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Potential coconut (*Cocos nucifera*) hybrids developed using Gangabondam (GBGD) as maternal parent for yield and quality for southern dry tract of Karnataka (India)

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ABSTRACT

A long term evaluation of nine coconut (*Coconut nucifera* L.) hybrids with a local check was conducted under irrigated conditions at All India Coordinated Research Project on Palms, Horticulture Research Station, Arsikere, Karnataka. The experimental material consisted of nine hybrids with different cross combinations, *viz*. Tall × Tall, Tall × Dwarf and Dwarf × Tall along with TPT (Tiptur Tall) as local check planted during 1987-1988 and evaluated for yield performance for a period of 18 years (till 2015-16). Among the nine coconut hybrids evaluated, the cross combinations involving dwarf as female parent (Gangabondam) and tall cultivars as male parent, *viz*. GBGD × LCOT, GBGD × PHOT and GBGD × FJT performed superior and recorded significantly higher nut yield (128.6, 124.3 and 110.3 nuts palm^{-1} year^{-1}, copra yield 22.0, 19.8 and 16.3 copra kg palm^{-1} year^{-1}), with oil yield ranged from 11.5 to 13.8 kg palm^{-1} year^{-1}when compared to local check. Hybrids possessed higher quantity of organoleptically 'good' tender nut water (326 to 395.4 ml) with TSS of 5.6 to 6.2 °Brix , 26.0 to 31.6 ppm of sodium and 2025.1 to 2110.1 ppm of potassium.

Key words: Gangabondam, Heterosis, Hybrids, Nut yield, Tender nut water

Coconut (*Cocos nucifera* L.) is a benevolent tree, a nature's gift to mankind which provides food security and livelihood to large size of population in India with the annual production of 23904 nuts with a productivity of 11,481 nuts/ha (CDB 2018) and cultivated across 18 states and 3 Union Territories in the country. India is the first country in the world to exploit hybrid in coconut with a cross between West Coast Tall and Chowghat Green Dwarf (Patel 1937) and superior varieties selected after evaluation of germplasm have been utilized in crop improvement programmes to develop high yielding hybrids. Selections from dwarf cultivar are highly suitable for tender nut purpose, which are mostly low yielders when compared to hybrids and tall cultivars and susceptible to adverse conditions. Hence, there is need to focus on incorporating the superior tender fruit traits of dwarf selections along with the dwarfness and early flowering traits into the hybrids involving superior tall selections. Due to the effort of crop improvement so far, 20 high yielding hybrids are released at the state/country level in coconut and still there is a good scope for exploitation of heterotic effects (CPCRI 2014 and Maheswarappa *et al.* 2016). The coconut hybridization programmes are aimed at searching heterosis for traits such as early flowering and bearing, more nuts and high copra and adaptability to a wide range of agro-climatic conditions. Most of the hybrid evaluation trials conducted involve inter-varietal crosses of Dwarf × Tall and Tall × Dwarf types, and the superiority of hybrids over local tall cultivars in terms of precocity, number of nuts per ha and copra/nut were established (Satyabalan and Vijayakumar 1982 ; de Taffin *et al*. 1991). Even though both types of hybrids are high yielding, D × T hybrids have distinct advantage over T × D hybrids as they could be produced on large scale by regular emasculating dwarf mother palms (Nair *et al.* 2010). Understanding the floral biology in individual palms of the selected cultivar is necessary while choosing the mother palms. In most tall accessions, there is clear time gap between male and female phases making cross-pollination the only option for fruit set. Hybrids have been developed by combining the early flowering trait of dwarf cultivar along with hardiness and high yielding characters of tall cultivar (Jerard *et al*. 2015). The expression of hybrid vigour is influenced by the environment (Chapman *et al*. 2000) and hence the evaluation of hybrids in different locations

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is necessary to ascertain their suitability to a particular locality. The productivity levels in coconut growing regions of Karnataka are at below the potential yield because of prevalence of local variety coupled with non adoption of scientific production technologies. Identification of suitable hybrid to a particular agro-climatic region play an important role in achieving higher and sustained yield. Keeping these points in view, the present investigation was carried out, for identifying a better performing coconut hybrid (T × T, T × D and D × T) for cultivation in southern dry tract of Karnataka.

