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A Physiological Analysis of the Branching Pattern in Sequential Types of Groundnut in Relation to the Fruiting Nodes and the Total Mature Pods Produced

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ABSTRACT

The branching pattern of eight sequential branching types of groundnut was studied and the contribution of each node (fruiting point) of the n, $n+1$ and $n+2$ branches (if present) to the total number of mature pods per plant ascertained. The results indicated that $n+2$ branches were present in several varieties and their contribution to mature pods was significant in some of them. The first three nodes of the $n+1$ branches contributed from 50.6 per cent (in a variety which had significantly more $n+2$ branches) to 88 per cent in other varieties. The results also indicated that the contribution of the late formed $n+1$ branches was low and the total mature pods produced from all nodes decreased with each successive (chronologically) $n+1$ branch in all the varieties studied. Neither the total number of $n+1$ branches nor the number of mature pods per node was related to the pod number or pod yield, but the total number of fruiting points from all branches showed a high correlation with pod yield and mature pod number at harvest. The results suggest that for higher pod yield it may be desirable to have only a few $n+1$ branches (4 or 5) but with more fruiting points on each branch.

Key words: *Arachis hypogaea*, branching pattern, sequential types, fruiting points.

INTRODUCTION

The cultivated groundnut (*Arachis hypogaea* L.) has been divided into two subspecies, *hypogaea* and *fastigiata* (Bunting, 1955; Smartt, 1961). These two subspecies primarily differ in the distribution of vegetative branches and inflorescences (reproductive branches) in the axils of the leaves on the main axis and the branches. In both the subspecies, primary vegetative branches (the so-called $n+1$ branches, the main axis being conventionally numbered n) arise in the axils of the cotyledons and at a number (seldom exceeding six) of higher nodes on the main axis.

In the subspecies *fastigiata* (Spanish *valencia*) inflorescences are borne at the second and several subsequent nodes of the primary branches in a sequential manner. The first node on such a branch may bear a secondary ($n+2$) branch (Smartt, 1961), but often it too bears an inflorescence.

In the subspecies *hypogaea* (Gregory, Smith and Yarbrough, 1951) the first two nodes of $n+1$ branches normally bear vegetative ($n+2$) branches, the next two bear inflorescences, the next two vegetative branches, and so on. The same sequence is repeated on the $n+2$ branches. In the sequential branching type (Spanish bunch), therefore, the reproductive branches are borne on the main axis as well as on the branches in a sequential manner (Gregory *et al*, 1951; Bunting, 1955, 1958; Smartt, 1961). Also

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in the sequential types, $n+2$ branches are few in number or absent in most varieties, or present only at higher nodes of $n+1$ branches.

Several studies have stressed the importance of the $n+1$ branches as a factor influencing pod yield (Dorairaj, 1962; Mahapatra, 1966; Sangha and Sandhu, 1975;

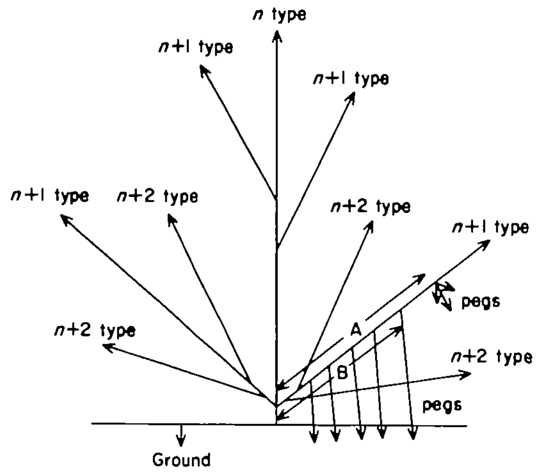

FIG. 1. A diagrammatic representation of the branching pattern in the sequential branching types (Spanish bunch). A, Total peg bearing zone. B, Total pod bearing zone. *n*, Main axis; $n+1$-primary branch; $n+2$, secondary branch.

