

DRY MATTER PARTITIONING AND GROWTH ANALYSIS OF PEANUT¹

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ABSTRACT

Four peanut (*Arachis hypogaea* L.) cultivars Chico, Early Bunch, McRan and Pronto were grown in 1982 season at 10, 20 and 30 plants/m². Plants were sampled at weekly intervals, and each treatment was analysed for the physiological parameters. Total dry weight increased with increasing densities in all cultivars. Spanish types, Chico and Pronto, exhibited larger seed to above ground total plant dry weight ratios than McRan and Early Bunch at harvest time. Rate of pod filling differed among cultivars and it increased as density increased in Spanish cultivars. There was no significant difference among cultivars in effective pod filling duration. Results indicated that leaf area index (LAI) increased with increasing density. Crop growth rate (CGR) appeared to decrease before pod filling and then increased to high levels during rapid seed development. The peak in CGR during pod filling was interpreted as a response of the plant to an increased demand for assimilates by the developing seeds.

KEY WORDS: Assimilate, Peanut (*Arachis hypogaea*), Photosynthate, Photosynthesis

INTRODUCTION

The peanut (*Arachis hypogaea* L.) is an annual legume native to South America. It is now widely grown and well adopted to most tropical, subtropical and warm temperate areas of the world. The seed contains approximately 25% protein and 50% oil.

There are two main botanical types of *Arachis hypogaea*, namely sequential and alternate branching (Bunting, 1955). The sequential branching types (Valencia and Spanish groups) have an erect bunch growth habit with light green foliage and take about 90—100 days to mature, while the

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alternate branching types (Virginia group) have a runner or spreading bunch habit, with dark green foliage and take about 120—150 days to mature (Enyi, 1977).

This study was conducted to compare Spanish, Valencia and Virginia bunch group cultivars for the effect of plant density on dry matter production, distribution of dry matter into various plant parts and assimilation rates.

MATERIALS AND METHODS

Four peanut genotypes, Chico, Pronto (Spanish type), Early Bunch (Virginia type) and McRan (Valencia type) were grown at 10, 20 and 30 plants/m² in a split-plot experiment at the Agriculture Research Station field, Delhi, Ontario. The soil in this location is a Fox loamy sand with medium to high phosphorus and potassium. A split-plot design was used with plant densities as the main plot and cultivars as the sub plot. The experimental unit consisted of ten rows and the row length was 7m. Each treatment was replicated four times.

Sample plants were harvested at weekly intervals, and on each sampling date, five plants per plot were dug out with a shovel.

Each plant was separated into roots, stems, branches and petioles, leaflets, pegs, pods and developing kernels. The various plant parts were oven-dried to constant weight at 80°C and their dry weights determined. Leaf area was measured using an automatic area meter. Harvest index was calculated by dividing seed dry weight by total above ground dry weight, and expressed as a per cent at the end of the season. Mean values of leaf area index (LAI) and crop growth rate (CGR) were plotted for each treatment. Crop growth rate was calculated using the equation of $CGR = (W_2 - W_1) / (T_2 - T_1)$, where W_1 and W_2 are the above ground total dry weights per unit land area at times T_1 and T_2 respectively (Radford, 1967).

RESULTS AND DISCUSSION

Total dry matter production increased with increasing plant density (Table 1). Chico accumulated less dry matter than the other cultivars at all three densities. Highest total dry matter production was in Pronto at 30 plants/m².

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The distribution of dry matter among the different plant parts during the growing season for the plant density of 10 plants/m² is illustrated in Fig. 1. All 3 plant densities showed similar trends and hence for convenience data for only 10 plants/m² are discussed. In all cultivars, over 90% of the total dry matter was accumulated during the post-flowering period and most of the metabolites produced in the cultivars Early Bunch and McRan were present in the vegetative parts. Kernel weight declined with increasing densities in Early Bunch and McRan. Kernel weight in Chico and Pronto increased as density increased (Table 1). In Early Bunch, conversion of dry matter into reproductive organs began later than in the other three cultivars (Fig. 1). Extent of dry matter accumulation in the reproductive fraction for the different varieties followed the order Chico>Pronto>McRan>Early Bunch. Duncan *et al.* (1977) reported that the major reason for yield variation among peanut cultivars was the partitioning of assimilate between vegetative and reproductive growth during the pod filling period.

