

EVALUATION OF CERTAIN COCONUT CROSSES FOR HETEROSIS

D.V.R. Rao, H.Hameed Khan*, B.Srinivasulu, N.B.V.C.Rao and M.Kalpana

Acharya N.G. Ranga Agricultural University,
Agricultural Research Station, Ambajipeta – 533 214, A.P.

*CPCRI, Kasaragod - 671 124, Kerala

ABSTRACT

The extent of heterotic effects in coconut crosses involving different parent combinations of 16 crosses and 7 characters was studied. The studies revealed the prevalence of wide range of variability and heterosis in the coconut crosses. The level of heterosis with respect to different characters in the crosses studied and its significance in the coconut breeding programme are discussed in this paper.

INTRODUCTION

Coconut is one of the important plantation crops cultivated in the Southern states and Andhra Pradesh ranks fourth in area in the country. Due to the efforts of crop improvement so far, only a few hybrids are released at the state/country level in coconut and still there is a good scope for exploitation of heterotic effects in this crop. To know the potentiality of hybrids in a crop, it is essential to understand the magnitude and direction of heterosis and the nature of gene action. However, in coconut, information on the heterotic effects of different traits in respect of certain popular parents/varieties is scattered but for stray reports (Bavappa *et al.*, 1973; Liyanage and Sakai, 1961; Khan *et al.*, 2000). For exploitation of hybrid vigour and for development of a good hybrid, planned crop improvement programme envisages the knowledge of heterosis in different crosses. Hence, in the present study the extent of heterotic effects in coconut crosses involving different parental combinations in respect of 16 crosses and 7 characters were discussed.

MATERIALS AND METHODS

The present study was conducted at the Agricultural Research Station, Ambajipeta and 11 parents and their 16 crosses (F_1 s) already laid out in Randomized block design formed the experimental material. The parents were selected based on their phenotypic performance and comprised of Laccadive ordinary, Laccadive micro, Java, Phillippines ordinary, Cochin China, Andaman ordinary, Fiji, East Coastal Tall, West Coast Tall, Chowghat orange dwarf and Gangabondam. There were three replications @ six palms/plot and the trees were aged 16 years and spaced at 8 x 8 m. Recommended cultural practices were followed to maintain the

experimental palms with assured irrigation and the soils are deltaic alluvials. Three palms were labeled for each treatment and data on 7 characters *viz.*, mean nut yield/palm/year, no. of functional leaves/palm, copra content/nut (g), whole nut weight (g), husk content (g/nut) and nut water content (ml/nut) were collected during 2001-02. Data were statistically analysed and the extent of heterosis for crosses was calculated over both better parent and mid parent and expressed as percentage.

RESULTS AND DISCUSSION

A perusal of data indicated that the differences among the parents and F_1 crosses were considerable in many characters studied in coconut. The means of F_1 s and estimates of heterosis both over better parent and mid parent for different characters are presented in Table-1. Data on range of parents and F_1 s average performance of heterosis, number of heterotic crosses, range of heterosis over better parents, best heterotic F_1 s and the best performing F_1 crosses are presented in Table 2. In general, it was observed that higher values for means were recorded by F_1 s in many of the characters studied compared to their parents reflecting the heterotic effects in coconut. Out of 16 crosses, 12 crosses were superior to their better parents in respect of mean nut yield per palm, 6 crosses in leaf number, 12 crosses in female flower number and copra content/nut, 15 crosses in nut weight, 10 crosses in husk weight and 11 crosses in nut water content indicating the higher degree of heterotic effects. The differences among the 11 parents and 16 crosses were significant in respect of all the characters studied except leaf number.

If nut yields are considered (Table-1), among the 11 parents tested, Laccadive Micro

