Dry Matter Accumulation by Upland and Pima Cotton

B. L. Unruh, J. C. Silvertooth, A. J. Steger, and E. R. Norton

Abstract

Several investigations of dry matter accumulation by Upland cotton (Gossypium hirsutum L.) have been conduced, however no investigations of this type have included American Pima cotton (G. barbadense L.). We conducted a study to describe the total dry matter accumulation and partitioning of that dry matter into various plant parts for both Upland and Pima cotton. During the growing seasons of 1990, 1991, and 1992 at two south-central Arizona locations, both Upland (var. DPL 90) and Pima (var. S-6) cotton were grown. Beginning 14 to 20 d after emergence, whole cotton plants were removed and cotton plants were separated into stems, leaves (including petioles), burs (carpel walls), lint, and seeds. The bur fraction, also included squares, flowers, immature bolls, and burs from mature bolls. Regression analyses was used to model nutrient uptake as a function of both days after planting (DAP) and heat units after planting (HUAP). Regression analyses indicated that HUAP was equally good, and in most cases superior to using DAP to model dry matter accumulation and partitioning within both Upland and Pima cotton. The general patterns of dry matter partitioning for Upland and Pima cotton are similar. However, Upland and Pima differ in the relative amount of dry matter incorporated into reproductive (bur, seed, and lint) and vegetative (leaf and stem) structures. Upland cotton produced 3527 lb/acre more total dry matter than Pima cotton. At the end of this study the vegetative/reproductive ratio for Upland was 83% compared to 70% for Pima. Upland was also more efficient at partitioning lint dry matter within the total dry matter of the reproductive structures. Dry matter incorporated into reproductive structures was 23% lint for Upland, compared to only 14% lint in Pima cotton. In summary, Upland placed more total dry matter into reproductive structures, and of the amount placed into reproductive structures, a greater proportion was incorporated into lint, when compared to Pima cotton.

Introduction

There have been many studies to describe dry matter accumulation by Upland cotton (Bassett et al., 1970, Halevy, 1976, Mullins and Burmester, 1990) and even extensive investigations to compare dry matter partitioning between obsolete and improved Upland cotton varieties (Meredith and Wells, 1989, Wells and Meredith, 1984a, b, c). However, none of these types of experiments have been conducted with American Pima cotton. In addition, there has been a shift in emphasis from scheduled operations on a calendar basis (or days after planting, DAP) to production management of cotton using heat unit (HU) accumulations (Brown, 1989, Silvertooth et al., 1993). For these reasons, we conducted a study to describe the dry matter accumulation and the partitioning into various plant parts for both Upland and Pima cotton using HU accumulations after planting (HUAP) throughout the development of the plant.

Materials and Methods

The experimental procedure for this study has been fully described in a companion portion of this experiment published within this report (Unruh et al., 1994).

Results and Discussion

Figure 1 shows the plant height-to-node ratios (HNR) and nodes above the top white bloom (NAWB) measurements modeled as a function of HUAP for all six site years of data. This figure gives an indication of the relative vegetative/reproductive balance (HNR) and progression of the plant along the fruiting cycle (NAWB). Both DPL 90 (a full season maturity type) and Pima S-6 have similar relationships between growth stage and NAWB as described by Silvertooth et. al., (1993). From Fig. 1 it appears that Pima never reach cut-out (NAWB $\leq$ 5) throughout the sampling period, while Upland reached cut-out at about 3000 HUAP.

The predicted total dry matter accumulation for Upland and Pima cotton are given in Fig. 2. Upland produced about 395 g m^{-2} (3950 kg ha^{-2} or about 3527 lb/acre) more total dry matter than Pima (Fig. 2). The general pattern of the partitioning of dry matter into the various plant parts is similar for Upland and Pima, however there were some noted differences in the amount of dry matter accumulated by some of the parts. Upland incorporated more dry mass into stems, seeds, and lint, about 110, 130, and 95 g m^{-2}, respectively, whereas Pima incorporated about 25 g m^{-2} more dry matter into the bur fraction. Leaves were nearly the same for both Upland and Pima in terms of dry matter accumulation (Fig. 3 and 4). The differences in dry matter partitioning is illustrated in Fig 5. By the end of the sampling period in this study, the reproductive (bur, seed, and lint) dry matter was 83% of the vegetative (leaf and stem) dry matter in Upland and 70% for Pima cotton. Also, the ratio of lint to reproductive dry matter was greater for Upland than Pima (Fig. 5). By the end of the sampling period, the lint dry matter was 23% of the total reproductive dry matter produced in Upland compared to 14% for Pima (Fig. 5). This indicates that Upland cotton produces more reproductive structures for the amount of vegetative structures produced and incorporates more lint into those reproductive structure than Pima cotton.