The Harvest index (HI) was significantly higher for Chico and Pronto than Early Bunch and McRan (Table 1). Harvest index decreased with increasing density in Chico, Early Bunch and McRan, while it was not affected by density in Pronto (Table 1).

Cultivars differed in the rate of pod filling (Table 1). The rate of pod filling was significantly higher in Pronto (5.1g/m²/day). Pod filling rate was not affected by density treatments in Early Bunch. There was no significant difference among cultivars in effective pod filling period (Table 1) and the duration of pod filling was unaffected by plant density except in Early Bunch. This suggested that the difference in seed yield between cultivars was due to a difference in rate of pod dry weight accumulation per unit area. Chevalier (1983) and Burton (1983) reported that final kernel yield correlated more with the rate of kernel growth than with the duration of kernel growth in wheat (*Triticum aestivum* L.) and soybean (*Glycine max* L.) respectively.

Leaf area index (LAI) increased in all cultivars with increasing densities (Fig. 2) indicating that there was greater ground cover at the high densities, a result similar to that obtained by Enyi (1977). This advantage in leaf area available for photosynthesis at the high densities resulted in

higher dry matter production. The correlation between LAI and total dry weight was highly significant ($r=0.93^{***}$). Early Bunch produced a greater LAI than the other three cultivars (Fig. 2). Enyi (1977) found a positive linear relationship between leaf area duration (LAD) and peanut kernel yield. In this study LAD was positively correlated with final yield ($r=0.81^{**}$).

Crop growth rate (CGR) increased as the season progressed up to 62 days in Pronto, McRan and Early Bunch and then declined; it rose again during the period of rapid seed development. But in Chico CGR increased up to about 90 days and then declined (Fig. 3). CGR increased with increasing plant density. The CGR was highest in the cultivar Pronto. The ability of the cultivars Pronto, McRan and Chico to accumulate total dry weight at a rate higher or as great as Early Bunch (Fig. 1) with less leaf area (Fig. 2) suggested that Pronto, McRan and Chico possessed a greater net assimilation rate (NAR) than Early Bunch.

The mean NAR for Chico, Early Bunch, McRan and Pronto for the entire sampling period was 1.85, 1.25, 1.30 and 2.36 mg/cm²/day respectively. Elkan *et al.* (1989) and Tonn and Weaver (1981) have reported that peanut cultivars developed more nodule mass and reduced C₂H₄ at a faster rate up to pod initiation and Virginia cultivars had substantially greater nodule mass and greater rates of N₂-fixation than the Spanish cultivars. After seed development began, the activity of the nodules declined (Tonn and Weaver, 1981) mainly because the developing seeds started to compete for available photosynthates. The secondary peaks in CGR were due to an increased demand for assimilates by the developing seeds.

The Spanish type cultivars, Pronto and Chico gave higher yields than the Valencia (McRan) and Virginia type (Early Bunch) cultivars (Table 2). This was mainly attributed to differences in the pattern of dry matter partitioning and the rate of dry matter accumulation. High percentage of dry matter partitioning into the reproductive fraction was the reason for better performance of the cultivar Pronto than McRan even though both cultivars had very similar CGRs. The cultivar Chico had a lower CGR than McRan and Pronto, but the harvest index was higher than McRan and Pronto as seeds accumulated a high percentage of photosynthates. (Fig. 3; Table 1). Thus, it appears that Chico is more efficient at partitioning

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dry matter into the seed than Pronto but because Pronto had a greater CGR and higher total dry matter accumulation it gave a higher yield (Fig. 1 and 3; Table 1). Although Early Bunch had the highest LAI, its NAR resulted in a low CGR (Fig. 2 and 3).

Pod filling rate was lowest in Early Bunch, and it increased with density in the Spanish type cultivars (Table 1). Chico, Pronto and McRan apparently responded to plant competition by altering the size of the metabolic sink rather than changing the growth rate of individual seeds. The reproductive sink was not a limiting factor as high percentages of immature pods were present at final harvest in McRan and Early Bunch.

