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Heterosis breeding in coconut (*Cocos nucifera* L.)

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Abstract: A total of twenty four coconut hybrids comprising of twelve direct (Tall x Dwarf) and their reciprocals (Dwarf x Tall) involving three tall varieties *viz.*, East Coast Tall, Cochin China and Siam with seven dwarf varieties were studied for the manifestation of heterosis for nut and yield characters. The result revealed that high degree of heterosis was observed for wholenut weight, dehusked nut weight, kernel weight, copra weight, annual nut and copra yield in both direct and reciprocal crosses. Among the twenty four cross combinations, direct and reciprocal crosses of ECT x MOD, ECT x MYD, ECT x CGD and ECT x GBD were found to be superior recording significant positive heterosis for most of the characters over the standard variety East Coast Tall.

Key words: Heterosis, Coconut, Nut yield.

Introduction

Genetic improvement of coconut (*Cocos nucifera* L.) has not received the attention that it deserved mainly due to some unique problems encountered with the crop. The perennial habit, long juvenile period, highly outcrossing and heterozygous nature, difficulties in clonal propagation and large area required for systematic experimentation are some of the barriers to achieve rapid progress in coconut breeding. Among the several breeding methods, exploitation of heterosis had the maximum impact in coconut improvement. Since the desired characters such as high yield, precocity in bearing, better quality, high copra and oil content, drought tolerance and diseases resistance are distributed among different varieties or different individuals of the same variety, hybridization is by far the most useful method to bring together the desirable traits. Systematic work on hybridization in India was started in 1930's between West Coast Tall as a female parent and Chowghat Green Dwarf as the male parent. This is considered to be one of the notable achievements in coconut breeding as Patel (1937) who studied the performance of these Tall x Dwarf (T x D) hybrids reported for the first time the manifestation of hybrid vigour in coconut. In an attempt to exploit hybrid vigour, crosses were effected involving three tall varieties and seven dwarf varieties and a total of twenty four hybrid were studied for their performance and the results are presented in this paper.

Materials and methods

The materials consisted of 24 inter varietal hybrids including 12 Tall x Dwarf combinations and their reciprocals. Seven dwarf genotypes, Ayiramkachi, Andaman Orange Dwarf, Chowghat, Green Dwarf, Gangabondam, Malaysian Orange Dwarf, Malaysian Green Dwarf, Malaysian Yellow Dwarf and three tails *viz.*, Siam, Cochin China and East Coast Tall were used as parents. In each combination four palms were selected in each replication which were planted in a randomized block design with two replications during 1973 at Coconut Research Station, Veppankulam, Thanjavur District, Tamil Nadu. The data on nut and copra yield of the hybrids and the East Coast Tall (Local check) were collected from 1996 to 2002. Observations on nut characters *viz.*, wholenut weight, dehusked nut weight, kernel weight and copra weight were recorded from four matured nuts harvested from each palm separately by following standard procedure during the summer months. Heterosis was estimated in hybrids for all the six characters on the standard parent East Coast Tall. Appropriate

Table 1. Nut characters of coconut hybrids

Sl. No.	Hybrid combination	Direct crosses: Whole nut weight (g)	Direct crosses: Standard heterosis (%)	Direct crosses: Dehusked nut weight (g)	Direct crosses: Standard heterosis (%)	Reciprocal Crosses: Whole nut weight (g)	Reciprocal Crosses: Standard heterosis (%)	Reciprocal Crosses: Dehusked nut weight (g)	Reciprocal Crosses: Standard heterosis (%)
1.	ECT x AOD	1100.27	25.64*	710.15	75.68**	950.28	8.51	640.15	58.36**
2.	ECT x AY	534.43	-38.97**	304.49	-24.68	480.54	-83.07**	265.41	-34.34**
3.	ECT x GBD	819.49	-6.42	410.48	1.54	810.40	-7.46	378.28	-6.42
4.	ECT x CGD	916.35	4.64	577.68	42.91**	793.15	-9.43	535.64	32.51**
5.	ECT x MOD	896.72	2.40	422.72	4.57	619.48	-29.26**	405.24	0.25
6.	ECT x MOD	976.42	11.49	630.43	55.95**	695.72	-20.56	476.43	17.86
7.	ECT x MYD	943.26	7.71	534.32	32.18*	876.24	0.06	557.72	37.97**
8.	COC x AY	1068.72	22.04*	688.48	70.31**	913.49	4.31	674.61	66.88**
9.	COC x CGD	1110.42	26.80**	705.84	74.61**	849.72	-2.97	528.32	30.69*
10.	COC x MYD	1123.36	28.28**	724.42	79.21**	868.63	-0.81	626.03	54.87**
11.	Siam x AY	607.48	-30.63**	465.15	15.07	629.08	-28.17**	446.82	10.53
12.	Siam x CGD	796.64	-9.03	517.18	27.94*	821.18	-6.23	508.31	25.74*
13.	ECT (check)	875.74	0.00	404.24	0.00	875.74	0.00	404.24	0.00
	Mean	905.33	-	545.81	-	783.36	-	495.94	-
	SE(d)	83.59	-	50.26	-	52.87	-	45.67	

**Significant at P = 0.01 *Significant at P = 0.05

tests of significance were applied to bring out information on superiority or otherwise of the hybrids.