Choudhary, Udaya Kumar and Sastry, 1985). There is considerable ambiguity with regard to the presence of $n+2$ branches in the sequential types, and, if present, their relative contribution to the total mature pods produced in relation to the $n+1$ branches has also not been critically analyzed. A recent study (Choudhary *et al.*, 1985) has shown that $n+2$ branches were present in most of the 30 bunch varieties studied and that, although the overall contribution of pods from $n+2$ branches was much less than the $n+1$ branches, there were significant differences amongst varieties in the number and contribution of pods on these $n+2$ branches.

In order to resolve these questions, a detailed analysis of the mature and immature pods from n, $n+1$ and $n+2$ branches (if present) were made in eight sequential branching cultivars (Spanish bunch) of groundnut. New information on the total number of fruiting points on each branch and the number of pods from each fruiting point was also determined. This was related to the total number of mature pods produced per plant at harvest from all branches.

MATERIALS AND METHODS

Eight varieties of groundnut (Spanish bunch) were grown in a field experiment conducted during summer 1982 in the red loam soils of the Gandhi Krishi Vignana Kendra (GKVK) Farm, University of Agricultural Sciences, Bangalore. Each variety was sown in plots measuring 3 × 3 m in three replications, with a spacing of 30 cm between rows and 15 cm between plants. There were thus 200 plants of each variety in each plot. A fertilizer dose of 25 kg N ha^{-1} as urea, 60 kg P_2O_5 ha^{-1} as single superphosphate and 25 kg K ha^{-1} as muriate of potash was given at the time of sowing. The crop was irrigated at weekly intervals. At harvest, 10 sample plants of each variety were selected from each replication for detailed observations on the following traits: (1) Number of $n+1$ and $n+2$ branches;

TABLE 1. *Analysis of* n+1 *branches: Contribution of different nodes of* n+1 *branches to total mature pod number per plant*

	From all nodes							
Varieties	Average number of *n*+1 branches	Number of mature pods from *n*+1 branches	Per cent contribution of *n*+1 branches to total mature pods per plant	Number of mature pods from the 1st three nodes of *n*+1 branches	Per cent contribution of 1st three nodes to number of mature pods	Mature pods from upper nodes (above 3rd nodes)	Mature pods per plant	Pod dry weight per plant (g per/plant)
X 1–21B	5·2	35·0	89·0	30·0	76·3	5·0	39·3	16·5
13–10	5·3	18·7	86·9	15·1	70·2	3·6	21·5	8·2
DH 4	5·6	32·0	71·1	22·8	50·6	9·2	45·0	18·7
OG 11–3	6·8	29·3	82·7	23·8	67·2	5·5	35·4	15·8
DH 8	5·8	25·8	67·2	21·3	67·2	4·5	31·7	14·1
RSHY 1	5·6	28·3	88·9	23·2	72·9	5·1	31·8	14·6
JL 25	5·5	22·2	97·8	20·0	77·1	2·2	22·7	9·3
S 206	5·4	27·0	97·8	21·6	78·2	5·4	27·6	12·2
LSD ($P < 0.05$)	1·2	6·2	—	5·2	—	1·6	6·2	4·2

TABLE 2. *Analysis of the numbers of pods on the* n *branch and* n + 2 *branches (if present) and their per cent contribution to the total number of mature pods*

	n		*n*+2		
Variety	Number of pods per plant (mature)	Per cent contribution to total mature pods per plant	Average number of *n*+2 branches	Number of mature pods on *n*+2 branches	Per cent contribution to total mature pods per plant
X 1–21B	0·8	2·0	3·0	3·5	8·9
13–10	1·5	6·9	1·4	1·3	6·0
DH 4	3·5	7·7	5·9	9·5	21·1
OG 11–3	3·5	9·8	1·7	2·6	7·3
DH 8	3·5	11·0	2·8	2·4	7·6
RSHY 1	1·7	5·3	1·4	1·8	5·6
JL 25	0·5	2·2	—	—	—
S 206	0·6	2·1	—	—	—
LSD ($P < 0{\cdot}05$)	1·5	—	1·5	2·4	—

(2 a) Number of mature pods present on all $n+1$ and $n+2$ branches; (2b) The branches were tagged chronologically and the number of pods produced from each successive $n+1$ branch was determined; (3) Number of fruiting points on individual n, $n+1$ and $n+2$ branches. A fruiting point was designated as the node from which a flower had developed into a pod.

