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SPECIFIC GRAVITY SELECTION OF SEEDS IN COCOA AND CASHEW

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ABSTRACT

This paper gives the results of a trial conducted to study the impact of specific gravity selection of seeds on germination and seedling vigour. Seeds of cocoa and cashew were classified into different specific gravity groups using a water-sugar system. The seeds from each group was studied for their performance with respect to germination, shoot and root growth, leaf production and dry matter accumulation.

Seeds of higher specific gravity gave significantly earlier and higher germination in cashew and better seedling growth and dry matter production in cocoa and cashew. In cashew a vigour index could be calculated based on germination rate and period required for germination. Seed specific gravity is found to be a convenient practical criterion for assessing seed vigour. Elimination of the lower specific gravity groups can enhance the speed and rate of germination as well as ensure vigorous seedlings.

INTRODUCTION

Seed vigour can be defined as the condition that permits germination to proceed rapidly and uniformly resulting in the production of uniform seedling stands. Size, weight and density are commonly recognised as the components of seed vigour. Selection of seeds based on these components have been found useful in barley (Boyd, *et al.* 1971), spring wheat (Austenson and Walton, 1970), *Lolium* (Thomas, 1966), and *Bromus* (Tossel, 1960). In soyabeans, mass selection of seeds based on specific gravity is being used in selection programmes (Hartwig and Collins, 1962; Fohr and Weber, 1968; Smith and Weber, 1968). Seed characters were reported as influencing establishment ability also (Allen *et al.* 1965; Rafii and Barnett, 1970; Wright, 1971).

The information available on the subject is much less in plantation crops, though heavier seeds were reported to influence the quality and vigour of seedlings in arecanut (Bavappa, *et al.*, 1964), cashew (Northwood 1967, Turner, 1956) and rubber (Saraswathy Amma and Nair, 1976). The studies conducted at CPCRI Regional Station at Vittal have shown that specific gravity of seeds could be used as an efficient mass selection criterion in cashew (Menon *et al.*, 1979) and cacao. The present paper summarises the results of these studies.

Materials and Methods

In the present study, specific gravity (sg) of seeds was used as the screening criterion instead of seed weight, as the former will be a better indicator of dry matter content. Specific gravity of seeds has been defined as the ratio of the weight of a given volume of seed to that of an equal volume of another substance used as a standard (Fohr and Weber, 1968). Specific gravity was determined by keeping the seeds in water, and then in a series of sugar solutions of increasing sg. The seeds that float belong to the lower sg group. In this way cacao seeds were classified into five sg groups; less than 1.00 (T1). 1.00-1.03 (T2); 1.03-1.06 (T3); 1.06-1.09 (T4) and above 1.09 (T5). In the case of cashew only four groups were recognised: below 1.03 (T1); 1.03-1.06 (T2) 1.06-1.09 (T3) and above 1.09 (T4). The seeds were kept for 2-3 minutes in each solution before taking to the next higher grade. After each, the seeds were blotted dry. In the case of cashew, seeds from a bulk sample were used while in the case of cacao fresh seeds from four genotypes were used.

The seeds from each sg class were sown in polybags, kept in uniform shade in a polyethylene roofed house under uniform conditions. Germination, growth and other characters were recorded from each treatment. Two applications of an NPK mixture (2% Suphala) were given to all seedlings. The cashew seedlings were taken out after 90 days and the cacao seedlings after 100 days, by cutting open the bags and immersing them in water so as to get the root system undamaged. Shoot length, root length, leaf number, root and shoot fresh and dry weights were recorded in a random sample of 25 seedlings from each treatment. Dry weight was recorded after drying the shoots and roots at 1100C for 48 hrs.

Results and Discussion

The frequency of seeds falling in the different sg groups followed almost a normal distribution in cashew with the maximum number (68%) occurring in the middle groups. The highest frequency was in T3 (27%) while about 45% of the seeds were in the lower sg groups (T1 and T2).

In the case of cacao, the distribution of seeds in the various sg groups was different in the four genotypes studied (Fig. 1). In one genotype, it was almost normally distributed, while in others the seeds were concentrated in one or two sg groups. In all the types the highest frequency was in the T4 class (1.06-1.09).

Certain extent of variability could be expected in cacao because of the heterozygous nature of the species. Still the distribution pattern of sg groups seems to be an inherent character, because the same pattern was noted when seeds were collected from different trees and studied.