References

Bassett, D. M., W. D. Anderson, and C. H. E. Werkhoven. 1970. Dry matter production and nutrient uptake in irrigated cotton (*Gossypium hirsutum*). Agron. J. 62:299-303.

Brown, P. W. 1989. Heat units. Bull. 8915, Univ. of Arizona Cooperative Extension, College of Ag., Tucson, AZ 85721.

Halevy, J. 1976. Growth rate and nutrient uptake of two cotton cultivars under irrigation. Agron. J. 68:701-705.

Meredith, W. R., Jr., and R. Wells. 1989. Potential for increasing cotton yields through enhanced partitioning to reproductive structures. Crop Sci. 29:636-639.

Mullins, G. L., and C. H. Burmester. 1990. Dry matter, nitrogen, phosphorus, and potassium accumulation by four cotton varieties. Agron. J. 82:729-736.

Silvertooth, J. C., P. W. Brown, and J. E. Malcuit. 1993. The development and delivery of a crop monitoring program for Upland and Pima cotton in Arizona. p. 17-26. *In* J. C. Silvertooth (ed.) Cotton, A College of Ag. Rep. Univ. of Arizona, Series P-94.

Unruh, B. L., J. C. Silvertooth, A. J. Steger, and E. R. Norton. 1994. Nitrogen, Phosphorus, and Potassium Uptake for Upland and Pima cotton. *In* J. C. Silvertooth (ed.) Cotton, A College of Ag. Rep. Univ. of Arizona, (this issue).

Wells R. and W. R. Meredith, Jr. 1984a. Comparative growth of obsolete and modern cotton cultivars. I. Vegetative dry matter partitioning. Crop Sci. 24:858-862.

Wells R. and W. R. Meredith, Jr. 1984b. Comparative growth of obsolete and modern cotton cultivars. II. Reproductive dry matter partitioning. Crop Sci. 24:863-368.

Wells R. and W. R. Meredith, Jr. 1984c. Comparative growth of obsolete and modern cotton cultivars. III. Relationship of yield to observed growth characteristics. Crop Sci. 24:868-872.

