

# COTTON PRO: SOFTWARE FOR PLANT MAPPING AND ANALYSIS

Richard E. Plant and Linda G. Bernheim

Depts of Agronomy and Range Science and Biological and Agricultural Engineering

University of California

Davis, CA

## Abstract

Plant mapping has become an important tool for cotton management. This practice involves regular sampling of cotton plants for key agronomic data such as number of retained fruiting structures at the top and bottom of the plant, height-to-node ratio, and position of the white flower. When applied during the growing season, plant mapping may be used for determining application rates of plant growth regulators, for treatment decisions on certain insect pests, and so forth. When applied at the end of the season, it may be used for a *post hoc* analysis of crop productivity and the factors affecting yield. University of California personnel are engaged in an effort to develop software for use in plant map data collection, analysis, and interpretation. Previous efforts have focused on programs that can be carried into the field on palmtop computers. The present paper describes a desktop computer-based program called CottonPro for archival storage and graphical analysis of plant map data.

## Introduction

The technique of plant mapping, which was developed through the collaborative efforts of a number of cotton researchers (e.g., Bourland et al., 1992, Kerby and Hake, 1996), is achieving widespread acceptance by cotton growers. Plant mapping involves sampling a number of plants for data describing boll retention by position, plant height, number of vegetative nodes below the first fruiting branch, number of bolls on vegetative branches, and, when sampling is done during the season, data such as number of nodes above the highest white flower. When applied during the growing season, plant mapping may be used for determining application rates of plant growth regulators, for treatment of certain insect pests, timing of final irrigation and defoliation, and other decisions. When applied at the end of the season, it may be used for a *post hoc* analysis of crop productivity and the factors affecting yield.

Plant mapping is a useful part of the grower's management tool kit because it provides a precise quantification of crop status and vigor. This permits more accurate determination of proper application rates of plant growth regulators and fertilizers, and because it provides the grower with the

ability to accurately forecast the timing of management actions such as defoliation. Use of the plant mapping technique requires that the grower collect and analyze a considerable amount of numerical data.

Workers at the University of California have previously developed two computer programs to assist in the collection and interpretation of plant map data. One of these, California Cotton Manager or CCM (Munier et al., 1994) is primarily used for in-season plant mapping. The other, Cotton Plant Mapper or CPM (Plant and Kerby, 1995) is used for final plant mapping. Both programs are intended primarily for use on the palmtop computer so that they may be used directly in the field. As such, their design is intended to match the needs and constraints of a program used in the field on a small device. The programs, which are constrained by the small storage capacity of the palmtop computer, are very simple and focus on easy data entry. The CCM program, which is a collection of Lotus 1-2-3 macros, provides information for in-field decision making on lygus bug treatment, plant growth regulator application, and defoliation. Both provide summary display of statistics. However, the limitations of the palmtop computer and of the field environment preclude full analytical and archival use. For this reason we have developed a desktop computer-based program called CottonPro. This program is intended to complete the set of software offered by the University of California to its cotton clientele as shown in Figure 1.

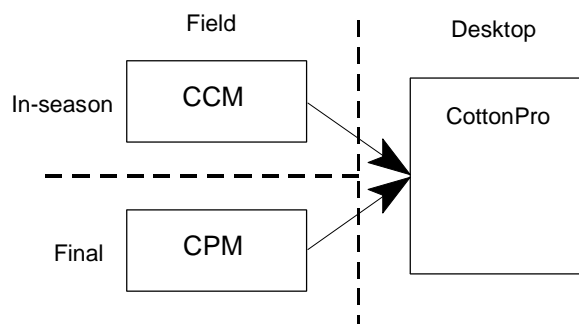


Figure 1. Organization of University of California cotton plant mapping software.

The features of CottonPro are intended to take advantage of desktop computer facilities. It loads data files from both CCM and CPM and converts them into an organization suitable for long-term storage. It does not provide for in-season plant map data entry, although it does provide for final plant map data entry since many users prefer to remove plants from the field for this procedure. CottonPro's features emphasize long-term storage and manipulation of data and strategic decision making, both in-season and between seasons. As such, the program emphasizes graphical data display. At present CottonPro, like CCM and CPM, runs in DOS; a Windows-based version is under development.

## File Organization

The anticipated mode of in-season data collection is as follows. The user will go out regularly and collect data using CCM, in general taking data in more than one field. Every so often, the user will move these data into CottonPro. Long-term storage of data files is best accomplished if every field's data set is stored in a separate file. Therefore the file transfer process from CCM to CottonPro is organized as shown in Figure 2. A single CCM file is a Lotus 1-2-3 PRN file containing data from multiple fields and multiple days. File transfer from CPM to CottonPro is more straightforward since CPM files are already stored on a field-by-field basis. These files are simply merged into the existing CottonPro files. Thus, CottonPro data files each contain both in-season and final plant map data for an individual field or plot. The two types of data do not overlap, with one exception. The number of vegetative nodes is recorded both during the season in CCM and at the end of the season in CPM. Since this value is easier to measure during the season than at the end, CCM data, recorded in the form of average number of vegetative nodes, is used a default value.

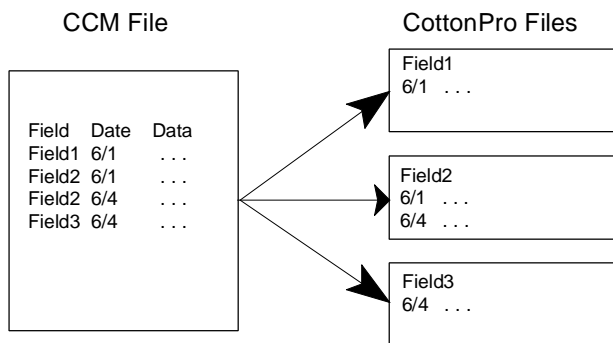


Figure 2. Organization of file transfer from CCM to CottonPro.