Heterosis in Coconut crosses

(56.75 nuts/palm), ECT (54.80) and Laccadive Ordinary (53.00) registered significantly higher nut yields/palm. Among the 16 crosses, ECT x GB (69.50), GB x F (67.08), GB x LO (64.88) were found superior in nut yield/palm. Out of 16 crosses, 12 crosses exhibited positive heterosis over better parent and 14 showed heterosis over mid parent. The range of heterosis over better parent comprised 0.32 to 68.33 per cent for nut yield and the crosses GB x F (68.33 %) followed by GB x LO (62.81 %) registered higher values of heterosis and were superior. These two crosses recorded higher nut yields also. Nut yield in coconut is a complex variable and would depend on several yield attributes. Heterotic effects in nut yields of coconut were also reported earlier by Satyabalan *et.al.* (1970), Satyabalan and Rajagopal (1987) and Liyanage and Sakai (1961). Considerable variability in yield and yield attributing characters in coconut accessions were reported by Louis (1971), Ramanathan *et.al.* (1982) and Khan *et.al.* (2000). In respect of no. of functional leaves/palm, the difference among the parents and their F₁s were found to be non-significant and only 6 crosses showed heterosis over better parent. Crosses *viz.*, COD x WCT (29.04 %) and CC x GB (22.26 %) recorded higher values and the range of heterosis over better parent comprised 3.15 to 29.04 % and 1.03 to 36.51 over mid parent. The differences in female flower number per plant were significant and 12 crosses were found to be heterotic over better parent and 13 crosses over the mid parent.

The range of heterosis varied from 0.14 – 49.79 and 2.27 – 273.76 % respectively over better and mid parents. COD x WCT (257.00) recorded the highest percentage of heterosis over better parent. The differences among varieties and crosses were significant and out of 16 crosses studied, 12 and 13 crosses showed positive heterotic effects over better and mid parent respectively. Crosses *viz.*, GB x PO (67.24 %) and GB x F (55.77 %) registered higher percentage of heterosis over the better parent and were found promising for copra yield. The range of heterosis over better and mid parent comprised 3.64 – 75.33 and 13.38 – 155.44 respectively.

The differences among the average nut weight among parents and crosses were significant and 15 and 16 crosses respectively showed heterosis over better and mid parent. The range of heterosis varied from 8.61 to 70.66 and from 3.28 to 169.46 in respect of better and mid parents respectively. Coconut crosses GB x PO (70.66) and F x GB (70.30) followed by GB x ECT (63.55) registered higher heterotic effects compared to the better parent and thus were promising for the heterosis of nut size.

Though the differences among husk content were significant, out of 16 crosses evaluated, only 11 crosses exhibited heterotic effect over better parent and 12 crosses exhibited heterosis compared to mid parent. Range of heterosis over better parent comprised of 0.85 – 65.96 over better parent

Table-1 (a). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Mean nut yield/ palm/year	No. of functional leaves/palm
Parents			
1.	Laccadive Ordinary (LO)	53.00	31.7
2.	Laccadive Micro (LM)	56.75	33.1
3.	Java (J)	43.06	35.2
4.	Philippines Ordinary (PO)	48.63	36.0
5.	Cochin China (CC)	50.00	23.8
6.	Andaman Ordinary (AO)	41.65	34.1
7.	Fiji (F)	40.45	34.5
8.	East Coast Tall (ECT)	54.80	33.3
9.	West Coast Tall (WCT)	44.90	30.2
10.	Chowghat Orange Dwarf (COD)	37.20	24.1
11.	Gangabondam (GB)	39.85	29.1
Mean of Parents		43.62	31.3

Table-1 (b). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Mean nut yield/palm/year			No. of functional leaves/palm		
		Mean (No. nuts)	Heterosis over B.P (%)	Heterosis over M.P. (%)	Mean	Heterosis over B.P (%)	Heterosis over M.P. (%)
Crosses (F1)							
1.	LO x GB	53.17	0.32	34.02	32.7	3.15	12.37
2.	LM x GB	55.42	—	39.07	31.2	—	7.21
3.	J x GB	40.89	—	2.60	29.8	—	2.40
4.	PO x GB	54.51	12.09	36.78	31.8	—	9.27
5.	CC x GB	61.48	22.96	54.27	29.1	22.26	—
6.	AO x GB	53.93	29.47	35.33	29.9	—	2.74
7.	LO x PO	43.28	—	—	30.7	—	—
8.	F x GB	48.74	20.49	22.31	29.4	—	1.03
9.	LO x COD	44.72	—	20.22	32.9	3.78	36.51
10.	ECT x GB	69.50	26.82	64.40	31.0	—	6.52
11.	GB x ECT	50.96	27.87	—	30.1	3.43	—
12.	GB x F	67.08	68.33	65.83	25.4	—	—
13.	GB x PO	55.14	38.36	13.38	29.1	—	—
14.	GB x LO	64.88	62.81	22.41	26.8	—	—
15.	WCT x COD	62.15	38.42	67.05	32.8	8.60	36.09
16.	COD x WCT	54.50	46.50	21.38	31.1	29.04	2.98
Mean of F1		51.27	32.87	35.64	30.2	11.71	11.71
CD (0.05)		6.16			—		

