GENETIC AND ENVIRONMENTAL CONTRIBUTIONS TO EARLINESS

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Abstract

Delta and Pine Land Company field size variety test plots with plant map data were conducted at 110 locations from Arizona to North Carolina during 1994 and 1995. Variability in growth and earliness factors were partitioned into that due to locations (environment), varieties, or error by maturity test, region, and year. Averaged over maturity test group, regions, and years, the ratio of location: variety was 3.0 for the number of vegetative nodes to the first fruiting branch; 6.9 for percent retention of the bottom five first position bolls; 6.7 for average retention of all first position bolls in the zone that held 95 percent of all harvestable bolls (the 95% zone); 5.1 for the node number of cutout; 7.6 for final plant height; 7.5 for final number of nodes; and 4.2 for height to node ratio (HNR). The Southwest region had a slightly greater percentage of the variation attributable to environment with the Mid-South having less than the average. These slight regional differences suggest either more variation in the weather, field growing conditions, and/or consistency of management in the Southwest with less variation in the Mid-South. Differences were minor and did not alter the conclusion that where and how the crop is grown is a larger contributor to earliness than variety.

Introduction

Earliness has been a hot discussion topic for at least the last decade. Most people agree it is important, but they do not agree on how to achieve it. Some agronomists/ physiologist say the key is proper pest control, some entomologists suggest agronomic management factors are most important, while plant breeders are prone to suggest early varieties are important. All are important, which is most important may vary.

While varieties should have an impact on earliness, how they are grown may have more impact on earliness. For example, in the San Joaquin Valley of California, Acala SJ-2 compared to all the new experimentals in Dr. Bassetts testing program showed no difference in earliness when averaged over 15 years of testing at eight locations per year (Kerby and Bassett, 1993). However, Acala SJ-2 as well as all other varieties under evaluation showed an equal increase in the percentage of fields ready for harvest on October 1 (an increase from 55 to 80 percent). This represented a real increase of 11.5 days in earliness over the 15 year period. All of this earliness was the result of management practices since the gains in earliness for Acala SJ-2 (which was planted in each of the 15 years) were identical to the average increase in earliness of experimental varieties that changed every two years.

If we go beyond these 15 years, it is clear from studies in California (Bassett and Kerby, 1996) and Mississippi (Wells and Meredith, 1984) that modern varieties are earlier than old varieties. These modern varieties initiate fruiting at a lower node number and have less vegetative growth than old varieties. In a California test where varieties were evaluated under a wide range of growing conditions, sustained vegetative development (new leaf growth) was dependent on early boll load and the size of the plant when boll set began (Kerby et al., 1990). The same relationships in the balance between source and sink were apparent whether the balance shifted due to genetics or early fruit load.

Earliness can be good because it has the potential to decrease production costs and minimize exposure of the crop to weather. However, as was evident in many locations in 1995, extreme earliness has the potential to decrease profits due to premature cut out when stresses are present. This creates a dilemma for the cotton grower. When varieties are selected with genetic earliness and stress occurs (hot dry summer with inadequate irrigation water), yields will be decreased more for the early varieties than for the mid to full-season varieties.

Earliness is a product of planting date, favorable temperature for rapid development of the plant, node for the first fruiting branch, rate at which new nodes develop, retention of early fruit, node numbers required to set the crop, and the time interval from flowering to open bolls. Many of these variable are influenced by both genetics and the environment. Delta and Pine Land Company conducts field trials that include a full range of its' commercial varieties at approximately 100 locations per year. Plant monitoring data that can describe earliness is collected from approximately 50 locations per year. This study reviews how earliness varied according to locations (different environments) and varieties for tests conducted in 1994 and 1995.

Materials and Methods

Delta and Pine Land Company conducts variety performance trials at multiple locations each year. Tests are divided up into two basic groups: Short to mid-season varieties and mid-season to full season varieties. Deltapine commercial varieties and advanced experimental varieties are included. Varieties included in this evaluation include DP 20, DP 50, DP 51, DP 5409, and DP 5415 in the short to mid-season tests and DP 50, DP 51, DP 5409, DP 5415, DP 5690, and DP 90 in the mid to full season tests.

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Plots were 4 to 6 rows the length of growers fields. There were approximately 100 yield trials per year, however, we did not have plant map data for all tests. Plant map data was collected from 59 locations in 1994 and 51 locations in 1995. Regional distribution of tests was: Far West 4 locations; Southwest 31 locations, Mid-South 47 locations; and Southeast 28 locations.

Twenty plants were mapped at the end of the season to document earliness and growth factors. Data was analyzed by year within region and maturity grouping. Mean square totals were separated into location, variety, and error within each maturity group, region, and year. Differences were small in percentage due to the three factors (location, variety, and error). Analysis over regions and years could have increased the variation of "locations" since it would have included greater regional variation and year variation. Although there were some regional differences in environmental versus genetic contribution to earliness, they were small. The Southwest had a greater percentage of the variation attributable to environment, while the Mid-South had the least. This paper will only review average variance partitioning over maturity groups, regions, and years.

