ASSOCIATION OF FRUIT RETENTION PERCENTAGES ON YIELD AND EARLINESS

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Abstract

About 20 years ago control of early season pests generally became more aggressive in the US in an effort to obtain earliness and avoid the cost and yield loss associated with late season pests which were often difficult to control. During the past 20 years new management tools have been developed. These include early more determinate varieties, plant monitoring tools, and Bollgard varieties where control of some pests were provided without beneficial pest disruption. Delta and Pine Land Company conducted extensive variety testing and collected plant map data from field trials represented by most of the US cotton growing areas since 1994. This national data base was used to define the association between early boll retention and yield and the time required to develop yield potential. No association existed between yield and retention of the bottom 5 FP-1 unless the season length for effective flowering was restricted to approximately 17 days. Even then the association was weak. There was an association between % retention of the FP-1 positions in the 95 % zone and yield. Low retention of the bottom 5 FP-1 required more time to set the crop. As average bottom 5 FP-1 retention increased by 14 %, the node number of the 95 % zone was decreased by 1.0.

Introduction

During the past 20 years we have learned much more about managing cotton. The development of plant mapping (monitoring) has provided additional information for decision making. Plant map data is now generally available to document the influence that fertility, water management, variety evaluation, and pest management have on cotton development.

As plant monitoring increased, general associations between early square or boll retention were associated with yield, crop earliness, and cost of production. Detailed plant mapping studies demonstrated the yield contribution of different fruiting positions to yield and fiber quality (Kerby et al. 1987; Jenkins et al. 1990; and Constable 1991). The accumulation of plant map data demonstrating the economic value of early fruiting positions has produced some discord between agronomists who tend to view management from the perspective of a cotton plant and entomologists with a natural tendancy to view cotton management from an insect perspective. Aggressive early insect control was known to create other pest problems later in the season with the possibility of more severe consequences than not controlling the early season pest. In some states agronomists and entomologists worked together to establish retention thresholds for a particular pest (Leigh et al. 1988). Likewise pest management and cotton agronomy were jointly evaluated by University of Arkansas researchers who integrated these concepts into the software cotton management support system known as COTMAN (Danforth and O'Leary, 1998).

Cotton is well known for its ability to compensate for early fruit loss. Compensation is a complex issue requiring simultaneous consideration of multiple factors. Age of shed fruit, length of the growing season, probability that water and plant nutrition will be adequate throughout the season, cost and effectiveness of late season pest control are some important factors that determine the degree of plant compensation for fruit loss (Dunnam et al. 1943; Passlow and Trudgian 1960; Patterson et al. 1978; Kerby and Buxton 1981; Kletter and Wallach 1982; and Ungar et al. 1987).

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A successful strategy in one area with the environment of a single year may not prove successful in another location or in the same location another year with a different environment.

Delta and Pine Land Company collects plant map data to describe growing environments and differences in how varieties respond to multiple environments. This end-of-season plant map data base makes it possible to evaluate the association of plant map data to yield across multiple environments and years. The purpose of the present study is to use this extensive data set to describe the association between minimal early season boll set and yield, or early boll set and maturity under varying conditions.

Material and Methods

Yield and final plant map data existed for 439 field test locations from 1994 through 2000. Locations included the entire US cotton growing region with a higher concentration of trials in the picker regions of Texas, the Mid-South, and the Southeast. California and the stripper areas are under represented. A few trials represent small replicated plot work at Delta and Pine Land Company field stations, but the vast majority of data represent on farm large-plot variety trials with grower cooperators using crop management typical for their farming operations.

Each data point represents an average of all plants of all varieties and represents the environment of a particular location. On average there were 9 varieties in a trial with an average of 121 plants mapped to represent the mean. Locations were grouped according to region as follows: CALF (California); ARIZ (Arizona); NOHP (Northern High Plains); SOHP (Southern High Plains); TPEC (Trans Pecos); ROPL (Rolling Plains); CTBL (Central Texas Black Lands); SOTX (South Texas); SODE (Southern Delta); NODE (Northern Delta); NOSE (Northern Southeast); and SOSE (Southern Southeast). There were 6 of the 439 test locations where region designation could not be established, these will be designated as UNK.

Final plant map data were collect at least two weeks after cutout and prior to harvest. Bolls were not counted as retained unless they were determined to be "harvestable" bolls. Plant map data used in this analysis included: Plant height; number of nodes; node number of first fruiting branch; node number where 95 % of all first position bolls were accumulated; % retention of the bottom five first position fruit; % retention in the 95 % zone; and number of nodes for the last 5 % of first position bolls. Yields were machine harvested (spindle picker or brush stripped according the grower management) with a 15 to 20 pound seed cotton sample ginned to determine lint yield.