Results and Discussion

Nut characters

The mean expression of the hybrids and the local check East Coast Tall for the nut characters along with the expression of standard heterosis on ECT are presented in Tables 1 and 2.

Manifestation of hybrid vigour was observed for all the four nut characters in the hybrids. The magnitude of standard heterosis recorded for the dehusked nut weight was the highest followed by kernal weight, copra weight and whole nut weight. In general, the *per se* performance of Tall x Dwarf hybrids was found to be superior to Dwarf x Tall hybrids. More number of the hybrids showed significant standard heterosis for dehusked nut weight, kernel weight and copra weight, while only few have recorded significant heterosis for whole nut weight. Hybrids, COC x MYD, COC x CGD, COC x AY and ECT x AOD showed significant positive standard heterosis for whole nut weight. Apart from these hybrids, ECT x MOD, ECT x CGD, ECT x MYD and Siam x CGD also showed significant positive standard heterosis for dehusked nut

Table 2. Nut characters of coconut hybrids

Sl. No.	Hybrid combination	Direct crosses				Reciprocal Crosses			
		Kernel weight g/nut	Standard heterosis (%)	Copra weight g/nut	Standard heterosis (%)	Kernel weight g/nut	Standard heterosis (%)	Copra weight g/nut	Standard heterosis (%)
1.	ECT x AOD	345.32	46.77**	178.73	37.43**	315.32	34.02**	167.48	28.78**
2.	ECT x AY	214.74	-8.73	105.18	-19.12*	182.08	-22.61*	102.14	-21.46*
3.	ECT x GBD	280.39	19.17*	148.86	14.46	278.34	18.30*	143.45	10.30
4.	ECT x CGD	296.72	26.11**	142.14	9.30	284.64	20.98*	145.15	11.61
5.	ECT x MOD	274.28	16.58	150.37	15.62	232.62	-1.13	125.48	-3.51
6.	ECT x MOD	315.24	33.99**	165.42	27.20**	295.40	25.55**	148.78	14.40
7.	ECT x MYD	299.49	27.29**	154.05	18.45*	280.90	19.39*	145.62	11.97
8.	COC x AY	347.62	47.75**	176.35	35.60**	307.54	30.71**	174.04	33.83**
9.	COC x CGD	356.42	51.49**	178.15	36.99**	280.84	19.36*	156.48	20.32*
10.	COC x MYD	377.34	60.38**	190.44	46.44**	315.08	33.92**	171.61	31.96**
11.	Siam x AY	270.42	14.94	143.38	10.25	243.14	3.34	140.25	7.84
12.	Siam x CGD	256.34	8.95	136.18	4.71	233.32	-0.83	133.18	2.41
13.	ECT (check)	235.28	0.00	130.05	0.00	235.28	0.00	130.05	0.00
	Mean	297.66	-	153.79	-	268.04	~	144.90	-
	SE(d)	21.60	-	11.64	-	19.49	-	10.98	-

**Significant at P =0.01 *Significant at P = 0.05

weight. In contrast, most of the Dwarf x Tall hybrids showed only negative standard heterosis for whole nut weight indicating the influence of maternal parent for the character wholenut weight in the hybrids. However, the standard heterosis for the dehusked nut weight in Dwarf x Tall hybrids was significantly positive.

Both Tall x Dwarf and Dwarf x Tall hybrids showed significant positive heterosis for kernel weight and copra weight except in ECT x AY and its reciprocal AY x ECT where it was negative. Ayiramkachi, a small fruited genotype in coconut with inferior nut characteristics when crossed with ECT produced nuts with inferior quality only. Among the hybrids, COC x MYD, COC x CGD, COC x AY, ECT x AOD and ECT x MOD and their reciprocals produced nuts with high kernel and copra weight. The standard heterosis for kernel weight was the highest in COC x MYD with 60.38 per cent over ECT in direct crosses and among the reciprocals, AOD x ECT with 34.02 per cent was the highest. COC x MYD and AY x COC showed the highest standard heterosis for copra weight with 46.44 per cent and 33.83 per cent respectively among the direct and reciprocal combinations.

