Evaluation of Planting Date Effects on Crop Growth and Yield for Upland Cotton, 1998

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Abstract

A field study was conducted in 1998 at the University of Arizona Marana Agricultural Center (1,974 ft. elevation) to evaluate the effects of three planting dates on yield and crop development for three Upland varieties. Planting dates ranged from 9 April to 28 May and 342-885 heat units accumulated since Jan 1 (HU/Jan 1, 86/55^o F thresholds). Crop monitoring revealed early season fruit loss leading to increased vegetative growth tendencies with all three planting dates. General trends also showed decreasing lint yield with the later dates of planting for all varieties. The more determinate variety (STV 474) was able to set and a fruit load more rapidly than the other varieties in this study at several dates of planting, which resulted in higher yields.

Introduction

There are numerous factors that contribute to the realization of a successful cotton crop in Arizona. Two major management decisions, variety selection and planting date management can have a profound effect on the development and final outcome of the crop. Selection of a specific variety will have a large impact on the way in which planting date should be managed. Similarly, the time frame in which a crop can be planted due to weather and/or other circumstances should have a large impact on the selection of a suitable variety.

Previous research in Arizona has shown that delayed plantings often result in higher vegetative growth tendencies at the expense of yield. Optimum planting date windows have been developed for different variety maturity groups (Figure 1) based upon heat units accumulated from January 1 (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995; Norton et al., 1997; Silvertooth et al., 1997, and Silvertooth et al., 1998). Planting date management not only has a large effect on crop growth, development, and yield but it also impacts insect pest management (Brown et al. 1992, 1993, 1994, 1995, 1996, 1997, and 1998). Reduced season management, of which early planting plays a major role, has become increasingly important in recent years. The ability to plant and establish a crop early, carry it through the primary fruiting cycle in a timely and efficient manner, followed by early termination; has become increasingly important with increased late-season insect pressures in Arizona. This approach to earliness management has also been important in terms of avoiding inclement weather conditions commonly associated with the summer monsoon season, which creates higher humidities (higher dew point temperatures) and higher night temperatures, resulting in accelerated rates of fruit loss and abortion (Brown and Zeiher, 1997).

Another method used for insect pest management is delayed planting. Delayed plantings have been utilized by many producers in some parts of Arizona to aid in the management of pink bollworm (PBW, Pectinophora gossypiella (Saunders)) populations. Delayed plantings are intended to encourage suicidal emergence of overwintering PBW populations, theoretically lowering early season infestation levels. However, with the increasing use of transgenic cotton varieties that provide resistance to PBW pressures this method of pest management is becoming less common.

The objective of this study was to further evaluate planting date windows and use the information for the validation and revision of current UA Extension agronomy recommendations. This evaluation involves an investigation of the effects of planting date management on the growth, development, and yield of cotton.

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Methods and Materials

A study was conducted in 1998 at the University of Arizona Marana (1,974 ft., Pima clay loam soil) Agricultural Center. The experimental design was a split-plot within a randomized complete block design. The mainplots were planting dates with subplots being varieties. Each subplot consisted of 8, 40 inch rows that extended the full length of the irrigation run (approximately 600 ft.). Planting dates (PD) were constructed so as to have three representative points along the recommended planting date range (Figure 1). Table 1 summarizes planting dates and respective heat units accumulated since 1 January (HU/1Jan., 86/55°F thresholds). Varieties selected for this study (Table 2) ranged in maturity from a mid-season, determinate variety (STV 474) to more indeterminate varieties (DP 5415 and DP NuCOTN 33b). The two DP varieties also provide a direct comparison between a transgenic Bt variety (33b) and its recurrent parent (5415). All plots were planted into moisture for all varieties and planting dates. All inputs such as fertilizer, water, and pest control were managed on an as-needed basis.

Complete sets of plant measurements were collected from all plots on 28-day intervals. Measurements taken included: plant height, number of mainstem nodes, first fruiting branch, total number of aborted sites (positions 1 & 2), number of nodes above the top (first position) white flower, canopy closure, and the number of blooms per unit area ($167ft^2$). Climatic conditions were also monitored using an Arizona Meteorological Network (AZMET) site located at the station.