In cashew, higher sg groups gave significantly higher germination percentage compared with the lower groups (Table 1). In the last two groups (T3 and T4) 45% of the seeds had germinated by the 13th day, and by the 20th day 93% seeds were germinated, while in the lowest sg group germination was below 50%. Correlation of date of germination and frequency of seeds germinated in each day was significantly negative. In the T4 group the Gr_50 (50% germination rate) was reached by the 14th day, while in T1, Gr_50 could be reached only by the 23rd day, and that was also the highest germination obtained. Correlation between germination and sg was highly significant (0.84).

In cacao, reduction in germination was noted in the two lower groups; those in T1 (below 1.00) gave only 36% germination, while T2 (1.00-1.03) gave 72%. No differences were observed in the period required for germination in the different sg classes. The difference between the two species could be expected because of the difference in their physiological make up. In cacao the seeds were fresh and physiologically active and the germination process started immediately after sowing, while in cashew the seeds were dormant and dry.

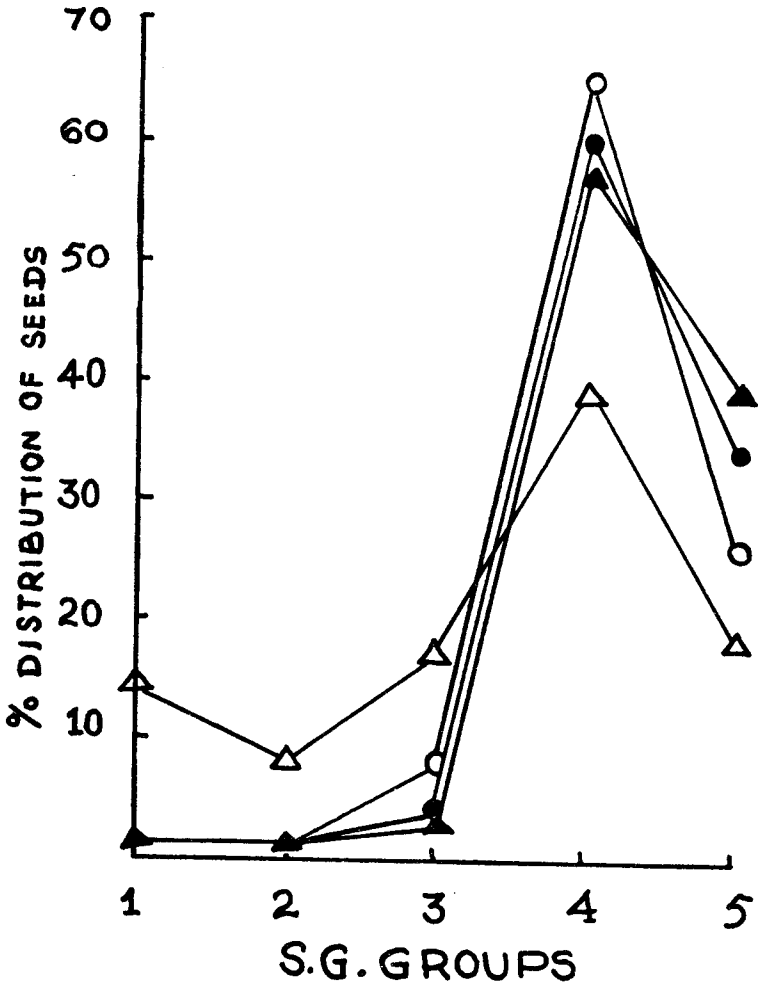

Fig. 1. Distribution of specific gravity (sg) groups in the four cacao genotypes.

In cashew it was found possible to compute a vigour index (VI) using the formula: VI = NX/DX, where NX = number of seeds germinated in X days, DX = number of days from beginning of germination test to X days. (Camrago and Vaughan, 1973). The index values obtained were 4.16, 7.08, 7.33 and 8.17 for the treatments T1, T2, T3 and T4 respectively (Table 1). The greater the VI value the greater the germination ability and thus greater will be the seed vigour.

Table 1. Germination (%), vigour index and coefficient of correlation (R) between germination date and frequency of germination in different sg groups (Cashew)

SG groups	Germination (%)	r	b	Vigour index
T1 (1.03)	.. 50*c****	—0.84**	—0.75**	4.16
T2 (1.03-1.06)	.. 85 *abc*	—0.61*	—0.70*	7.08
T3 (1.06-1.09)	.. 88 *ab*	—0.70*	—1.09*	7.33
T4 (1.09)	.. 93 *a*	—0.88**	—2.10**	8.17
LSD (P—0.05)	.. 9.7	..	..	..

b=Regression coefficient.