Table 3. Annual nut and copra yield of coconut hybrids

Sl. No.	Hybrid combination	Direct crosses				Reciprocal Crosses			
		Annual nut yield/ palm	Standard heterosis (%)	Copra weight kg/palm	Standard heterosis (%)	Annual nut yield/ palm	Standard heterosis (%)	Copra weight kg/palm	Standard heterosis (%)
1.	ECT x AOD	87.48	-1.35	15.64	35.65**	83.42	-5.93	13.97	21.16
2.	ECT x AY	86.75	-2.18	9.12	-20.90	122.48	38.11	12.51	8.50
3.	ECT x GBD	125.73	41.78*	18.72	62.36**	129.10	45.58*	18.52	60.62**
4.	ECT x CGD	129.74	46.30*	18.44	59.93**	125.32	41.32*	18.19	57.76**
5.	ECT x MOD	100.85	13.72	15.16	31.48**	135.48	52.77*	17.00	47.44**
6.	ECT x MOD	152.48	71.94**	25.22	118.73**	148.74	67.73**	22.13	91.93**
7.	ECT x MYD	148.10	67.00**	22.81	97.83**	133.84	50.92*	19.49	69.04*
8.	COC x AY	75.54	-14.82	13.32	15.52	113.92	28.46	19.83	71.99**
9.	COC x CGD	80.60	-9.11	14.36	24.54*	85.48	-3.61	13.38	16.05
10.	COC x MYD	120.60	36.00	22.97	99.22**	84.56	-4.65	14.51	25.85*
11.	Siam x AY	87.96	-0.8	12.61	9.37	197.20	20.88	15.03	30.36**
12.	Siam x CGD	91.48	3.16	12.46	8.07	78.80	-11.14	10.49	-9.02
13.	ECT (check)	88.68	0.00	11.53	0.00	88.68	0.00	11.53	0.00
	Mean	105.85	–	16.34	–	110.54	–	15.89	–
	SE(d)	16.98	–	1.29	–	17.73	–	1.25	–

**Significant at P=0.01 *Significant at P = 0.05

Yield characters

The annual mean nut and copra yield of the hybrids and the local check East Coast Tall and the expression of standard heterosis on ECT are presented in Table 3.

The nut and copra yield are the most important economic attributes in coconut. The *per se* performance of the hybrids indicated that the hybrid ECT x MOD recorded the highest nut yield of 152.48 nuts followed by its reciprocal MOD x ECT (148.74 nuts), ECT x MYD (148.1), MOD x ECT (133.84) and MYD x ECT (135.48). The copra yield was the highest in ECT x MOD with 25.22 kg followed by COC x MYD (22.97 kg) ECT x MYD (22.81 kg) and MOD x ECT (22.13 kg). Most of the hybrids exhibited significant positive heterosis for nut yield and copra yield. Negative heterosis was observed in ECT x AY, COC x AY, Siam x AY, MYD x COC, CGD x Siam and also in direct and reciprocals of ECT x AOD and COC x CGD for nut yield. The standard heterosis for nut yield ranged from 3.16 per cent to 71.94 per cent in direct crosses while in reciprocals it was from 20.88 per cent to 67.73 per cent. The highest standard heterosis for nut yield was recorded by ECT x MOD and its reciprocal followed

by ECT x MYD, MOD x ECT, MYD x ECT, ECT x CGD, GBD x ECT, ECT x GBD and CGD x ECT. The copra yield of all the hybrids studied were found to exhibit positive heterosis except ECT x AY where it was negative. The highest standard heterosis of 118.73 per cent was exhibited by ECT x MOD and the heterosis of the direct and reciprocal hybrids of ECT x MOD, ECT x GBD, ECT x CGD, ECT x MYD, COC x MYD and hybrids ECT x AOD, AY x COC, COC x CGD and AY x Siam was significant and positive for copra yield.

Exploitation of heterosis for commercial cultivation of coconut is gaining momentum in recent years. It was in India that manifestation of hybrid vigour in coconut was first reported. This finding has led to the exploitation of heterosis in coconut which has been adopted as the major programme of improvement in all the coconut growing countries in the world. Tall female x Dwarf male hybrid are found to be early bearing and high yielding. The superiority of T x D hybrids has subsequently been confirmed by many workers (Satyabalan *et al.* 1970). Among the different dwarfs tested as male parents, Chowghat Orange Dwarf (COD) and Gangabondam (GBD) were found to be superior to Chowghat Green Dwarf (CGD). The superiority of Gangabondam a dwarf variety from Andhra Pradesh as a male parent with good combining ability has been reported from Nileshwar by Krishnan and Nambiar (1972). On the other hand Ramachandran *et al*, (1974) established the superiority of Chowghat Green Dwarfs and Malaysian Yellow Dwarf (MYD) as the best combiners with Tall cultivars. Satybalan (1991) after his detailed studies made on different combinations of palms from both the talls and dwarfs suggested that certain combinations are more promising than others. Since it is necessary to identify palms in both the tall and dwarf varieties to obtain promising hybrids based on the combining ability of the parents. The parental combinations have to be identified for the production of promising hybrids.

In the present study, among the seven dwarf parents used, MOD, MYD, Chowghat Green Dwarf and Gangabondam were found to be superior and identified as the best combiners with Tall parents. This clearly suggests that both dwarfs and talls differ in their combining ability and there is a need to select the parental combinations based on their combining ability. Among the different hybrid combinations studied, hybrids involving tall parents ECT and Cochin China with the above dwarf parents had superior nut characteristics, while the hybrids involving ECT and the above dwarf parents were found to be outstanding for the nut and copra yield. In view of the vast potential of coconut hybrids in achieving higher levels of production, emphasis should be laid in future to select promising talls and dwarfs from different geographical regions based on their combining ability so as to realize enhanced hybrid vigour.

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