



# Defoliation of Pima Cotton

Defoliation of American Pima (*Gossypium barbadense* L.) and Upland (*G. hirsutum* L.) cotton continues to be an important feature of the production and management systems in the desert southwest. This is particularly true with Pima cotton due to its more indeterminate nature and the very high priority given the quality of harvested lint. Pima cotton has long been recognized (Kittock, et al., 1977) in terms of the difficulties associated with successful defoliation of this crop. Pima growers often have to make three to six applications of chemical defoliant in an effort to prepare the crop properly for harvest (Silvertooth, 1988). This often has been attributed to the robust, perennial nature which is characteristic of Pima cotton and the difficulties in altering the basic physiological processes necessary for defoliation (Cathey, 1986) through crop management.

A number of experiments have been conducted across Arizona from elevations of 150 ft. to 2,000 ft. above sea level with the primary objective of developing management guidelines oriented towards accomplishing a successful defoliation of a Pima crop from a single application of chemical defoliant (Silvertooth and Howell, 1988; Silvertooth et al., 1989; Silvertooth et al., 1990a; Silvertooth et al., 1990b; Nelson and Hart, 1991; Nelson and Silvertooth, 1991; and Silvertooth et al., 1991b). Considerable progress has been made from these experiments on the development of chemical defoliant treatments capable of accomplishing a satisfactory defoliation (≈ 75% leaf drop) from a single application. The information gained from these experiments has also shown the importance of a number of other factors which impact the defoliation efficiency besides the chemical itself. Factors such as plant-water relations, nitrogen (N) fertility status, the extent of honeydew deposits on the leaves from insects such as the sweetpotato whitefly (*Bemisia tabaci* (Gennadius)) or aphids, and weather conditions following the defoliant application have been recognized as being important in terms of the final defoliation resulting from a given defoliant material.

The purpose of this report is to provide a brief review and summary of the aforementioned factors concerning the management of a Pima cotton crop towards optimum production and efficient defoliation.

## AGRONOMIC PRODUCTION FACTORS

The primary agronomic focus of desert cotton production systems is the production of optimum amounts of high quality lint, not to develop a crop that is easy to defoliate. However, the two most important agronomic inputs provided to a cotton crop for optimum production, water management (plant-water relations) and N fertility status, also serve to impact defoliation efforts as well. General agronomic guidelines for Pima cotton production are outlined in another publication (Silvertooth, 1991), but water and N management are worthy of being addressed within the context of both optimum yield and defoliation.

### Water Management

The details of plant-water relations and water management which optimizes yield from a Pima cotton crop extend beyond the scope of this paper. In terms of late season water management, the timing of the last (terminal) irrigation and the time interval between the terminal irrigation, and the application of the chemical defoliant can be very important (Oosterhuis et al., 1991).

The physiological process of defoliation is linked closely with the natural senescence (aging) of the plant and its individual leaves. During the senescence of the leaves, a series of hormonal reactions occur which promote the formation of an abscission layer at the base

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of a leaf petiole. In chemically defoliating a crop, an attempt is made to accelerate and enhance the natural senescence process, leaf abscission, and ultimately leaf drop (Cathey, 1986).

Late in the season some degree of crop senescence will be occurring naturally and can be enhanced by imposing some degree of water stress. After the final irrigation has been applied, the crop will progressively desiccate at a rate dependant upon weather conditions, water holding capacity of the soil (soil texture), the amount of water applied in the last irrigation, and the overall condition of the crop fruit load and canopy. In general, it has been found that for most cases the time interval between the last irrigation and the application of the chemical defoliant should be 2X (twice) the normal time span used between the late-season irrigations. This provides for the water needs of the late set harvestable fruit intended for harvest and also some degree of crop dry-down, which in turn promotes crop senescence.

The management for optimal plant-water relations has several facets. A certain degree of crop drying and senescence is desired, but plant-water status should remain sufficient to maintain adequate physiological activity necessary to carryout the effects of the defoliant material. In addition, the plant must maintain satisfactory water relations such that adequate green leaf weights are maintained to enable the leaves to break through an abscission layer once it is formed, and actually drop to the ground. (Cathey, 1986).

