Basic Cotton Crop Development Patterns

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Abstract

Summaries of cotton crop phenology, as a function of heat units (HU, 86/55°F limits) have been developed across a wide range of production conditions in Arizona. Optimum ranges in HU accumulations since January 1 are used to describe planting dates to maintain optimum yield potentials with full season varieties. Basic events such as the occurrence of pinhead squares, squares that are susceptible to pink bollworm, and first bloom are described in terms of HU accumulations since planting. Also, the expected ranges of HU's accumulated since planting that are required to accomplish crop cut-out are shown for three general maturity types of Upland cotton.

Introduction

The cotton (Gossypium spp.) producing areas of the desert southwest offer many diverse settings. In Arizona, these areas range from elevations less than 100 feet above sea level to over 3,000 feet. Most of the Arizona cotton acreage is situated geographically so that a rather long growing season can be employed for a cotton crop. Important stages in the development of many crops are often described as a range of calendar dates. For example the times for optimum planting are often described as a range of calendar dates, and important crop development stages are described as number of days after planting (DAP). However, plants are biological organisms that respond in direct relation to the temperature and environmental conditions to which they are exposed. Therefore, it has been shown for many different crop plants (and insects) that growth and development can be described much more accurately and predictably by the use of some measure of thermal conditions. As a result, various types of heat unit (HU) systems have been developed to assist in making predicting and/or projecting plant and insect development. By using HU's, one can describe thermal conditions pertinent to crop development for specific locations or specific seasons and not assume consistency among locations or years on a calendar basis.

Relationships describing both cotton crop and pink bollworm (Pectinophora gossypiella (Saunders)) development have been formulated to some extent (Brown et al., 1990). The HU terms used in this case were with 86 and 55°F, upper and lower limits, respectively. The HU relationships for pink bollworm development have been developed and tested more substantially than those for cotton. The purpose of this paper is to outline some of the basic aspects of cotton crop management and development that can be described by use of HU (86/55°F limits) accumulations.

Methods

Descriptions of optimum planting date times or "windows" have been developed from data collected from a number of date of planting by variety experiments conducted in Arizona (Kittock and Hofmann, 1987; Kittock et al., 1988; Silvertooth et al., 1989; and Malcuit et al., 1990). Yield responses as a function of date of planting, have been related to HU accumulations since January 1, on a given planting date. This provides a common basis among locations and seasons (years).

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Data on the number of HU necessary to achieve specific points in cotton crop development such as pinhead square, match-head square, first bloom, and cut-out have been collected in a number of field experiments conducted across Arizona. Upland (G. hirsutum L.) varieties that have been used for these measurements include: DPL 90, DPL 77, DPL 50, and DPL 51. Also Pima (G. barbadense L.) variety S-6, has been used for pertinent data collection. Because basic plant development patterns relative to HU accumulation after planting (plant phenology) were generally consistent among all varieties, and both species, outlines and descriptions are offered as a general description for all varieties, unless otherwise noted.

All HU data was obtained from the AZMET system and the weather station in closest proximity to the field location under study.

Results

Planting date can have an impact on subsequent crop management. A series of date of planting by variety experiments (Kittock and Hofmann, 1987; Kittock et al., 1988; Silvertooth et al., 1989; and Malcuit et al., 1990) have shown us that full-season varieties have greater yield potential over a single fruiting cycle or when extended into a top crop, and maintain best yielding potentials, if planted relatively early. For example, early planting dates in central Arizona would translate roughly to a window extending from about March 20 to April 20. In terms of HU, this would be approximately between 300 to 900 HU accumulated since January 1 (Figure 1).

Delays in planting past this "window" with the full season varieties (i.e., Pima S-6, DPL 77, DPL 90, STV BR 110, STV BR 115, and S-1001, just to name a few) often result in taller, more vegetative plants that do not initiate fruiting as well as those planted earlier, and are thus more difficult to manage (Figure 2).

The development of cotton plants in the early stages of the growing season can be predicted rather well by measuring HU accumulations since the date of planting. As shown in Figure 3, pinhead square, first square size susceptible to pink bollworm, and first bloom can be expected to occur at approximately 700,900,and 1200 HU accumulated since date of planting, respectively.

In a group of experiments that were initiated to evaluate the response of Upland and Pima cotton to two dates of planting and two dates of irrigation termination, we are developing information that can be of some help for cotton growers making the decision on when to terminate a crop, and what type of yield increases can be expected from those last two or three irrigations (Silvertooth et al., 1990). These experiments have been conducted at the Yuma Valley, Maricopa, and Marana Agricultural Centers of the University of Arizona (approximately 150, 1300, and 2000 ft. elevations, respectively and have also served as a source of plot measurements describing growth and development. Flower counts per unit area and the number of nodes occurring above the top white bloom (NAWB), have been routinely collected and related to crop cut-out. A general flowering curve is shown in Figure 4, indicating cut-out, followed by the top-crop development. Table 1 outlines the general HU accumulations after planting expected to achieve cut-out for several types of cotton varieties, which is dependent to some extent on the boll load and the basic production conditions.

