Defoliation of Pima Cotton, 1991

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Abstract

Four field experiments were carried out in several representative cotton producing areas of Arizona to evaluate the effectiveness of a number of defoliation treatments on Pima cotton. Somewhat variable but generally hot and dry conditions were encountered among the experimental locations in 1991 for treatment comparisons. It appears that consistencies in the effectiveness of several treatments for Pima defoliation offer a basis for further refinement of recommendations across the state.

Introduction

Due to the rather indeterminate nature of Pima cotton (Gossypium barbadense L.) crops are often still actively flowering and vigorous, late in the growing season. As a result, many Pima cotton growers have experienced difficulty in satisfactorily defoliating the crop in preparing for harvest. Since lint quality is a very important factor when marketing Pima cotton, the preparation and picking of the crop is a very important step in the production process. Ideally, Pima growers would like to accomplish a complete and satisfactory defoliation with a single application of defoliant. Historically, it has often required two applications and sometimes even three or four applications to accomplish defoliation of Pima cotton.

In terms of developing consistent and effective strategies for Pima cotton defoliation, our view is that defoliation is the final effect of a combination of several important agronomic features of the crop or field in question. Setting up the plant for defoliation is certainly a function of the senescent trends as the crop matures, which certainly interacts to some degree with the plant-water status, nitrogen (N) fertility status, and then, of course, the choice and timing of the chemical defoliant. Other factors such as weather, some insect infestations, and some disease problems also will affect defoliation. However, the results of cotton defoliation are too often related to the chemical treatment alone, which is not a complete representation of the overall picture. It is our objective with these projects to describe the crop conditions, at least to some extent in terms of plant-water status and N fertility status at, and before, the time of defoliation in comparing various chemical defoliation treatments at several locations. These projects have been specifically oriented towards defoliation of Pima cotton. This has been the case due primarily to the particular difficulty often associated with defoliating Pima plants due to the strong indeterminate character. Therefore, Pima cotton often represents a worst case scenario for defoliation, and similar strategies and treatments certainly pertain to Upland (G. hirsutum L.) fields as well.

In 1987, a single field experiment was conducted in the Yuma Valley to compare several defoliation treatments on a field of Pima cotton (Silvertooth and Howell, 1988). That experiment was followed by a series of at least four similar experiments each year from 1988 (Silvertooth et al., 1989), 1989 (Silvertooth et al., 1990) and 1990 (Silvertooth et al., 1991) in an effort to expand locations, and treatment comparisons. Some treatment consistencies were identified from the 1987, 1988, and 1989 experiences, which were then used for the 1990 and 1991 experimental projects.

Methods

Four field experiments were conducted at various locations across southern Arizona in 1991 as outlined in Table 1. Tables 2 through 5 provide basic crop and experimental conditions for the four locations. All experiments were carried out with a ground rig application, with treatments being arranged in a randomized complete block design with three or four replications. Plots were a minimum of 16 rows and a maximum of 20 rows wide, and extended the full length of the irrigation run in each case.

After treatments were applied, visual estimates of percent defoliation, and the regrowth/topgrowth control ratings were made at a minimum of 14 days past the treatment date. Measurements and ratings were made in each plot and analyzed statistically in accordance to the statistical design employed. Regrowth ratings were made on a scale of 1 - 10, with a rating of 1 indicating excellent regrowth and topgrowth control and 10 indicating very poor control.

The total treatment lists utilized in the 1990 and 1991 Pima defoliation projects are shown in Table 6. The treatments shown in Table 7 represent the culmination of the experimental results and lessons gained over the past four growing seasons, since 1987. The most common component in the 1990 and 1991 list of treatments is Dropp (50% WP). It has been consistently apparent since this project was initiated in 1987, that Dropp alone had very poor efficiency and consistency in defoliation; but when used in combination with other materials (such as Accelerate, DEF/FOLEX, Prep, etc.) a satisfactory defoliation could often be accomplished from a single application. Due to some of the initial combinations tested in 1987 and 1988, a combination of Dropp (0.4 lbs. material/acre) plus Accelerate (1.0 pt. material/acre) was considered to be an optimum treatment recommendation. Further testing has shown increasingly promising results from other combinations, particularly Dropp plus DEF or FOLEX (or any organo-phosphate material). Also, lower rates with combination treatments are in order with warmer temperatures. A basic objective of the 1991 project was to evaluate different rates of materials in combination to "fine-tune" guidelines and recommendations based principally on crop conditions and expected weather patterns after defoliant applications.

