COTTON PHYSIOLOGY TODAY

Newsletter of the Cotton Physiology Education Program -- NATIONAL COTTON COUNCIL

September 1993, Volume 4, No. 8

THE COTTON DIARY

Dave Guthrie and Tom Kerby

Cotton harvest is welcomed for many reasons. It may be greeted with a grin that the season's good fortune will actually deliver on the promise. Harvest also may signify that payday is near for a year's hard work. Sometimes it just brings a sigh of relief that a frustrating season can finally be put to rest. Whatever the perspective, harvest time can bridge the past season with the next. It is an excellent time to record the year's highs and lows to learn from them. The final plant map can provide this kind of information to help evaluate this year's crop and plot next year's strategy. This newsletter will detail how to conduct the final plant map, what it means and how to use it in the future.

Cotton plants keep a detailed record of events that affect their lives. Their response to environmental conditions and management inputs can be traced by observing their vegetative structure and fruit distribution. These events can be placed in developmental time by noting where the symptoms were left on the plant. Early-season conditions are recorded in vegetative growth and square retention. Mid-season affects are seen in internode lengths and boll retention. Late-season influences impact location of last harvestable boll and degree of second growth.

Growers can obtain a permanent record of these events and the crop's response to them by performing a final or terminal plant map. Information obtained from this procedure helps producers measure the environmental, biological and production inputs that affected crop development. Management strategies can then be refined to enhance and sustain favorable development trends and shore up any weak links. The diary also may prove useful when growers assess long-term trends in their management formula.

The final map can be conducted any time after the crop has cut out. Additional information on late-season second growth and questions on harvestable bolls can be obtained if mapping is delayed until harvest preparation treatments are made. In those years when cutout occurs before the end of the effective bloom period (see July 1993 newsletter "Charting a Course to Cutout"), harvestable bolls can be identified 3 weeks after cutout. Defoliated crops are easier to map. Sometimes questions on field performance surface only after harvest. A post mortem can help answer these questions. Picker harvested fields can be mapped, although information on boll location will be incomplete due to burr losses during picking.

Mapping Technique — Sampling

The value of the final plant map is only as good as the sampling technique. If insufficient samples are collected or they are not representative of overall field conditions, inappropriate conclusions may be drawn from the technique. For instance, plants growing at the end of rows, in border rows, next to tree or power lines and next to abnormal skips are all poor candidates for sampling because they do not represent general field conditions.

The sample should try to reflect the variation in the field. If part of a field is on a slope, part on a ridge and the remainder in the bottom, plants should be sampled from each region in the same proportion. The proportion also should reflect the percentage of the field in wheel rows vs. non-wheel rows. Even in uniform fields, sampling 4 quadrants is better than selecting plants from 1 central site.

Optimum sample size continues to prompt lively discussions among scientists. Statistics theory says that reliability of the information increases with sample size.

Research journals require a 90% or 95% confidence factor. That translates to 10 or more plants per plot in field research, equal to hundreds of plants per acre. But we can obtain valuable crop management information from a 20 plant sample per field. In certain instances, 10 plants per field are sufficient. Inferences or generalities drawn from plant mapping always are compromised by the possibility that our random samples do not reflect the actual field conditions.

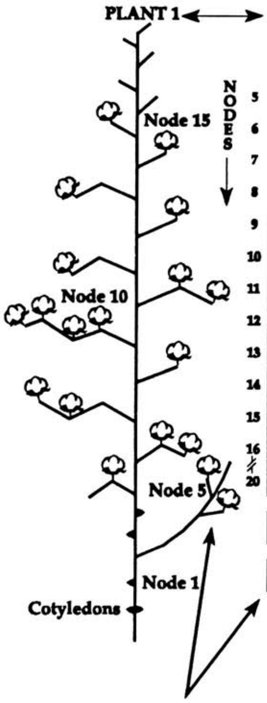
There are 2 commonly used approaches to sampling. One uses consecutive plants in a row and the other samples individual plants from different areas of a field.

