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Evaluation of cocoa half sib selection for morphological and yield traits under Tamil Nadu conditions

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Abstract
Seven half sib selections (CCRP1 x X, CCRP2 x X, CCRP3 x X, CCRP4 x X, CCRP5 x X, CCRP6 x X and CCRP7 x X) were evaluated for morphological and yield characters at Kaliyapuram, Pollachi, Coimbatore district during July to December 2018. There were significant differences among the half sib selections for, first branching height, stem girth, number of flowers per cushion, number of flower cushions per tree, number of pod harvested per tree, pod weight, pod value, single dry bean weight and dry bean yield per pod. The results indicated that, CCRP5 x X recorded maximum number flower cushion per tree (179.11), number of pod harvested per tree (21.74), pod weight (376.93 g), single dry bean weight (1.02 g) and dry bean yield per pod (41.22 g). This clone CCRP5 can be utilized for further breeding program to obtain high yield in cocoa.

Keywords: Half sib selection, cocoa, pod value, correlation, single dry bean weight

Introduction
Cocoa (*Theobroma cacao* L.) is one of the important plantation crops native to Amazon region of South America. The genus *Theobroma* belongs to the family Malvaceae. There are over 20 species in the genus *Theobroma* but *cacao* is the only one widely cultivated species. It is a diploid species with 20 chromosomes in the somatic cells (2n=20). Cocoa being a tropical crop, survives under hot, humid climate between 20º N and 20º S of the equator, predominantly cultivated in the area of Central and South America, Asia and Africa. Cocoa is the primary raw material for the production of chocolate and various confectioneries. The by-products are used in cosmetics, perfumeries and pharmaceuticals. In India, cocoa is being cultivated in the states of Kerala, Karnataka, Andhra Pradesh and Tamil Nadu in an area of 78,000 ha with total production of 16,050 MT. Tamil Nadu ranks first with an area of 29,969 ha. Andhra Pradesh ranks first in production (8085 MT) and Kerala rank first in productivity (785 kg ha^{-1}). In Tamil Nadu, the production is 1733 MT and productivity is 320 kg ha^{-1}. The national average productivity of cocoa is 475 kg ha^{-1} (DCCD, 2018).
Crop improvement experiments in cocoa undertaken in the Cadbury- KAU Co-operative research project of Kerala Agricultural University has resulted in the release of seven improved clonal varieties of forastero types *viz.*, CCRP 1, CCRP 2, CCRP 3, CCRP 4, CCRP 5, CCRP 6 and CCRP 7 (Amma *et al.*, 2009) [2]. These improved varieties are suitable for cultivation in different cocoa growing tracts of Kerala and also in the other warm tropical areas. These improved clonal varieties are being subjected to continuous evaluation to study their suitability and performance under hot tropical condition of Tamil Nadu. The present study was focused on evaluating the performance of the open pollinated cocoa half sib selections (male is unknown parentage) in Coimbatore and to identify the important yield contributing characters for effective selection of cocoa types for improving the productivity.

Materials and methods
Polyclonal orchards were established with selected self in-compatible but cross compatible high yielding parents which were multiplied as clones through soft wood grafting. Thus, all the pods harvested from the polyclonal garden can be considered as hybrids. The polyclonal gardens were established at CRS, Aliyar Nagar and HRS, Thadiyankudisai with clones of CCRP 1 to CCRP 7. Half-sib progenies were developed in polyclonal gardens through natural hybridization. The seedling progenies of seven half-sib population were planted in the farmers field Kaliyapuram, Pollachi during 2015 and evaluated for vigor, yield and quality.

The age of the cocoa crop was three years old and possible parentages are CCRP1 x X, CCRP2 x X, CCRP3 x X, CCRP4 x X, CCRP5 x X, CCRP6 x X and CCRP7 x X (X- Male parent not known). In each half sib, 45 plants were planted and evaluated for various traits. One row of cocoa was planted at a spacing of 2.7 m in between two rows of coconut spaced at 7.5 m x 7.5 m. The experiment was laid out in Randomized Block Design without replication and observations on ten yield contributing characters were recorded *viz*., first branching height, stem girth, number of flowers per cushion, number of flower cushions per tree, number of pod harvested per tree, pod weight, pod value, single dry bean weight and dry bean weight per pod. Pods were harvested at full maturity stage 4 to 5 months after flowering. The statistical mean was calculated using the method suggested by Goulden (1952) [6].