It has been noted that under similar weather conditions, management factors, and insect pest pressures, all cotton varieties measured had the tendency to develop mainstem nodes rather consistently in the early stages of the season, and also to initiate first squares (first fruiting branches) at similar mainstem node positions. Earlier reports of differences in the occurrence of pinhead square, for example between Upland and Pima cotton (Brown et al., 1990), could be largely attributed to measurements with earlier Pima varieties such as Pima S-5 and earlier; which commonly initiate fruiting at higher nodes than many of it's Upland counterparts. Also, the ability of a short season type of plant to complete a flowering cycle and cut-out faster than a full season variety, is not consistently associated with initiating fruiting branches at lower nodes, but rather due to a high fruit retention level and a resultant tendency to exhaust it's vegetative structure (thus cutting out).

Cotton growers in Arizona and the desert southwest face many challenges and obstacles in an effort to maintain adequate return from production systems. Improvements in cotton production efficiency (agronomically and economically) offer a means to pursue and maintain long-term stability in the agricultural community. The development of a better understanding of crop dynamics and potentials is a necessary goal of agronomists and producers alike. Consideration of crop growth and development expected as a function of actual weather conditions (HU) instead of a calendar, may offer some advantages to growers in crop management. This is particularly true in terms of integrating crop management and pest management factors.

References

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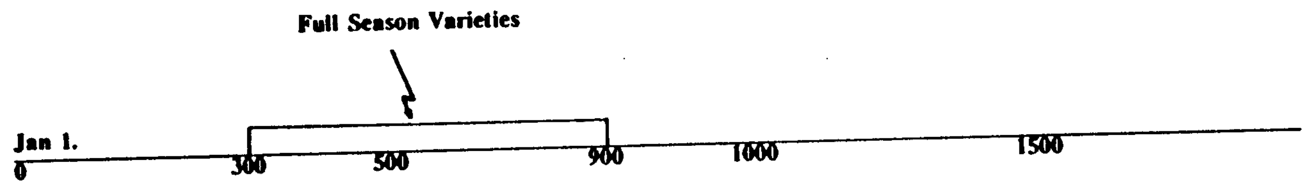
Variety Type	HU at Cut-Out*
Short Season	2200-2400
Mid Season	2300-2600
Full Season	2500-2800

*Heat Units (86/55°F) accumulated since planting.

Table 1. Cut-out occurrence for cotton varieties grown in Arizona.



Optimum Range --HU (86/55°F)--	Cotton Variety Type
300-900	Full season (indeterminate)
900-1500	Mid season (medium determinance)
< 1500	Short season (most determinant)

Figure 1. Optimum planting times as a function of heat unit (86/55°F) accumulations since 1 January, for Arizona cotton growing areas.

