RELATIONSHIP BETWEEN LINT YIELDS AND SELECTED PLANT MAPPING DATA

Dr. Lowell J. Zelinski
Delta and Pine Land Company
Mr. Marc Bates
Deltapine Seed Company
Scott, MS

The complex but orderly nature of cotton vegetative and reproductive growth lends itself to the recording of various physical characteristics that can be used to explain differences in aggregate performance, such as lint yield. Small plot studies (Landivar, 1997, Plant 1997) have indicated only a poor relationship to lint yield. To investigate the lint yield to plant mapping relationship more exhaustively, an analysis of 233 cotton trials conducted by Deltapine Seed between the years of 1996 and 1998 was conducted. Most of the trials were variety trials that average 15 treatments per trial. Trials were generally field length and contained between 4 and 32 rows per plot. The row spacing varies with 1 meter being most the common. Trials were conducted in every cotton producing state, except Kansas and the San Joaquin Valley of California, though a similar paper reported findings for the San Joaquin Valley in 1997 (Plant et. al. 1997). A total of 107 different cotton varieties were evaluated with 3605 total plots and approximately 40,000 plants. Each trial was final plant mapped at between 30 - 50% open boll, with height, number of mainstem nodes (MSN) and boll presence or absence by MSN and position along the fruit branch being recorded. The trials were harvested with farmer cooperator equipment into a weighing boll buggy. A seedcotton sample was obtained from each plot and was ginned to determine turnout, which was then used to calculate lint yield.

Since many of the locations were not replicated, location was used as replication for the analysis of variance of lint yield versus location and variety. The following plant mapping parameters were calculated from the height, node and retention data:

HNR = height to node ration = final height(cm) / MSN

1st Node w/ boll = average MSN where the first harvestable was found, note that this is not node of first fruiting branch.

Nodes in 95% Zone = number of MSN required to produced 95 percent of total harvestable bolls, working up from the bottom.

Earliness Index (EI) = 1st Node w/boll + Nodes in 95% Zone (note that the smaller this value the more rapidly total yield was produced.

% Bolls at Pos. N, (were N = 1, 2 or >2) = bolls @ position N / total bolls * 100

Boll frequency N - M, (were N - M = 6 - 10, 11 - 15, 16 - 20, > 20) = number of bolls found at sympodial node position 1 between MSN N - M / number of potential sites between MSN N -M * 100

Statistical analysis was performed using JMP software from the SAS Institute.

Lint yield distribution was normal with a mean of 1001 kg/ha and a standard deviation of 396 kg/ha. When lint yield analysis of variance was performed using location and variety as the independent variables, the whole model R^2 was .927, indicating a highly significant relationship. The percentage of the total sums of squares attributable to location was 88% and variety was only 1.4%.

The table below presents the linear and quadratic R^2 values for the plant mapping parameters evaluated and the significance of the quadratic term:

Table 1. Relationships between lint yield and plant mapping parameters.

Factor	Linear R2	Quadratic R2	Significance of Quadratic term
Final Height	.239	.332	<.0001
Total Nodes	.124	.154	<.0001
HNR	.106	.167	<.0001
1st Node w/ Boll	.001	.016	<.0001
MSN 95% Zone	.170	.204	<.0001
Earliness Index	.066	.066	.7469
% Bolls Pos. 1	.063	.102	<.0001
% Bolls Pos. 2	.129	.194	<.0001
% Bolls > Pos. 2	.015	.027	<.0001
Boll Freq. 6 - 10	.010	.017	<.0001
Boll Freq. 11 - 16	.249	.263	<.0001
Boll Freq. 16 - 20	.078	.105	<.0001
Boll Freq. > 20	.007	.016	.0005
Boll Freq. 95% Zone	.067	.110	<.0001

Three plant mapping parameters which when considered separately, were more highly correlated with yield are discussed below along with the impact of earliness.

Final height was the single plant mapping parameter most predictive of lint yield. This agrees with a small plot study by Landivar (Landivar 1997), who also found that total number of fruiting sites were well correlated with lint yield. A quadratic fit was significantly better than a linear fit, and from differentiation of the quadratic equation the final height associated with maximum yields was 114 cm.

Boll frequency between MSN 11-16 was the second most predictive plant mapping parameter and the quadratic form was more significant than the linear model though through the range of most of the data the linear model appears to give similar estimates. The linear model is:

$$\text{Lint Yield} = 404 + 11.76 * \text{BF11-16}$$

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:530-531 (1999)
National Cotton Council, Memphis TN

Other research has shown that this zone produces the greatest frequency of harvestable bolls (Jenkins et. al. 1990) and was the greatest contributor to lint yield (Jenkins and McCarty, 1995).

Percentage of total bolls at 2nd sympodial position was more closely related to lint yield than either percent bolls at the 1st sympodial position or sympodial positions greater than 2. This is in contrast to the preliminary results of Plant et. al. (1997), who found bolls at the first position more closely related to yield.

It is also interesting to consider the earliness index relative to yield. Though is was not especially highly correlated ($R^2 = .066$) the relationship was highly significant ($p < .0001$) with a linear model of:

$$\text{Lint Yield} = 467 + 25.26 * \text{EI}$$

The positive slope indicates that as the EI increases the lint yield increases, or as the "earliness" of the field or variety increases the yield decreases. This is an indicator that the general trend for increased earliness in management practices and in variety development may not be advantageous in the achievement of high yields.

The use of forward stepwise regression identified the following parameters which were significant in lint yield prediction, listed in order decreasing F ratio: BF11-16, EI, %BP1, BF>20, BF6-10, %BP2, BF16-20, Height, MSN, %B>P2 and HNR. The adjusted R2 of the regression equation was .260, contrasting with the adjusted R2 for the location x variety model of .927. This illustrates that, even when considered together, plant mapping parameters provide only moderate yield predicting ability.

Both individual and collectively, plant mapping parameters were not highly correlated with yield. This is not to say that the relationships were not significant - indeed most were highly significant - but the maximum predictive ability of a single factor did not explain more than 33% of the yield variability (quadratic equation for height). With multiple regression only 26% of the variability could be explained. Since fruit retention is intuitively related to yield, there must be problems with the plant mapping procedures used. Inadequate sample size, 10 - 20 plants per plot or field, represent much less than 0.1% of the total plants in most sample areas. Also, the fact that bolls from different positions do not contribute equal to yield, and the relative contribution by position can vary from year to year (Jenkins et al, 1995, Plant 1997) are additional complications. Until the problems with plant mapping and/or sample size are resolved, mapping should be used for a qualitative understanding of yield variability and not as a predictor of actual lint yields.

References

Jenkins, J.K. and J.C. McCarty. 1995. Useful Tools in Managing Cotton Production: End of Season Plant Maps. Mississippi Agric. and Forestry Exp. St., Bulletin 1024.

Jenkins, J.K., J.C. McCarty and W.L. Parrott. 1990. Effectiveness of Fruiting Sites in Cotton: Yield. Crop Sci. 30:365-369.

Landivar, J.A. 1997. Using Plant Mapping to Determine Potential Lint Yield of Cotton Crops. Proceedings of Beltwide Cotton Conferences. 1362.

Plant, R.A., M. Keeley, D. Munk, B.A. Roberts, R.K. Vargas, B.L. Weir and S. Wright. 1997. Relationship Between Yield and Final Plant Map Data in Acala Cotton. Proceedings of Beltwide Cotton Conferences. 1446-1450.