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# Management Considerations for Short Season Cotton in Arizona

The use of a short season production strategy on cotton (Gossypium spp.) in Arizona versus a conventional, full season approach offers several facets of potential benefit to a cotton grower. In an effort to capitalize upon these potential benefits derived from a short season system, one must consider several factors and manage them toward a short season production objective in a premeditated manner. Those familiar with the multitude of factors associated with the management of a cotton production program realize that the exact combination of conditions leading to a definite advantage of short season over full season cotton production is not clear cut. However, there is a good deal of information concerning a number of the key factors to be considered in such an option. Some of these factors include: insect pest management, cotton variety, irrigation management, soil fertility (particularly nitrogen) status, use and timing of defoliant applications, ultimate yield potential, overall cost of the top crop, lint quality, and the time and expense of harvest operations. It is the purpose of this paper to outline and highlight some of the more important factors that need to be taken into account when considering a short season option for cotton production. As the title indicates, this paper is oriented toward management considerations.

In an effort to discuss a short season cotton production program, it is probably best to define what is meant by short season. According to Hathorn and Taylor (1972), terminal irrigation dates of 31 August and 15 September are commonly practiced by cotton producers in Pima, Pinal, and Maricopa counties. These dates, in this context, would include full season cotton programs. Short season management, in this case, could be considered as having a 15 August irrigation termination date. The exact date of irrigation termination varies depending upon location and actual planting date. Assuming a common planting date (20 March) for these three alternative irrigation dates __ 15 August, 31 August, and 15 September __ schedules of operations could be hypothetically projected for each, as taken from Willett, Taylor, and Buxton (1973) and presented in Table 1. This planting date is presented for purposes of illustration only. The 15 August irrigation termination date is used as an example date in this case based upon the data summarized by Farr and Kittock (1979). Farr and Kittock's data revealed a larger incremental yield increase for a mid-August irrigation termination date than either an early September or mid-September irrigation termination date. Similar to Willett et al (1973), the 15 August, 31 August, and 15 September irrigation termination dates are referred to as Alternative I, II, and III, respectively, as shown in Table 1. Therefore, the reference to short season cotton,as used in the context of this paper, refers to early termination of the crops.

The fact that the response of a cotton crop to the terminal irrigation date is also a function of planting date, variety, weather patterns that occur, and an accumulation of other management factors has a direct bearing on the final outcome of such a strategy. As pointed out by Farr in two papers, (1980 and 1982), atypical weather patterns alone can create differences in the attributes of a given management strategy from year to year. This leads to the difficulty in assessing potential advantages of one management alternative over another in a clear-cut fashion, particularly in economic terms. Cannon et al (1981) concluded that the merits of a short season program are heavily dependent upon the length of available growing season and the price of cotton. They also discussed the difficulty in anticipating potential long season benefits derived from atypical weather conditions. Currently, there is limited

**7/2001** **AZ1244**

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information available concerning the interaction of cotton variety, planting date, and a chosen terminal irrigation date on final yield and quality of cotton as recognized by Fisher et al (1979). This information could be of some benefit in planning for a short season production program.

One thing that is of some certainty, though, is that in opting for a short season approach (such as Alternative 1, Table 1), one sacrifices a yield potential that exists in the possible development of the ªtop cropº (Cannon et al 1982). Management in a short season system should attempt to maximize the benefit from the production of early bolls by the crop. The relative merits, then, of a short season cotton program essentially lie in the management of the crop toward this end from planting date on, and in the overall savings incurred by terminating early. The economic benefits or constraints become of paramount importance in committing a management program to either short or long season cotton production for the duration of a growing season.

## POTENTIAL BENEFITS FROM SHORT SEASON MANAGEMENT

### Insect Pest Management

A source of considerable concern to cotton producers in Arizona is that of effective control of insect pests such as the tobacco budworm (Heliothis virescens (Fabricius)), pink bollworm (Pectinophora gossypiela (Saunders)), and boll weevil (Anthonomus grandis Boheman). Each pest is capable of exerting tremendous pressure on a cotton crop and each has been the subject of a good deal of research in an effort to develop adequate control measures. In the case of these serious insect pests, entomologists stress the importance of utilizing a short season cotton production pattern on a wide-spread basis to extend the host-free period.