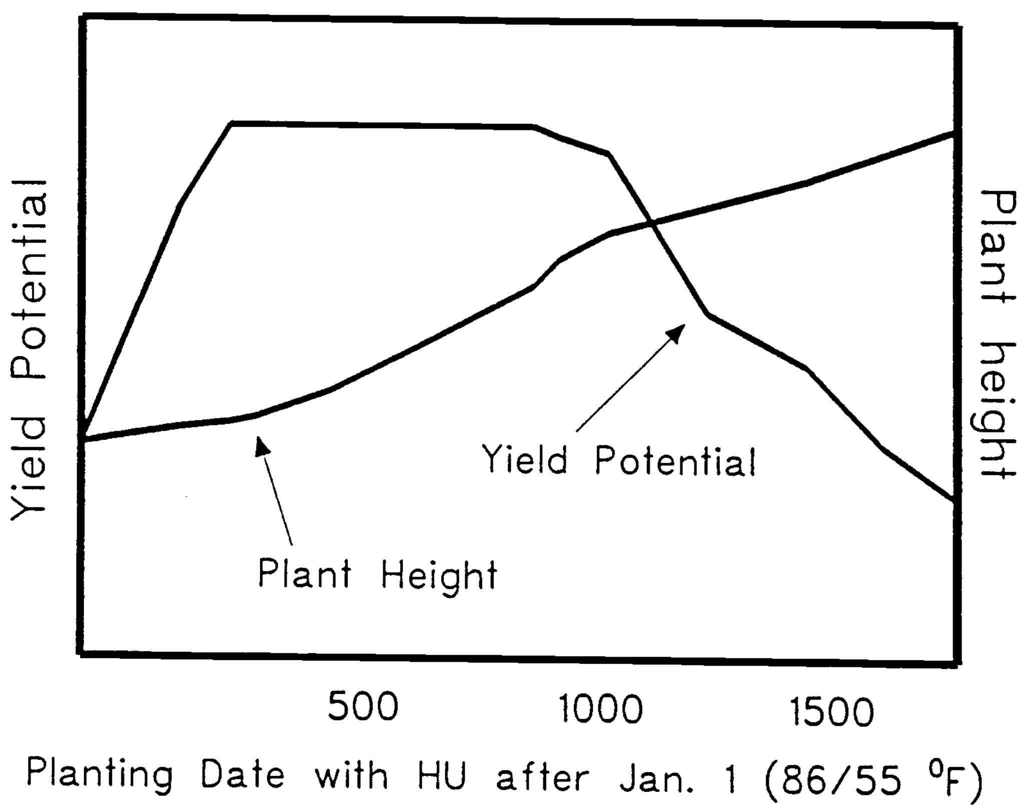


Figure 2. Generalized full season cotton variety response to planting date.

Planting Date		Pinhead Square	Susceptible Squares		First Bloom	
0	500	700	900	1000	1200	1500

Heat Units (86/55°F)

Figure 3. Early season cotton plant development as a function of heat units (86/55°F).

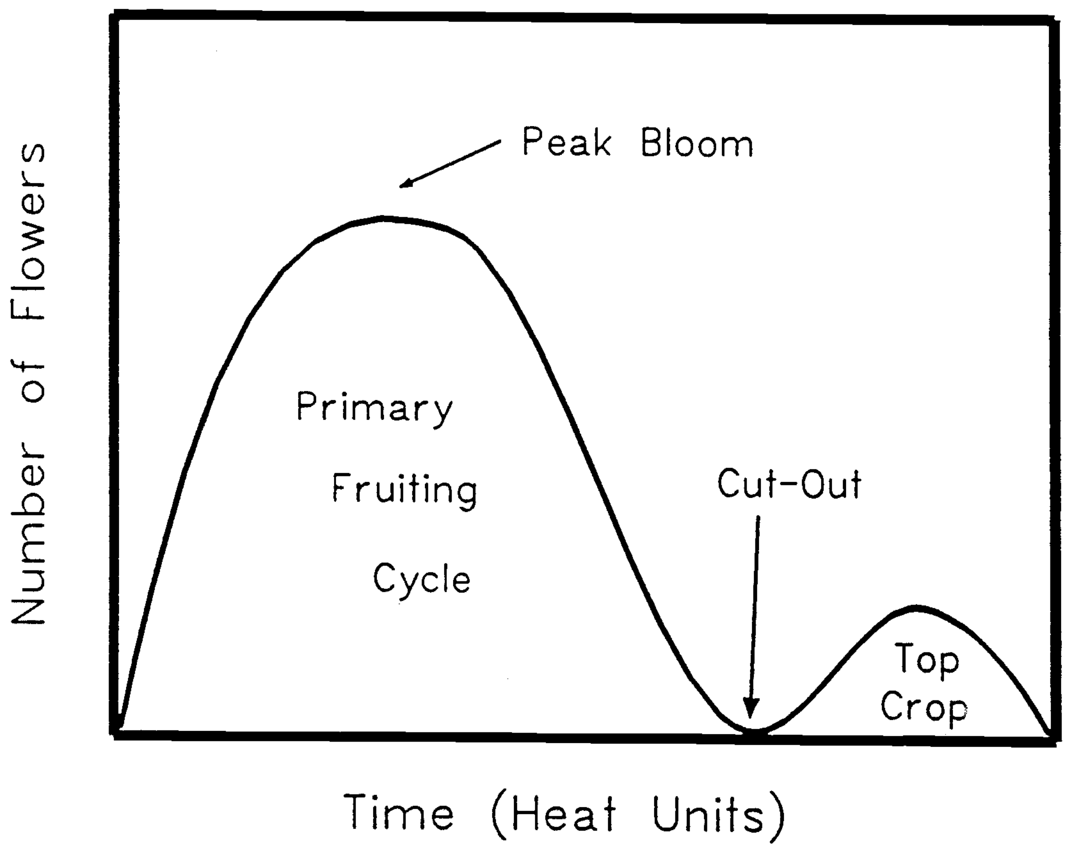


Figure 4. Generalized flower curve for Arizona cotton varieties.