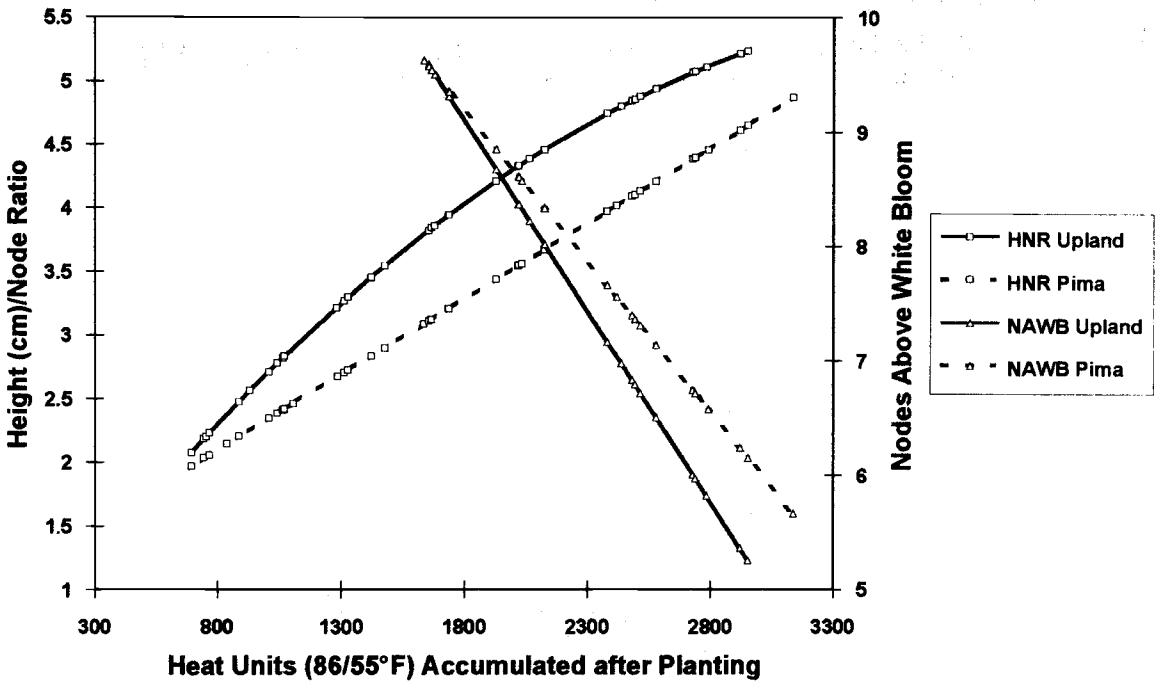

Fig. 1. Predicted height-to-node ratios (HNR) and nodes above the top white bloom (NAWB) for Upland (var. DPL 90) and Pima (var. S-7) cotton.

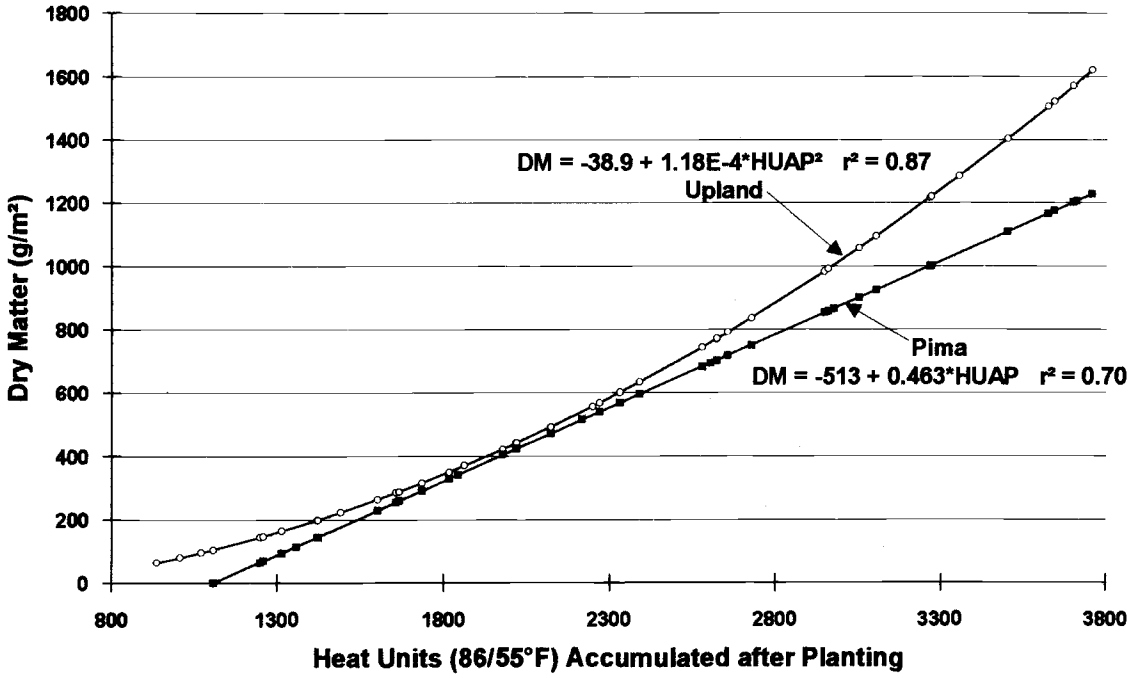

Fig. 2. Predicted total dry matter accumulation by Upland (var. DPL 90) and Pima (var. S-7) cotton.