Result and discussion

Morphological and yield characters are presented in Table 1. Among the seven half sib selection evaluated, maximum first branching height was observed in CCRP2 x X (159.46 cm) and minimum was observed in CCRP7 x X (120.06 cm). Standard deviation of first branching height was 14.44. Level of variability for stem girth ranged from 18.92 cm to 24.61 cm. CCRP3 x X showed maximum stem girth (24.61), whereas CCRP7 x X recorded minimum stem girth (18.92). Standard deviation was 2.16. The results were in line with Sumitha *et al*. (2018) [13] who reported that, first branching height in cocoa is an important criteria for selection of plus trees as higher the jorquette height, more could be the yield as the lengthier jorquette could allow more number of flower cushions in the trunk, thus leading to higher yield.

Among the seven half sib selections, CCRP 5 x X registered maximum number of flowers per cushion (8.87) and number flower cushion per tree (21.74). Southwick (1984) suggested that cocoa flower production cannot be attributed to a particular factor as it varied from tree to tree and also influenced by the level of fruiting in the preceding year, suggesting a possible inter year linkage in resource use by leaves and fruit. Flowering in cocoa varies with different geographical locations and seasonal differences in flowering and intensity of flowering in cocoa has been reported by Efron *et al*. (2003) [4].

The potential yield of a plant can be achieved by maximizing yield contributing characters like number of pods per tree, number of beans per pod and weight of individual beans (Wood and Lass, 1985) [15]. Variation in number of pod harvested per tree ranged from 10.35 to 21.74. Number of pod harvested per tree was minimum in CCRP4 x X and maximum in CCRP5 x X. Standard deviation of number of pod harvested per tree was 3.69. In Tamil Nadu, after the summer season (March-May) and two pruning, *viz.,* February-March and June July, the cocoa crop attains good vegetative growth and thus better partitioning of synthesized food material for pod and bean production can be observed during July to December season which is considered as the peak season as the yield is significantly higher during this season when compared to January to June crop e (Karthikkumar, 2014) [7].

Pod weight showed variation ranging from minimum of 300.59 g in CCRP1 x X and maximum in CCRP5 x X (376.93 g). Adewale *et al.*, (2013) [1] suggested that selection of cocoa genotypes with heavier pod weight and bean weight. Pod weight of more than 350 g to ensure pod filling with > 35 beans is the ideal selection criteria for yield improvement Vikram *et al*. (2000) [14].

Table 1. Performance of cocoa half sib selection for morphological and yield traits

CROSSES	First branching height (cm)	Stem girth (cm)	No. of flowers per cushion	No. of flower cushion per tree	No. pod harvested per tree	Pod weight (g)	Pod value	Single dry bean weight (g)	Dry bean yield per pod (g)
CCRP1 x X	125.21	20.12	3.94	82.74	12.96	300.59	33.14	0.86	30.18
CCRP2 x X	159.46	19.18	7.48	120.36	15.90	342.41	30.01	0.98	33.32
CCRP3 x X	124.74	24.61	5.70	111.97	18.51	357.10	26.66	0.88	37.51
CCRP4 x X	135.64	21.29	5.20	152.44	10.35	329.40	31.07	0.85	32.19
CCRP5 x X	144.64	23.57	8.87	179.11	21.74	376.93	24.26	1.02	41.22
CCRP6 x X	122.42	20.67	8.07	138.33	15.33	354.87	28.59	0.89	34.98
CCRP7 x X	120.06	18.92	6.90	91.50	14.67	333.34	32.11	0.85	31.14
MEAN	133.17	21.19	6.59	125.21	15.64	342.09	29.41	0.90	34.36
MAX	159.46	24.61	8.87	179.11	21.74	376.93	33.14	1.02	41.22
MIN	120.06	18.92	3.94	82.74	10.35	300.59	24.26	0.85	30.18
SD	14.44	2.16	1.73	34.05	3.69	24.37	3.14	0.07	3.89

As pod weight had significant (P<0.01) and positive correlation with pod length and pod girth was suggested by Sobowale *et al.,* 2016.

Level of variability for pod value ranged from 24.26 to 33.14 in CCRP5 x X and CCRP1 x X respectively. Low value for pod index is the desirable character and thus CCRP5 x X expressed the most desirable value in terms of pod index. This line supported with Karthikkumar (2014) [7] who reported that in cocoa lower pod value is preferred to have higher bean yield.