Results and Discussion

Regional Averages

Tables 1 and 2 provide the number of locations, yield, and plant map data for these tests locations by region. There was considerable difference in data between regions reflecting the length of growing season available as well as regional differences in management practices. Considerable differences exist within regions as well. Eight of the 14 California locations are in Southern California with a long growing season while six locations are from the San Joaquin Valley. Regional values are generally within the expected range except that yield is higher than similar regional averages suggesting many trials were conducted in better than average conditions.

Yield and Retention

Lint yield was regressed against % retention in the bottom 5 FP-1. There was no correlation ($R^2 < 0.01$) when all the data were considered. Since many locations were represented by long growing seasons, only data where harvestable yield was acheived with less than 15 nodes were considered. Eliminating these data from long growing seasons did not result in a significant correlation between yield and retention of the bottom 5 FP-1 (R^2 = 0.018). Eliminating all locations where node of the 95 % zone was 12 or more resulted in a modest association between % retention in the bottom 5 FP-1 and yield (R^2 = 0.147; N = 44). This was still a modestly weak association for data from fields with an extremely short growing season. Considering node of the first fruiting branch averaged 6.2 (Table 1) and restricting the data to < 12 nodes for the 95 % zone, the maximum number of fruitng branches for yield was 5.7 fruiting branches (11.9 - 6.2). With 3 days per node, this represents an effective flowering period of only 17 days.

Associations between yield and FP-1 retention in the 95 % zone were significant (y = 500 = 9.0 (% Ret. 95 % Zone) - 2.2786 (% Ret. 95 % Zone - 48.28)^2 with R^2 = 0.109 and N = 427). When locations with a reasonable length growing season (node for 95 % zone of 15 or more) were eliminated the association between yield and % retention of the 95 % zone was improved (Fig. 1). It appeared retention of approximately 45 % of the FP-1 positions in the 95 % zone represented an adequate boll load to achieve yield potential of the field.

Yield and Node Number for 95 % of FP-1 Bolls

For all data there is a significant relationship between yield and number of nodes to achieve 95 % of the FP-1 bolls (R^2 = 0.103). Length of season and growth condition (short plant height) contribute to scatter in data that minimize the relationship. When only fields in the Southern Delta and Southern Southeast (reasonable growth and a longer season) are considered, the relationship between yield and number of nodes for the 95 % zone is improved (Fig. 2). Most fields are able to achieve yield potential when the 95 % zone is at node 17 to 18 (22 to 23 total plant nodes).

Retention and Earliness

Earliness is quantified as the node number for 95 % of all FP-1 bolls. A significant relationship between % retention of the bottom 5 FP-1 and number of nodes for the 95 % zone is given in Figure 3. As retention increased by 14 %, there was a corresponding average decrease in nodes for the 95 % zone of 1.0. This difference would extend the effective flowering period about 3 days, but would extend the timing of defoliation by about 50 DD_{60} (3 to 7 days depending on temperature at the time of defoliation).

Summary

For this broad US cotton growing area data set, there was no association between % retention in the bottom 5 FP-1 and yield except when number of fruiting branches for the 95 % zone was extremely limited. Even then, the association was low. A better association was obtained between yield and % retention in the 95 % zone. For these studies, yield was generally limited by growing conditions, not by a limited number of fruiting sites capable of adding to yield potential.

Early boll retention was associated with the time (number of nodes) required to set 95 % of all harvestable bolls. There seemed to be no disadvantage of high early season boll load. Since yield was not associated with early boll set, crop managers should balance the cost required to obtain high early season boll set (in terms of dollars, potential beneficial pest disruption, and impact on the environment) against the disadvantages of delayed crop maturity. This balance is subject to the conditions of local environments and specific management abilities.

Acknowledgement

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Table 1. Number of locations per region grouping and the average final plant height, total number of nodes, and node number of the first fruiting branch for the various regional groupings. See methods for region description.

