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Research Article

Estimation of heterosis for tender nut yield traits in coconut hybrids (C*ocos nucifera* L.)

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Abstract
An experiment to evaluate the coconut hybrids for tender nut was conducted at Coconut Research Station, Aliyar nagar during 2017-18. Seven cross combinations along with eight parents were studied. The heterosis for number of female flowers/palm/year, number of bunches/palm, number of tender nuts/bunch/palm and total number of tender nuts/palm/year of coconut were assessed. All coconut hybrids showed a well pronounced heterotic expression which could be exploited. It is concluded from the present study that all the cross combinations performed better than the parents for all the four economically important traits. The coconut hybrids showing well pronounced heterotic expression could be exploited for development of location specific hybrids of commercial importance.

Keywords
Coconut genotypes, Better parent, Economic heterosis

Introduction

Coconut (C*ocos nucifera* L.) is one of the most useful tree among tropical palms. It is important in providing a variety of useful products, every part of the tree being utilized for various purposes called as "Tree of Heaven". . Coconut is grown in 2082.11 thousand ha in more than 16 states and Union Territories of the country producing 23904.10 million nuts with an average productivity of 11481 nuts per ha. The four Southern states put together account for more than 92 per cent of the total production in the country (Kerala 31.11%, Tamil Nadu 28.33%, Karnataka 27.48%, Andhra Pradesh 5.70% and other states 8.0%) (Coconut Development Board, 2018). Out of this, tall trees constitute 90 per cent and 10 per cent are dwarf and hybrid varieties which is only meant for tender coconut cultivation. From the 90 per cent tall trees, growers harvest tender coconut for four to six months. Coconut palms exhibit wide variability in productivity ranging from 30 to 400 nuts/ palm/year depending upon the growth conditions and cultivars (Iyer *et al.* 1981). The economic yield of any crop depends on the solar radiation intercepted, the efficiency of conversion of this intercepted solar radiation to dry matter and the efficient partitioning of assimilated dry matter between vegetative and harvestable parts of the plant. The term heterosis describes increased size and yield in crossbreds as compared to the corresponding inbred lines (Shull, 1948). Being a perennial crop with indeterminate flowering, the productive features of the palm is influenced considerably by environmental factors (Coomans, 1975; Murray, 1977). Heterosis was also has been reported for yield (Ramanathan, 1989; Damodaran *et al.* 1991). The present study was undertaken to analyze the hybrid vigour for seven hybrids and their eight parents.

Materials and Methods

The present study was carried out during 2017-2018 at Coconut Research Station, Aliyar nagar. The area is located in the foot hills of Western Ghats at the geographic co-ordinates of 10º N latitude and 77ºE longitude, 20km south of Pollachi at an elevation of 260m above MSL with an undulating topography. The hybrids and the parents evaluated in this study were planted at a distance of 7.5 x 7.5 m in randomized block design with three replications. Six palms were taken for observation in each genotype (two palms per replications).

The details of the hybrids and parents involved in the study are given in Table 1. Observations were taken for economically important traits *viz.*, number of female flowers/palm/year, number of bunches/palm, number of tender nuts/bunch/palm and total number of tender nuts/palm/year. The mean values were subjected to statistical analysis. The heterobeltosis of F_1 hybrids was computed as per Fehr (1987) and economic heterosis as per Meredith and Bridge (1972).

Results and Discussion

The mean performance for number of female flowers per palm per year of hybrids varied from ALR1×MGD (196.83) to MGD×ALR (1253.17).

Among parents, it's ranged from COD (159.60) to ADOT (281.33). (Table 2)

In present study, the hybrid, ALR1×MGD recorded highest number of bunches per palm followed by ECT×LCT and the lowest was recorded by COD×ALR1. This might be due to shy bearing tendency in dwarf which is the undesirable genetic trait in the variety as reported by Henry Louis (2002). When dwarf is kept as female parent in hybridization scheme the progenies are likely to express the recessive genes in homozygous form. In parents, the highest number of bunches per palm was recorded by COD and the lowest by ECT as reported by Selvaraju *et al.* (2011) due to the nature of its stabilized genetic position.

Significant difference between hybrids and parents were observed for the number of tender nuts per bunch per palm. Among the hybrids, KTD×ALR1 (14.42) has recorded highest number of tender nuts per bunch per palm followed by ADOT×ECT (13.50). In parents, ECT (11.64) recorded higher number of tender nuts per bunch per palm and lowest is KTD (9.43). (Table 2)

Kumaran *et al.* (2006) evaluated the performance of coconut hybrids along with local control under rainfed conditions. The highest value was observed in the hybrid MYD×WCT can be attributed due to the heterotic effect of the hybrid.

