001
Least Significant Difference	5.19	487

* Means within a column followed by the same letter are not significantly different at the 95% confidence level.