MATERIALS AND METHODS

A set of nine hybrids maintained at the All India Coordinated Research Project on Palms, Horticulture Research Station, Arsikere which is located in the east maidan tracts of Karnataka, India were utilized for the study. The area is located in longitude of 76.5^0 E, Latitude of 13^{0}15^1 N, altitude of 800 m MSL, the mean minimum temperature 13.8^0 C, the mean maximum temperature 34.6^{0}C. The average annual rainfall 694 mm received in 46 raining days having bimodal distribution with peak in May-June and Sept-Oct. The soil of the experimental site was medium black with alkali pH - 7.5 to 8.0, low in available nitrogen (254.1 kg N/ha) and phosphorous (19.0 kg P_2O_5/ha) and medium in available potassium (246.0 kg K_2O/ha). The experimental material consisted of nine hybrid cross combinations developed at different centres, *viz.* Tall × Tall (CCNT × LCOT, LCOT × PHOT and LCOT × CCNT) from Veppankulam centre (Tamil Nadu), Tall × Dwarf (WCT × COD, WCT × GBGD and WCT × MYD) from Pillicode centre and Dwarf × Tall (GBGD × FJT, GBCD × PHOT and GBGD × LCOT) from Ambajipeta (Andhra Pradesh) were collected and planted with a spacing of 7.5 × 7.5 m with three replications, 10 palms were maintained per replication and the details of parents are presented in Table 1 along with Tiptur Tall as local check. The experiment was initiated in the year 1987-88 and evaluated for yield performance till 2016 with the recommended package of practices (500:320:1200g/palm/year) with soil application in two split dose by following drip irrigation (Maheswarappa and Rajkumar 2014). Morphological characters related to leaf, inflorescence, fruit and fruit components, tender nut quality, *viz.* volume of water (mL), total soluble solids (^{o} brix), total sugars (g 100 mL^{-1}), sodium (ppm) and potassium (ppm) were also recorded in the adult palms during 2015-16 at the age of 25 years. Data pertaining to nut production and estimated copra out turn recorded from 2006 to 2016 (10 years) was used for assessing the performance of the hybrids. The yield (nuts palm^{-1} year^{-1}) was recorded periodically during each harvest from July to June and pooled to get the yield palm^{-1} year^{-1}. Fruit components analysis was carried out by selecting 12 month old mature nuts of each hybrid crosses (six Nos.) by following the method prescribed by Ratnambal *et al*. (2000). Copra yield per palm was calculated based on the copra content per nut and it is expressed as kg per palm. The oil content in copra was analyzed in Soxhlet apparatus by drawn pooled samples of each hybrid over replication and oil yield per palm was computed. The data on different characters were subjected to statistical analysis as per the standard procedures (Panse and Sukhatme 1985). The economic heterosis of F_1 hybrids were calculated as per Meredith and Bridge (1972) for important traits and discussed over check.

Table 1 Details of parental palms used in hybridization programme

Genotype	Crosses	Code
CCNT × LCOT	Selection from Cochin China as female parent and selection from Laccadive Ordinary as male parent.	H_1
LCOT × PHOT	Selection from Laccadive Ordinary as female parent and selection from Philippines Ordinary Tall as male parent.	H_2
LCOT × CCNT	Selection from Laccadive Ordinary as female parent and selection from Cochin China as male parent.	H_3
WCT × COD	Selection from West Coast Tall as female parent and selection from Chowghat Dwarf Orange as male parent.	H_4
WCT × GBGD	Selection from West Coast Tall as female parent and selection from Gangabondam as male parent.	H_5
WCT × MYD	Selection from West Coast Tall as female parent and selection from Malayan Yellow Dwarf as male parent.	H_6
GBGD × FJT	Selection from Gangabondam as female parent and selection from Fiji as male parent.	H_7
GBGD × PHOT	Selection from Gangabondam as female parent and selection from Philippines Ordinary Tall as male parent.	H_8
GBGD ×LCOT	Selection from Gangabondam as female parent and selection from Laccadive Ordinaryas male parent.	H_9
Tiptur Tall	Local check	Check