Farr (1978) summarized the trends in Arizona cotton production toward later harvests during the early 1960s and the associated increase in the tobacco budworm and pink bollworm infestations. The positive relationship between an increasing percentage of these two insect pests successfully entering diapause and delayed harvest was further established by Crowder et al (1975). Each of these studies emphasized the feasibility of improved control of pests, such as the pink bollworm, by use of short season cotton management. By reducing the number of late season, immature cotton bolls, the overwinter survival rate of the insects is substantially diminished.

Another insect pest that represents a serious threat to Arizona cotton production is the boll weevil. Boll weevil infestations were first reported in Arizona in Santa Cruz, Pima, Pinal, Maricopa, and Yuma counties in 1965 and 1966 (Fye, 1968). Infestations have generally intensified with a gradual westward movement (Beasley and Henneberry, 1985). The biology and life cycle of this insect lends itself to control by the removal of a suitable host crop for the purpose of overwintering. Again, the practice of shorter season cotton management is regarded as a particularly effective means of implementing both short- and long-term control of this insect pest. Watson (1985) emphasized the benefits of short season cotton in managing the boll weevil infestations. He also suggests that chemical control of this pest could potentially extend cotton production costs into a range of economic unfeasibility.

In review of the production alternatives (I, II, and III) outlined in Table 1, there are seven, 10, and 12 total insecticide applications projected for these three ranges in cotton production systems. These insecticide applications were projected based upon pink bollworm control efforts needed on seven-day intervals from 15 July to crop termination (Willett et al 1973). It should be noted that insect pest management strategies used in these projections did not include boll weevil control measures. A source of potential economic benefit, as a result of engaging in short season cotton management, is that of savings realized by the curtailment of insecticide applications with early terminations. Savings in this sense are due to reduced insecticide applications during the season. Entomologists believe that requirements for insecticide applications during the following crop season may also be reduced due to reduced numbers of insect pests that successfully overwinter in fields terminated early (Watson, 1978).

### Cotton Quality

Even though extending the growing season of a cotton crop into the fall provides a greater potential for quantity of cotton yield, there is some evidence that a diminished quality of the lint may result. The poorer quality is basically a function of weathering of the cotton lint produced early and left in the field until a later harvest. Buxton et al (1973) conducted both greenhouse and field tests to determine the effect of later harvests on cotton lint quality. They found that weathering in the field resulted in reductions of 0.8 percent, 0.8 percent, and 1.0 percent per week for upper-half-mean-length, strength, and fineness of fibers respectively on the average, during October and November. Overall conclusions indicated a general loss in quality of cotton lint with later harvests.

Kittock, Daugherty, and Selley (1984) evaluated cotton lint quality as a consequence of late harvest by use of cotton classing data from the Phoenix, Arizona classing office for the 19 years between 1964 and 1982. Their study also included actual farm data taken at several harvest dates in 1982. This study revealed that the highest quality of lint was classed in October and early November, with a slightly lower value in September-classed cotton, then progressively lower qualities each week in December- and January-classed cotton. It was assumed that there was some lag time between harvest and classing. The farm data indicated very little loss of cotton value during the first pick. The second pick cotton had reduced quality, and quality continued to decrease with delay of picking.

The final contribution or benefit derived from higher quality cotton harvested earlier in a short season program will be dependent, of course, upon factors such as overall yield and quality differentials that might exist for a given field over the span of possible harvest dates.

