Cultural and Management Practices for Pima Cotton Production

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Abstract

The good use of cultural or agronomic practices is fundamental to the production of high yields and quality of American Pima cotton. In order for Pima farmers to maintain viable production operations, a continual review and improvement upon the existing set of cultural practices are in order. Basic aspects of crop production such as planting date management, soil fertility and plant nutrition, plant growth regulator use, crop termination, and defoliation are reviewed in this paper in relation to American Pima cotton production. Specific attention is also given to potassium (K) fertility management and Alternaria leaf spot regarding new aspects of potential management needs.

Introduction

American Pima cotton (Gossypium barbadense L.) has historically been an important feature of Arizona, New Mexico, and west Texas cotton production. Of course in the past several years, the San Joaquin Valley of California has also become a significant member of the "Pima Belt". The balance of acreages among these various areas is shifting to some extent, and will likely continue in response to changing conditions in the market, and with constraints being experienced at the production level. It is without question, however, that for any of the areas involved in Pima production to maintain profitable operations, cultural management (agronomic) factors will continue to be very important for optimum crop production.

Newcomers and veterans to Pima production are quick to recognize that differences do exist between Upland (G. hirsutum L.) and Pima in terms of growth habits and management. Even with the release of Pima S-6 in 1983, Pima has always been more indeterminate (full season nature) than it's Upland relatives, a factor which figures very strongly in several aspects of it's management. With the recent release of Pima S-7 in 1991, we now have a Pima variety that is even more determinate (earlier in nature), with improved heat tolerance, and improved yield capacity, and still maintains excellent fiber quality characteristics. So as our varieties change, it is always appropriate to review some of the basic features of our crop management systems. It is the purpose of this paper to outline of some of the major agronomic factors involved in the production of Pima cotton that are common to each of the Pima growing areas.

PLANTING DATE

Even though Pima seeds are generally regarded as being more cold tolerant, they emerge and became an established stand best when planted in suitably warm conditions. Such conditions could be generally described as 60°F in the zone of seed placement for several days prior to planting, with a well prepared seedbed. We have found in Arizona from a number of date of planting experiments that Pima S-6 performed best when planted early, and realized rather consistent declines in yield with delayed plantings. The point to be taken is that planting of Pima is probably best for as early a date as conditions will allow.

From the experimental work done in Arizona, we see that optimal dates are going to vary with location (elevation) and season. A good way of standardizing recommendations of this type is by using heat units (HU). The HUs we commonly use in Arizona to describe cotton plants and cotton insects are the 86/55 °F HU values (upper and lower thresholds, respectively) which are readily available to all cotton producing areas in Arizona through the Arizona Meteorological Network (AZMET) run by Dr. Paul Brown. What we have found in reviewing the date of planting data, is that an optimum window for planting can be described by using HU accumulations beginning on January 1 (HU/Jan.1) of any given year. For Pima, this type of window begins at 450 HU/Jan. 1 and extends to 700 HU/Jan. 1. On the front side of the window it is most important to watch soil temperatures and a five day forecast. The simple fact of the matter is that cottonseeds have a basic requirement concerning temperatures needed for germination and development. Cottonseeds (Pima or Upland) placed in cool soil will be delayed in germination, development, and general vigor. The later side of this window is probably the most important part, in that delays in planting past this point consistently result in serious losses in yield potential for all full season, indeterminate varieties, such as Pima.

We have also consistently found from these experiments that as Pima was planted later, plants grew taller, were more vegetative, and less productive. This is generally regarded as a plant response to greater amounts of heat (HU) being accumulated in shorter periods of time, which tends to cause greater internode length, larger leaves, and a lesser tendency to begin fruiting. So a delayed planting of Pima will tend to bring about taller, more vegetative plants, causing the grower a lot of anxiety and ending up with lower yield potentials.

IRRIGATION

Probably one of the toughest decisions to make in a Pima production season is when to initiate that first irrigation. Plant-water stress itself is a tool that many veteran Pima growers have found useful, particularly with pre-S-6 varieties, and also sometimes with S-6, to control vegetative growth. However, many successful Pima S-6 growers currently do not intentionally water-stress a Pima crop at anytime except during very early periods in the season. This is usually just prior to the first irrigation. Just how much to stress a Pima crop at this time is a very good question. We do not have, as of yet, a well established, easily measured point where enough stress has been incurred and irrigation is needed before significant harm is done for Pima. However, related research to this question indicates that early season stress of this type can be very damaging and can have season-long impact on growth, development, and yield. This still remains to be a somewhat "artistic" act that Pima farmers carryout in timing that first irrigation. We need to develop a useful and reliable technique for monitoring plant conditions and timing this first irrigation at an optimal point so that we promote fruiting and make good use of the irrigation.

