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The Pattern of Dry Matter Distribution During Podding and its Effect on Pod Yield in Medium Maturing Peanut Cultivars[1]

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ABSTRACT

Data collected under field conditions from 12 medium maturing peanut cultivars were used to determine the average weekly changes in the dry weight of the roots, shoots, and pods. Root growth rate appeared to have diminished with the formation of pods. However, dry matter increased significantly in both the shoot and pods until the seeds began to mature. The incremental rate of the pod dry weight was linear with time during pod filling, but declined from 88 d after planting (DAP) when most pods were physiologically inactive due to maturation. Final pod yield was positively correlated to the rate of dry matter accumulation, duration of dry matter accumulation, and number of leaves, pegs, and pods/m^2. Results suggest that significant improvements for higher pod yield can be achieved in medium maturing peanuts through selection for cultivars with high pegging and podding potentials.

Key Words: *Arachis hypogaea*, groundnut, physiological sink.

The yield of peanut, *Arachis hypogaea* L., can be improved by increasing the proportion of photosynthates allocated to the pods (10). If the physiological sink has good potential for enlargement, such a translocation would result in larger seeds. Large and well-filled seeds are preferred in most developing countries where peanuts are used as confectionery for snacks. When assimilates are deficient, empty or shrivelled pods with malformed seeds are produced. Considering these situations, the two major physiological aspects, rate and duration of dry matter accumulation, would appear to have relevance in pod yield determination. Both components have been emphasized in maize (*Zea mays* L.) (2), soybean (*Glycine max* L. Merrill) (3), and peas (*Pisum sativum* L.) (1, 6). Similar information on peanut is meager in the literature, and studies on dry matter distribution in peanut have been with early and late maturing genotypes (7, 13, 14).

The present study was initiated to investigate the contributions of rate and duration of dry matter accumulation to pod yield. As a corollary under field conditions, the changes in dry weight and number of pods, pegs, and leaves were studied to determine their effects on pod yield in medium maturing peanut cultivars.

Materials and Methods

Eleven medium maturing [average maturity more than 100 d after planting (DAP), with the exception of late maturing lines] peanut lines—namely, MDR8-15, 88-801, M517-801, M343-81A, KGUSM-8621, KGMS-42, RMP-12, M554-76, M516-791, M576-801, and KGU87-123—obtained from the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) and one medium maturing local cultivar, NS-OM1, were studied. The cultivars were planted in four-row plots. Each row was a ridge spaced 1 m apart. The within-row spacing was 30 cm. The experimental design was a randomized complete block (RCBD) with three replications. Weeding was done manually with an Indian hoe. The plants depended on residual soil fertility, and no fertilizer was applied to the plots.

Data collection began at anthesis (60 DAP) and was by destructive sampling. Two plants were harvested from each plot at weekly intervals according to Schenk (10). The pegs were counted, pods were detached, and the root portion was cut and separated from the shoot. Each fraction (root, shoot, and pods) was separately bagged and dried to a constant moisture at a temperature of 85 C in a ventilated oven. The dry weights were recorded and the results were

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analyzed as means of single plants. However, the samples collected at 95 DAP were destroyed in the course of drying and the results are not included the final analysis.

The rate of dry matter accumulation was determined by examining the post-anthesis weight-time relationships for the pod component and expressed in g/m²/d. The duration of dry matter accumulation in the pods was calculated by a slight modification of Daynard *et al.* (2) as the ratio of the final pod dry weight/m² to the mean rate of dry matter accumulation and expressed in days.

Analysis of variance was performed to test for significance using the F test as described by Little and Hills (8). When significant treatment means were detected, they were compared using the Least Significant Difference (LSD). Regression analyses between pod yield and the yield determining plant components were done with the STATGRAPHICS software computer package (12).

Results and Discussion

Figure 1 shows the pattern of dry weight changes in the root, shoot, and pods from the time of pod initiation to maturity. The regression estimates of the linear function used to describe the relationship between pod yield and the rate and duration of dry matter accumulation and the number of pods, pegs, and leaves are presented in Fig. 2a-e. The incremental rate of the pod dry weight over time is illustrated in Fig. 3 and the mean number of leaves, pods, and pegs are presented in Table 1.