Yield differences among the three types of peanuts were mostly due to the greater partitioning of dry matter into the seed fraction and the high rate of dry matter accumulation in the pod fraction.

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Table 1. Dry matter yield, harvest index, pod filling rate, pod filling period, pod yield and kernel yield of four peanut cultivars at 3 different plant densities

<i>Cultivar</i>	<i>Density (Plants/m²)</i>	<i>Total dry matter (g/m²)</i>	<i>Weight of leaves & branches (g/m²)</i>	<i>HI</i>	<i>Pod filling rate (g/m²/day)</i>	<i>Pod filling period (days)</i>	<i>Pod yield (kg/ha)</i>	<i>Kernel yield (kg/ha)</i>
Chico	10	315 c	125 d	55 a	2.25 bc	43 a	1457 c	1082 c
	20	440 c	139 d	48 a	3.00 b	41 a	1591 c	1145 b
	30	528 b	167 d	42 b	4.00 a	39 a	1856 b	1272 b
Early Bunch	10	375 c	225 c	32 c	1.75 c	38 a	1238 d	592 ef
	20	491 bc	318 b	27 cd	2.00 c	35 a	1184 d	534 f
	30	576 b	349 a	22 d	2.25 bc	31 b	991 e	407 g
McRan	10	575 b	350 a	35 c	2.00 c	40 a	1552 c	1023 c
	20	623 a	370 a	30 c	2.25 bc	39 a	1477 c	870 d
	30	639 a	378 a	25 cd	3.00 b	36 a	1275 cd	663 de
Pronto	10	500 b	260 c	42 a	2.50 bc	45 a	1738 b	1284 b
	20	621 a	300 b	43 a	4.00 a	43 a	2391 b	1547 a
	30	735 a	330 a	44 a	5.10 a	41 a	2816 b	1722 a
CV(%)		9.7	11.1	7.0	9.6	13.9	6.8	8.6

Values followed by the same letter within a column are not different at $P = 0.05$ according to Duncan's Multiple Range Test (DMRT)