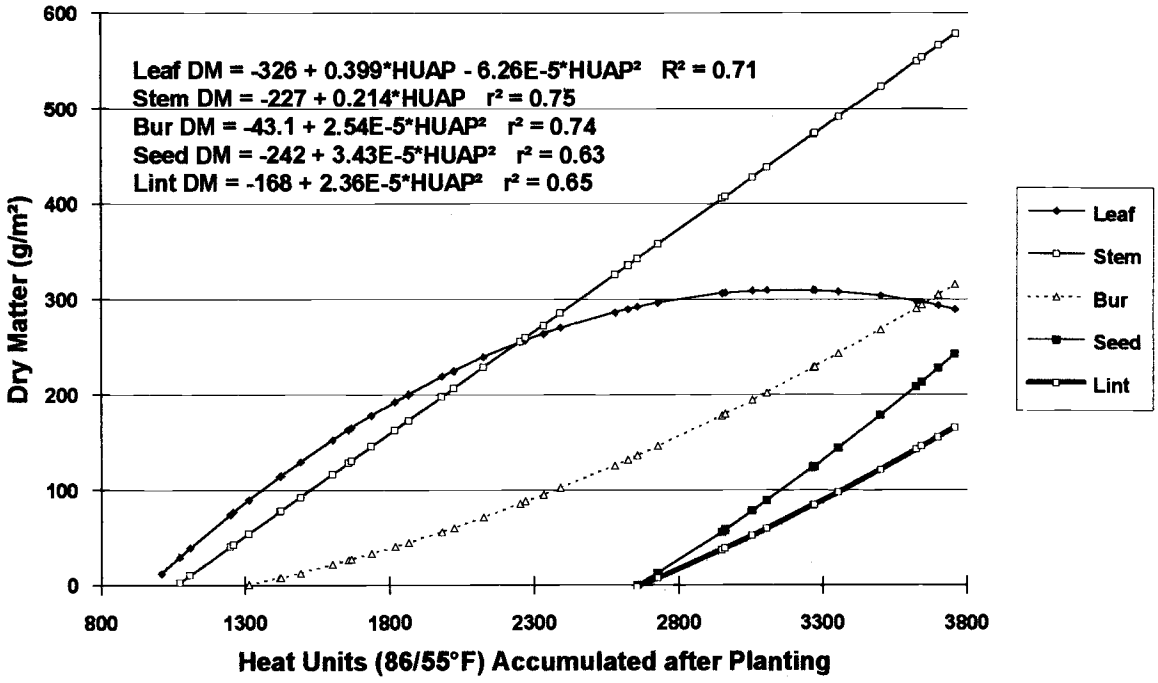

Fig. 3. Predicted dry matter accumulation in each plant part by Upland (var. DPL 90) cotton.