Prior to pod initiation at 60 DAP, assimilates were partitioned between the vegetative structures consisting of the roots and the shoot only. Pod initiation at 60 DAP implied additional sites to which metabolites were deployed. In response, the plant changed the way its limited supply of metabolites was partitioned to the various organs. The increase in root dry weight from 67 to 102 DAP was not significant and the incremental rate appeared to diminish over time. The growth of the shoot increased progressively until 88 DAP (Fig. 1) when the rate of formation of new leaves presumably declined or approached the rate at which leaf senescence was occurring. Due to the indeterminate flowering habit of peanut (11, 13), pods were continually produced (Table 1), and

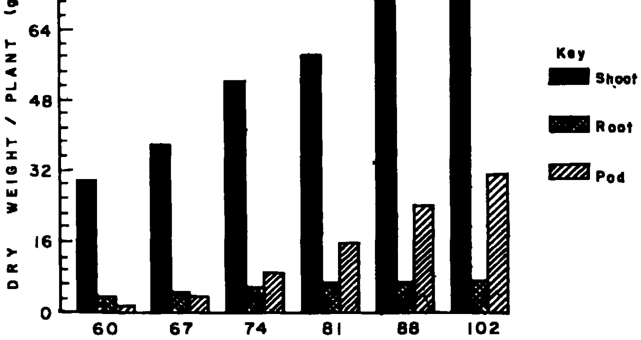

Fig. 1. Pattern of dry matter partitioning into the root, shoot, and pod from the time of pod initiation to maturity.

Table 1. Mean number of leaves, pegs, and pods/m² from pod initiation to maturity.

Days after planting	Leaves/m²	Pegs/m²	Pods/m²
	no.	no.	no.
60	256	67	21
67	309	96	42
74	372	126	69
81	408	141	90
88	489	213	132
102	492	222	144
$LSD_{(0.05)}$	17.2	5.8	3.0

pod filling appeared to have been sequential, occurring at varying number of nodes at a time (9). Correspondingly, there was continuous demand for assimilates for the growth and development of the pods. Because pods had competitive advantage over the roots, the former had the potential to divert the metabolites at the expense of the latter. This antagonistic relationship between roots and pods is likely responsible for the nonsignificant root growth during podding in peanut.

The rate and duration of dry matter accumulation were significantly and positively correlated with the final pod yield (Fig. 2a,b). The sequential podding pattern of peanut (13) may be responsible for this relationship. It is very likely that every sequential set of pods during the pod-filling stage was given priority and photosynthates were apportioned to the pods at a fast rate. After the pod-filling stage, the mobilization of assimilates may then be biased in favor of the next sequential set. Because the different sets of pods were filled at different times, the pod-filling period would be extended, thereby explaining the relevance of the duration of dry matter accumulation in the determination of the final pod yield. The significant positive correlations between pod yield and number of pods, pegs, and leaves (Fig. 2c-e) implicate these components as yield determinants. Thus, their prolific production would be an advantage to yield in medium maturing peanut cultivars.

Evidence exists that the increase in grain weight in some crop species is approximately linear with time during the greater period of pod filling (4, 5, 13). The results obtained in the present study agree with this important physiological process as can be discerned from the sigmoidal growth pattern of the pods (Fig. 3). Pod growth rates increased minimally from 60 to 67 DAP, increased rapidly from 67 to 81 DAP, increased less rapidly from 81 to 88 DAP, and declined thereafter. These are indications that pods at all stages of development attracted assimilates, but at different rates. Pods at the formative stage attracted a small amount of metabolites as implicated by the minimal initial growth phase between 60 and 67 DAP. At the period of perceptible growth rate, the plant had pods at different developmental (formative and pod filling) stages to maintain. This had a strong influence on the carbon flow and photosyn-