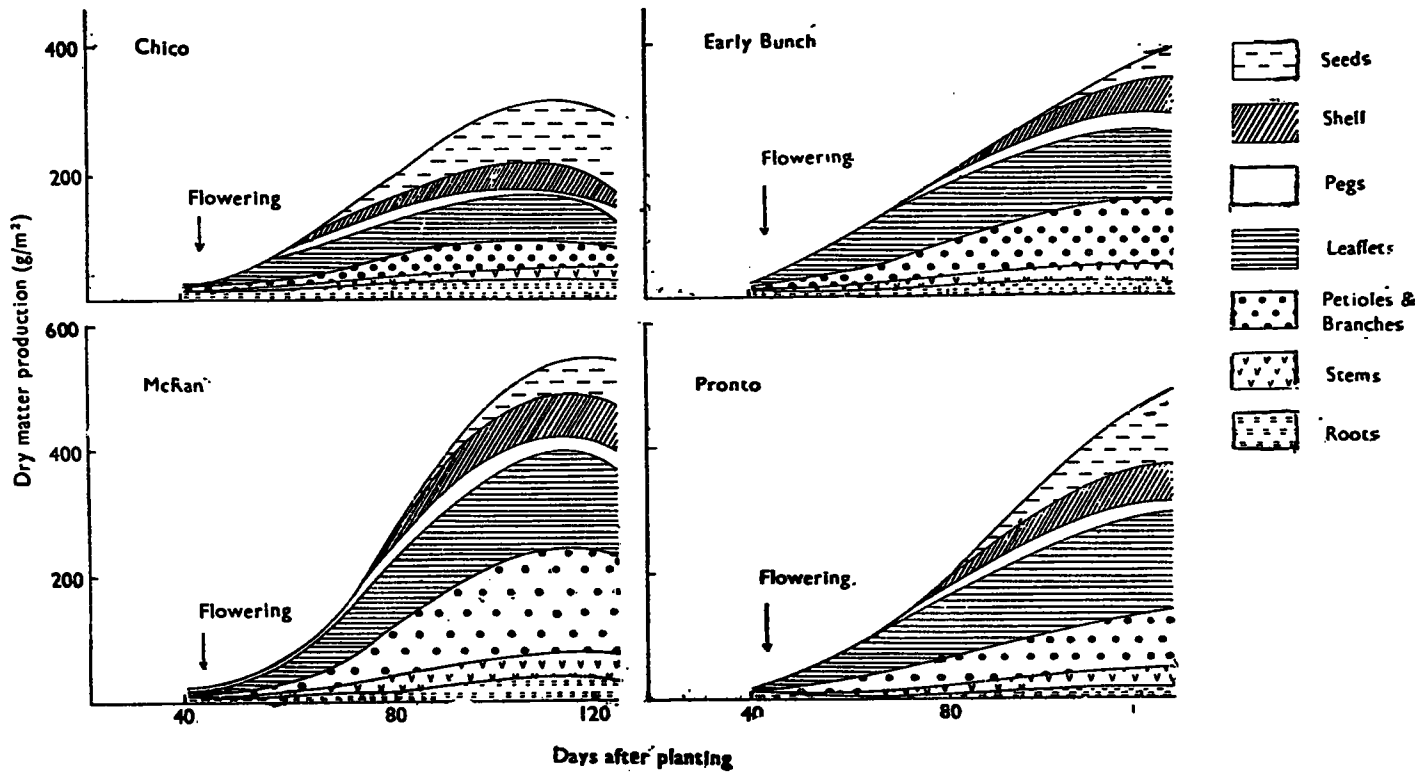


Fig. 1. Variation of dry matter yield of different Plant parts of 4 peanut cultivars with growth (plant density-10 plants /m²)