## Irrigation

Another savings that might be realized in a short season program is reduced irrigation costs. Reduced irrigation costs include water, labor, and power costs. As depicted in Table 1, Alternatives II and III (full season options) require eight and nine irrigations, respectively. This is in comparison to the seven irrigations needed in Alternative I. The exact amount of savings one obtained by utilizing less total irrigations from terminating the crop early is dependent upon the source of irrigation water and the specific costs of providing water for each irrigation. The point is simply that fewer irrigations result in lower total production costs and represent an area of potential savings.

From the standpoint of efficient water use by the cotton crop later in the growing season, one should consider this factor in the selection of an irrigation termination date. In a comparison of water-use efficiencies, Kittock et al (1981) found that Upland cotton (G. hirsutum L.) made most efficient use of water applied in midseason. A final irrigation in early August was most efficient in central Arizona, and a late July final irrigation was most efficient in the Colorado River Valley and Imperial Valley. Water-use efficiency decreased with each subsequent irrigation thereafter, for each of the optimum dates. Pima cotton (G. barbadense L.), on the other hand, had increasingly efficient water use from August and September irrigations. They concluded, that based upon their summary of data from over 40 experiment station and cooperator field studies, fewer irrigations may be warranted for Upland cotton than conventionally practiced.

## Fertilization

Probably the largest input, with respect to fertilizer, on most Arizona cotton fields is that of nitrogen (N). Nitrogen fertilization rates can be estimated, based upon expected yield goals on a given field due to the behavior of N in a soil-plant system. Accordingly, higher rates of N fertilizer are applied to fields with higher yield goals. Another important facet of N fertilization of cotton, besides total rate, is that of timing and incremental additions of N fertilizer through the course of the growing season to reach the projected total N needs. To aid in the assessment of a crop's N status during the course of the growing season, many growers employ a petiole nitrate-nitrogen analysis outlined by Pennington and Tucker (1984). This is a very reliable tool to aid in the judicious use of fertilizer N based upon both the short-term N status and full season projections for total N needs. The use of this technique for N fertility management is highly recommended.

In the use of a short season production system, the timing of fertilizer N additions becomes perhaps even more critical. Fertilizer N applied too late in the growing season on a crop intended for early termination could enhance growth continuation and delayed maturity. Also, to utilize N applied late in the season more efficiently, adequate time should be given to the crop to capitalize on the enhanced N status in the soil. Otherwise, residual fertilizer N could be left in the soil unused by the present crop.

Doerge, Farr, and Watson (1986) indicated that the use of diagnostic tools such as petiole nitrate tests have not been widely used by growers across the state. They also found that applications of fertilizer N in excess of actual crop needs are apparently a problem in some areas of Arizona. Excess amounts of fertilizer N can result in decreased efficiency of its use by the crop and potential contamination of groundwater by fertilizer-derived nitrates, as well as provide difficulty in successfully bringing a crop to full maturity under short season management.

In experiments studying the effects of N on the vegetative and fruiting characteristics, Gardner and Tucker (1967) found that N deficiency in early growth stages limited development of vegetative branches, internode elongation, and fruiting, particularly in ªone-peakº flowering areas. They also found that early season N deficiencies can be compensated for by the cotton plant, if provided adequate available N later in the growing season to take advantage of a second flowering peak. However, in the case of developing an efficient management strategy for a short season cotton production program, this indicates the importance of maintaining adequate levels of available N early in the growing season to capitalize upon early boll production in the first flowering period.

In short season systems, one should avoid late season build-up of elevated levels of available (nitrate) N. Soil and plant tissue analysis should be used to refine N fertilizer applications in a short season system in accordance to guidelines put forth by Pennington and Tucker (1984). This includes pre-season soil tests to evaluate residual NO-3-N in the top 2 feet of the soil profile, and petiole tests for NO-3-N during the course of the growing season.

