

## POD AND BEAN CHARACTERISTICS OF COCOA HYBRIDS DURING EARLY YEARS OF BEARING

V. ANIL KUMAR\*, D. BALASIMHA and K. S. ANANDA

*Central Plantation Crops Research Institute,  
Regional Station, Vittal 574 243, Karnataka*

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### ABSTRACT

Nine cocoa hybrids and seven parents were evaluated for their pod and bean characters during two seasons. Maximum number of beans per pod were noted in the hybrid I-29 × NC 23/43 (41/pod). Single dry bean weight ranged from 0.610 to 1.066g and the maximum was showed by the cross II-67 × NC 29/66. Likewise pod index ranged from 53.92 to 21.72, and the least value was noted in the cross II-67 × NC29/66. Quantification of some of the biochemical constituents like total fat, sugars, amino acids and phenolics were also performed. Hybrid II-67 × NC42/94 has given the highest fat content of 43 per cent. Seasonal and varietal variations were found to be significant for most of the traits studied. The dry bean weight showed considerable decrease during the second season (0.873g to 0.789g). Correlation studies revealed that there exists a positive correlation of ovary weight to single bean weight and pulp percentage showed a negative correlation to the pH of the bean.

Key words: Pod value, Fat content, Bean characters, Cocoa hybrids

### INTRODUCTION

In any crop improvement programme an assessment of variability is of immense value in identifying superior genotypes. The main objective of cocoa breeding, besides breeding for pest and diseases or to drought tolerance, is to increase yield which is one of the highly variable metric characters (Soria, 1975). The pod value studied provides fine details of commercially desirable yield character of cocoa cultivars. Variability for bean size, pod weight, shell per cent, bean weight, number of beans/pod have been reported in cocoa clones of different genetic origin and significant differences found for these characters (Enriquist and Soria, 1968; Kumaran and Prasanna-kumari, 1981; Subramonian and Balasimha, 1981; Mallika *et al*, 1996).

This study was initiated to evaluate the extent of variability found in the hybrids over their parents with respect to season and for various crosses for some of the important traits like weight of fresh pod, number of beans per pod, dry peeled bean weight, pulp per cent and quantification of some of the biochemical constituents like total fat, free amino acids, sugars and total phenolics in the fermented nibs.

### MATERIALS AND METHODS

The cocoa genotypes used in the experiment were grown as mixed crop in arecanut (*Areca catechu* L.) under irrigated conditions at CPCRI Seed Farm, Kidu, Karnataka. The pods harvested from nine hybrids (I-14 × NC29/66, I-14 × NC 42/94, I-21 × NC23/43, I-21 × NC 29/66, I-21 × NC42/94, I-29 ×

\* Present address: Jr Field Officer, Rubber Board, Kanhangad - 671 321, Kerala

NC23/43, I-29 × NC42/94, II-67 × NC29/66, II-67 × NC42/94) and seven parents (I-14, I-21, I-29, II-67, NC23/43, NC29/66, NC42/94) planted in a randomized block design with three replications were used for the study. They were planted as mixed crops in arecanut garden under irrigated condition at CPCRI Seed Farm, Kidu, Karnataka. Nine healthy open pollinated pods (3×3) were harvested and weighed. The wet beans with mucilage (without placenta) were weighed and beans counted. Pulp per cent was determined as reported by Subramonian and Balasimha (1981). Beans were fermented by box method (Wood and Lass, 1985) and oven dried. Dry bean weight before and after peeling were taken. Experiment was conducted in two seasons during 1995 and 1996; one during February - March and the other during the peak harvest (June-July). Pod value (Atanda and

Jacob, 1973) and pod index (Paulin and Eskes, 1995) were also calculated. Ovary weight was determined by weighing the gynoecial part of 50 excised flowers after two days of anthesis.

Biochemical analysis was carried out by standard methods. Extraction of fat was done by chloroform methanol 2:1 solvent system in soxhlet extractor for six hours and quantified gravimetrically. The defatted nibs were used for amino acid (More and Stein, 1948), sugars by phenol sulphuric acid method (Dubois et al, 1956) and phenolics by Swain and Hills (1959). All quantifications were done in the pooled samples of the nibs. Data were statistically analysed and correlation for some of the traits were developed.