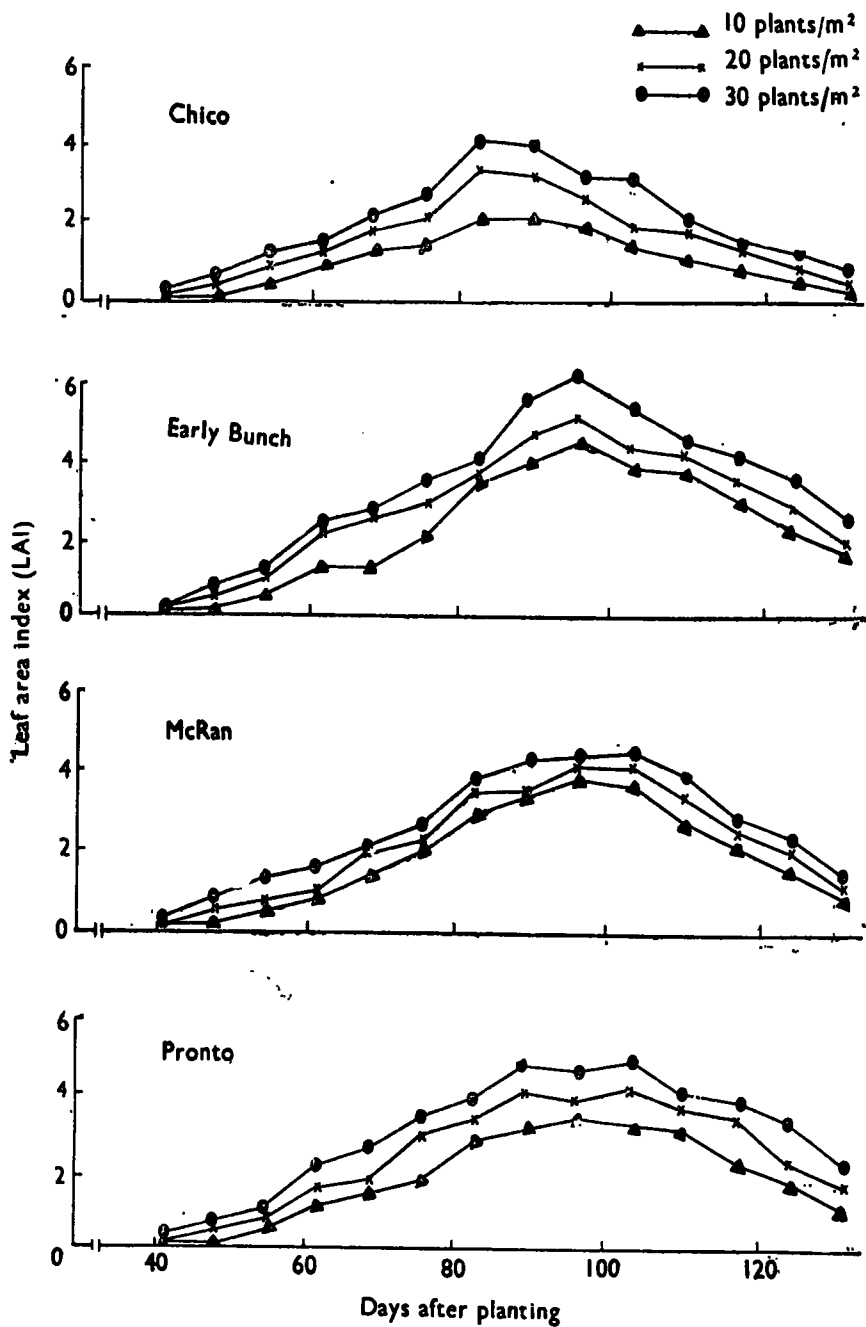


Fig. 2. Variation of LAI with growth of 4 peanut cultivars at 3 plant densities

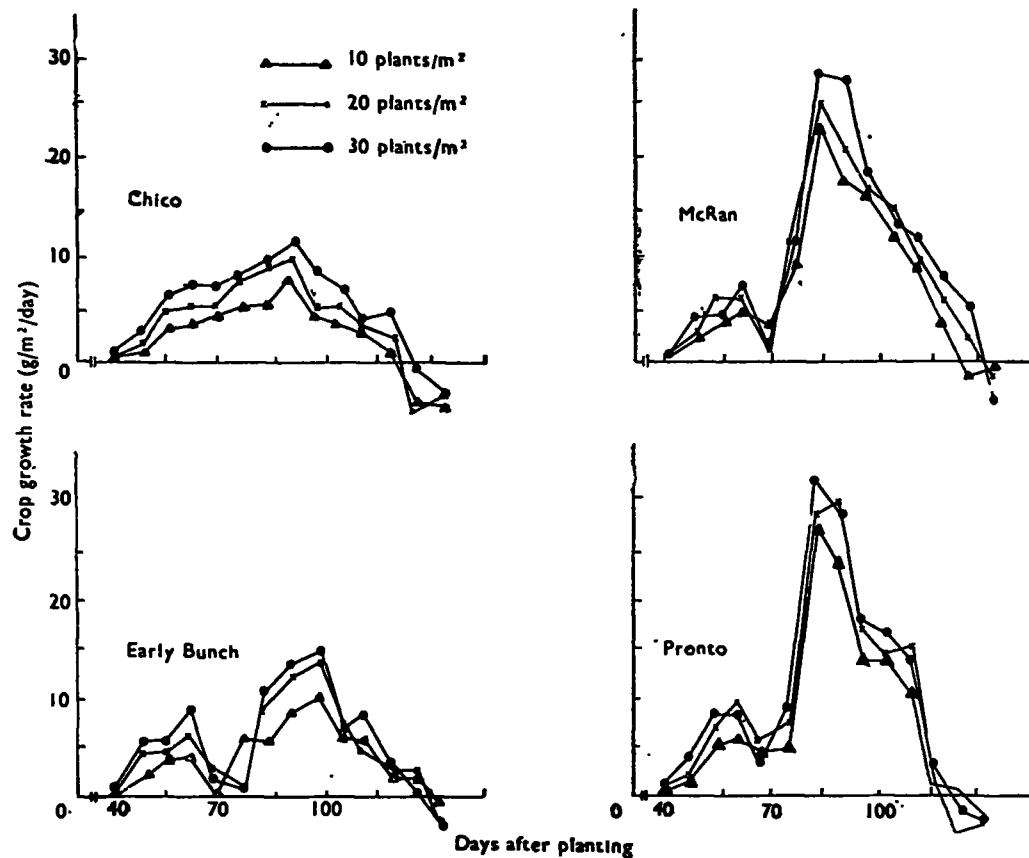


Fig. 3. Crop growth rate of 4 peanut cultivars at 3 plant densities