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Standardization of Seedling Selection Criteria in Cocoa (*Theobroma cacao* L.)

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A B S T R A C T

K e y w o r d s Cocoa, Seedling selection, Nursery **Article Info** *Accepted:* 10 November 2018 *Available Online:* 10 December 2018	In cocoa, four yielding categories *viz*., ['Low' (<1 kg), 'Medium' (1-2 kg), 'High' (2-3 kg), 'Very high' (> 3.0 kg)] were evaluated for standardization of seedling selection criteria at nursery stage. The results showed that the highest germination percentage, seedling height, girth, number of leaves, leaf area and seedling vigour were registered in high and very high yielding categories compared to other yielding categories.

Introduction

Cocoa (*Theobroma cacao* L.) is a highly cross-pollinated and heterozygous crop, the seedling progenies exhibit higher variability (N'Goran *et al.,* 2000). The seed is the cheapest and simplest propagule of cocoa, which is available in large quantity and give a convenient growth habit. Propagation through seedlings normally produces wide variability in their progenies. In perennial crop like cocoa, the selection of planting material is very important to perpetuate healthy, high yielding and quality plants. In a similar cross-pollinated perennial seed propagated crops like coconut and arecanut attempts by earlier workers (Liyanage, 1953; Sahasranaman, 1962; Bhagavan and Nair, 1989) resulted in the standardization of criteria for selection of mother palms and selection of seedlings in the nursery based on the certain morphological traits, which are likely to produce quality and high yielding seedlings. Ascenso and Bartley (1966) suggested seedling selection criteria for cocoa could be applied in the early stage of plant development as it would be valuable in saving time and land. No earlier attempt was made in cocoa in these aspects and hence the present study was undertaken to evaluate the different groups of progenies based on mother plants yield to standardize the pre-selection criteria in the seedlings itself in cocoa.

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Materials and Methods

In Tamil Nadu Agricultural University, the survey was made in Anaimalai region of Coimbatore during 2008-2012 and 151 trees were identified (Thondaiman, 2011) based on yield, pod and bean characters. The trees were classified based on dry bean yield (kg) / tree as 'Low' (<1 kg), 'Medium' (1-2 kg), 'High' (2-3 kg), 'Very high' (> 3.0 kg) yielding categories. The mature Forastero type pods were collected in different categories and from each category, eight pods showing yellow color particularly in furrows were harvested. The pooled seeds from each category were sown in black polythene bags of 6"x 9" size and 250 gauge thickness with 4 drainage holes filled with a potting mixture of 2:1:1 proportion of Soil: Sand: FYM. The seeds were sown at a depth of 1 cm. The experiment was laid out in completely randomized design with five replications and 200 seedlings per treatment were raised in the nursery at Anaimalai, Coimbatore, Tamil Nadu for evaluation. The germination percentage and seedling growth characters such as height (cm), girth (cm) and number of leaves were recorded at fortnightly intervals starting from 30th day to 150th days after germination. Intermodal length (cm) was calculated at 90th and 150th day after germination. The length and breadth of the standard leaf (6th leaf from top) were measured in 5 randomly plants in each replication and the average was calculated. The leaf area was estimated as its length multiplied by its maximum width multiplied by 0.666 + 0.73 (cocoa leaf calibration factor) suggested by Bismark (2011) and expressed in cm^{2}.

Leaf Area = L x B x 0.666 + 0.73

L – Length of the leaf

B – Breadth of the leaf

The vigor of cocoa seedlings was calculated by multiplying the height and stem diameter suggested by Amma *et al.,* (2002).

HD^{2}= Height x (Stem Diameter) ^{2}.

The data collected were subjected to statistical analysis for their significance (Panse and Sukhatme, 1967)

Results and Discussion

In the present investigation, seeds were collected from 4 different categories of mother trees based on dry bean yield such as 'low', 'medium', 'high' and 'very high' (<1, 1-2, 2-3 and >3 kg dry beans per tree respectively) and the seeds were collected from each category separately and evaluated for growth parameters.

Germination percentage (%)

The seed germination percentage of different yielding categories is presented in Figure 1. The results revealed that seedlings from high, very high and medium yielding categories invariably exhibited higher germination percentage (86, 80 and 82 per cent) than low yielding categories (62 per cent). Amma *et al.,* (2002) reported that the speed of germination had no significant association with final seedling vigour in hybrid cocoa seedlings. However, in coconut, Liyanage and Abeywardena (1957) suggested early germination is associated with higher yield in the adult palms and Ananda *et al.,* (2008) observed that arecanut seedlings from early and high initial germination produced significantly more vigorous than seedlings from delayed germination.