Results and Discussion

The range of values for earliness and growth parameters are given in Table 1 by location and variety. The percentage of total variation due to location, variety, and error are given in Table 2.

Number of vegetative nodes to the first fruiting branch indicates the physiological age of the plant when fruiting branch development begins. The test average was 5.2. Locations had a greater range in the value than did varieties. The ratio of location:variety for percentage of variance averaged 3.0. Temperature at the two to three leaf stage is known to affect the node of the first fruiting branch (Kerby and Hake, 1996). Field studies have indicated when temperatures are cooler than normal, the node of the first fruiting branch is higher, and lower than normal when temperatures during the two to three leaf stage are higher than normal. High plant densities can also increase the node number of the first fruiting branch (Buxton et al., 1977). While variety is an important component of when the field begins fruiting, it is small compared to weather and management factors.

Percent retention of the bottom five first position fruiting forms at the end of the season averaged 55 percent. Locations had a greater range in the value than did varieties. The ratio of location: variety for percentage of variance averaged 6.9. Early first position retention is influenced greatly by pest management practices and to a lesser extent by growth condition. With high plant density, strong vegetative growth, and cloudy weather, some early fruit may shed independently of pests, but pests are generally the major factor. Weather and management factors are large compared to the true differences between varieties.

Percent retention of the first position fruiting forms in the zone that contains 95 percent of all harvestable bolls at the end of the season averaged 53. Locations had a greater range in the value than did varieties. The ratio of location: variety for percentage of variance averaged 6.7. The magnitude of this response is very similar to retention of the bottom five first positions.

The node number at which 95 percent of all harvestable bolls were set (cutout node) averaged 17.2 nodes. Locations had a greater range in the value than did varieties. The ratio of location: variety for percentage of variance averaged 5.1. Determinate varieties cutout at lower nodes than indeterminate varieties. Some varieties have the capacity to sustain vegetative development at the same time carbohydrates are being allocated to bolls. However, environment where the varieties are grown is far more important than the variety in determining when the field reaches cutout. Early boll load, moisture supply, nutrient supply, and diseases are important variables in determining timing of cutout.

Final plant height averaged 36.1 inches. Number of nodes at the end of the season averaged 20.9. Height to node ratio (HNR) at the end of the season averaged 1.73. Locations had a greater range in the value than did varieties. The ratio of location: variety for percentage of variance of final height, total nodes, and HNR averaged 7.6, 7.5, and 4.2, respectively. Final plant height, number of nodes, and HNR are greatly affected by the same variables as the cutout node number. Conditions for strong growth through the season (low boll load, available water, ample nutrients, disease free, and no Pix®) result in plants that are tall and late maturing. As was the case with all other variables, environment contributes much more to the final result of these growth variables than does variety selection.

Summary

Earliness of a crop depends upon planting date, early fruit set, and the ability of the plant to sustain boll set over a long flowering period. Our results these past two years suggests environment has a much greater influence on earliness than does variety. This is not to say that variety selection is not an important part of earliness. The environment varieties are grown in are very important. If the season length is limited by either date of planting or degree days, early varieties should be selected. If stresses will be present that limit yield potential, early varieties are usually more adversely affected by stress than are the full season varieties. This gives a clear advantage to full season varieties for dryland conditions or areas with a limited number of irrigations.

Full season varieties are not naturally disadvantaged when adequate water is available. However, when grown with ample supplies of water and fertilizer, early boll retention (and probably Pix® use) will be necessary to channel growth towards boll development. This will increase the "earliness" of full season varieties.

References

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Table 1. Range for earliness and growth factors by location and variety averaged over regions and years for 110 test locations.

	Locations		Variety	
Factor	Low	High	Low	High
Veg. Nodes to 1st FB	4.42	6.07	4.85	5.57
% Ret. Bot. 5 FP1	36	77	51	60
% Ret. 95% Zone	37	69	48	56
Cutout Node	13.7	20.9	16.4	18.0
Final Height	23.8	46.7	34.8	38.9
Number of Nodes	16.7	25.1	20.2	21.8
HNR	1.30	2.09	1.67	1.83

Table 2. Percent of mean square variance, averaged over regions and years, attributed to location, variety, or error.

Factor	Location	Variety	Error
Veg. Nodes to 1st FB	72.2	23.8	4.0
% Ret. Bot. 5 FP1	81.1	11.7	7.2
% Ret. 95% Zone	81.8	12.3	5.9
Cutout Node	80.7	15.7	3.6
Final Height	86.3	11.3	2.4
Number of Nodes	84.9	12.4	2.7
HNR	77.3	18.5	4.2