Attempts to defoliate cotton plants that are excessively dry can often result in complete leaf desiccation but poor leaf drop. In some cases an abscission layer may form, but due to very dry conditions the leaves do not have sufficient green leaf weight to accomplish a shear across the abscission layer, and consequently the leaves fail to drop from the plant. In some cases where plants are exceedingly dry at the time of defoliation, defoliant materials may completely desiccate the leaves rather than enhance the formation of an abscission layer and defoliation. In any case, the retention of desiccated leaves on the plant often results in excessive trash in the harvested lint.

Attempts have been made to quantify and identify critical levels in plant-water relations by use of infrared thermometry and a Crop Water Stress Index (CWSI) (Silvertooth et al., 1990b). However, the application of this technology and CWSI levels identifying critical points in crop desiccation for defoliation management has not proven to be satisfactory in providing a reliable, quantitative approach. Alternate technology such as leaf water potential measurements may be worthy of further study in this application. At present the general approach using 2X the late season irrigation interval as the minimal time period between final irrigation and defoliant application, can serve as a guide for estimating satisfactory plant-water relations for defoliation.

## Nitrogen Management

Nitrogen is the mineral nutrient to which cotton crops in Arizona most consistently respond and is often required as fertilizer N additions to maintain optimum yield potentials. Excessive N fertility promotes vegetative growth and delayed senescence. High N fertility levels late in the season also have a particularly negative effect on defoliation. Recent research results have shown that N fertility levels corresponding to 3,000 ppm (or less)  $\text{NO}_3^-$ -N concentrations in petioles prior to defoliation will not interfere with defoliation effectiveness. Excessive N levels ( $\approx$  5,000 ppm  $\text{NO}_3^-$ -N in petioles) will retard effective defoliation.

Management of N for optimum yield and late season crop management (including defoliation) is described more thoroughly in other publications (Silvertooth and Doerge, 1990; Silvertooth et al., 1991a). It is very important to minimize N applications past the peak bloom stage of crop development because it will complicate late season management problems, such as defoliation. Applications of N fertilizer should be split over the course of the season and made in response to crop N status (petiole samples and analyses), crop fruiting patterns (plant mapping), and stage of crop development (Silvertooth and Doerge, 1990) to accomplish highest possible efficiency of the N fertilizer applied and to achieve optimum yield potentials for the crop.

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## EXTERNAL FACTORS

### Whitefly Populations

Populations of sweetpotato whitefly in cotton fields usually result in a liberal coating of a sugary exudate (honeydew) on the foliage and lint. Honeydew buildup on cotton lint results in adverse conditions for ginning and milling, and is a serious threat to many cotton producing regions. The presence of honeydew coatings on the leaves of cotton plants due to whitefly (or any honeydew producing insect) populations can also diminish the effectiveness of any chemical defoliant application due to reduced uptake and penetration of the defoliant through the leaf cuticle and epidermis. Physiological activity of any defoliant is dependant upon uptake of the material through the leaf surface. Therefore, defoliation results may be affected by late season whitefly populations and the extent of honeydew deposited on the leaves prior to defoliant application.

### Weather Conditions

As with most management efforts in crop production, weather can have a very strong influence on the final results obtained from a given defoliant application. Temperature conditions experienced in the period after defoliant application on cotton can

affect the results. It is often found that under warmer conditions plant physiological activity is higher and therefore defoliant effects may be more pronounced and rapid than under cooler conditions. This pattern of response also impacts the rate of materials which may be required for obtaining a satisfactory defoliation. Results obtained in the experimental programs conducted since 1987 (Silvertooth and Howell 1988; Silvertooth et al., 1989; Silvertooth et al., 1990a; and Silvertooth et al., 1991b), have shown that a period of 14 days should be allowed for the full defoliation response for most treatments and weather conditions. Rates of selected materials should be adjusted in accordance to current and anticipated (forecast) weather conditions. Under very warm or hot conditions, lower rates may suffice; whereas under cooler conditions (late season and/or higher elevations) higher labeled rates may be required for satisfactory effects from a given defoliant application.

There are several ways of describing prevalent temperature conditions. A common means of describing temperature conditions with regard to crop response is by the use of heat units (HU, 86/55°F thresholds; Brown, 1989). Because of the interaction with other factors such as plant-water relations, N fertility status, honeydew

deposits, etc.; it is difficult to explicitly prescribe rates of defoliant in response to temperature conditions. A general set of guidelines as shown in Table 1, can be used to determine the relative rates of a chosen defoliant treatment which corresponds with anticipated weather conditions.