In hybrids, the highest total number of tender nuts per palm per year was recorded by KTD×ALR1 followed by ADOT×ECT and the lowest was recorded by ALR1×MGD. In parents, the highest total number of tender nuts per palm per year was recorded by ECT and the lowest by KTD. However all the hybrids recorded the highest total number of tender nuts per palm per year indicating the expression of the heterotic effects as reported by Satyabalan *et al.* (1970), Ramachandran *et al.* (1975), Satyabalan and Rajagopal (1987), Natarajan *et al.* (2006) and Jayabose *et al.* (2008).

The range of degree of significant heterosis in percent and number of heterotic crosses for respective traits are given in Table 3. Among the hybrids, MGD x ALR1 recorded highest value of relative heterosis (47.51 %), followed by COD x WCT (41.43 %), KTD×ALR1 (28.87 %), COD×ALR1 (27.16 %) and ALR1×MGD (14.69 %). In respect of heterobeltiosis, the hybrid MGD x ALR1 recorded the highest positive heterobeltiosis (46.04 %) followed by COD×WCT (37.14 %) and KTD×ALR1 (27.21 %). The economic heterosis ranged from 15.85 to 49.01 per cent. Among the seven hybrids, MGD x ALR1 registered the highest standard heterosis value of 49.01 per cent.

Among the hybrids, ALR1×MGD recorded highest value of relative heterosis (15.74 %), followed by ECT×LCT (10.42 %) and MGD×ALR1 (6.23 %). In respect of heterobeltiosis, the hybrid ALR1×MGD recorded the highest positive heterobeltiosis (12.05 %) followed by ECT×LCT (6.03 %) and MGD×ALR1 (2.84 %). (Table 3)

The economic heterosis ranged from -7.37 to 9.86 per cent. Among the seven hybrids, ALR1×MGD registered the highest standard heterosis value of 9.86 per cent.

All the hybrids recorded positive relative heterosis for number of bunches per palm. Among the hybrids, KTD×ALR1 recorded highest value of relative heterosis (49.16 %), followed by MGD×ALR1 (32.36 %) and COD×WCT (22.97 %). In respect of heterobeltiosis, the hybrid KTD×ALR1 recorded the highest positive heterobeltiosis (46.21 %) followed by MGD×ALR1 (30.01 %) and COD×WCT (22.44 %).The economic heterosis ranged from 9.26 to 37.30 per cent. Among the seven hybrids, KTD×ALR1 registered the highest standard heterosis value of 37.30 per cent. (Table 4)

Heterosis is the superiority of the hybrid over the mid, better parent and standard variety and is the result of allelic or non-allelic interaction of genes under the influence of particular environments. All the parameters *viz.*, number of female flowers per palm per year (MGD×ALR1), number of bunches per palm (ALR1×MGD), number of tender nuts per bunch per palm (KTD×ALR1) and total number of tender nuts per palm per year (KTD×ALR1) showed surpass than the parents and highest values of d_i, (relative heterosis), d_{ii} (heterobeltiosis) and d_{iii} (standard heterosis). When two alleles of various genes are brought together, there is a combined allelic expression. When complementation of alleles in different genes was cumulative in phenotype, then heterosis would result as reported by James *et al.* (2003).

Jayabose *et al.* (2008) also conducted studies to identify better hybrids based on heterobeltiosis (superior to better parent) as well as economic heterosis.

It is concluded from the present study that all the cross combinations performed better than the parents for all the four economically important traits. The expression of heterosis which indicates marked maternal influence on character expression and hence the choice of parents in developing hybrids is highly important. The coconut hybrids showing well pronounced heterotic expression could be exploited for development of location specific hybrids of commercial importance.

