## FACTORS AFFECTING SOURCE-SINK RELATIONS IN COTTON

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### Abstract

A series of experiments have been conducted to determine the opportunity to manipulate source-sink ratios in cotton. Growth habits, water supplies, row spacings, and plant population have been used as experimental variables. Total dry matter, fruit dry matter, and leaf areas were measured over time. Source-sink ratios have been expressed on both a ground area and a leaf area basis.

The more determinant varieties were more efficient at generating fruit dry weight per $m^2$ of leaf area and ground area, as well as at partitioning into fruit (FDW/TDW). Water supply affected both fruit production efficiency and partitioning. Dryland conditions produced plants that were more efficient (than those receiving supplemental irrigation) at producing total dry weight and fruit dry weight per $m^2$ of leaf area. However, on a ground area basis, irrigated plants produced more total dry weight and fruit weight per $m^2$. Plants in narrower row spacings generated more total dry weight per $m^2$ of ground area. Also, the narrower the row, the more efficient the partitioning. Row spacing also had an effect on dry matter production and partitioning efficiency. The intermediate plant density (15 plants/ $m^2$) produced the most TDW/ $m^2$ of ground area and leaf area; however, partitioning (FDW/TDW) was the most efficient with 10 plants/ $m^2$.

Since there were differences in dry matter partitioning and fruit production efficiency, the opportunity exists to manage the cropping system to obtain the most fruit with the least amount of leaf area (improving water use efficiency), and obtain the most *efficient* harvest index.

### Introduction

The cotton plant is a woody perennial with an indeterminate growth habit. It produces an excess of fruiting sites and leaf area relative to its final harvestable yield. Water use is directly proportional to the amount of leaf area present, so it becomes apparent that any excess is merely wasting water above and beyond that necessary to grow fruit. In the Southern High Plains environment where the potential evapo-transpiration can easily average 10mm/day during the growing season, water is the limiting factor in crop production. If we are to increase cotton yields under these environments, we must first determine what the current source-sink ratios are and second, can they be altered through management and/or genetics for maximum production and efficiency.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1387-1389 (1997)
National Cotton Council, Memphis TN

### Materials and Methods

Field experiments have been conducted over several years at two locations providing different soil textures: the Crop Production Lab at Terry County (loamy sand) and Northeast Lubbock County (clay loam). The experimental variables studied were plant density (10, 15, and 20 plants/$m^2$), row spacing (0.5, 0.75, and 1.0m), determinate and indeterminate growth habits, and water supply ( % Eta replacement). Growth analysis was taken several times during each growing season. Leaf areas, and vegetative and reproductive masses were determined. The respective dry weights were then used to calculate total dry matter production and fruit production per $m^2$ of leaf area and per $m^2$ of ground area. Partitioning was calculated by determining fruit dry weight/total dry weight.

Photosynthetic rates were determined for vegetative and sympodial leaves on 5 plants per plot with each growth analysis. Photosynthetic activity was regressed against total dry weight and total fruit weight per $m^2$ of leaf area.

### Results and Discussion

Growth habit, water supply, row spacing, and plant density all had an effect on total dry weight (TDW/$m^2$ *leaf area* and TDW/$m^2$ *ground area*), fruit production ef-ficiency (FDW/$m^2$ *leaf area* and FDW/$m^2$ *ground area*), and partitioning efficiency (FDW/TDW).

Varieties were pooled into growth habits defined as determinate and indeterminate types. The determinate types are the rapid fruiting type that are early maturing. The indeterminate types prolong the flowering period and are later maturing. At 75 d.a.p., determinate type plants produced more total dry weight/$m^2$ of ground area than the indeterminate varieties (Fig. 1). However, at 100 d.a.p., the indeterminate ones had a higher amount of total dry weight/$m^2$ ground area. Determinate growth habits were more efficient than indeterminate ones not only at generating more FDW/$m^2$ of leaf area and ground area, but also at partitioning (FDW/TDW) photosynthate into fruit weight (Fig. 2)

