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Analysis of Genetic Parameters of Selected Cocoa (*Theobroma cacao* L.) Hybrids

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ABSTRACT: *Cocoa (*Theobroma cacao *L.) is the only source of chocolate. Perennial nature, high heterozygosity and out breeding system are factors necessitate breeding procedure unique to this crop. A sound knowledge of genetic parameters (i.e. phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance etc) pertaining to traits used as selection criteria become imperative before embarking any major selection procedure in cocoa. The present study was envisaged to select superior hybrids developed as a part of different breeding programme to release this as a variety or for selecting it as parents in clonal garden. High amount of variability exist among the hybrids selected for the study. The hybrid VSDI 23.21 recorded highest pod number showed reduction in pods size and weight. This indicated that increase in pod weight is directly correlated to reduction in other yield contributing characters. Even though hybrid PIV 59.8 rank first in pod weight and dry bean weight in terms of total yield (No. of pods X Wet bean weight) it is inferior even with the check CCRP I . So cannot be recommended for release. High PCV and GCV ratios indicated high amount of variation and the variation is due to the genetic constitution of the hybrids. Heritability was high for single dry bean weight but genetic advance was very low. Hence even though five hybrids (PIV 58.6, VSD 33.8, SIV 3.18, PIV 19.9 and PIV 59.8) showed dry bean weight value more than international standard , they cannot be selected for further breeding programme.*

Key words: *Cocoa, genetic parameters, PCV, GCV, heritability, genetic advance*

INTRODUCTION

Cocoa (*Theobroma cacao* L.) the "golden tree" is a high value beverage crop. It forms the only source of chocolate. Cocoa was introduced to India during 1978 and now due to its attractive remuneration, the crop is cultivated throughout the South Indian states and the area under cultivation is increasing at a rate of 10-20 percent every year. Kerala Agricultural University (KAU) along with Cadbury India Ltd. had played a major role in area extension. Development of new hybrids satisfying the breeding objective forms the major mandate of Cocoa Research Centre (CRC), KAU. Perennial nature, high heterozygosity and out breeding system are factors necessitate breeding procedure unique to this crop. A sound knowledge of genetic parameters (i.e. phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance etc) pertaining to traits used as selection criteria become imperative before embarking any major selection procedure in cocoa. Thus the present study is envisaged to select superior hybrids developed as a part of different breeding programme for further crop improvement or use this as parent in clonal garden.

MATERIALS AND METHODS

Ten hybrids bred under various breeding programme was selected after initial screening for the present study. Details are given in Table 1. VSD hybrids are from breeding programme for development of hybrids resistant to Vascular Streak die back (VSD) disease, PIV and SIV hybrids are selected from progeny trial IV and Series IV hybrids respectively which is bred for yield improvement. They also showed some degree of resistance to VSD. CCRP I, first variety released from CRC formed the check.

The experiment was laid out during 2006 (CCRP report, 2006-07) in CRC. The crop was raised as per

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Table 1
Hybrids and their Parentage

Sl.No.	*Hybrids*	*Parentage*
H1	VSD I 23.21	GVI 171 X G VI 55
H2	VSD I 33.4	G IV 148 X G IV 18.5
H3	VSD I 11.11	G VI 126 X G IV 18.5
H4	P IV 58.6	H 5.3 X H 6.14
H5	VSD 33.8	G VI 185 X G IV 18.5
H6	P IV 56.9	H 5.3 X H 6.14
H7	VSD 10.13	G VI 126 X G IV 18.5
H8	S IV 3.18	G I 5.9 X G III 4.1
H9	P IV 19.9	H 5.3 X H 6.14
H10	P IV 59.8	H 5.3 X H 9.15
	CCRP I	Check

the recommended package of KAU and the hybrids started study bearing in 2013. The design used was randomized block design (RBD) with two replication. Five budded plants of each hybrid were included per replication.

Yield observations were recovered. To study the yield contributing characters like pod weight (g), wet bean weight (g), number of beans and single bean weight (g) five pods per plant per hybrid was observed as per the procedure described by Amma *et al*., 2009.

Analysis of variance was done and genetic parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) (Sivasubramanian and Madhavamenon, 1973), heritability and genetic advance (Johnson *et al*., 1955) were estimated.

RESULT AND DISCUSSION

The yield and yield contributing characters were subjected to analysis of variance. The difference in the mean value of different parameters are presented in t Table 2, and compared with the respective CD value. The result showed that significant differences were there between almost all hybrids except in the character dry single seed weight. This indicated there is high variability among the hybrids for pod yield, pod weight and wet bean weight. Velayutham *et al*., 2013 also reported high amount of variability for yield and yield contributing in coca hybrids or clones.