## RESULTS AND DISCUSSION

Wide significant variations existed in all pod and bean characters between accessions (Table 1). The highest pod

**Table 1. Pod and bean characters of cocoa hybrids and parents**

Accessions	Freshpod Weight (g)	Number of beans	Wet bean weight (g)	Dry bean weight (g)	Shell (%)	Pod value	Pod index
<b>Hybrids</b>							
I-14 × NC29/66	239.4	31.8	87.4	0.91	10.6	31.9	31.5
I-14 × NC42/94	316.5	32.4	117.1	0.88	8.3	30.9	32.3
I-21 × NC23/43	365.9	40.3	95.0	0.77	14.5	35.3	28.4
I-21 × NC29/66	383.0	34.7	91.6	1.03	9.9	39.4	25.9
I-21 × NC42/94	295.0	31.1	80.4	0.77	14.8	27.5	36.6
I-29 × NC23/43	276.0	41.0	75.8	0.66	8.8	29.5	33.9
I-29 × NC42/94	316.5	29.4	85.8	0.73	12.2	24.1	41.7
II-67 × NC29/66	466.6	39.3	109.3	1.07	13.7	47.9	21.7
II-67 × NC42/94	438.5	36.9	99.8	0.99	12.1	41.2	24.7
<b>Parents</b>							
I-14	378.7	37.7	130.7	0.87	9.3	35.9	28.0
I-21	397.9	32.5	100.0	0.73	11.4	26.2	39.4
I-29	345.7	32.3	82.5	0.80	10.9	28.6	35.0
II-67	420.5	37.8	127.7	0.93	13.0	39.9	25.2
NC23/43	366.0	33.0	77.2	0.68	10.9	24.9	40.3
NC29/66	226.0	28.1	60.1	0.61	9.5	19.7	53.9
NC42/94	391.0	35.8	109.7	0.85	11.5	34.1	29.6
<b>LSD (p &lt; 0.01)</b>	<b>37.2</b>	<b>3.2</b>	<b>14.7</b>	<b>0.08</b>	<b>2.4</b>	<b>3.9</b>	<b>4.3</b>

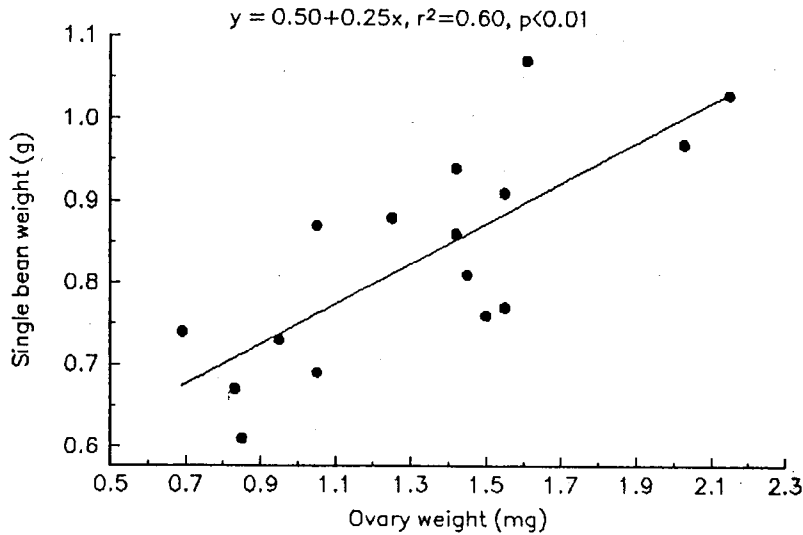


Fig. 1. Correlation of single bean weight to ovary weight.

value was noticed in the cross II-67 × NC29/66 (47.86g) followed by II -67 × NC42/94 (41.25g) and among parents II-67 showed the highest (39.90g) value. Pod value is the dry peeled bean weight/pod and it gives a direct indication of actual yield on commercial basis. So the highest pod value shown by the cross II-67 × NC29/66 should have come from the mother parent II-67. In the case of pod index also the same trend was observed. The hybrid II-67 × NC29/66 showed the least pod index value (21.47) and the cross I-29 × NC42/94 showed the highest value for pod index (41.74) among the hybrids. The higher the pod index the more the

number of pods required to make one kilogram dry bean. Except for the pulp per cent all the other traits showed significant variation among the hybrids.

Correlation studies with respect to ovary weight after two days of anthesis to the single bean dry weight showed a positive correlation. The accessions with higher ovary weights had higher single bean weight (Fig 1). This will be helpful for the characterization and cataloguing of the pod characters in cocoa as suggested by Bekele (1993).