The branches were designated as n, $n+1$ and $n+2$ based on the classification of Bunting (1955) as shown in Fig. 1.

TABLE 3. *Total number of fruiting points from* n, n+1 *and* n+2 *branches and number of mature pods per fruiting point*

Genotypes	$n+1$	$n+2$	n	Total	Mature pod number per plant	Number of pods per fruiting point
X 1–21B	18·4	2·7	0·9	22·0	39·3	1·79
13–10	11·5	1·2	1·3	14·0	21·5	1·54
DH 4	20·8	8·5	2·3	31·6	45·0	1·42
OG 11–3	22·6	2·1	2·1	27·2	35·4	1·30
DH 8	16·4	2·5	0·2	19·1	31·7	1·66
RSHY 1	15·2	1·7	1·5	18·4	31·8	1·73
JL 25	15·2	—	0·4	15·6	22·7	1·46
S 206	15·0	—	0·5	15·5	27·6	1·78

RESULTS

Contribution of n, n+1 *and* n+2 *branches*

The number of $n+1$ branches varied from 5·2 to 6·8 (Table 1). Except in the variety OG 11–3, the differences in number of $n+1$ branches between the cultivars were not significant. The contribution of mature pods from all the nodes of all $n+1$ branches to the total mature pods produced per plant ranged from 67 per cent in variety DH 8 to nearly 98 per cent in S 206 and JL 25. The first three nodes of the $n+1$ branches were more productive than the younger nodes and their contribution to the total pod number ranged from 50·6 per cent in variety DH 4 to 78·2 per cent in variety S 206.

The contribution of the n branch to the total number of pods ranged from only 2·0 per cent in X 1–21B to 11·0 per cent in DH 8 (Table 2). Those pods which were formed were present only in the first two or three nodes on the n branch (data not given).

Sequential branching types do not always have $n+2$ branches (Bunting, 1958; Smartt, 1961). In this study, six out of eight varieties produced pods on the $n+2$ branches. In particular, variety DH 4 produced a large proportion of its pods from $n+1$ (71·1 per cent) and $n+2$ (21·1 per cent) branches (Table 2) resulting in a high pod yield per plant (Table 1). In cultivars JL 25 and S 206 $n+2$ branches were absent, and only the n and $n+1$ branches produced pods. The total mature pod number and pod dry weight in these two cultivars and in cultivar 13–10, was less than the other cultivars.

Mature pods from each successive n+1 *branch*

The number of mature pods decreased markedly with each successive $n+1$ branch (Fig. 2). Such a trend was observed in all the varieties. The data on the number and distribution of fruiting points on the n, $n+1$ and $n+2$ branches is presented in Table 3. The total number of fruiting points ranged from only 14·0 in variety 13–10 to 31·6 in DH 4 where the $n+2$ branches contributed 8·5 fruiting points. The contribution of the $n+2$ and n branches was much less in the other varieties. There was a positive significant relationship between the number of fruiting points and total number of pods per plant ($r = 0{\cdot}87$). There were no differences amongst cultivars in the number of pods produced per fruiting point. The relationship between number of $n+1$ branches per plant and pod number per plant was not significant ($r = 0{\cdot}227$) (Table 4).