Table-1 (c). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	No. of female flowers/palm/year	Copra content (g/nut)
Parents			
1.	Laccadive Ordinary (LO)	171.3	152.6
2.	Laccadive Micro (LM)	240.1	135.4
3.	Java (J)	140.2	175.0
4.	Philippines Ordinary (PO)	145.4	211.0
5.	Cochin China (CC)	116.2	173.0
6.	Andaman Ordinary (AO)	204.3	205.2
7.	Fiji (F)	160.1	148.2
8.	East Coast Tall (ECT)	170.0	139.6
9.	West Coast Tall (WCT)	154.2	112.5
10.	Chowghat Orange Dwarf (COD)	52.6	83.4
11.	Gangabondam (GB)	158.8	120.3
Mean of Parents		155.7	150.5

Heterosis in Coconut crosses

and in respect of mid parent it ranged from 40.87 to 127.10.

With respect to water content per nut, eleven crosses exhibited heterosis over better parent and 12 crosses over mid parent. The

heterosis percentage varied from 1.58 to 139.04 among crosses over better parent and from 6.49 to 86.35 among crosses over mid parent. Crosses viz., ECT x GB (139.04) followed by LM x GB (104.09) registered higher values of heterosis over better parent and were promising.

Table-1 (d). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	No. of female flowers /palm/year			Copra content (g/nut)		
		Mean (No. nuts)	Heterosis over B.P (%)	Heterosis over M.P. (%)	Mean	Heterosis over B.P (%)	Heterosis over M.P. (%)
Crosses (F1)							
1.	LO x GB	192.4	12.31	21.15	174.5	14.35	45.05
2.	LM x GB	180.0	—	13.35	158.1	16.76	31.42
3.	J x GB	142.2	0.14	—	199.0	14.36	155.44
4.	PO x GB	217.8	49.79	37.15	135.2	—	12.38
5.	CC x GB	167.8	44.40	5.66	179.3	3.64	49.04
6.	AO x GB	124.5	—	—	220.1	7.26	82.95
7.	LO x PO	148.7	—	2.27	134.0	—	—
8.	F x GB	154.8	—	—	134.5	—	—
9.	LO x COD	196.6	14.76	273.76	109.2	—	30.93
10.	ECT x GB	203.1	19.47	27.90	160.3	15.04	92.56
11.	GB x ECT	211.8	33.37	24.58	157.3	30.75	12.67
12.	GB x F	204.5	28.77	27.73	187.4	55.77	26.45
13.	GB x PO	197.5	24.37	35.83	201.2	67.24	—
14.	GB x LO	183.1	15.30	6.88	176.3	46.55	15.53
15.	WCT x COD	180.5	17.05	243.15	138.1	22.75	65.58
16.	COD x WCT	187.8	257.00	21.78	146.4	75.53	30.13
	Mean of F1	180.8	43.06	57.01	163.2	30.83	50.04
	CD (0.05)	8.6			5.8		

Table-1 (e). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Nut wt. (g)	Husk wt. (g/nut)
Parents			
1.	Laccadive Ordinary (LO)	1011.0	620.6
2.	Laccadive Micro (LM)	874.2	465.0
3.	Java (J)	1160.1	725.5
4.	Philippines Ordinary (PO)	1183.0	692.8
5.	Cochin China (CC)	1366.2	934.8
6.	Andaman Ordinary (AO)	1294.3	761.3
7.	Fiji (F)	570.4	580.0
8.	East Coast Tall (ECT)	938.1	545.0
9.	West Coast Tall (WCT)	926.2	502.2
10.	Chowghat Orange Dwarf (COD)	850.2	451.0
11.	Gangabondam (GB)	940.5	540.3
	Mean of Parents	1010.4	619.8