Weather conditions are difficult to predict for any extended period of time. Generally, warm to hot conditions can be expected in Yuma County in early September in contrast to cooler conditions common in Pima County in late October to early November. Under these very general climatic descriptions, one could prescribe rates for selected defoliant at a relatively low rate for the Yuma County case and relatively high (close to top of labeled rate) for the Pima County case as described. The information in Table 1 can be used in combination with predictions of HU accumulations for a given time frame and location based upon historical, long-term weather records listed in another University of Arizona publication (Brown, 1991). A general prediction of HU accumulations expected for a 14-day period after defoliant application could then be applied to Table 1 outlines, and a given defoliant treatment selected as listed in Table 2.

Table 1. Suggested ranges in defoliation treatment rates in response to expected heat unit accumulations over a 14 day period after application.

General Treatment Rate*	Expected Heat Unit Accumulations**
<i>HU (86/55°F)</i>	
Low	above 300
Medium	200 - 300
High	below 200

\* Refer to ranges in labeled rates for a given defoliant material.

\*\* Heat units (85/55°F threshold) expected over 14 day period after application. (See: Brown, 1991)

Table 2. Treatments suggested for Arizona Pima cotton defoliation.\*

Treatment**	Rate	
	Material/acre	lbs. a.i./acre <sup>†</sup>
Dropp WP + DEF/F ‹	0.15 lb.+ 0.5 pt.	0.075 + 0.38
Dropp WP + DEF/ff	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/ff	0.2 + 1.0 pt.	0.10 + .075
Dropp WP + DEF/ff	0.3 lb. + 1.0 pt.	0.15 + 0.75
Dropp WP + DEF/ff	0.3 lb. + 1.5 pt.	0.15 + 0.13
Dropp WP + DEF/ff	0.3 lb + 2.0 pt.	0.15 + 1.50
Dropp WP + DEF/ff + Prep	0.2 lb. + 1.0 pt. + 1.0pt.	0.10 + 0.75 + 1.0
Dropp WP + DEF/ff + Accelerate	0.2 lb. + 1.0 pt. + 0.75 pt.	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

\* Treatments listed are based upon field experiments conducted under a wide range of conditions in Arizona. Trade names are provided for the benefit of the reader and do not imply endorsement by the University of Arizona.

\*\* All treatments included 1.0pt. Agridex/acre.

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

† Pounds of active ingredient per acre.

## Defoliant Treatments

A list of some defoliant treatments are shown in Table 2 which include only materials tested under experimental conditions described earlier. This list is not all inclusive and does not describe all possible materials and/or combinations. The list in Table 2 does provide a group of treatments which have proven to be capable of providing a satisfactory defoliation (<sup>3</sup> 75% total defoliation) from a single application. The ranges in rates listed in Table 2 should be considered in light of expected weather conditions as previously described (Table 1).

An important point to recognize is that all treatments listed in Table 2 represent a **combination** of two or more materials. For example it has been consistently found with Pima cotton defoliation that combinations of materials such as DROPP + DEF/FOLEX or DROPP + Accelerate are much more effective than applications of any of these materials individually at a given rate. Also, under warm conditions (more than 200 HU in 14 days expected) the combination treatments at low to medium rates are more effective and consistent than single material applications at higher rates.

In the use of any chemical defoliant, label specifications should always be followed closely.

## Summary

Defoliation often represents the final step in the production of a cotton crop. With the emphasis on premium quality associated with Pima cotton production, efficient defoliation is a matter of paramount concern in late season crop management. In managing a Pima crop for defoliation, a number of important factors such as plant-water relations, N fertility status, extent of insect honeydew deposits present on the foliage, and weather conditions must be taken into account before a defoliant treatment is selected and applied. General descriptions of these factors and their contributing influence on Pima cotton defoliation have been described in this report for consideration towards achieving a satisfactory defoliation from a single treatment application. Successful defoliation from a single application can be accomplished under a wide range of conditions. Best defoliation results have a higher probability of occurring when the applicator is conscious of the prevailing circumstances and manages the crop accordingly.

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