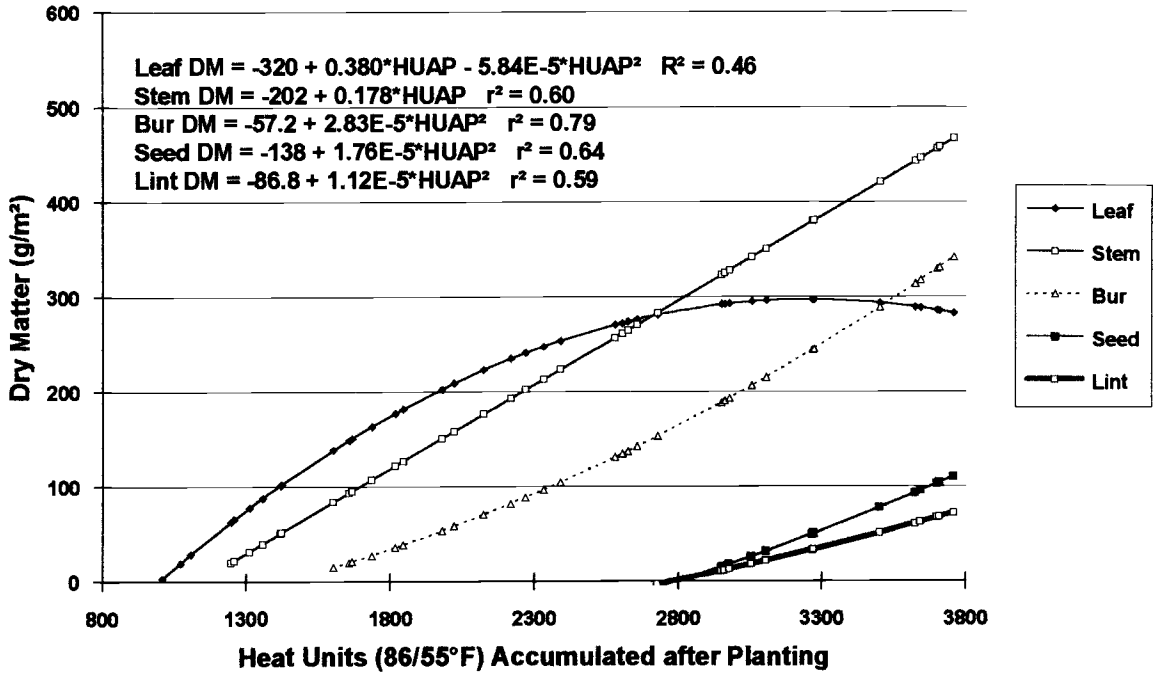

Fig. 4. Predicted dry matter accumulation in each plant part by Pima (var. S-7) cotton.

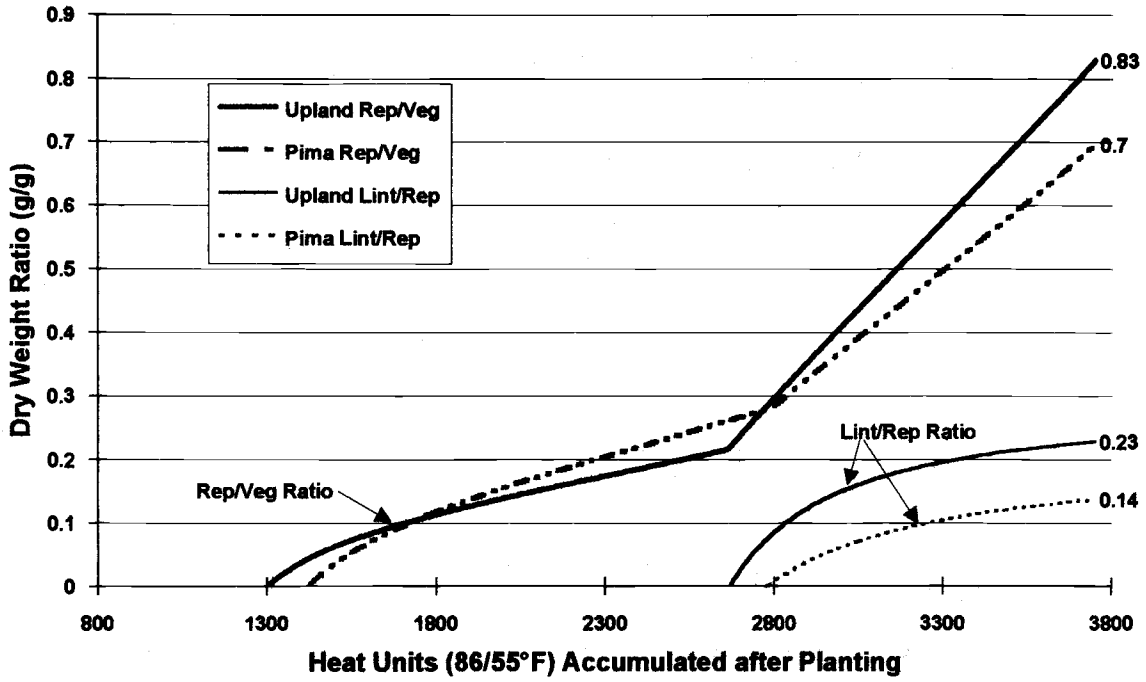

Fig. 5. Predicted reproductive-to-vegetative (Rep/Veg) and lint-to-reproductive (Lint/Rep) dry matter ratios for Upland (var. DPL 90) and Pima (var. S-7) cotton. Where reproductive dry matter includes lint, seed, and bur fraction, and vegetative dry matter includes leaves and stems.