Seedling height (cm) and girth (cm)

The seedling height recorded at a monthly interval from one month after sowing till

5 months showed significant differences among the different categories of seedlings from 3rd month onwards. During 5th month after sowing, the significantly superior seedling height was recorded in very high yielding category (37.10 cm) while the lowest was recorded in low yielding category (26.36 cm). In general, seedling height increased with increasing the level of categories of seeds; very high categories registering as high as 25.08 cm of mean seedling height (Table 1). Significant differences with respect to seedling girth (Table 2) were recorded up to four months after sowing. The high and very high yielding categories registered more seedling girth (2.18 cm and 2.15 cm respectively) than low yielding category (1.81 cm) at all the stages of growth (Table 2).

Number of leaves and Leaf area (cm²)

The effect of different yielding categories on a number of leaves of cocoa seedlings was presented in Table 3. At four and fifth months after sowing, high yielding categories was significantly different from the other treatments having 15.12 (4th month) and 17.80 (5th month) leaves per plant followed by very

high yielding categories with 14.73 (4th month) and 16.60 (5th month) leaves while low yielding categories had the lowest value of 11.96 (4th month) and 13.20 (5th month) leaves. Invariably the mean number of leaves in the seedlings was very high in high (10.45) and very high (10.35) categories and the low category registered the least number (8.66) of leaves. Perusal of data (Table 4) revealed that leaf area parameter failed to attain the level of significance at early stage of observations (up to 3 months). However, at later stages the differences gain statistical significance. Very high (98.26 cm²) category followed by high (93.61 cm²), medium (83.89 cm²) and low (72.13 cm²) yielding categories recorded highest leaf area per seedlings at different stages of growth.

Internodal length (cm)

The effect of different yielding categories on internodal length of cocoa seedlings was shown in Table 4. Very high yielding categories registered longest internodal length (3.13 cm) followed by high (2.62 cm), medium (2.44 cm) and low (2.20 cm) yielding categories in order.

Table.1 Seedling height (cm) at monthly intervals in different seedling categories

Yield Category	Seedlings height (cm)					Mean
	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	
Low	14.19	16.55	19.74	23.59	26.36	20.08
Medium	14.29	17.09	21.98	25.93	31.54	22.16
High	14.51	17.44	25.59	32.29	35.22	25.01
Very high	14.46	18.72	24.81	30.33	37.10	25.08
Mean	14.36	17.45	23.03	28.03	32.55	
SE(d)	0.82	0.74	1.14	1.07	0.96	
CD (P=0.05)	NS	NS	2.42**	2.27**	2.04**	
NS- Non Significant, * Significant, ** Highly Significant						

MAS- Months After Sowing

Table.2 Seedling girth (cm) at monthly intervals in different seedling categories

Yield Category	Seedling girth (cm)					Mean
	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	
Low	0.94	1.41	1.75	2.14	2.82	**1.81**
Medium	1.12	1.54	1.91	2.39	3.00	**1.99**
High	1.34	1.69	2.15	2.58	3.15	**2.18**
Very high	1.27	1.68	2.07	2.68	3.07	**2.15**
Mean	**1.16**	**1.58**	**1.97**	**2.45**	**3.01**	
SE(d)	0.10	0.07	0.10	0.06	0.15	
CD (P=0.05)	0.22**	0.15**	0.22**	0.13**	NS	
NS- Non Significant, * Significant, ** Highly Significant						

MAS- Months After Sowing

**Table.3** Number of leaves at monthly intervals in different seedling categories

Yield Category	Number of Leaves					Mean
	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	
Low	4.40	5.27	8.46	11.96	13.20	**8.66**
Medium	4.61	5.47	9.88	12.20	15.20	**9.47**
High	4.60	5.58	9.13	15.12	17.80	**10.45**
Very high	4.70	5.89	9.82	14.73	16.60	**10.35**
Mean	**4.58**	**5.55**	**9.32**	**13.50**	**15.70**	
SE(d)	0.32	0.26	0.76	0.83	0.86	
CD (P=0.05)	NS	NS	NS	1.76**	1.82**	
NS- Non Significant, * Significant, ** Highly Significant						

MAS- Months After Sowing

Table.4 Internodal length (cm) and leaf area per seedling (cm^2) at monthly intervals in different seedling categories