TABLE 4. *Correlation values to show the relationship between mature pod number per plant and other characteristics*

Characters	Total mature pod number per plant at harvest	
	r-value	Significance
1. Number of $n+1$ branches	+0·22	n.s.
2. Contribution of upper nodes of $n+1$ branches (above 3rd node)	+0·60	**
3. Total number of fruiting points per plant	+0·87	**

**$P < 0{\cdot}01$; n.s., not significant.

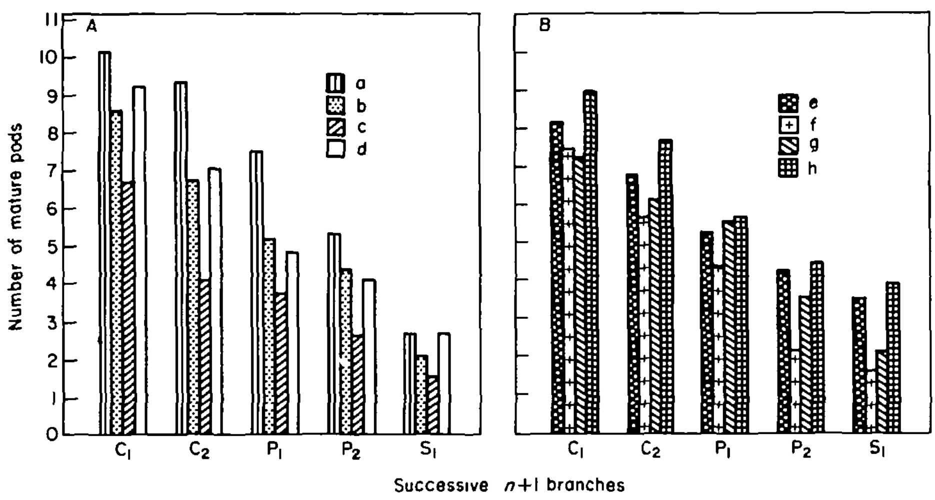

FIG. 2. Number of mature pods from all the nodes of each successive $n+1$, branch produced in chronological order. C-1 and C-2 represent the first two cotyledonary branches, P-1 and 2 the next two primaries, and S_1, S_2...Sn the secondary $n+1$ branches produced on the n branch. A, Cultivars (a) X-1-21-B, (b) S 206, (c) 13–10 (d) RSHY 1. B, Cultivars (e) OG 11–3, (f) JL 25, (g) DH 8, (h) DH 4.

DISCUSSION

In the present study significant genotypic variation was observed in the number of fruiting points and in the pod weight and number of mature pods produced per plant. The lack of a significant relationship between the number of $n+1$ branches and pod number per plant shows the importance of the number of fruiting points per plant and the number of pods per fruiting point for achieving higher pod numbers. The former character appears to be more important to explore in any breeding programme, because there is little difference between varieties in the number of mature pods per fruiting point. This point is illustrated further in the data presented in Table 4. Since there were relatively few fruiting points in the later formed $n+1$ branches (Fig. 2), any increase in the number of fruiting points would be most likely to be found in the lower $n+1$ branches.

An increase in the number of $n+1$ branches can increase pod number but could introduce a time lag in flowering between the early formed and late formed branches. Inadequate synchrony in the development of reproductive organs usually results in the establishment of early formed sinks as potential pods which obtain more than 90 per cent of the current photosynthates translocated to the reproductive organs (Choudhary *et al.*, 1985). Both vegetative and reproductive organs compete for photosynthates in groundnut resulting in both inter-and intra-organ competition (Bunting, unpublished). It may be better, therefore, to select genotypes with fewer $n+1$ branches per plant, but with more fruiting points per branch, possibly by increasing the length of the fruiting zone on each branch.

An alternative or additional approach in sequential branching types could be to increase the $n+2$ branches. The $n+2$ branches on the cotyledonary $n+1$ branches (if present) would be produced earlier than $n+1$ branches in the upper nodes of the main axis. Since these $n+2$ branches are nearer to the ground surface, and are produced early during the development of plants, they can contribute towards an increased pod number per plant and the present data show that there are genotypes with distinctly higher contributions from $n+2$ branches, confirming observations of Choudhary *et al.* (1985).

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