The influence of seasonal variation on pod and related characters were found to be significant (Table 2). Fresh pod weight showed an increase of weight

Table 2. Seasonal changes in bean and pod characteristics of cocoa hybrids and parents

Treatment	Fresh pod weight (g)	Number of beans	Fresh bean weight (g)	Dry bean weight (g)	Pulp (%)	Shell (%)	Pod value	Pod index
Season I (Feb-Mar)	335.25	35.25	97.16	0.873	41.28	9.57	33.92	31.56
Season II (June-July)	367.66	34.07	94.16	0.789	57.74	13.14	30.58	34.37
<b>LSD</b>	<b>6.61**</b>	<b>1.11*</b>	<b>NS</b>	<b>0.042**</b>	<b>1.654**</b>	<b>0.978**</b>	<b>2.17**</b>	<b>1.80**</b>

p < (\*\*) or 0.05(\*)

in the second season than the first season. The mucilage per cent also showed considerable increase over the first season. So the increase in initial weight of pod may be contributed by the pulp. Single dry peeled bean weight decreased during the peak harvest. This may be due to the heavy bearing during

that period. This was in corroboration with Taxopeus and Wessels (1970). Here the second season pods mainly developed during the summer period. There is not much variation in the number of beans produced during these two seasons, which indicates that these are not affected by environ-

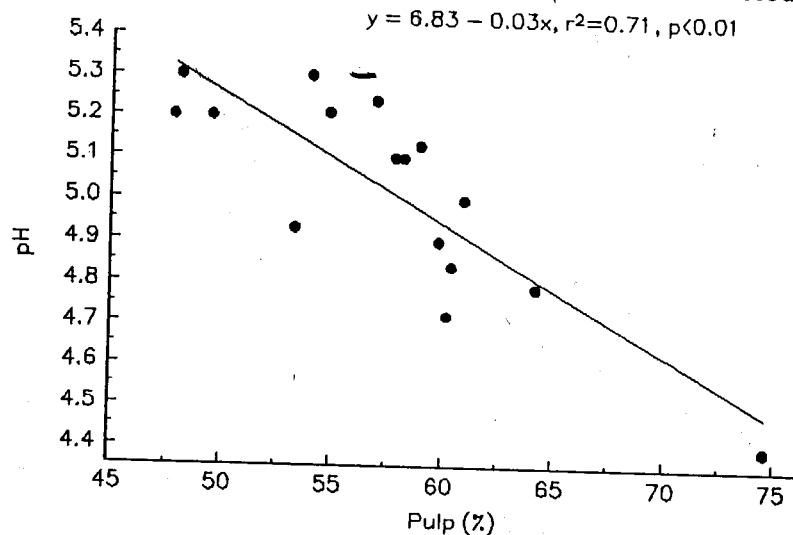


Fig. 2. Relationship between pulp pH and pulp content of pods.

Table 3. Biochemical constituents of cocoa hybrids and parents

Accessions	Fat (%)	Aminoacid N $\mu$ g/g	Sugars mg/g	Phenolics mg/g
<b>Hybrids</b>				
I-14 $\times$ NC29/66	41.3	44.2	12.17	2.308
I-14 $\times$ NC42/94	29.4	60.2	15.17	2.568
I-21 $\times$ NC23/43	39.6	50.4	10.61	1.852
I-21 $\times$ NC29/66	36.4	62.0	12.12	2.048
I-21 $\times$ NC42/94	31.9	52.6	16.27	2.061
I-29 $\times$ NC23/43	33.4	67.8	20.65	2.696
I-29 $\times$ NC42/94	30.3	36.6	15.54	2.048
II-67 $\times$ NC29/66	40.1	73.6	17.66	3.567
II-67 $\times$ NC42/94	43.3	50.8	20.83	2.892
<b>Parents</b>				
I-14	31.2	82.4	15.22	2.372
I-21	34.3	50.6	19.50	2.176
I-29	40.7	39.5	12.66	2.764
II-67	32.6	53.2	22.00	2.965
NC23/43	29.8	26.8	16.65	2.372
NC29/66	34.9	21.3	14.44	2.184
NC42/94	30.4	65.0	19.61	3.640

mental factors but are genetically controlled. Relationship between pH and pulp per cent revealed that they are negatively correlated (Fig 2). Chick *et al*, (1981) reported that volatile acidity gets reduced by decreasing the pulp volume.

Total fat varied from 29 per cent to 43 per cent among the lines studied (Table 3). The parent line NC23/43 showed the least fat content (30%) whereas the cross II-67 x NC42/94 and I-14 x NC29/66 showed the highest fat content of 43 and 41% respectively. Butter content of cocoa nibs is important as it is one of the major quality deter-

mining factors. Among the other biochemical constituents studied free amino acids showed variation among the accessions but sugars and phenolics did not vary much among the hybrids studied. These biochemical components are indirectly taking part in determining the quality of beans. Based on these results the hybrids II-67 x NC42/94 and II-67 x NC29/66 were found promising for future planting and breeding programmes.

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