## Crop Maturity and Defoliation

Determination of the maturity of a cotton crop (percentage of the cotton bolls open) is important in crop termination procedures and harvest. Defoliation is usually done when 70 percent to 80 percent of the cotton is open. First harvest may start when 60 percent (green pick) to 90 percent of the bolls are open. Usually, decisions concerning terminating irrigation and insecticide treatments are influenced by percentage of the crop remaining unopened. Defoliants are likely to be more effective on a crop that is naturally maturing to a sufficient state (Kittock and Selley, 1984). Natural maturity of the crop will be dependent upon the variety, date of planting, irrigation management, fertilization, and insect damage incurred. Nitrogen fertilization management is important in this respect, and has been discussed to some extent in the previous section. To successfully manage towards a short season objective requires incorporation of each of these managerial categories in a concerted manner. Effective defoliation is but one part, which is dependent to some degree upon the final combination of these other crop production inputs.

### SUMMARY

If a cotton crop is successfully managed toward short season production, several areas of improved input efficiency should be realized. The bulk of the potential yield is realized (excluding top crop potential) with a lower degree of total input. Particularly if areas of management mentioned in this review are optimized, 85 to 93 percent of the total yield potential obtained with a full season program (Farr, 1978) could be harvested after early termination (Alternative I), and the season completed with theoretically lower costs and higher quality cotton which is marketed. This provides possible advantages in insect pest control for the next growing season, and broader options to the grower in terms of double-cropping possibilities.

Short season cotton production is an increasingly attractive and viable option to Arizona producers. The major source of reservation about short season cotton management for many growers remains the total potential yield that exists with the inclusion of a top crop from a second flowering peak. Obviously, this represents a lucrative option that growers often choose. In any case, the use of a short season system is best evaluated on the basis of production costs that are realistically anticipated on a field-by-field basis. It is best to consider the various categories of management input discussed in this review as it affects the feasibility of short season cotton and its successful operation.

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Table 1. Projected schedule of operations for selected cotton termination alternatives for Central Arizona.[1]

| DATE | I | II[2] | III[2] |
|---|---|---|---|
| March 20 | Plant | Plant | Plant |
| May 10 | 1st Irrigation | * | * |
| June 1 | 2nd Irrigation | * | * |
| June 15 | 3rd Irrigation | * | * |
| July 1 | 4th Irrigation | * | * |
| July 15 | 5th Irrigation | * | * |
| | 1st Insecticide appl. | * | * |
| July 22 | 2nd Insecticide appl. | * | * |
| July 29 | 3rd Insecticide appl. | * | * |
| July 31 | 6th Irrigation | * | * |
| August 5 | 4th Insecticide appl. | * | * |
| August 12 | 5th Insecticide appl. | * | * |
| August 15 | Last Irrigation | 7th Irrigation | 7th Irrigation |
| August 19 | 6th Insecticide appl. | 6th Insecticide appl. | 6th Insecticide appl. |
| August 26 | 7th Insecticide appl. | 7th Insecticide appl. | 7th Insecticide appl. |
| August 31 | | Las Irrigation | 8th Irrigation |
| September 2 | | 8th Insecticide appl. | 8th Insecticide appl. |
| September 9 | Defoliate | 9th Insecticide appl. | 9th Insecticide appl. |
| September 15 | | | Last Irrigation |
| September 16 | | 10th Insecticide appl. | 10th Insecticide appl. |
| September 23 | 1st Pick | Defoliate | 11th Insecticide appl. |
| September 30 | | 1st Pick | 12th Insecticide appl. |
| October 15 | | | Defoliate |
| October 25 | | | 1st Pick |
| October 31 | 2nd Pick and Rood | | |
| November 15 | | 2nd Pick and Rood | |
| November 25 | | | 2nd Pick and Rood |
| December 5 | Completionof harvesting and shredding | | |
| December 23 | | Completionof harvesting and shredding | |
| January 10 | | | Completionof harvesting and shredding |
| **Totals** | | | |
| **Irrigations** | 7 | 8 | 9 |
| **Insecticide appl.** | 7 | 10 | 12 |

[1] Developed from Willett, Taylor, and Buxton (1973)
[2] Projections for alternatives II and III are identical to alternative I from March 20 to August 15.