Results

Petiole samples were collected from each experimental area prior to the application of treatments and analyzed for NO_3^--N concentrations. All locations had less than 3,000 ppm NO_3^--N. In the past, a level of 3,000 ppm NO_3^--N has been considered a general target for late season N fertility status in an effort to encourage senescence and defoliation of the crop. Adequate levels of NO_3^--N in the petioles prior to the later stages of the season can ensure the maintenance of optimum yield potentials. However, high NO_3^--N concentrations in petioles late in the season, can cause plants to be more vegetative and difficult to defoliate.

Yuma Valley

Treatments and results from the Yuma Valley experiment are listed in Table 7. All treatments were combinations including Dropp. The emphasis was placed on comparing rates using various combinations of Dropp, DEF, Accelerate and Prep. All treatments were very similar in terms of defoliation results and provided satisfactory one time defoliation or picking. An important point to draw from this study is that lower rates used in combination performed as well as higher rates. Some slight differences were noted among treatments relative to regrowth and topgrowth control ratings. In this case, some treatments did not perform equally, particularly with the topgrowth control, which was most notable.

Another factor commonly encountered in defoliation attempts in the Yuma Valley and elsewhere in Arizona in 1991, was that of excessive leaf burn and desiccation. Weather conditions in the late summer were hot and dry. This experiment accumulated 352 HU in the 14 day period after defoliant application (18 September to 4 October). A substantial boll load had been set by the crop and in combination with the weather, produced rapid

canopy senescence. As a result, only medium to low rates of the various defoliant treatments were used. Still, substantial leaf burn and desiccation occurred. The desiccation was worse in appearance than in final affect. In fact, most of the leaves remaining on the plants after defoliation (approximately 30% leaves remaining) were severely desiccated. In this case, picking was still accomplished after a single defoliant application and excellent grades were recorded on the harvested cotton.

In summary, this study reinforces recent recommendations concerning lower rates of defoliant combinations under warm weather conditions (Silvertooth, 1991). It also emphasizes the point that caution should be exercised in pursuing defoliation on a crop canopy that is rapidly drying down and senescing.

Aguila

The treatments used and defoliation results from the Aguila experiment are listed in Table 8. Treatments again were structured to emphasize rate comparisons and defoliant combinations. Essentially all treatments performed very well in terms of defoliation and regrowth control. The one distinctively different treatment in this case was the sodium chlorate as compared to other combination treatments with Dropp. The major deficiency provided by the sodium chlorate treatment was noted in terms of regrowth and topgrowth control. This type of response with sodium chlorate has been noted in previous Pima defoliation experiments (Silvertooth et al., 1989 and Silvertooth et al., 1990a). Often sodium chlorate provides adequate defoliation, but lacks consistency and therefore requires multiple applications to complete defoliation.

It should also be noted from this experiment that warm and dry conditions were experienced 14 days after defoliant application (227 HU accumulated). Leaves remaining after defoliation in this study were also desiccated, but this was not excessive and did not negatively affect grades.

Queen Creek

Treatments and defoliation results for the Queen Creek experiments are listed in Table 9. At this location defoliant applications were made somewhat later (17 October) and experienced slightly cooler weather conditions (173 HU accumulated 14 days after application). The treatment consisting of the Dropp + DEF + Accelerate combination provided an average defoliation of approximately 80%. All other treatments were noted as progressing towards more complete defoliation 14 days after application, but doing so at a slower rate, presumably due to the cooler conditions experienced, particularly during the last week of October. All treatments provided satisfactory final defoliation from this single application.