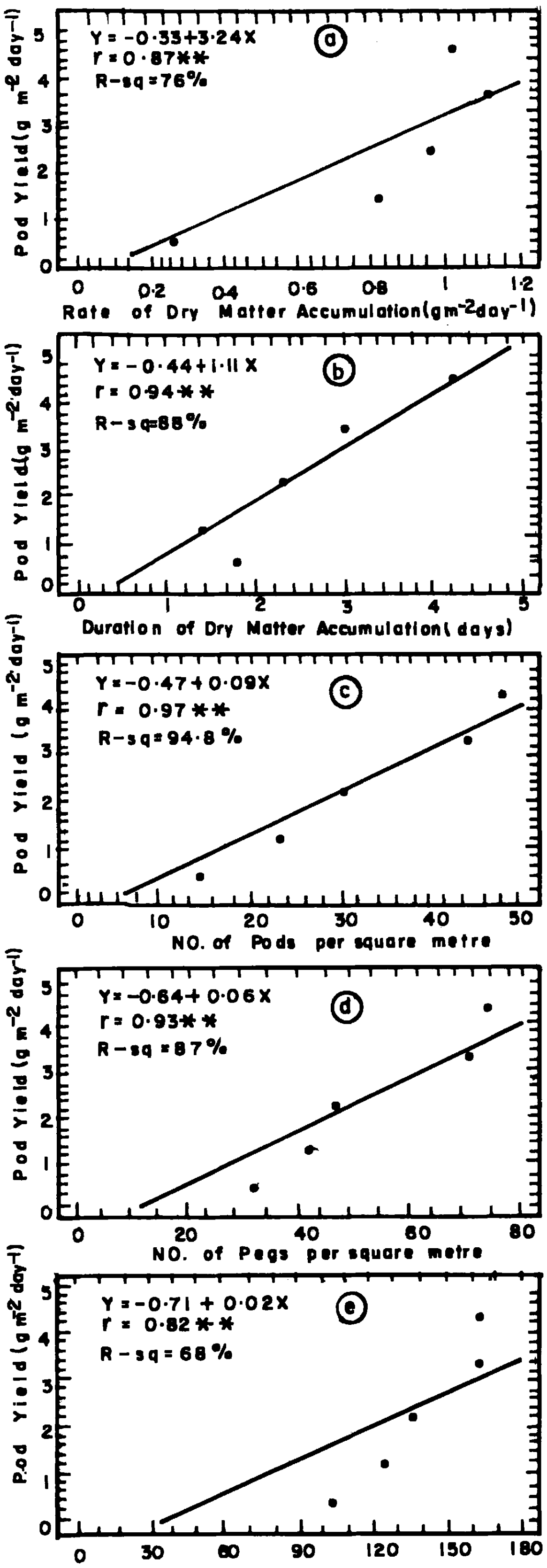

Fig. 2. Linear relationships between pod yield and (a) rate of dry matter accumulation, (b) duration of dry matter accumulation, (c) number of pods, (d) number of pegs, and (e) number of leaves/m².

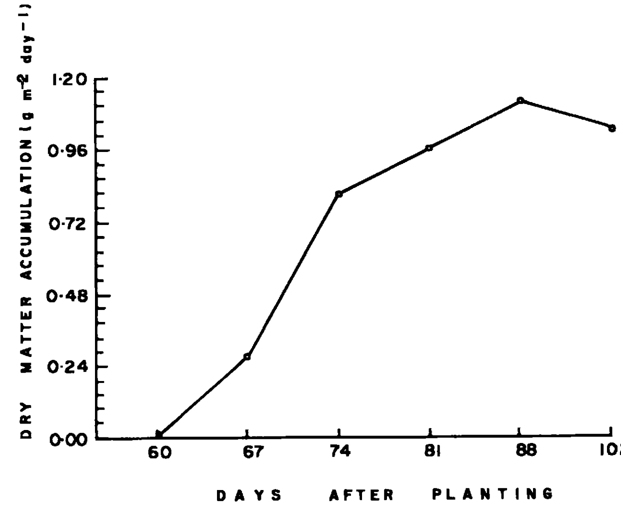

Fig. 3. Incremental rate of dry weight of the pod from pod initiation to pod maturity in peanut.

thates were preferentially apportioned to the pods. After 88 DAP, there were maturation indications such as leaf senescence as implicated by the drop in the incremental rate of the number of leaves (Table 1). As most pods have passed through the pod-filling stage, they became physiologically inactive and the plants' demands for metabolites were essentially for the maintenance of the later-formed pods. This accounts for the decline in the rate of dry matter deployment to the pods after 88 DAP.

The results of this study indicated the vulnerable period for high assimilate demand for optimum pod development and pod sustenance in medium maturing peanut cultivars. Although pod maturity in the present study was attained at about 102 DAP, a slight delay in the harvest of medium maturing cultivars may be of practical significance. This proposition is due to the direct contributions of the duration of dry matter accumulation to the final pod yield. Additionally, significant improvements for higher pod yield can be achieved in medium maturing peanut through selection for cultivars with prolific peg and pod production.

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