RESULTS AND DISCUSSION

Growth characters

The palm height and stem girth at the age of 25 years varied significantly among different coconut hybrids (Table 2), and the cross combination, GBGD × PHOT recorded the lowest plant height (6.2 m) and was on par with other hybrids with GBGD as female parent, whereas WCT × GBGD recorded the highest palm height (7.7 m). The lowest palm height recorded in GBGD × LCOT and GBGD × PHOT (Dwarf × Tall) could be attributed to the dwarf nature of the female parent and similar result was also reported by Ramanandam *et al.* (2017) in coastal Andhra Pradesh. The girth at one m height was the highest with LCOT × CCNT (95.94 cm) in Tall × Tall cross and was on

Table 2 Performance of coconut hybrids and a variety for growth parameters

Hybrid cross combination	Palm height (m)	Girth at 1 m height (cm)	No. of functional leaves	Annual leaf production (Nos.)	Petiole length (cm)
CCNT × LCOT	6.4	90.5	27.1	12.1	130.2
LCOT × PHOT	7.2	87.5	30.3	12.0	130.1
LCOT × CCNT	7.5	95.9	28.2	12.0	135.2
WCT × COD	6.4	80.2	35.3	11.9	134.4
WCT × GBGD	7.8	92.7	32.3	12.0	135.1
WCT × MYD	6.9	86.3	32.8	12.3	128.6
GBGD × FJT	6.8	91.5	29.7	12.3	106.8
GBGD × PHOT	6.4	84.8	33.6	12.3	107.3
GBGD × LCOT	6.2	88.5	30.6	12.6	110.8
Tiptur Tall	7.2	93.9	32.8	12.2	120.1
SEm±	0.42	3.61	1.20	0.31	2.11
CD (P=0.05)	1.24	10.73	3.56	NS	6.32

par with Tiptur Tall (93.9 cm) and WCT × GBGD (92.6 cm). Long (1993) classified the tall and dwarf based on the stem girth and revealed that the tall varieties showed straight and thick stem base as compared to the dwarf. In the present investigation, significant differences were observed in respect to the number of functional leaves, length of petiole among the different hybrid crosses and variety (Table 2). However, annual leaf production did not differ significantly among the hybrids and variety. Whereas the hybrid, GBGD × PHOT recorded significantly higher number of functional leaves on the crown (33.6) followed by TPT (32.9) compared to other hybrids. Nampoothiri *et al.* (1975) also reported that the number of leaves present on the crown was positively correlated with yield in coconut. The number of functional leaves was on par with the hybrids, *viz.* WCT × MYD (32.8), WCT × GBGD (32.3) and LCOT × PHOT (30.3). Similar result of the highest number of functional leaves was reported by Basavaraju *et al.* (2011) in GBGD × PHOT cross combination.