Consecutive Plants: Select an area of the field that is representative of the field and go a previously determined number of paces into the field. Determine that the area to be sampled is typical of the plant size and density of the field. In the "consecutive" sample, exclude plants with multiple main stems, spacing significantly different from area average or that are barren of fruit.

National Cotton Council OF AMERICA

This procedure is a better measure of the variation between plants in the field than the other method, but has the weakness of increased plant-to-plant variation. A minimum of 7 plants per location is required to have a reasonable level of confidence that the sample represents the field. When sampling consecutive plants, determine the field average from 7 plants in 3 locations, or 10 plants from 2 locations.

Non-Consecutive Sampling: Walk a previously determined number of paces into the field to initiate sampling. Before selecting a plant, determine if it has the distance between plants that is typical for the field and select the plant only if it falls within the middle 50% for plant height (exclude if it is among the shortest 25% or tallest 25% for the area). Sample 5 plants from 4 areas of the field to determine the field average.



NODES	PLANT 1 FP 1	PLANT 1 FP 2	PLANT 1 FP 3+	PLANTS 2 - 20 FP 1	PLANTS 2 - 20 FP 2	PLANTS 2 - 20 FP 3+	ALL PLANTS FP 1	ALL PLANTS FP 2	ALL PLANTS FP 3+	% Boll Retention 1	% Boll Retention 2	% Boll Retention 3+	Cumulative % Loading at FP 1	Equivalent # of Days from 1st Fruiting Branch
5	1	0	0	4	0	0	5	0	0	25	0	0	8	0
6	1	1	0	6	1	0	7	2	0	35	10	0	20	3
7	0	1	1	9	4	0	9	5	1	45	25	5	35	6
8	1	0	0	7	4	0	8	4	0	40	20	0	48	9
9	1	1	2	7	5	0	8	6	2	40	30	10	62	12
10	1	1	0	7	4	0	8	5	0	40	25	0	75	15
11	0	1	0	5	2	1	5	3	1	25	15	5	83	18
12	1	0	0	4	2	0	5	2	0	25	10	0	92	21
13	0	1	0	2	0	1	2	1	1	10	5	5	95	24
14	1	0	0	0	1	0	1	1	0	5	5	0	97	27
15	1	0	0	0	1	0	1	1	0	5	5	0	98	30
16	0	0	0	1	0	0	1	0	0	5	0	0	100	33
20	0	0	0	0	0	0	0	0	0	0	0	0	100	
SUB-TOTAL	8	6	3	52	24	2	60	30	5					
VEGETATIVE BOLLS	2			3			5							
TOTAL							100							
	D			E			F			G				H

Record Plant Characteristics

Several final plant mapping kits are available, including computer software that performs calculations and produces reports. The technique described below is used in the Beltwide Cotton Monitoring Project. Each plant can be mapped in the field or taken to another location. The illustration is an example of a mapped plant and the recorded data. The following information is recorded for each plant:

A. Plant height measured from the cotyledons to the terminal. (Not shown on illustration.)

B. Nodes are counted beginning at the first true leaf and continuing to the terminal. The cotyledons are counted as node 0. Those nodes without remaining leaves or branches may be distinguished by scars on the main stem. Nodes near the terminal resulting from late season second growth may be difficult to distinguish. Second regrowth will appear lighter green with longer internodes. Record nodes and height to end of first growth separately from second growth. For example, first growth might equal 36 inches and 20 nodes with 12 inches and 5 nodes of second growth. (Number of nodes are not recorded in the example shown.)

C. Vegetative branches are usually confined to the bottom 5 or 6 nodes. Bolls produced on vegetative branches are summed and recorded as one number per plant.

D. Node and position of bolls produced on fruiting branches is recorded. For convenience, all bolls produced beyond fruiting position (FP) 2 are summed and recorded as one number.

You can further distinguish the bolls by indicating if they are damaged from insects and/or boll rot or did not reach harvestable maturity. They can be considered as a total lost to damage or entered by node to estimate when and where problems occurred.