Region	N	Height	No. Nodes	Node 1st FP
ARIZ	30	41.8	27.1	7.1
CALF	14	38.9	24.5	6.5
NOHP	6	21.4	16.8	5.6
SOHP	8	23.0	18.2	6.4
TPEC	16	21.0	19.5	6.7
ROPL	17	22.7	19.6	6.6
CTBL	40	29.6	19.5	6.7
SOTX	46	31.5	20.0	6.0
SODE	105	38.9	21.3	6.0
NODE	58	38.8	20.3	6.3
NOSE	39	36.4	19.2	5.9
SOSE	54	40.4	21.4	6.0
UNK	6	40.6	21.7	5.9
Total / Avg.	439	35.6	21.0	6.2
LSD 0.05	N/A	3.6	1.3	0.4

Table 2. Regional averages for lint yield, % retention in the bottom 5 FP-1, % retention for the 95 % Zone (fP-1), nodes for the 95 % zone, and nodes for the last 5 % FP-1 bolls. See methods for region description.

Region	Yield lbs/A	% Ret Bot. 5 FP-1	% Ret. 95 % Zone	Nodes for 95 % zone	Nodes Last 5 % Zone
ARIZ	1225	52.7	43.0	18.2	8.9
CALF	1469	70.3	51.5	14.7	9.8
NOHP	1017	65.4	45.7	10.4	6.5
SOHP	1207	71.3	43.0	11.9	6.2
TPEC	913	73.2	47.6	13.2	6.3
ROPL	616	47.9	37.8	14.7	4.9
CTBL	640	48.4	38.2	14.2	5.2
SOTX	856	57.7	48.1	13.9	6.2
SODE	865	57.2	49.2	15.0	6.4
NODE	873	64.1	51.1	14.8	5.5
NOSE	923	66.7	54.1	14.2	5.0
SOSE	952	59.8	53.7	16.1	5.3
UNK	814	41.2	42.1	17.8	3.9
Avg.	896	58.7	48.3	14.9	6.1
LSD 0.05	144	8.5	5.1	1.3	0.9

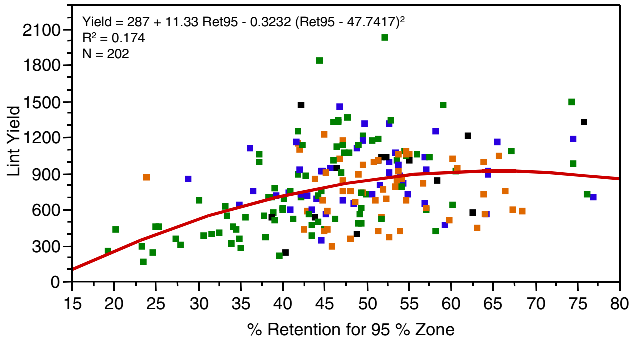

Figure 1. Lint yield and % retention for the 95 % zone for data where the node number for 95 % of harvestable bolls was less than 15.0.

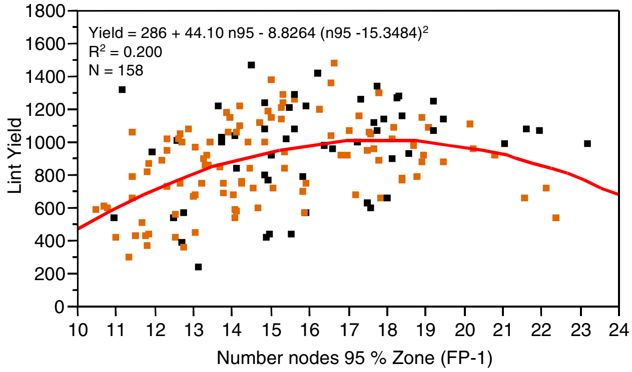

Figure 2. Association between yield and number of nodes for the 95 % zone for locations with growth conditions to produce an adequate plant size and a long growing season (South Delta and Southern Southeast).

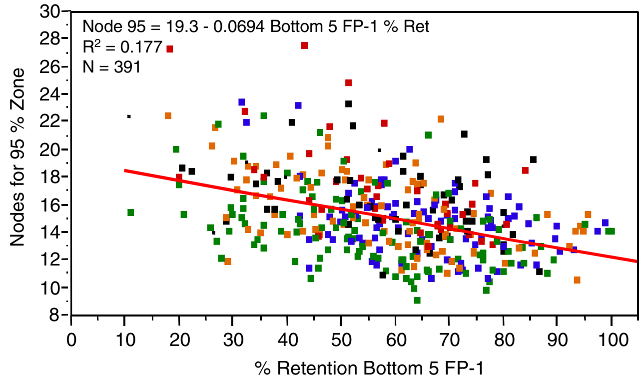

Figure 3. Association between % retention in the bottom 5 FP-1 and number of nodes required to obtain 95 % of all FP-1 bolls.