* Significant at $P \leqslant 0.05$.

** Significant at $P \leqslant 0.01$.

*** Mean values with the same letters are not significantly different.

In both cashew and cacao, length, fresh and dry weights of shoots significantly increased with an increase in sg. There was general increase in shoot length and weight as the sg increased, reaching the maximum values in the T4 and T5 groups (Figs. 2, 3 and 4 and Table 2). High correlation was noted between sg and other characters (Table 3) in cacao. In cashew, an additional character namely, seedling girth was also studied which was found to be highly correlated with seedling height, shoot weight and number of leaves (Table 4).

Similarly in cacao, root length, fresh and dry weights were found to be much influenced by the specific gravity differences (Figs. 5, 6, 7). High correlations were observed between sg and root length, root fresh weight and dry weight (Table 3). On the

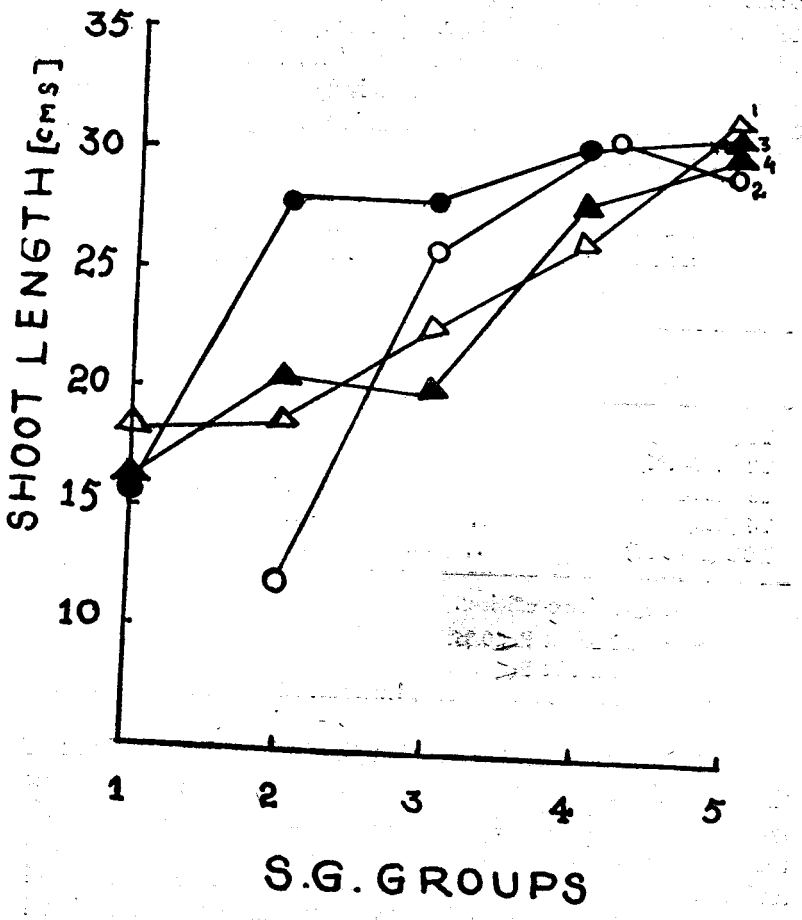

Fig. 2. Shoot length in the four cacao genotypes in relation to the sg of seeds.