Yield Category	Internodal length (cm)				Leaf area per seedling (cm^2)			
	3 MAS	**4 MAS**	**5 MAS**	**Mean**	**3 MAS**	**4 MAS**	**5 MAS**	**Mean**
Low	1.65	2.38	2.58	**2.20**	54.17	64.18	98.03	**72.13**
Medium	2.16	2.54	2.63	**2.44**	62.50	79.71	109.45	**83.89**
High	2.43	2.64	2.80	**2.62**	64.25	90.20	126.39	**93.61**
Very high	2.77	3.18	3.45	**3.13**	68.19	99.27	127.32	**98.26**
Mean	**2.25**	**2.68**	**2.86**		**62.27**	**83.34**	**115.29**	
SE(d)	0.16	0.16	0.15		5.22	7.18	4.65	
CD (P=0.05)	0.34**	0.35**	0.31**		NS	15.22**	9.87**	
NS- Non Significant, * Significant, ** Highly Significant								

Fig.1 Effect of different seedling categories on germination percentage (%) of cocoa at 7th and 15th day after sowing
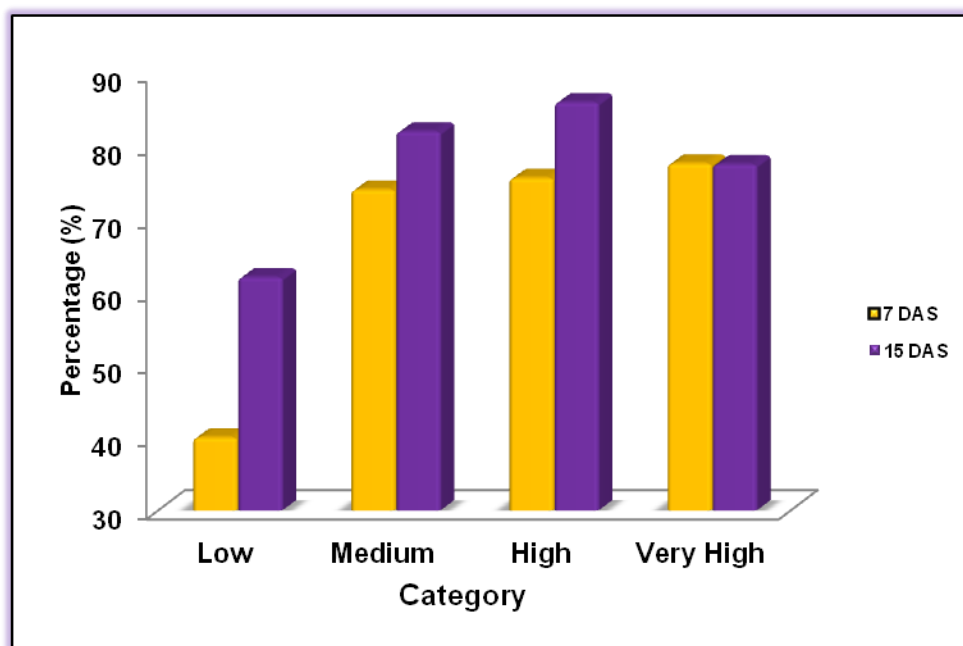
DAS: Days After Sowing

Fig.2 Seedling vigour at different seedling categories at nursery stages of cocoa

Seedling vigour

Seedling vigour exhibited significant differences among the different categories of seedlings at all stages of observations. However, at most of the stages, high and very high yielding categories (152.34 and 150.50) remained on par with each other. The low yielding category invariably exhibited poor seedling vigour (85.34) at all stages of growth (Fig. 2). Seedling vigour of cocoa was influenced by varieties (Adenikinju, 1969) and bean maturity at the time of sowing (Adenikinju, 1972, 1974, 1978).

Further, in the present investigation was evident that the seedlings from 'very high' and 'high' yielding groups exhibited better morphological traits in terms of seedling height, number of leaves, girth, internodal length and leaf area per seedlings *etc.,* than 'medium' and 'low' yielding categories of seedlings. This kind of approach when taken up in coconut and arecanut has resulted in ideal seedling selection criteria based on high heritable characters (earliness in germination, seedling height, girth of the seedling *etc.*

It is concluded, on the basis of the different growth parameters recorded, (germination percentage, seedling height, girth, no of leaves, seedling vigor *etc.*), it is concluded that seeds from 'high' and 'very high' yielding mother trees are likely to produce vigorous seedlings. The selection based on seedling vigour has to be verified in the field based on yield performance.

Acknowledgment

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