Mean value for yield and yield contributing characters are presented in table 3.Hybrid VSD1 23.21 recorded high yield in terms of number of pods (79.1) where as lowest pod number was recorded in SIV 3.18 (30.6). VSD1 23.21 is superior to the check variety CCRP 1.In general the number of pods recorded was less throughout the experiment. This may be due to the reason that experiment was laid out in abanded rubber plantation with high level of shade due to lack of land. Reduction in yield in cocoa due to over shade was reported by Samual, 2012 in his study. PIV 59.8 was the hybrid with highest pod weight (648.5 g) and single dry bean weight (1.35 g). In the case of wet bean weight it ranked second (130.95 g). Even though number of pods was highest for VSD1 23.21 their recorded low pod weight, wet bean weight, and single dry bean weight. This indicated that pod size is reduced when number of pods increased (Wood and Lass, 1985).

PIV 58.6 which ranked second in terms of pod weight (494.3 g) ranked first in terms of wet bean weight (148 g) and third in terms of single dry bean weight (1.05g). Yield is calculated considering number of pods and wet bean weight together. Total wet bean weight (No. of pods x wet bean weight) for hybrids VSD I 23.21 is 7.3 kg/tree/ year, for hybrid PIV 59.8 it is 5.97 kg /tree/year, while for hybrid PIV 58.6 it is 8.7 Kg/tree/year. Hence even though hybrid PIV 59.8 rank first in pod weight and dry bean weight in terms of total yield it is inferior to VSD I 23.21 and PIV 59.8 and inferior even with the check CCRP I (7.45 Kg/ tree/year). So the hybrid PIV 59.8 as such cannot be recommended for release as a variety. But it can be used in further breeding programme improving wet bean weight and single dry bean weight.

Five hybrids PIV 58.6,VSD 33.8,SIV 3.18,PIV 19.9, PIV 59.8 had single dry bean weight more than one gram, where international standard for dry bean weight is one gram (Wood and Lass, 1985).

PCV and GCV are highest for the character pod weight (35.06 percent and 35. 05 percent respectively) as per the classification of Johnson *et al*., (1955). Other traits studied viz., wet bean weight (g), no. of beans and single dry bean weight of bean (g) also showed the same tendency. This indicated high amount of variability among the material used for the study and the variation is due to the genetic constitution of the hybrids. Similar report was given by Lachenaud and Oliver (2005) in their study.

The maximum heritability was observed for the character pod weight (99.9 percent) and minimum for single dry bean weight (95.2 percent). Genetic advance was high for all the three characters except dry single seed weight (0.42 percent). High heritability accompanied with high genetic advance for the character, pod yield, pod weight, wet bean weight indicate that heritability is due to additive gene effect and selection may be effective if these characters are considered.

Table 2
Difference between Mean Pod Yeild, Pod Weight (g) Wet Bean Weight (g) and Single Dry Bean Weight (g) for each Pair of Treatment of Data

		T1	*T2*	*T3*	*T4*	*T5*	*T6*	*T7*	*T8*	*T9*	*T10*	*CCRP 1*
H1	Pod Yeild	0	13.5*	42*	20.1*	40*	40.7*	47.33*	48.5*	36.8*	33.5*	18.35*
	Pod wt	0	4.75	79.45*	204.4*	8.55*	81.6*	14*	190.7*	18.4*	358.6*	90.1*
	wet bean wt	0	21*	22.95*	55.55*	0.05	7.45*	13*	7.7*	14.4*	38.5*	31.75*
	single dry bean wt	0	0.04	0.09	0.17	0.27	0.05	0.06	0.32	0.37	1.35	0.88
H2	Pod Yeild		0	28.5*	6.6*	26.5*	27.2*	33.825*	35*	23.3*	20*	4.85
	Pod wt		0	84.2*	199.65*	13.3*	76.85*	9.25*	185.95*	23.15*	353.90*	85.35*
	wet bean wt		0	31.75*	76.55*	20.95*	28.45*	8*	28.7*	6.6*	59.5*	52.75*
	single dry bean wt		0	0.05	0.21	0.31	0.01	0.02	0.36	0.41	0.51	0.06
H3	Pod Yeild			0	21.9*	2	1.3	5.325	28.4*	5.20	8.5*	23.65*
	Pod wt			0	283.85*	70.9*	161.05*	93.45*	270.15*	61.05*	438.1*	169.55*
	wet bean wt			0	78.5	22.9	30.4	9.95	30.65	8.55	61.45	54.70
	single dry bean wt			0	0.26	0.36	0.04	0.03	0.41	0.46	0.56	0.01
H4	Pod Yeild				0	19.9*	20.6*	27.225*	28.4*	16.7*	13.4*	1.75
	Pod wt				0	212.95*	122.8*	190.4*	13.7*	222.8*	154.2*	114.3*
	wet bean wt				0	55.6*	48.1*	68.55*	47.85*	69.95*	17.05*	23.8*
	single dry bean wt				0	0.1	0.22	0.23	0.15	0.20	0.30	0.27
H5	Pod Yeild					0	0.7	7.325*	8.5*	3.20	6.5*	21.65*
	Pod wt					0	90.15*	22.55*	199.25*	9.85*	367.15*	98.65*
	wet bean wt					0	7.5*	12.95*	7.75*	14.35*	38.55*	31.8*
	single dry bean wt					0	0.32	0.33	0.05	0.10	0.20	0.37
H6	Pod Yeild											
	Pod wt						0	6.625*	7.8*	3.90	7.2*	22.35*
	wet bean wt						0	67.6*	109.1*	100*	277*	8.5*
	single dry bean wt						0	20.45*	0.25	21.85*	31.05*	24.3*
H7	Pod Yeild											
	Pod wt							0	1.18	10.525*	13.825*	28.975*
	wet bean wt							0	176.7*	32.4*	344.6*	76.1*
	single dry bean wt							0	20.7*	1.40	51.5*	44.75*
H8	Pod Yeild											
	Pod wt								0	11.7*	15*	30.15*
	wet bean wt								0	209.1*	167.9*	100.6*
	single dry bean wt								0	22.1*	30.8*	24.05*
H9	Pod Yeild											
	Pod wt									0	3.30	18.45*
	wet bean wt									0	377*	108.5*
	single dry bean wt									0	52.9*	46.15*
H10	Pod Yeild											
	Pod wt										0	15.15*
	wet bean wt										0	268.5*
	single dry bean wt										0	6.75*
CCRP 1	Pod Yeild											
	Pod wt											0
	wet bean wt											0
	single dry bean wt											0
												0