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Table 1. List of Genotypes used in this study

Parents	Hybrids	Hybrids Code
ALR1 (Arasampatti Tall)	ALR1×MGD	H_1
MGD (Malayan Green Dwarf)	MGD×ALR1	H_2
COD (Chowghat Orange Dwarf)	COD×ALR1	H_3
WCT (West Coast Tall)	COD×WCT	H_4
KTD (Kenthali Dwarf)	KTD×ALR1	H_5
ADOT (Andaman Ordinary Tall)	ADOT×ECT	H_6
ECT (East Coast Tall)	ECT×LCT	H_7
LCT (Laccadive Ordinary Tall)		

Table 2. Mean performance of coconut genotypes for nut yield and their traits

Genotypes	Number of female flowers/ palm/year	Number of bunches/palm	Number of tender nuts/ bunch/palm	Total number of tender nuts/ palm/year
ALR1×MGD	196.83	11.25	11.47	137.41
MGD×ALR1	253.17	10.33	12.82	153.68
COD×ALR1	209.50	9.49	12.40	150.42
COD×WCT	233.00	10.11	12.82	154.76
KTD×ALR1	221.83	10.48	14.42	174.01
ADOT×ECT	201.17	9.65	13.50	162.46
ECT×LCT	218.17	10.55	12.94	157.46
ALR1	169.90	10.04	9.86	118.49
MGD	173.35	9.40	9.51	113.91
COD	159.60	11.36	10.38	124.06
WCT	169.90	10.24	10.47	124.79
KTD	174.38	10.73	9.43	113.69
ADOT	281.33	9.65	10.43	125.48
ECT	256.47	9.16	11.64	141.34
LCT	257.53	9.95	10.35	122.84
Mean	211.74	10.16	11.50	138.32
S.E.	4.38	0.17	0.19	2.31
CD (P = 0.05)	8.97	0.35	0.38	4.74
CV %	2.53	2.04	1.98	2.05

Table 3. Heterosis for economically important characters in coconut hybrids

Hybrids code	Hybrid combination	Mean	Relative Heterosis (%)	Hetero Beltiosis (%)	Economic Heterosis (%)
Number of female flowers per palm per year					
H_1	ALR1×MGD	196.83	14.69*	13.55*	15.85*
H_2	MGD×ALR1	253.17	47.51*	46.04*	49.01*
H_3	COD×ALR1	209.50	27.16*	23.31*	23.31*
H_4	COD×WCT	233.00	41.43*	37.14*	37.14*
H_5	KTD×ALR1	221.83	28.87*	27.21*	30.57*
H_6	ADOT×ECT	201.17	-25.19	-21.56*	18.40*
H_7	ECT×LCT	218.17	-15.11	-15.28*	28.41*
Number of bunches per palm					
Hybrids code	**Hybrid combination**	**Mean**	**Relative Heterosis (%)**	**Hetero beltiosis (%)**	**Economic Heterosis (%)**
H_1	ALR1×MGD	11.25	15.74*	12.05	9.86*
H_2	MGD×ALR1	10.33	6.23*	2.84	0.83*
H_3	COD×ALR1	9.49	-11.35	-16.50	-7.37*
H_4	COD×WCT	10.11	-6.43	-11.05	-1.32
H_5	KTD×ALR1	10.48	0.89*	-2.35	2.32*
H_6	ADOT×ECT	9.65	2.63*	0.02	-5.74*
H_7	ECT×LCT	10.55	10.42*	6.03	3.03*

*Significant at 5% level

Table 4. Heterosis for nut yield characters in coconut hybrids

Number of tender nuts per bunch per palm					
Hybrids code	**Hybrid combination**	**Mean**	**Relative Heterosis (%)**	**Hetero beltiosis (%)**	**Economic Heterosis (%)**
H_1	ALR1×MGD	11.47	18.45*	16.35	9.26*
H_2	MGD×ALR1	12.82	32.36*	30.01	22.09*
H_3	COD×ALR1	12.40	22.56*	19.49*	18.12*
H_4	COD×WCT	12.82	22.97*	22.44*	22.09*
H_5	KTD×ALR1	14.42	49.16*	46.21	37.30*
H_6	ADOT×ECT	13.50	22.34*	15.98*	28.57*
H_7	ECT×LCT	12.94	17.73*	11.21*	23.28*
Total number of tender nuts per palm per year					
Hybrids code	**Hybrid combination**	**Mean**	**Relative Heterosis (%)**	**Hetero beltiosis (%)**	**Economic Heterosis (%)**
H_1	ALR1×MGD	137.41	18.25*	15.96*	10.11*
H_2	MGD×ALR1	153.68	32.25*	29.70*	23.15*
H_3	COD×ALR1	150.42	24.03*	21.25*	20.54*
H_4	COD×WCT	154.76	24.38*	24.01*	24.01*
H_5	KTD×ALR1	174.01	49.89*	46.86*	39.44*
H_6	ADOT×ECT	162.46	21.77*	14.94*	30.19*
H_7	ECT×LCT	157.46	19.20*	11.40*	26.18*

*Significant at 5% level