FERTILITY MANAGEMENT

With the abundance of HUs that descend upon Pima cotton crops, the two main throttles a grower has is water and nitrogen (N) fertilizer. Keeping the plant in good condition with water relations through the season is an obvious objective in all parts of the Pima Belt. Since the control of the vegetative/reproductive balance is particularly critical in Pima, one must also consider the N fertilization of Pima in a unique light. Many producers and researchers agree that Pima is sensitive to excessive N levels, and can convert extra growth to pure vegetation without any trouble. In fact, many Pima growers purposely avoid fields where a high level of residual available nitrate - N (NO_3^--N) will be present. This should be a point of condsideration for growers placing Pima in a field behind vegetable crops or alfalfa.

Guidelines have been developed for managing N fertility in Pima by use of petiole sampling in-season (Pennington and Tucker, 1984 and Silvertooth and Doerge, 1990). In comparison to Upland levels of petiole nitrates, Pima levels should be somewhat lower throughout the season. Caution should particularly be taken to avoid excessive levels of nitrate-N in the Pima petioles early in the season, to avoid excessive vegetative growth before fruit set begins.

A considerable amount of research has been conducted with Pima cotton concerning N management. It is virtually impossible to predict the exact amount of N fertilizer that a crop will require before the season begins. Therefore, it follows that optimal management of fertilizer N will have to be done in line with actual crop conditions. The basic recommendations include the following points:

- Avoid preseason applications of fertilizer N. Preseason applications are consistently the least efficient.
- An estimate of the maximum amount of fertilzer N that a field may need can be developed using a yield goal multiplied by 60 (lbs. N/bale) as a N requirement. For example, a two bale yield X 60 lbs. N/bale = 120 lbs. N/acre. This could then be used a total, maximum N requirement for the season.
- Split applications of fertilizer N, beginning at first square formation and ending by peak bloom.
- Base in-season N applications on actual crop condition (plant measurements and petiole samples). Height:node ratios (HNRs) serve as an easy measure of a cotton crop's vigor, with high HNR trends indicating a vegetative plant condition. A grower would want to hold back on any N fertilization if a crop were developing vegetative tendancies, but proceed if fruiting and growth patterns were more favorable. Actual N fertility conditions can be monitored easily by use of a petiole sampling and analysis program.

Nitrogen represents a very important part of crop management, and it is important to maintain as much control as possible over the N inputs to a cotton crop, particularly Pima. Even subtle increases in a crops N fertility status can promote vegetative growth, delay maturity, complicate defoliation, and ultimately decrease yield and quality.

There are other plant nutrients which also should be considered as possible fertilizer inputs to a Pima crop, such as phosphorus (P), potassium (K), and zinc (Zn). Due to the nature and behavior of these nutrients in the soil, their need is best determined by a soil test for a given field in relation to the specific crop to be grown. Extension guidelines concerning P, K, and Zn fertilization of Pima cotton are available for each of the states in which is Pima cotton is grown and should be referenced following the analysis of a soil sample.

There has been quite a lot of recent interest relative to K nutrition and it's relation to fiber development, particularly with Pima cotton. Recent work in Arizona indicates that Pima appears to be more sucseptible to K deficiencies. This is most apparent in cases where a Pima crop: 1) has a strong boll load developing (strong K demand), 2) is following alfalfa (a high K removing crop), and 3) is being grown on sandy and/or shallow soils. A case such as this would merit particular concern in managing the crop for high yields and quality. Unfortunately, this is an area where we are limited in a research base which is needed in defining exactly what soil test levels warrant applications of K fertilizer, at what rates, methods of application, or stage in the season to best prevent K deficiency conditions.

PLANT GROWTH MANAGEMENT

Sometimes, unfortunately, cotton plants do get out of control and become somewhat vegetative, and this can certainly happen with Pima. Besides exercising control over N inputs, as we have already discussed, the use of plant growth regulators (PGRs), such as PIX_{tm}, often become important tools in maintaining a well-balanced crop. Effective use of PGRs can best be made by following actual crop conditions. In an attempt to control vegetative tendancies, the first step is to determine if the crop is experiencing a loss in fruit retention and an increase in vegetative growth. The use of HNRs serve as an easy measure of this aspect of a crop's condition, and are a direct reflection of actual fruit retention levels. Guidelines and recommendations for PIX_{tm} use have been developed which utilize actual HNR measurements in reference to established baselines for Pima (Silvertooth et al., 1993). Use of this type of a feedback approach can improve upon the efficient use of PGR inputs and best serve any needs in controlling vegetative growth.