Coolidge

Applications were made at the Coolidge location (8 October) after gaining the benefit of the Yuma Valley experiment and the common occurrence of desiccation which was taking place in western and central Arizona in September 1991. Therefore, treatments used did not include high rates of any materials but focused on medium to lower rates. Treatments used and defoliation results are shown in Table 10. All treatments performed very well in terms of both total defoliation from a single chemical application and also for topgrowth and regrowth control. Conditions at this location were also dry and warm, with 254 HU accumulated 14 days after defoliant application. Some desiccation was experienced in that essentially all remaining leaves after defoliation (approximately 20%) were desiccated on the plant. However, all treatments were satisfactory for picking after the single application and very good grades were recorded.

Summary

The results from the four Pima cotton defoliation experiments described in this report represent the cumulative experience developed from the previous 20 experiments conducted across southern Arizona from 1987 to 1990. Also, the work of Nelson and his associates at Maricopa and Marana (Nelson and Hart, 1991a; Nelson and Hart, 1991b; and Nelson and Silvertooth, 1991) has been important in addressing specific aspects of this problem. A set of guidelines and recommendations for Pima cotton defoliation have recently been published as a result of this work (Silvertooth, 1991). The continuation of experimental efforts such as these in 1991 are necessary for the continued refinement and improvement of defoliation guidelines. In terms of the basic objective of this project to develop an approach and method for accomplishing a satisfactory defoliation from a single defoliant treatment application, significant progress has been realized since 1987. The combination treatments including Dropp listed on Tables 6, 7, 8, 9, and 10 represent defoliant materials capable of accomplishing a good defoliation (generally $\geq 70\%$) within 14 days from a single application.

Some variability certainly exists and can often be explained as a combination of crop and weather conditions. Crop and weather conditions have varied substantially over the past five seasons and 24 defoliation experiments. The 1991 season represented a unique set of conditions which led to a lot of leaf burning and desiccation problems which were commonly experienced across the state, often with treatments listed in this report. The point to be emphasized form this experience is that lower rates of treatment combinations will suffice under warm or hot conditions and that rates should be varied dependant upon expected weather and crop canopy conditions. As shown in this study, lower defoliant treatment rates proved to be satisfactory when weather conditions were warm (> 200 HU accumulated within 14 days after application). Some desiccation was experienced but it was not excessive.

Other conclusions that can be drawn from these series of experiments include the fact that applications of individual materials such as Dropp or DEF alone or sodium chlorate treatments should not be expected to accomplish satisfactory results from a single application on Pima cotton. We have found Dropp to be an important component in a single application defoliant program, but we have also found that it must be used in conjunction with other selected materials for desired efficacy. Apparently, the combination effect is most strongly associated with the use of an organo-phosphate based material, which increases the uptake and absorption of Dropp into the leaf tissue, and renders the Dropp more effective in terms of the intended physiological activity.

The management of N fertility status and plant-water status have also been shown to be important factors in defoliation (Silvertooth et al, 1990b; Nelson and Hart, 1991b). Generally, it is recommended that petiole NO_3^--N concentrations be below 3,000 ppm at the time of defoliation. To hasten maturity, senescence, and defoliation; the plant water status is important. Excessive plant-water at time of defoliation promotes topgrowth and bottom regrowth. Excessively dry plants lack sufficient physiological activity to carry out defoliant activity (abscission layer development), and also lack sufficient green leaf weight to break through the abscission zone that may develop. The easiest and most useable recommendation for accomplishing a proper plant water status for good defoliation is to wait approximately one month after the last irrigation before attempting to defoliate the crop. This "rule of thumb" of course would vary slightly, dependant upon basic crop canopy conditions, water holding capacity of the soil, and the weather conditions. For example, a slightly earlier defoliant application may have been approprite in some cases in 1991 due to very dry weather conditions.

When water, N, and the choice and timing of chemical defoliants are managed together, a single defoliant application can bring about consistent and satisfactory results necessary for picking a high quality crop in a timely and efficient manner. New chemicals and new combinations will certainly warrant further research on this topic, but the fundamentals (managing water conditions, N, application timing, and proper selection of defoliant materials), will remain important.

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Table 1. Location and cooperators for Pima cotton defoliation experiments, 1991.