## Final Plant Map Data Entry

Plant Number 1 of 1

Plant height 45  
 Number of vegetative bolls 6  
 Vegetative nodes to first fruiting branch 7

Branch No	FP-1&2 Code	FP-3+ Number
1	2	0
2	1	0
3	1	1
4	3	0
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-
11	-	-

Next Plant  
Prev Plant  
Done

0- no FP1 or FP2; 1- for FP1; 2- FP2 but not FP1; 3 for FP1

Figure 3. Final plant map manual data entry screen.

At present, the only way to enter in-season data into CottonPro is to download it from CCM. However, final plant map data may be either downloaded from CPM or entered manually. The principal reason for this distinction is that most users (i.e., growers and consultants) in California who do plant mapping in-season use the palmtop computer, but many who do final plant mapping do so by pulling up selected plants and entering map data away from the field.

The manual data entry screen, shown in Figure 3, is designed for ease of use. Each screen represents a single plant, and the user enters boll data into a spreadsheet that can be scrolled up and down. Data is entered according to a code devised by Bourland and Watson (1990). In this code, the four possible combinations of boll retention in the first two positions on a branch is indicated by a number between zero and three.

## Data Display

In addition to standard tabular display of data, CottonPro provides graphical display facilities for both in-season and final plant map data. In-season data displayed includes height-to-node ratio, growth rate, and nodes above white flower. Figure 4 shows an example: a plot of height-to-node ratio. The graph plots values for the current field against those of a reference standard SJ-2 field developed from data of Kerby et al. (1989). Final plant map data is plotted as number of bolls per node versus mainstem node and as percentage of total bolls (Figure 5). A plot of cumulative bolls per node is also available.

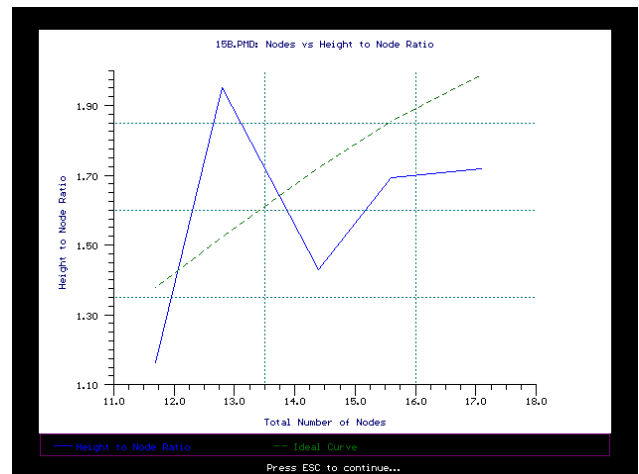


Figure 4. Plot of in-season height-to-node ratio.

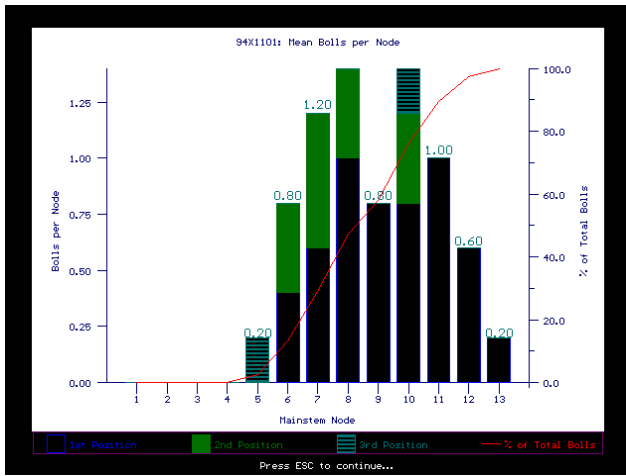


Figure 5. Plot of final bolls per node.

### Discussion

The development of CottonPro completes the array of software developed by the University of California for cotton plant mapping. Future work will focus on improvements in existing software. These include the transition to the Windows environment and the development of extended analytical facilities to assist the user in interpreting cotton plant map data.

### Acknowledgments

This work was supported by the Cotton Incorporated California State Support Committee and by the USDA National Research Initiative Competitive Grants Program. We are grateful to Tom Kerby, Mark Keeley, and Doug Munier for their helpful comments and assistance.

### References

- Bourland, F. M., Oosterhuis, D. M., & Tugwell, N. P. (1992). Concept for monitoring the growth and development of cotton plants using main-stem node counts. *Journal of Production Agriculture*, *5*, 532-538.
- Bourland, F. M., & Watson, C. E. (1990). COTMAP, a technique for evaluating structure and yield of cotton plants. *Crop Science*, *30*, 224-226.
- Kerby, T. A., & Hake, K. (1996). Monitoring Cotton's Growth. in *Cotton Production* (p. in press). Oakland, CA: Division of Agriculture and Natural Resources, University of California.
- Kerby, T. A., Keely, M., & Johnson, S. (1987). (Report No. Bulletin 1921). Oakland, CA: Division of Agriculture and Natural Resources, University of California.
- Munier, D. J., Plant, R. E., Young, J. A., & Kerby, T. A. (1994). A palmtop computer-based decision support system

for cotton management. in *Proceedings of the Fifth International Conference on Computers in Agriculture* (pp. 381-384). St. Joseph, MI: American Society of Agricultural Engineers.

Plant, R. E., & Kerby, T. A. (1995). CPM: Software for cotton plant mapping. *Agronomy Journal*, *87*, 1143-1146.