TERMINATION AND DEFOLIATION

In order to obtain the highest possible returns on a Pima crop, one must maintain the highest quality lint as possible. The quality of harvested lint is often a result of the preparation and picking process at the end of the season. Accordingly, the late season management of the crop, and the defoliation of the crop affect the way in which the cotton is harvested from the field.

The first step in this process is that of determining the timing of the last irrigation. If a Pima crop is maintaining a good fruit load it will progress towards a natural cut-out phase, particularly with the newer varieties such as S-7. An easy method of identifying stage of growth is by the use of the nodes above the top white bloom (NAWB) count. When the NAWB count in a field is dropping to five or less, the crop is moving into cut-out. It is at this stage in development that a manager must decide on the last set of bolls that he/she wants to mature to harvest, whether it would be the last set of blooms prior to cut-out or a later set of blooms developed with a top crop. Recent work with Pima has shown that 600 additional HU are required to mature a late set boll from a bloom to a hard, full-sized green boll. Therefore, adequate soil moisture must be maintained over the duration of this 600 HU period to insure full fiber length development. The final irrigation can then be timed accordingly to provide for this last set of bolls. There is always the temptation to try to make those later blooms, but this decision has to be balanced with a realistic consideration of the time and expenses required to make those later bolls. Factors such as late season insect infestations, length of the growing season which is remaining, and actual yield potentials must be fully and realistically considered.

Once the final irrigation is made, the processes leading to crop senescence and defoliation are set into motion. The first objective is to complete the maturation of the last bolls intended for harvest and then to direct an optimal timing for defoliation. It is important to remember that in defoliating a crop we are taking advantage of a natural physiological process, but we are just trying to accelerate the process to accomodate our own schedules.

The choice and timing of defoliant chemicals that are applied are important in achieving satisfactory defoliation. But other factors such as the late season plant-water status, the N fertility status, and the boll load that the crop plants are carrying have a definite impact on the way a cotton crop defoliates. This is true with both Upland and Pima due to their perennial nature, but particularly for Pima with it's robust and indeterminate growth pattern.

By using chemical defoliants, one is attempting to enhance the natural physiological process of plant senescence and leaf abscission. This process requires a certain degree of natural senescence, which can be brought along to some extent by a certain degree of water stress late in the season. Plants carrying a good boll load also naturally senesce a little more rapidly. A certain degree of physiological activity is needed to utilize the effects of chemical defoliants, and also to have a sufficent green leaf weight to actually drop from the plant once an abscission layer is developed. Otherwise, leaves may be burnt but not dropped, leading to a possible trash problem.

Late season N levels that are high can also cause the plant to maintain strong vegetative growth. Based upon the guidelines mentioned previously, petiole nitrate-N levels should be drawn down below 3,000 ppm prior to defoliation. This will not cause a yield limiting decline in N fertility, while allowing for a stronger trend in plant senescence.

Recent research conducted in an effort to develop better guidelines for Pima cotton reinforces these points. Exceedingly dry Pima plants are difficult to defoliate (usually leaving intact, burnt leaves), while fresh, lush growth is also very difficult to slow down and defoliate. Developing a slight degree of stress following irrigation termination encourages senescence, but too much will hinder defoliation efforts. Similarly with the N status late in the season. If petiole levels of nitrate-N are drawn below 3,000 ppm late in the season, Pima plants will be less difficult to defoliate, given proper application of materials, etc.

SUMMARY

Not every aspect of Pima cotton production has been addressed. However, I have attempted to discuss some basic points in Pima production where principle differences exist in comparison to Upland cotton production. Certainly, each factor addressed is associated to a major component of Pima cotton, which is quality. Quality is paramount to a successful Pima cotton production operation. Growing and maintaining high quality fiber is accomplished both at picking and through the skillful combination of many factors in growing the crop. Essentially, it all boils down to basic agronomics and good cultural management. The proper use and combination of all of these tools will change from season to season, which is why it is important to have a good plan but to be capable of being flexible in response to actual crop conditions that may change or develop in-season.

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