Reproductive characters

With respect to the age at first flowering, the hybrids showed significant differences for the trait (Table 3) and the earlier precocity for flowering was noticed in GBGD × LCOT cross combination with regular bearer habit and commenced flowering in 38 months after planting and it was on par with GBGD × PHOT (40 months) followed by GBGD × FJT (48 months). The earliest flowering was noticed in cross combinations wherein dwarf cultivar GBGD (characteristic feature of dwarf coconut types) was involved as female parent, these results were also in line with the early reports by Ohler and Magat (2001), Jerard *et al.* (2015) at ICAR-CPCRI, Kasaragod, Nath *et al.* (2016) at Assam and Ramanandam *et al.* (2017) at Coastal Andhra Pradesh. Number of inflorescences produced per palm per annum, mean number of female flowers per inflorescence and total number of female flower per palm exhibited significant differences among the hybrids evaluated (Fig. 1). The highest number of inflorescences per palm per annum was observed in GBGD × PHOT (14.4), GBGD × LCOT (14.2) and the lowest number of inflorescences per palm per annum was in Tiptur Tall (11.5). The highest number of female flowers per inflorescence were observed in WCT × GBGD (38.0) and was on par with WCT × COD (36.0) and the lowest was in CCNT × LCOT (28.3) when compared to other hybrids. Nut yield in coconut palm can be increased by increasing the number of female flowers per inflorescence and it is most important yard stick for yield. Kannan and Nambiar (1974) in their study indicated that high yielding hybrids produced higher number of female flowers. Fruit set percentage of coconut was observed to be an important trait influencing the yield of nuts and in the present study it was within the range from 25.8 to 43.8 and maximum fruit set (43.8 %) was obtained in GBGD ×

Table 3 Reproductive characters of coconut hybrids and a variety

Hybrid cross combination	Age of first flowering (months)	No. of inflorescences/palm	No. of female flower per inflorescence	No. of female flowers/palm	Fruit set percentage
CCNT × LCOT	68	12.4	28.3	350.9	38.5
LCOT × PHOT	70	12.0	33.9	406.8	31.3
LCOT × CCNT	60	13.5	34.0	459.1	36.5
WCT × COD	71	13.6	36.9	326.4	27.8
WCT × GBGD	72	12.4	38.0	471.2	25.8
WCT × MYD	65	13.4	32.1	430.1	30.5
GBGD × FJT	48	12.7	33.3	488.9	43.8
GBGD × PHOT	40	14.2	31.3	370.5	38.0
GBGD × LCOT	38	14.2	33.4	474.2	35.2
Tiptur Tall	72	11.5	30.4	349.6	32.4
SEm±	1.08	0.22	1.72	7.17	0.57
CD (P=0.05)	3.22	0.64	0.57	21.48	1.69

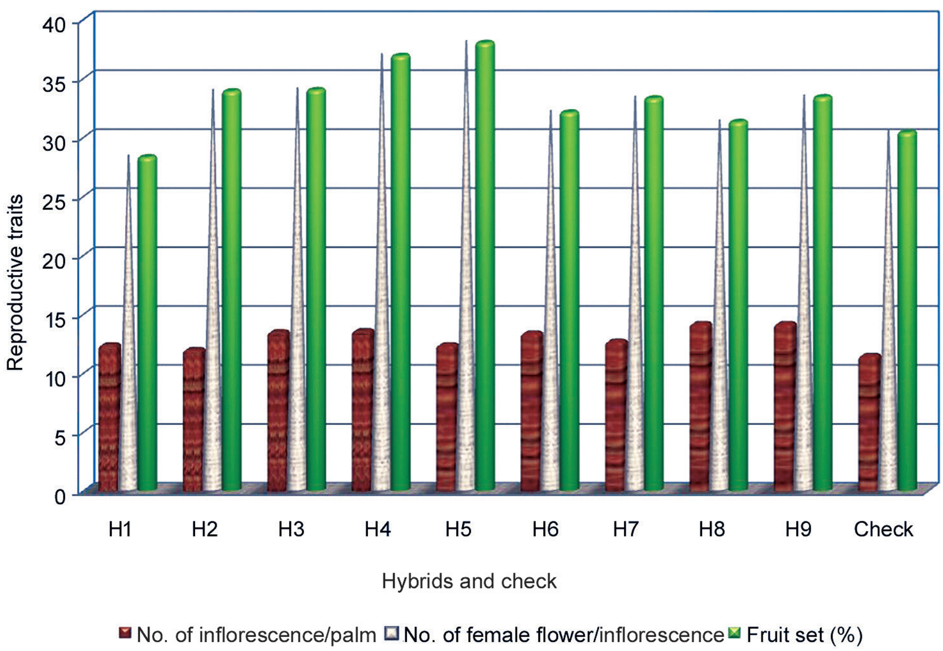

Fig 1 Reproductive characters of coconut hybrids and a variety.