Water supply affected both fruit production efficiency and partitioning. Well watered plants produced more total dry weight and fruit dry weight/$m^2$ of ground area (Fig 3). However, dryland conditions caused plants to partition more of the total dry weight into fruit. Furthermore, plants under dryland conditions were far more efficient at generating higher fruit weights/$m^2$ of leaf area. (Fig. 4)

Row spacing also affected the efficiency of the plants. The narrower the rows, the greater the total dry weight generated per m$^2$ of ground area. Furthermore, the narrower the row, the more efficient plants were at partitioning photosynthate into fruit. Therefore, the narrower the row, the more fruit dry weight generated per m$^2$ ground area. (Fig. 5)

Of the three plant densities (10, 15, and 20 plants/m$^2$), the 15/m$^2$ produced the greatest total dry weight/m$^2$ of leaf area and ground area. (Fig. 6) Fruit dry weight/m$^2$ leaf area and ground area was also highest at the 15 plants/m$^2$ density. However, partitioning was most efficient at the fewest number of plants/m$^2$. (Fig. 7)

## Summary

Growth habit, water supply, row spacing, and plant density all exhibited differences in both total production of dry matter and efficiency of fruit production. It becomes apparent that through proper varietal selection for the available water supply, as well as the utilization of narrow rows and moderate plant densities, the opportunity exists to modify source-sink ratios for maximum productivity and efficiency.

## Acknowledgments

We are grateful for the financial support provided by Cotton, Inc. through the Texas State Support Program.

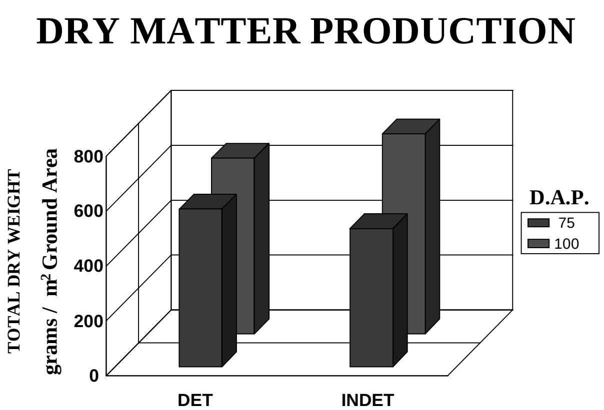


Figure 1. Growth habit differences in total dry matter production at 75 and 100 D.A.P.

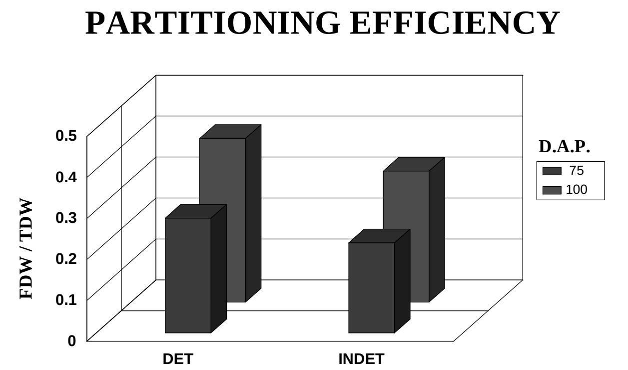


Figure 2. Growth habit differences in partitioning efficiency at 75 and 100 D.A.P.

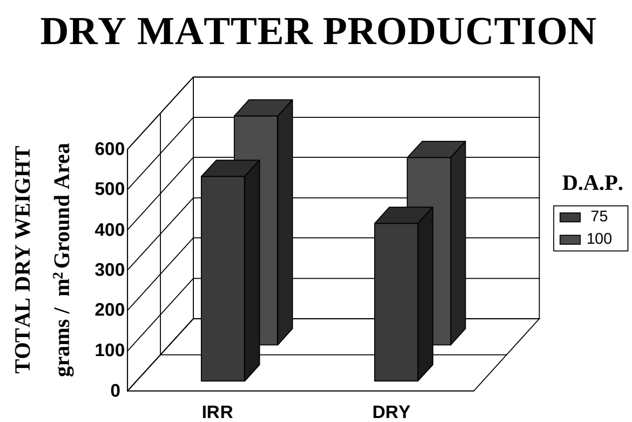


Figure 3. Water supply differences in total dry matter production / m$^2$ ground area at 75 and 100 D.A.P.