Irrigation termination dates are listed in Table 1. Lint yields were obtained for each treatment by harvesting the entire center four rows of each plot with a two row mechanical picker. Results were analyzed statistically in accordance to procedures outlined by Steel and Torrie (1980) and the SAS Institute (SAS, 1988).

Results

Lint yield results for all PD and variety combinations are presented in Table 4. Fruit retention (FR) and plant vigor estimate (height to node ratios, HNR) patterns are shown in Figures 2 and 3 for all PD and variety combinations.

Early spring weather patterns in 1998 presented difficult conditions in which to establish early plantings and produce healthy, vigorous stands as shown by early (<1500 HUAP) height to node ratio levels particularly for the first PD. Vegetative growth (HNR) increased at an extremely rapid pace at early bloom. This accelerated vegetative growth pattern was observed in all PDs but was most pronounced in the later PDs.

Increased vegetative tendencies are commonly observed with later PDs. In 1998 this tendency was also observed with the earlier planting dates mainly due to a sharp decrease in FR levels in the early season, at approximately the matchead square stage of development (Figure 2). Early season fruit loss was observed among all three varieties but was most pronounced with DPL5415. The loss was attributed to early season winds and insect pressures from adult lygus populations. The early season fruit loss problems were compounded by the loss of nearly 80% of terminals, due primarily to strong winds and blowing soil, and also to some extent to thrip pressures. This contributed substantially to the increased vegetative growth and delay in maturity. Despite the early fruit loss, FR levels improved to some extent as the season progressed. Due to the more determinate (shorter-season) nature of the Stoneville variety (STV 474) it was able to benefit the most from the improved FR levels. The more indeterminate nature of both DPL 33B and DPL 5415 prevented the maturity of the fruit that was set later in the season. This is reflected in the final yields (Table 3).

Main effects associated with date of planting (OSL=0.0014) and variety (OSL=0.0169) were significant with respect to yield. However, the interaction term (PD*Variety) was not significant. Differences among planting dates for each variety are shown in Table 4.

Overall, STV474 performed better than the other two varieties in this study. The more determinate nature of STV 474 lead to an earlier crop and significantly higher yields for all planting dates (Table 3). DP 33b and DP 5415, each demonstrated a classic response for a long-medium to full season variety, with significant yield reductions associated with later PD, particularly in comparison to STV 474.. In all cases (PD), yields were higher for DP 33b than DP 5415. These differences were attributed to PBW damage suffered in the DP 5415, even with the conventional, chemical PBW control measures that were applied. Agronomically, DP 33b and 5415 behaved very similarly in terms of growth and development patterns (HNR, FR, NAWF, etc.). All three varieties experienced decreases in yield with later planting dates

Summary

The delayed plantings generally demonstrated higher vegetative growth tendencies as noted by HNR measurements. However, due to early season fruit loss, particularly in PD 1, increased vegetative growth tendencies (HNR) were seen in earlier planting dates also. This pattern is consistent with earlier research (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995; Norton et al., 1997; Silvertooth et al., 1997, and Silvertooth et. al., 1998). A lint yield decrease was commonly seen for all varieties from PD2 to PD3. The 1998 season demonstrated that the more determinate nature of the Stoneville variety (474) allowed for the full maturity of fruit that was set after the early fruit loss. Whereas the more indeterminate varieties (DPL 5415 and DPL 33B) were not able to mature the later fruit set. This led to dramatically higher yields for STV 474 among all PDs (Table 3) employed in this study.

The highest yielding potentials are usually realized with an early, optimum (includes optimum soil temperatures) PD and a medium to full season type variety. In a delayed planting situation, a higher yield potential can often be realized from a more determinate, shorter season variety. These results also indicate a strong agronomic similarity between a transgenic Bt variety (DP 33b) and its recurrent parent (DP 5415) with higher yields associated with the Bt variety being attributed to its properties for PBW protection.

Acknowledgements

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Table 1. Planting dates with associated heat units accumulated from January 1 for each location, Marana, AZ, 1998.

Planting Dates	**Heat Units/Jan. 1 (86/55°F Thresholds)**
9 April	342
7 May	669
28 May	885

Table 2. Varieties planted, Marana, AZ, 1998.