Location	Cooperator
Yuma Valley, Somerton (Yuma Co.)	Barkley Ranch
Aguila (Maricopa Co.)	Martori Farms
Queen Creek (Maricopa Co.)	Layton Farm
Coolidge (Pinal Co.)	Prechel Farm

Table 2. Experimental conditions for Somerton, AZ, Pima cotton defoliation study, 1991.

Planting Date	27 February
Irrigation Termination	14 August
Defoliant Application	18 September
HU*, 14 Days Post Defoliation	352
Elevation (approx.)	150 ft.
Method of Application	Ground
Carrier Rate (gpa)	15

*HU = Heat Units, 86/55°F limits.

Table 3. Experimental conditions for Aguila, AZ, Pima cotton defoliation study, 1991.

Planting Date	24 April
Irrigation Termination	10 September
Defoliant Application	11 October
HU*, 14 Days Post Defoliation	227
Elevation (approx.)	2,160 ft.
Method of Application	Ground
Carrier Rate (gpa)	20

* HU = Heat Units, 86/55°F limits.

Table 4. Experimental conditions for Queen Creek, AZ, Pima cotton defoliation study, 1991.

Planting Date	19 April
Irrigation Termination	23 August
Defoliant Application	17 October
HU*, 14 Days Post Defoliation	173
Elevation (approx.)	1,200 ft.
Method of Application	Ground
Carrier Rate (gpa)	15

* HU = Heat Units, 86/55°F limits.

Table 5. Experimental conditions for Coolidge, AZ, Pima cotton defoliation study, 1991.

Planting Date	12 April
Irrigation Termination	10 September
Defoliant Application	8 October
HU*, 14 Days Post Defoliation	254
Elevation (approx.)	1,385 ft.
Method of Application	Ground
Carrier Rate (gpa)	16

* HU = Heat Units, 86/55°F limits.

Table 6. Treatments used in Arizona Pima cotton defoliation experiments, 1990 and 1991.

Treatment *	Rate	
	---Material/acre---	--lbs. a.i./acre--
Dropp 50 WP	0.2 lb.	0.1
Dropp WDG	0.2 pt.	0.1
Dropp WDG + DEF/F**	0.15 pt. + 0.5 pt.	0.075 + 0.38
Dropp WP + DEG/F	0.15 lb. + 0.5 pt.	0.075 + 0.38
Dropp WP + DEF/F	0.15 lb. + 1.0 pt.	0.075 + 0.75
Dropp WP + DEF/F	0.2 lb. + 0.5 pt.	0.10 + 0.38
Dropp WP + DEF/F	0.2 lb. + 1.0 pt.	0.10 + 0.75
Dropp WP + DEF/F	0.3 lb. + 1.0 pt.	0.15 + 0.75
Dropp WP + DEF/F	0.3 lb. + 1.5 pt.	0.15 + 1.13
Dropp WP + DEF/F	0.3 lb. + 2.0 pt.	0.15 + 1.50
Dropp WP + DEF/F + Prep	0.2 lb. + 1.0 pt. + 1.0 pt.	0.10 + 0.75 + 1.0
Dropp WP + DEF/F + Accelerate	0.2 lb. + 1.0 pt. + 0.75	0.10 + 0.75 + 0.05
Dropp WP + Accelerate	0.2 lb. + 0.75 pt.	0.10 + 0.05
Dropp WP + Accelerate	0.4 lb. + 1.0 pt.	0.20 + 0.75
Dropp WP + Accelerate + Prep	0.2 lb. + 0.75 pt. + 1.0 pt.	0.10 + 0.05 + 1.0
Dropp WP + Cotton-Aide	0.2 lb. + 1.0 pt.	0.1 + 0.4
Sodium Chlorate + Accelerate	2.5 gal. + 1.0 pt.	5.0 + 0.75
Sodium Chlorate + Penox	2.0 gal. + 1.0 pt.	8.0 0.06

* All treatments included 1.0 pt. Agridex/acre.

** DEF/F: Represents either DEF-6 or FOLEX, which are identical materials and can be used interchangeably.

Table 7. Results (means values) from the Pima cotton defoliation experiment, Yuma Valley, Barkley Ranch, 1990.