The same procedure is followed for the remaining plants. Column E is the sum of all bolls produced on all fruiting positions for plants 2 through 20. In the field, this information would be recorded for each plant in the same fashion as Column D. A complete map of 20 plants growing in moderate densities (3-4 plants per 38" row foot) can be completed in about 2 hours. This time can be reduced substantially if 1 person maps the plants and calls out the observations to a second person recording the numbers. An alternative is for 1 person to record their observations on a tape recorder for later use in the office.

The data from all the plants is summed (F) and divided by the number of plants (G) to indicate field average height, nodes, bolls on vegetative branches and boll retention percentage on fruiting branches by node and FP.

Several other useful measures can be calculated from these numbers. An estimate of the contribution to yield from FP1, 2, 3+ and vegetative branches can be obtained by adding the total boll count and dividing the various sums by that grand total. In this example, FP1 produced 60 bolls, FP2 produced 30 bolls, position 3+ produced 5 bolls and vegetative branches produced 5 bolls. The relative yield contribution from these positions is calculated as 60/100 X 100% = 60%, 30/100 X 100 = 30%, 5/100 X 100 = 5%, and 5/100 X 100 = 5%, respectively. The rate of boll loading can be estimated by dividing the FP1 sum per node by the FP1 total (in this example, 60). Following this process also yields a worthwhile index of the 95% zone (H).

95% Zone

This represents the number of fruiting branches that contains 95% of all FP1 bolls and indicates the length of the effective flowering period. In the example, there were 4 vegetative nodes to the first fruiting branch and 60 first position bolls. It may be more convenient to determine the number that contains the last 5% of all first position bolls. In this example, we are looking for the last 3 bolls (60 X 0.05). There is 1 boll at 14, 15, and 16, thus 95% of all first position harvestable bolls were set on the first 13 nodes. This is 9 fruiting branches (13 nodes minus 4 vegetative nodes before the first fruiting branch).

Interpreting the Results

Plant mapping data is most informative when considered with field history of production inputs such as variety, soil type, row spacing, plant population, planting date, pesticide and plant growth regulator applications, etc.

Plant Height at harvest is the easiest growth index to measure, but the most difficult to interpret. In general terms, if the plant height (in inches) is significantly less than the row spacing, stress or good boll retention has limited the crop growth potential. Suspect inadequate boll set and/or generous fertilization if plant size is significantly more than row spacing and consider Pix applications in future years.

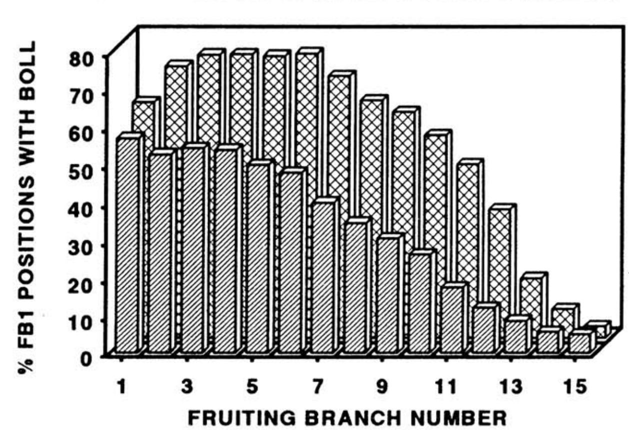
An examination of the individual plants can help sort out the causes of height extremes. Consistent, unrelenting stress from low fertility, nematodes or salinity would produce uniformly short internodes. Intermittent drought will produce graduated internode lengths indicative of periodic drought development and relief. During early season growth, higher temperatures produce longer internodes. Long internodes, particularly at nodes 15 or above, suggests low boll retention coupled with adequate to excessive nitrogen and water availability. Short internodes at nodes 15 or above can result from several factors including excellent boll retention, drought or nutrient deficiency.

Total nodes suggest the length of season, boll loading dynamics and severity of late season second growth. As season length increases, the number of potential nodes increases. In northern regions of the Belt, late-planted cotton will tend to have fewer nodes than cotton planted earlier. When mapping fields with similar production inputs, significant differences in total nodes can often be traced to differences in boll retention. Late season second growth that follows cutout can result in additional nodes without productive value. These nodes may indicate premature cutout and/or excessive fertility. This second growth is also the most difficult part of the plant to defoliate.