Varieties
Stoneville 474
Deltapine 5415
Deltapine 33B

Table 3. Lint yields expressed as means for each PD across varieties and for each variety across PDs.

Planting Date	Lint Yield (lbs. Lint/acre)
1	1065
2	1010
3	817
Variety	
Stoneville 474	1253
Deltapine 33B	880
Deltapine 5415	759

Table 4. Lint yields summarized by variety for each date of planting, Marana, AZ, 1998.

	Lint Yield (lbs. lint/acre)
Deltapine 5415	
PD1§	870 a*
PD2	772 a
PD3	635 a
LSD (α=0.05)	NS
OSL	0.2273
C.V. (%)	11.94
Dletapine 33B	
PD1	979 a
PD2	925 a
PD3	735 b
LSD (α=0.05)	79
OSL	0.0101
C.V. (%)	2.08
Stoneville 474	
PD1	1346 a
PD2	1332 a
PD3	1081 a
LSD (α=0.05)	NS
OSL	0.2057
C.V. (%)	8.55

§ PD = planting date

* Means followed by the same letter, within a variety grouping, are not significantly different (P<0.05) according to pairwise comparisons using a Fisher's LSD.

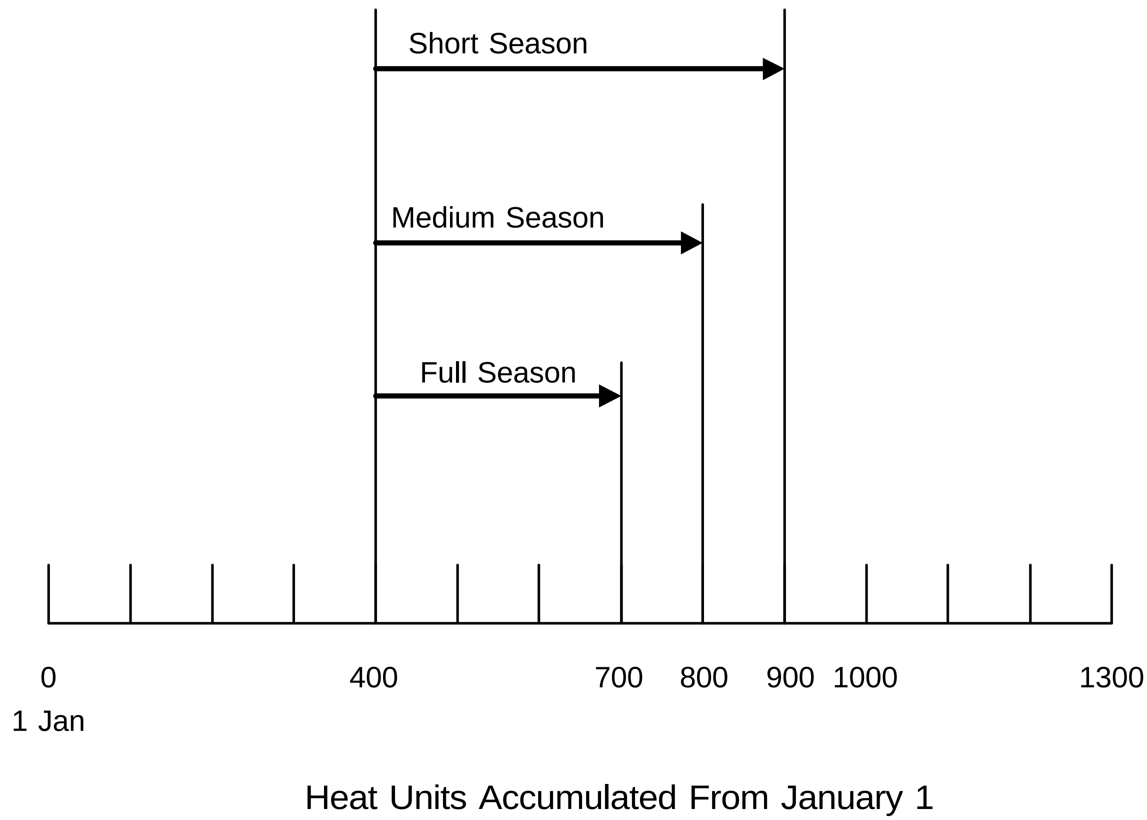

Figure 1. General recommended planting date windows for different maturity type varieties grown in Arizona (J.C. Silvertooth, Univ. of Arizona).