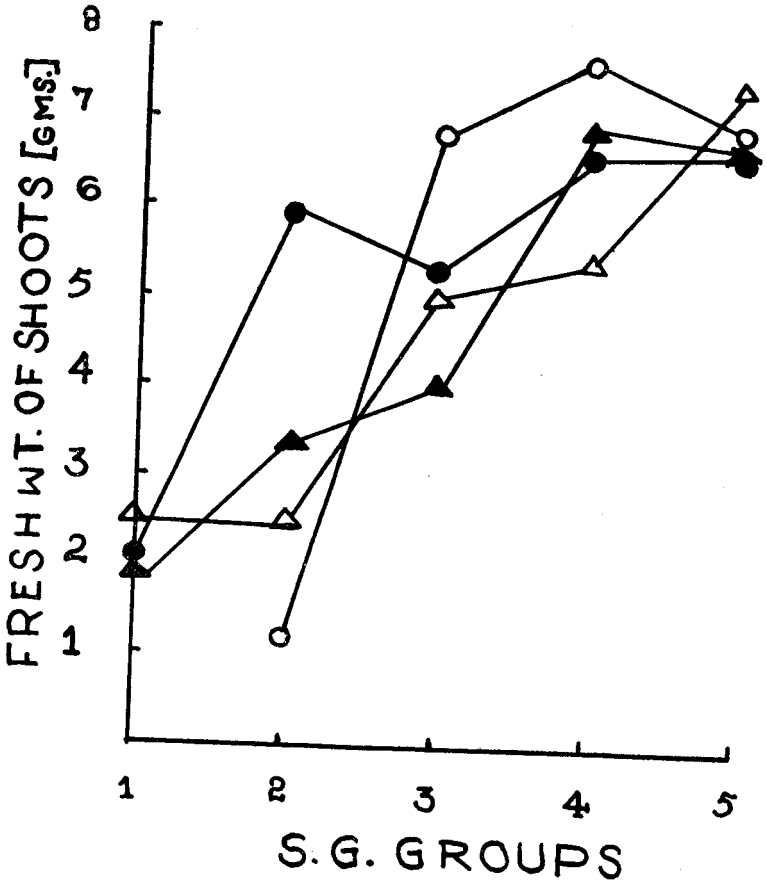

Fig. 3. Fresh shoot weight in the four cacao genotypes as influenced by the seed sg.

other hand, in cashew the differences in root length, fresh and dry weights, were not significantly different among the sg groups. Leaf production was not significantly different among the sg groups in both cacao and cashew.

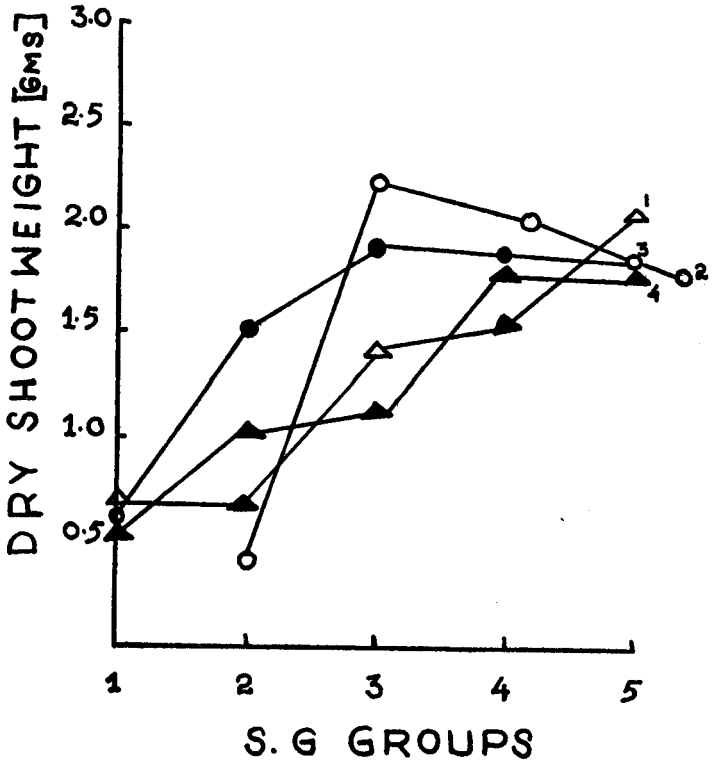

Fig. 4. Dry shoot weight in the four cacao genotypes in relation to seed sg.

The results thus showed that sg of seeds influenced the speed and rate of germination, seedling growth and dry matter accumulation. At least in the case of annuals and perennial grasses, the available evidences show that a positive association exists between seed weight and seedling vigour during both germination and early growth stages (Rafii and Barnett, 1970; Maranvillo and Clegg, 1972). Mc Daniel (1969) has shown that heavier seeds have got greater growth potential and that this was shown by enhanced

Table 2. Mean values of seedling characters in different sg groups in cashew

Sg groups	Shoot length (cm)	Girth (cm)	No. of leaves	Shoot wt. (fresh) (g)	Shoot wt. (dry) (g)	Root wt. (fresh) (g)	Root wt. (dry) (g)
T1 (1.03)	.. 27.5 *c***	0.56 *c*	10.28	9.56 *c*	1.92 *bc*	1.50	0.30
T2 (1.03-1.06)	.. 30.5 *abc*	0.57 *bc*	10.36	9.92 *bc*	1.94 *bc*	1.95	0.40
T3 (1.06-1.09)	.. 33.6 *ab*	0.64 *a*	10.86	11.44 *ab*	2.28 *ab*	1.91	0.40
T4 (1.09)	.. 34.4 *a*	0.62 *ab*	10.70	12.38 *a*	2.60 *a*	2.24	0.45
LSD ($P \leqslant 0.05$)	.. 3.98	0.05	NS	1.52	0.44	NS	NS

NS = Not significant.