Table 3
Mean Values for Yield and Yield Contributing Characters of Hybrids

S.L.No.	Hybrids	No of pods/tree/year	Pod weight(g)	Wet bean weight (g)	Dry single seed weight(g)
1	VSD I 23.21	79.100 ^{A}	289.900 ^{G}	92.450 ^{E}	0.880 ^{D}
2	VSD I 33.4	65.600 ^{B}	294.650 ^{G}	71.450 ^{G}	0.840 ^{D}
3	VSD I 11.11	37.100 ^{EF}	210.450 ^{J}	69.500 ^{G}	0.790 ^{D}
4	P IV 58.6	59.000 ^{C}	494.300 ^{B}	148.000 ^{A}	1.050 ^{C}
5	VSD 33.8	39.100 ^{E}	281.350 ^{H}	92.400 ^{E}	1.150 ^{B}
6	P IV 56.9	38.400 ^{E}	371.500 ^{E}	99.900 ^{D}	0.830 ^{D}
7	VSD 10.13	31.775 ^{FG}	303.900 ^{F}	79.450 ^{F}	0.820 ^{D}
8	S IV 3.18	30.600 ^{G}	480.600 ^{C}	100.150 ^{D}	1.200 ^{B}
9	P IV 19.9	42.300 ^{DE}	271.500 ^{I}	78.050 ^{F}	1.250 ^{B}
10	P IV 59.8	45.600 ^{D}	648.500 ^{A}	130.950 ^{B}	1.350 ^{A}
11	CCRP I	60.750 ^{BC}	380.000 ^{D}	124.200 ^{C}	0.780 ^{D}
	CD = (0.05 %)	6.209	8.448	3.224	0.997
	CV (%)	5.791	1.037	1.465	4.689

Table 4
Descriptive Statistics of Cocoa Hybrids

SI. No.	Characters	Range		Mean	SE	PCV (%)	GCV (%)	H2 (%)	GA (%)
		Minimum	Maximum						
1	No of pods/tree/year	30.6	79.1	48.1265	0.279	32.82	32.3	96.9	31.52
2	Pod weight(g)	210.45	648.5	366.059	0.379	35.06	35.05	99.9	264.16
3	Wet bean weight (g)	69.5	148	98.77	0.145	26.02	25.98	99.7	52.78
4	Dry single seed weight (g)	0.78	1.35	0.9945	0.466	21.43	20.91	95.2	0.42

Heritability was high for single dry bean weight but genetic advance was very low (0.42 percent). So the gene action here will be non-additive and selection for this character is non –rewarding. Hence even though five hybrids (PIV 58.6,VSD 33.8,SIV 3.18,PIV 19.9 and PIV 59.8) showed dry bean weight value more than international standard, they cannot be selected for further breeding programme.

CONCLUSION

High amount of variability exist among the hybrids selected for the study. The hybrid VSDI 23.21 recorded highest pod number showed reduction in pods size and weight. Even though hybrid PIV 59.8 rank first in pod weight and dry bean weight in terms of total yield (No. of pods X Wet bean weight) it is inferior even with the check CCRP I. So cannot be recommended for release. High PCV and GCV ratios indicated high amount of variation and the variation is due to the genetic constitution of the hybrids. Heritability was high for single dry bean weight but genetic advance was very low. Hence even though five hybrids (PIV 58.6,VSD 33.8, SIV 3.18, PIV 19.9 and PIV 59.8) showed dry bean weight value more than international standard, they cannot be selected for further crop improvement programme.

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