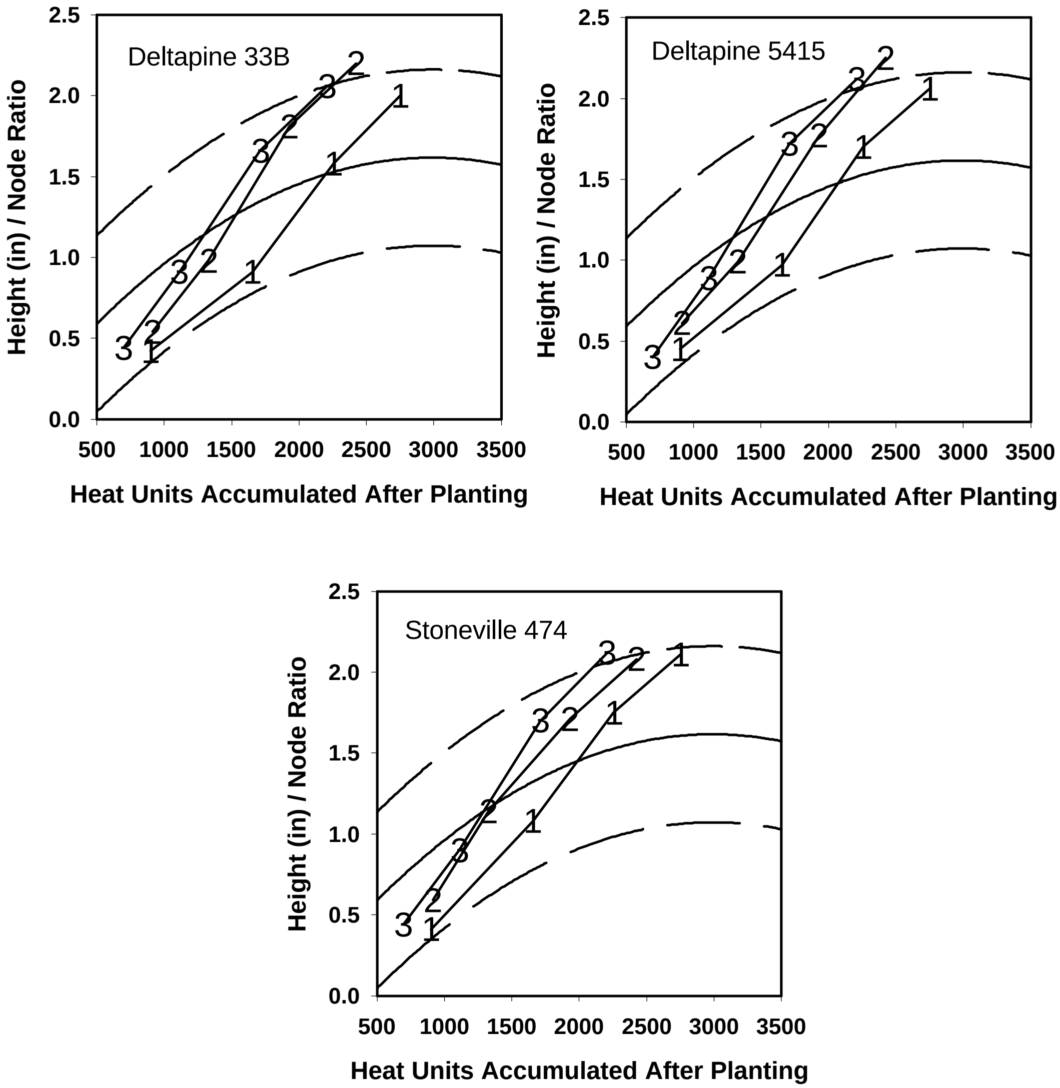

Figure 2. Height to node ratio results for the three varieties and three planting dates for the planting date by variety study, Marana, 1998.