** = Means with the same letters are not significantly different.

mitochondrial protein synthesis, greater enzyme production and higher respiratory rate. The better shoot and root development and dry matter accumulation might be indicating a better efficiency of the root system and assimilatory organs, and accelerated cell growth, which in turn is related to the endogenous level of growth factors. All these may be important in the successful establishment of the seedling in the early critical period of growth.

Table 3. Correlation coefficients of different sg groups and their early growth characters in cacao

Variety	Shoot length	Root length	Fresh shoot weight	Fresh shoot weight	Dry shoot weight	Dry root weight
1 ..	0.60	0.44	0.66*	0.65*	0.48	0.66*
2 ..	0.98**	0.77**	0.97**	0.90*	0.97**	0.96**
3 ..	0.84**	0.77**	0.76**	0.75**	0.62*	0.60*
4 ..	0.74*	0.41	0.78*	0.88*	0.83*	0.98*

* Significant at P=0.05 level.
** Significant at P=0.01 level.

Table 4. Coefficient of correlations among seedling characters in cashew

Characters	(1)	(2)	(3)	(4)
Shoot length	..	0.56**	0.44*	0.66**
Girth	..	..	0.25*	NS
No. of leaves	..	..	..	NS
Shoot wt. (dry)	..	..	..	..

* Significant at P≤0.05.
** Significant at P≤0.01.
NS=Not significant.

Seed vigour is an indication of its potential and for tree crops like cacao and cashew, selection of seeds is of primary importance. Sg of seeds can be employed as an easy mass selection criterion for selecting vigorous seeds that can give seedlings of greater vigour

and may prove beneficial in enhancing establishment ability and drought tolerance in the initial growth period.

Since selection can shift the population mean, selecting for high sg could be useful in raising the population mean of the progenies with respect to the character. It has been shown in the

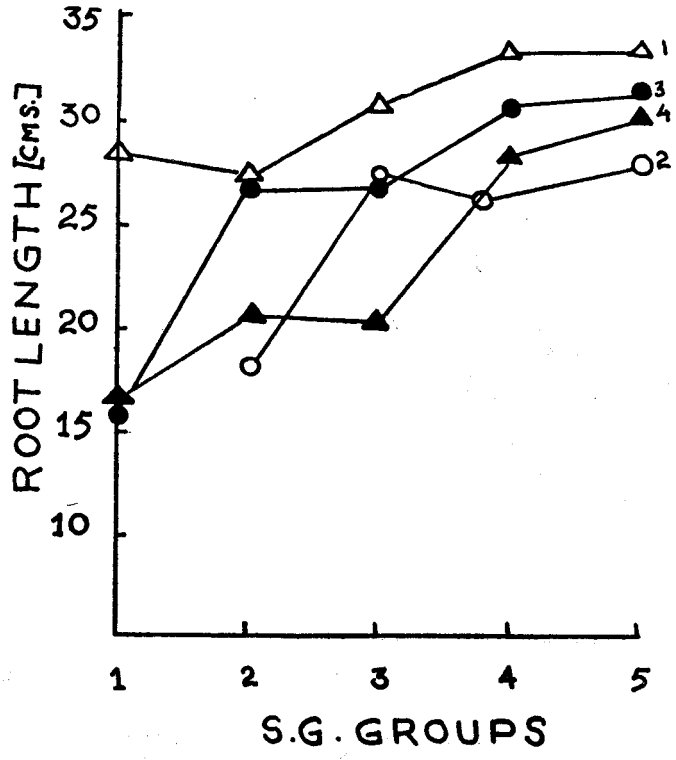

Fig. 5. Relationship between root length and sg of seeds.

case of soyabean that sg is related to protein and fat contents of the seeds (Fohr and Weber, 1968; Smith and Weber, 1968). In cashew, Turner (1956) observed that kernel content of cashew seeds increased proportionately with higher sg. Whether any such relationship exists in cacao is not known. Selection for high sg can thus shift the population mean to the higher sg side, which