Table-1 (f). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Nut wt. (g)			Husk wt. (g/nut)		
		Mean (No. nuts)	Heterosis over B.P (%)	Heterosis over M.P. (%)	Mean	Heterosis over B.P (%)	Heterosis over M.P. (%)
Crosses (F1)							
1.	LO x GB	1286.2	27.22	36.75	625.9	00.85	15.84
2.	LM x GB	1385.0	58.43	47.26	711.7	53.05	31.72
3.	J x GB	1412.3	21.74	50.16	618.4	—	14.45
4.	PO x GB	1126.1	—	19.73	518.6	—	—
5.	CC x GB	1537.2	12.51	63.44	718.5	—	32.98
6.	AO x GB	1610.0	24.39	71.18	810.8	6.50	50.01
7.	LO x PO	1253.1	23.95	5.92	664.0	7.00	—
8.	F x GB	971.4	70.30	3.28	486.9	—	—
9.	LO x COD	1098.0	8.60	29.16	601.9	—	33.45
10.	ECT x GB ₁	1534.3	63.55	63.13	904.5	65.96	67.40
11.	GB x ECT	1421.4	51.13	51.50	822.3	52.19	50.88
12.	GB x F	1537.0	63.42	169.46	840.1	55.48	44.84
13.	GB x PO	1605.1	70.66	35.68	881.2	63.10	27.19
14.	GB x LO	1411.5	50.01	39.61	809.4	49.80	127.10
15.	WCT x COD	962.3	38.97	13.20	473.0	—	4.87
16.	COD x WCT	955.6	12.41	31.88	468.6	3.90	—
	Mean of F1	1319.2	39.81	45.70	684.7	35.78	41.72
	CD (0.05)	38.3			27.4		

From the aforesaid discussion, it can be observed that the higher values of heterosis were recorded by many coconut crosses over better as well as mid parents in all the characters studied except number of functional leaves. Out of 16 crosses evaluated for 7 characters, the number of heterotic crosses over better parent ranged from 6 – 15 reflecting the existence of considerable heterosis for certain yield and yield attributes in coconut. The range of heterosis over better parent in F₁s comprised from 0.32 to 139.04 for different characters studied. For nut yields, the extent of heterosis in crosses ranged from 0.33 to 68.33 (%) over better parent. Certain of the better performing coconut crosses which had registered higher values of heterosis over better parent include GB x F (68.33%), GB x LO (62.81%) for nut yields; COD x WCT (25.7%) for female flower number per palm; COD x WCT (75.53 T), GB x PO (67.24%) for copra content/nut; GB x PO (70.66%) for nut weight; ECT x GB (65.96%) for husk content in nut; and crosses ECT x GB (139.04) and LM x GB (104.09) for nut water content. Among the various characters studied, higher values for

heterotic effects over better parent were registered for certain characters viz., nut water content (50.32%), female flower number per palm (43.06%),

Table-1 (g). Mean values of parents and F1 coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Water content (ml/nut)
Parents		
1.	Laccadive Ordinary (LO)	160.2
2.	Laccadive Micro (LM)	80.5
3.	Java (J)	182.2
4.	Philippines Ordinary (PO)	162.6
5.	Cochin China (CC)	220.5
6.	Andaman Ordinary (AO)	183.0
7.	Fiji (F)	121.0
8.	East Coast Tall (ECT)	113.2
9.	West Coast Tall (WCT)	116.5
10.	Chowghat Orange Dwarf (COD)	91.0
11.	Gangabondam (GB)	120.2
	Mean of Parents	140.9

Heterosis in Coconut crosses

Table-1 (h). Mean values of parents and F₁ coconut crosses and their heterosis percentage

Sl. No.	Parent/Cross	Water content (ml/nut)		
		Mean (No. nuts)	Heterosis over B.P (%)	Heterosis over M.P. (%)
Crosses (F₁)				
1.	LO x GB	168.2	5.00	39.93
2.	LM x GB	164.3	104.09	36.68
3.	J x GB	215.5	118.27	79.28
4.	PO x GB	130.3	72.38	8.40
5.	CC x GB	224.0	1.58	86.35
6.	AO x GB	175.6	—	46.08
7.	LO x PO	142.3	—	—
8.	F x GB	107.8	—	—
9.	LO x COD	101.2	—	—
10.	ECT x GB	168.6	139.04	40.26
11.	GB x ECT	154.0	28.11	36.04
12.	GB x F	191.2	59.06	58.00
13.	GB x PO	201.4	67.55	23.86
14.	GB x LO	170.6	41.93	6.49
15.	WCT x COD	110.5	—	21.42
16.	COD x WCT	106.1	16.60	—
	Mean of F₁	158.2	50.32	40.23
	CD (0.05)	8.2		

Foot note : B.P. = Better parent; M.P. = Mid Parent

Table-2. Range and mean values in parents and F₁ crosses and heterosis in coconut