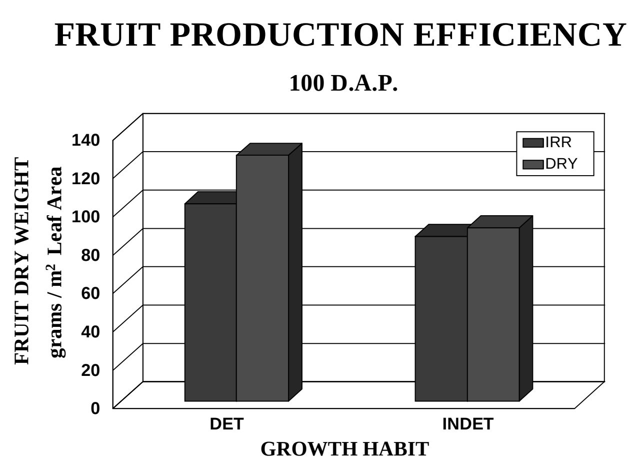


Figure 4. Water supply effects on fruit dry weight production / m$^2$ of leaf area for determinate and indeterminate varieties.

## FRUIT PRODUCTION EFFICIENCY

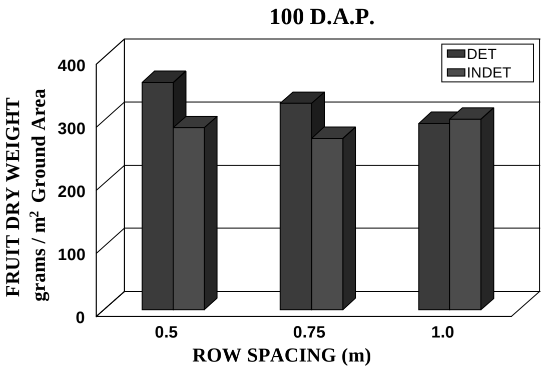


Figure 5. Row spacing effects on fruit dry weight production / $m^2$ ground area for determinate and indeterminate varieties.

## DRY MATTER PRODUCTION

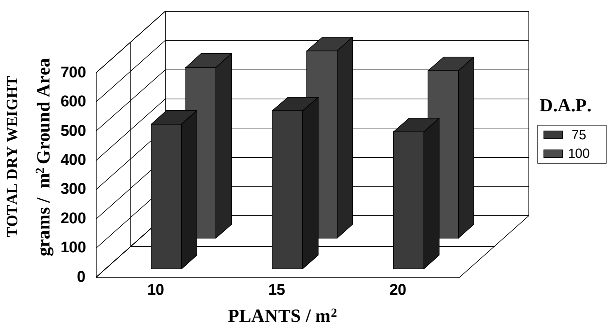


Figure 6. Plant density effects on total dry matter production / $m^2$ ground area at 75 and 100 D.A.P.

## PARTITIONING EFFICIENCY

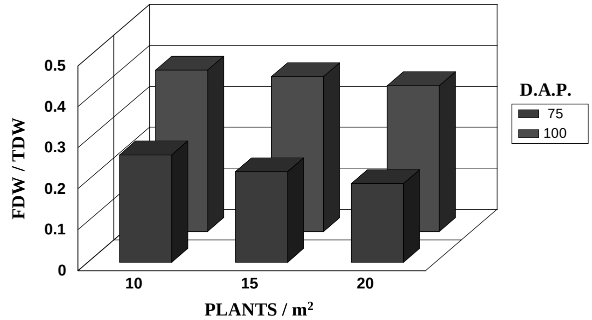


Figure 7. Plant density effects on partitioning efficiency at 75 and 100 D.A.P.