Main yield contributing character and economic part of cocoa is beans. In the present study, among the seven half sib selection CCRP5 x X registered highest single dry bean weight (1.02 g) and dry bean yield per pod (41.22 g). Single dry bean weight must be more than one gram (Monteiro *et al*., 2009 and Minimol *et al*., 2015) [9, 8]. From this study, it was observed that among half sib population, only CCRP5 x X recorded single dry bean weight of more than one gram. Similar results were reported by Sumitha *et al*., 2018 [13]. A group of authors had reported that yield expressed as fresh or dry bean weight is highly variable in cocoa (Pound 1932; Enriquez and Soria, 1968) [10, 5].

Conclusion

Evaluation of half sib population for morphological and yield traits under Tamil Nadu conditions revealed that all the yield characters *viz.*, number of flowers per cushion, number of flower cushions per tree, number of pod harvested per tree,

pod weight, pod value, single dry bean weight and dry bean yield per pod showed variations among the different half sib selection at three years after planting. Among the half-sib population, CCRP5 x X showed higher mean value for pod and bean characters. Thus, CCRP5 x X can be further exploited for crop improvement of cocoa. This is a preliminary study taken up at initial years of crop growth and continuous evaluation is required to select best performing cocoa types suited for Tamil Nadu condition.

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References

1. Adewale DB, Adeigbe OO, Adepoju OO, Muyiwa AA. Descriptive and discriminatory significance of pod phenotypic traits for diversity analysis of cocoa genotypes. Journal Plant Breeding Genetics. 2013; 1(3):131-137.
2. Amma SPKR, Vikraman N, Lalithabai EK, Mallika VK, Minimol JS, Koshy Abraham. Cocoa in India. Kerala Agricultural University, Mannuthy, Thrissur, 2009.
3. DCCD. Directorate of Cashew and Cocoa Development (http://dacnet.nic.in /cashewcocoa/stat2.htm). Accessed on 05 January, 2018.
4. Efron Y, Epaina P, Marfu J. Breeding strategies to improve cocoa production in Papua New Guinea. In: Abstracts of International Workshop on Cocoa Breeding for Improved Production Systems, INGENIC, 2003, 1-2.
5. Enriquez G, Soria JV. The variability of certain bean characteristics of cacao (*Theobroma cacao* L.). Euphytica. 1968; 17:114-120.
6. Goulden CH. Methods of statistical analysis. John Wiley and Sons Inc., New York, 1952.
7. Karthikkumar RB. Performance evaluation and adaptability behavior of plus trees of cocoa (*Theobroma cacao* L.). Ph.D. (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 2014.
8. Minimol JS, Shija TK, Vasanthan N, Sunil KM, Suma B, Krishnan S. Seasonality in cocoa: weather influence on pod characters of cocoa clones. Int. J Plant Sci. 2015; 10:102-107.
9. Monteiro WR, Lopes UV, Clement D. Genetic improvement in cocoa. In: Breeding Plantation Tree Crops: Tropical Species (Eds.) S.M. Jain and P.M. Priyadarshan, Springer, New York. 2009, 589-626.
10. Pound EJ. The genetic constitution of the cacao crop. In: Annual Report of Cacao Research, Imperial College of Tropical Agriculture, Trinidad. 1932; 2:9-25.
11. Sobowale OI, Akinyele BO, Odeiyi AC, Adewale DB, Muyiwa AA. Heterosis and heritability estimates of some yield traits in eight hybrids of cocoa (*Theobroma cacao*). Journal of Advance Biology and Biotechnology. 2016; 6(1):1-8.
12. Southwick EE. Photosynthate allocation to floral nectar: a neglected energy investment. Ecology. 1984; 65(6):1775-1779.
13. Sumitha S. Evaluation of cocoa (*Theobroma cacao* L.) clones, half sibs and hybrids for yield and quality. Ph.D. (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 2018.
14. Vikraman Nair R, Mallika VK, Amma Prasannakumari S, Koshy A, Balasubramanian PP. Cocoa Cultivation: Science and Technology. Directorate of Cashewnut and Cocoa Development (DCCD), Cochin. 2000, 82.
15. Wood GAR, Lass RA. Cocoa, 4th Edn. Longman Scientific and Technical, New York, USA, 1985.