Treatment	Defoliation Estimate	Regrowth Rating
	----------%---------	
Dropp + Accelerate (0.2 lb. + 0.75 pt.)	73 a	4.7 a b c
Dropp + DEF + Prep (0.3 lb. + 1.5 pt. + 1.0 pt.)	73 a	4.0 c
Dropp + Accelerate (0.4 lb. + 1.0 pt.)	73 a	6.0 a
Dropp + DEF (0.2 lb. + 1.0 pt.)	72 a	4.3 b c
Dropp + DEF 0.2 lb. + 2.0 pt.)	72 a	5.0 a b c
Dropp + Prep (0.2 pt. + 1.0 pt.)	70 a	4.7 a b c
Dropp + DEF + Prep (0.2 lb. + 1.0 pt. + 1.0 pt.)	70 a	4.7 a b c
Dropp + Accelerate (0.2 lb. + 0.5 pt.)	68 a	5.7 a b

Means followed by the same letter are not significantly different ($P \leq 0.05$) according to a Duncans multiple range test.
Defoliants applied: 18 September
Measurements taken: 4 October
14d HU = 352

Table 8. Results (mean values) from the Pima cotton defoliation experiment, Aguila, Martori Farm, 1991.

Treatment	Defoliation Estimate	Regrowth Rating
	--------%---------	
Dropp + DEF (0.2 lb. + 1.0 pt.)	80 a*	2.0 b
Dropp + DEF (0.2 lb. + . + 0.5 pt.)	80 a	2.0 b
Dropp + DEF (0.1 lb. + 1.0 pt.)	80 a	2.0 b
Dropp + DEF + Accelerate (0.2 lb. + 1.0 pt. + 1.0 pt.)	80 a	3.0 b
Dropp + Accelerate (0.2 lb. + 0.5 pt.)	80 a	3.0 b
Dropp + DEF (0.3 lb. + 1.0 pt.)	80 a	2.0 b
Sodium Chlorate + Moract (2.5 gal. + 1.0 pt.)	70 a	7.0 a

* Means followed by the same letter within a column are not significantly different ($P \leq 0.05$) according to a Duncans multiple range test.
Defoliants applied: 11 October
Measurements taken: 24 October
14d HU = 227

Table 9. Results (mean values) from the Pima cotton defoliation experiment, Queen Creek, Layton Farm, 1991

Treatment	Defoliation Estimate	Regrowth Rating
	---------%---------	
Dropp + DEF + Accelerate (0.2 lb. + 1.0 pt. + 1.0 pt.)	80 a	5.0
Dropp + DEF (0.1 lb. + 1.0 pt.)	67 b	5.0
Dropp + DEF (0.2 lb. + 1.0 pt.)	63 b	5.0
Dropp + DEF (0.2 lb. + 0.5 pt.)	63 b	5.3
Dropp + DEF (0.3 lb. + 1.0 pt.)	58 b	6.0
Dropp + Accelerate	57 b	6.7

* Means followed by the same letter within a column are not significantly different ($P \leq 0.05$) according to a Duncans multiple range test.
Defoliants applied: 17 October
Measurements taken: 4 November
14d HU = 173

Table 10. Results (mean values) from the Pima cotton defoliation experiment, Coolidge, AZ, Preshel Farm, 1991.

Treatment	Defoliation Estimate	Regrowth Rating
-Materials/acre-	---------%----------	
Dropp + DEF (0.2 lb. + 1.0 pt.)	80 a	4.7 a
Dropp + DEF (0.2 lb. + 0.5 pt.)	75 a	4.3 a
Dropp + DEF (0.10 lb. + 1.0 pt.)	80 a	4.3 a
Dropp + DEF + Accelerate (0.2 lb. + 1.0 pt. + 1.0 pt.)	77 a	3.3 a
Dropp + Accelerate (0.2 lb. + 0.5 pt.)	78 a	4.3 a

* Means followed by the same letter within a column are not significantly different ($P \leq 0.05$) according to a Duncans multiple range test.
Defoliants applied: 8 October
Measurements taken: 22 October
14d HU = 254