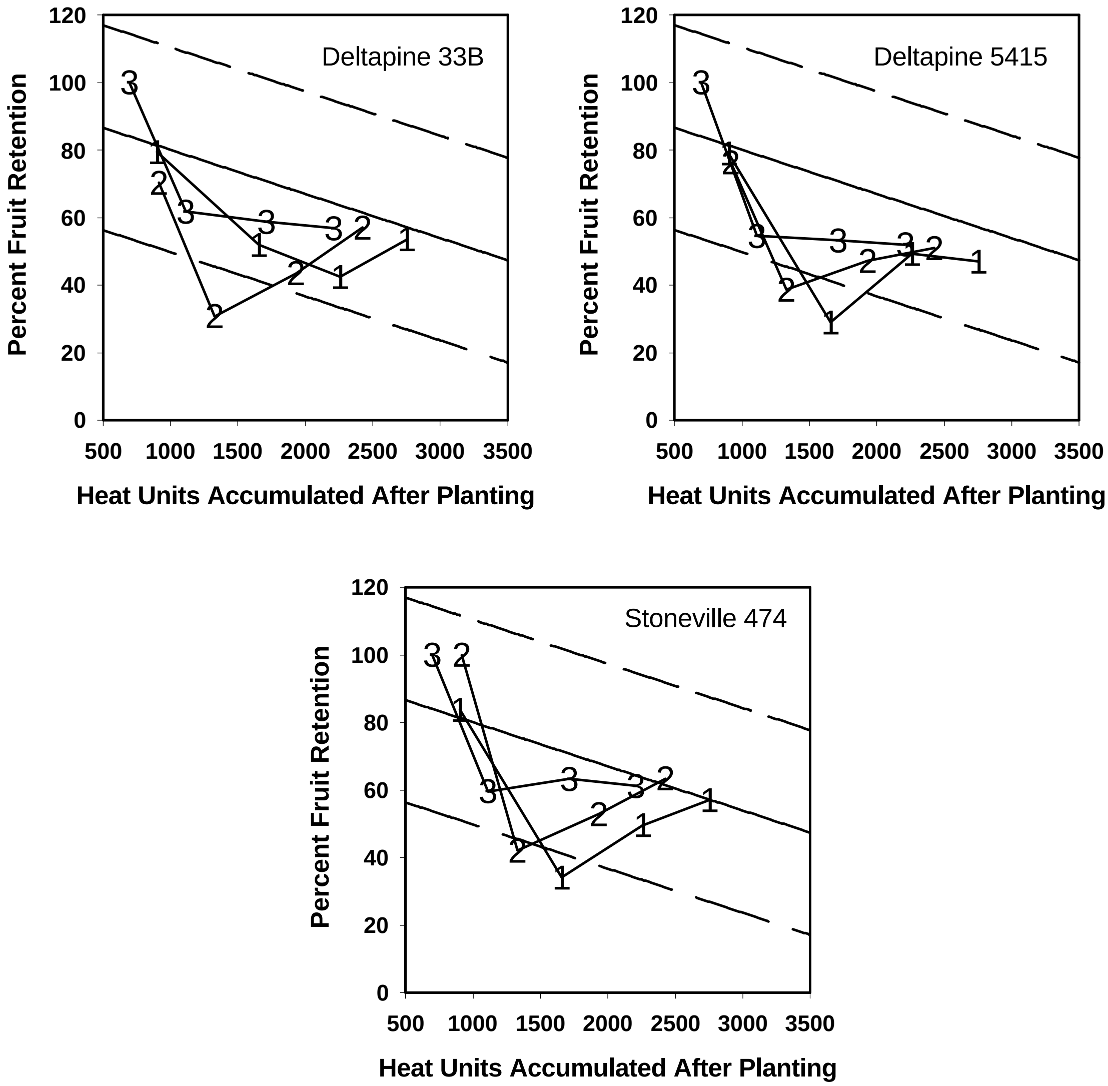

Figure 3. Fruit retention results for the three varieties and three planting dates for the planting date by variety study, Marana, 1998.