Range, Mean & Heterosis	Mean nut yield/palm/year (No)	No. of functional leaves/palm	No. of female flowers/palm/year	Copra content (g/nut)	Nut weight (g)	Husk weight (g/nut)	Nut water content (ml/nut)
Range parents	37.20 - 56.35	24.10 - 36.00	52.60 - 240.10	83.40 - 211.00	570.40 - 1366.20	451.00-934.80	80.50 - 220.50
Range F ₁	40.89 - 67.08	25.40 - 32.90	124.50-217.80	109.20-220.10	955.60 - 1610.00	468.60-904.50	101.20 - 15.00
Mean F ₁	51.27	30.20	180.80	163.20	1319.20	684.70	158.20
Mean (Parents)	43.62	31.30	155.70	150.50	1010.40	619.80	140.90
Best performing F ₁	67.08 (GB x F)	32.90 (LO x COD)	217.80 (PO x GB)	220.10 (AO x GB)	1610 (AO x GB)	904.50 (ECT x GB)	215 (J x GB)
Average heterosis % over heterotic crosses	32.87	11.71	43.06	30.83	39.81	35.78	50.32
No. of heterotic crosses over B.P.	12	6	12	12	15	10	11
Range of heterosis over B.P.	0.32 - 68.33	3.15 - 29.04	0.14 - 257.0	3.64 - 67.24	8.60 - 70.66	0.85 - 65.96	1.58 - 139.04
Best heterosis F ₁ over B.P.	68.33 (GB x F)	29.04 (COD x WCT)	257.00 (COD x WCT)	67.24 (GB x PO)	70.66 (GB x PO)	65.96 (ECT x GB)	139.04 (ECT x GB)

nut weight (39.81%) and husk weight (35.78%). In general, crosses involving Gangabondam (GB), Laccadive Ordinary (LO), Fiji (F) as one of the parents performed better in many yield attributes and these coconut varieties appear to be good combiners. It can be inferred from these results that coconut crosses *viz.*, Gangabondam x Fiji and Gangabondam x Laccadive Ordinary and ECT x Gangabondam are promising. However, crosses *viz.*, LM x GB, J x GB, LO x PO recorded heterosis over mid parent only and may be considered inferior.

This study revealed the prevalence of wide range of variability and heterosis in the coconut crosses which offers scope for exploitation of heterotic effects for varietal improvement in coconut. For formulation of a systematic breeding programme, further studies on heritability and genetic advance and gene action are necessary in a commercially important crop like coconut.

REFERENCES

- Bavappa, K.V.A., Sukumaran, C.K. and Mathew, J. 1973. A study of F_1 hybrids of Tall x Dwarf coconut and its bearing on the genetics of dwarfness. *J. Plantation Crops*, 1 (Suppl) : 1-6
- Liyanage, D.V. and Sakai, 1961. Heritabilities of certain yield characters of the coconut palm. *J. Genetic*, 57 : 245 - 252
- Louis, I.H. 1981. Genetic variability in coconut palm. *Madras Agric. J.*, 68 : 588 - 593
- Khan, H.H., Elangovan, M., Arunachalam, V., Nambiar, P.T.N., R.V.K.S. Reddy, Prasannakumar, Nageswar, D.D., Suresh, S., Giridharan, S., Natarajan : A., Namboothiri, K.V.K. and Parthasarathy, V.A., 2000. Stability of coconut yield in coordinated multilocation trials. *Placrosym XIV. Abst. Papers*. 46
- Ramanathan, T., Henry Louis, I and Venkateswaran, A.N. 1982. Genetic diversity and exploitation of heterosis in coconut. *Absts. of Papers. 5th Ann. Symp. on Plant Crops*. 20 -21
- Renuga, M., Vijaya Kumar, M., Raman, A. and Easwaran, S. 2000. Studies on genetic variability, heritability and genetic advance in certain varieties and hybrids of coconut seedlings. *Placrosym XIV. Abst. Papers*. 30
- Satyabalan, K., Ratnam, T.C. and Kunjan, P.V. 1970. Hybrid vigour in nut and copra characters of coconut hybrids. *Indian J. Agric. Sci.* 40 : 1088 - 1093
- Satyabalan, K. and Rajagopal, K. 1987. Genetic improvement of coconut palm - Combining ability of palms in Dwarf x Tall hybrids. *J. Plantn. Crops*. 15(1) : 23 - 30

* * *