Bolls on vegetative branches are associated with plant density, stress and damage. End of row, or lone plants, may have 30 or more bolls on vegetative branches. Higher light intensities stimulate vegetative branch development in shorter plants. Early season terminal damage from hail, insects, etc. also will increase the yield contribution from vegetative branches. Increases in plant density decrease the occurrence of these bolls. As the relative proportion of these bolls increases, the uniformity and earliness of the crop tends to decrease.

Distribution of bolls by node and position is the backbone of final plant mapping. The presence or absence of bolls at the various potential sites affects all aspects of crop and yield development. Several general trends should be noted. The proportion of yield from FP1 bolls increases with higher populations. Boll retention at FP1 sites indicates crop health in moderate densities (3 or 4 plants per foot in 38" rows). Missing bolls at FP1 are red flags indicating a possible problem. Fruiting sites may abort during any portion of the immature square stage (about 25 days) and during the first 10 to 15 days of their development as bolls. Square abortion is normally associated with injury from insects such as plant bugs, boll weevils and bollworms/budworms, etc. Young boll abortion can result from insects or physiological stress such as drought, saturated soil, cloudy weather and intra-plant competition for nutrients or carbohydrates. Boll retention at FP1 above 60% indicates excellent environmental conditions for yield development in moderate to high populations. In the San Joaquin Valley, FP1 boll retention in high yielding fields may exceed 60% on the first 10 fruiting branches. In less dense stands, branch productivity (FP1 + FP2 + FP3+) may be more indicative of the boll development environment than first position productivity.

DISTRIBUTION OF BOLL RETENTION--104 FIELDS SJV 1982 TO 1991
HIGHEST YIELDING 20 FIELDS (1801 LBS/A) VERSUS LOWEST 20 (982 LBS/A)



The rate of boll loading and the 95% zone are excellent indices of earliness. They also indicate favorable yield development windows as well as periods requiring increased vigilance against insect pest pressure. Compact boll loading periods accompanied by acceptable yields create a small window of susceptibility to insects. This boll loading profile becomes a powerful pest avoidance technique and may reduce total insecticide use.

The Model

An ideal cotton plant reflects the attributes of a given geographic area. Crops in Arizona tend to have more nodes and higher yields than those on the High Plains. Plant populations are higher on the alluvial soils of the Delta than on loamy sands of the Southeast Coastal Plains. However, these varied plants would share several important features.

The model of this ideal would have high boll retention leading to productive fruiting branches. In denser stands, fruiting branches would each have at least 1, preferably first position, boll. In thinner stands, branch productivity would increase to average 2 bolls per branch. The number of productive fruiting branches required to set 95% of yield would range from 6 in northern regions to 14 in Arizona and Southern California. Second growth would be absent or minimal.

Shaping Next Year's Crop

Managers can use this year's final map data to shape next season's overall strategy. If in-season monitoring is conducted next year, mid-course corrections are possible. Small management adjustments might include improving fruit retention from increased insect scouting and plant growth management. Final mapping also is useful in indicating corrections in plant population to reduce barren plants that resulted from thick stands or plants with high proportions of late maturing bolls on vegetative branches in thin stands. Fertilization corrections are indicated when second growth is observed or node development prematurely stops. At moderate plant densities a rapid cutout at FP2+ may indicate a nitrogen deficiency.

Wrap Up

The final map is the last opportunity to record the crop's development and yield profile. This information is vital to measuring the success of last season's practices and determining areas for improvement next year. The 1993 crop has disappointed many producers from the middle of Texas to the East coast. West of this area, prospects are better. In both situations, an examination of the evidence may provide clues on things to avoid or duplicate next year. The final plant map can provide that evidence.

The Cotton Physiology Education Program is supported by a grant to the Cotton Foundation from BASF Agricultural Products, makers of Pix® plant regulator, and brought to you as a program of the National Cotton Council in cooperation with state extension services.