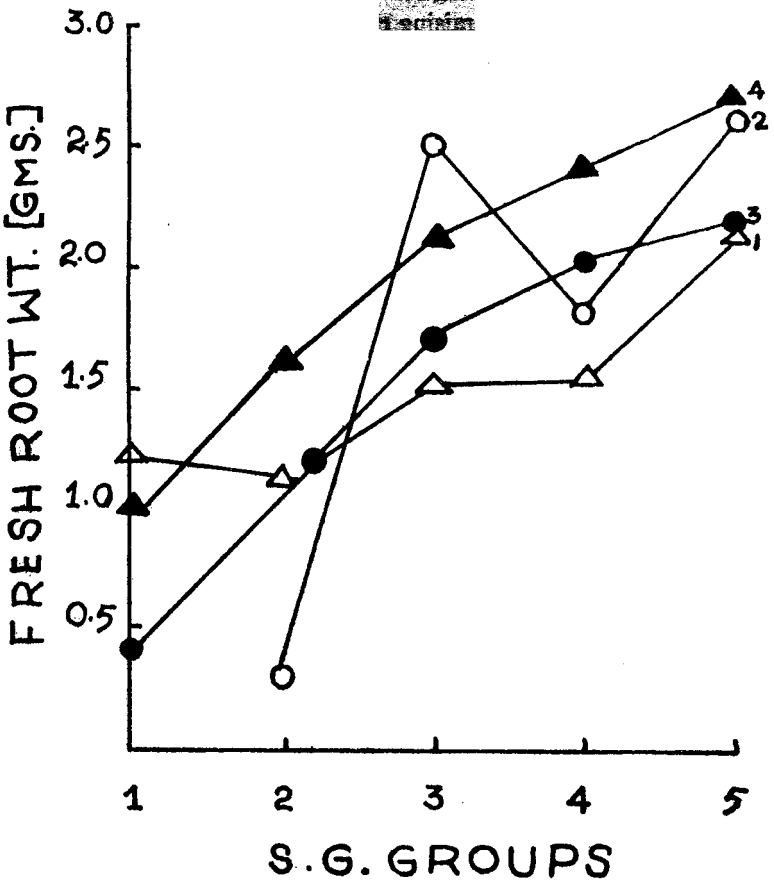

Fig. 6. Relationship between root weight (fresh) and seed sg.

will then be helpful in increasing the net output in cashew, and possibly in cacao also.

It is also evident from the results that about 40-45% of the seeds belong to the lower sg groups of poor vigour and should be eliminated. Seed selection based on sg will help in reducing the

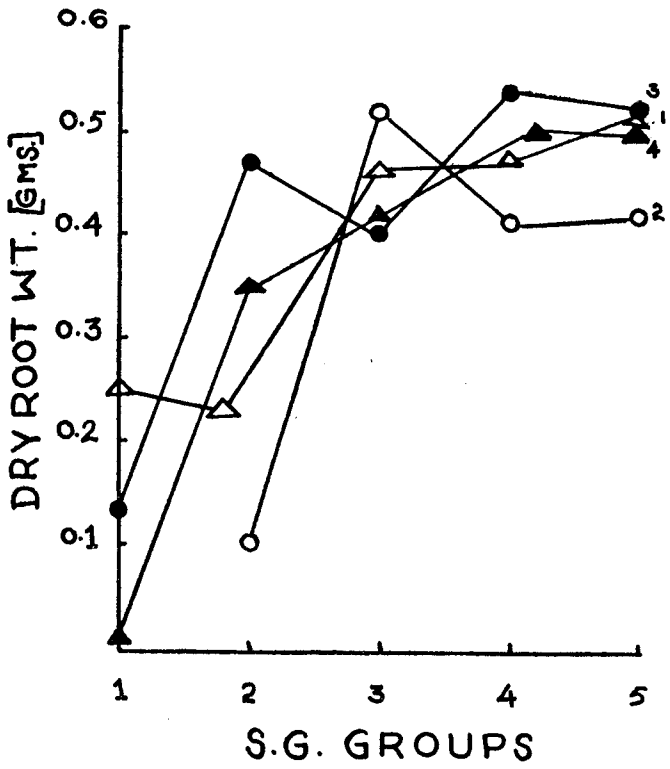

Fig. 7. Dry weight of root in the four cacao genotypes as influenced by seed specific gravity.

loss by way of ungerminated seed and seedlings of low vigour, and also by improving the seedling performance.

In India, at present no high yielding selection or hybrids in cacao or cashew are available commercially, and no selection of parent trees or seeds are being practiced. Under these circum-

stances the results of the present study assume greater significance as it suggests a method of selecting seeds that could lead to more vigorous seedlings, better establishment ability and subsequently more robust trees. Specific gravity of seed is suggested to be included as an important adjunct in future breeding programmes of cashew and cacao.

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