FJT and the lowest (25.8 %) in WCT × GBGD. In coconut, inter-spadix overlapping of female and male phases are an important factor in fruit set along with cross-pollination from nearby palms (Henderson 1988). The variation in fruit set percentage among the coconut hybrids was also recorded by some workers (Nair *et al*. 2003; Thomas *et al*. 2012 and Nath *et al.* 2016).

Yield attributing and quality parameters and yield

Nut component traits: The variations obtained in fruit component characters are shown in the Table 4. The fruit length and fruit breadth was significant among the hybrids and the highest fruit length was recorded in LCOT × PHOT (32.6 cm) and on par with GBGD × PHOT and CCNT × LCOT and the lowest fruit length recorded in GBGD × LCOT (18.2 cm). The fruit breadth ranged from 20.3 to 27.9 cm. Fruit length and breadth is generally greater in the tall palms as compared to that of dwarfs (Ratnambal *et al.* 2000). The fruit weight was significantly higher in GBGD × PHOT (1402.5 g) followed by GBGD × LCOT (1294.0 g) and GBGD × FJT (1187.5 g). The husk weight was significantly higher in WCT × GBGD (627.7 g), whereas the hybrid LCOT × PHOT recorded lower husk weight (319.9 g). The average dehusked fruit weight showed significant variation among different hybrids and it was maximum in GBGD × PHOT (960.5 g) followed by GBGD × LCOT (850.0 g). The dehusked fruit weight was the lowest in CCNT × LCOT. The shell weight and shell thickness found highly significant among the hybrids and variety studied. The hybrid cross (D × T) GBGD × PHOT and GBGD × LOCT recorded the highest copra thickness (11.5 and 11.4 mm). WCT × GBGD recorded significantly higher mean copra per nut (169.8 g) compared to hybrids under present evaluation except WCT × COD and Tiptur Tall (Table 6).

Tender nut traits: The tender nut traits of the hybrids involving dwarf as female parent (Gangabondam) (Table 5) showed its potential for tender nut purpose. The quality and acceptability of tender coconut water is governed by the maturity of the nuts, variety, agro-climatic conditions

Table 4 Nut characters of coconut hybrids and a variety

Hybrid cross combination	Fruit length (cm)	Fruit breadth (cm)	Whole Nut wt (g nut^{-1})	Husk wt (g nut^{-1})	Dehusked fruit weight (g nut^{-1})	Husk thickness (mm)	Shell wt (g)	Shell thickness (mm)	Copra/Kernel thickness (mm)
CCNT × LCOT	30.8	24.7	1027.0	563.0	464.0	25.02	142.0	4.6	9.9
LCOT × PHOT	32.5	24.3	998.0	319.9	678.1	30.38	176.7	6.4	13.3
LCOT × CCNT	18.9	23.1	1164.0	458.8	705.2	26.76	176.3	3.8	13.5
WCT × COD	24.0	27.9	1004.0	476.5	527.5	31.96	166.2	4.5	12.0
WCT × GBGD	22.9	24.5	1165.0	627.7	537.3	26.19	178.2	4.4	11.2
WCT × MYD	29.0	21.1	1093.5	429.7	663.8	38.08	120.0	5.2	9.6
GBGD × FJT	23.0	22.3	1187.5	515.0	672.5	30.00	144.0	6.2	7.9
GBGD × PHOT	31.8	25.2	1402.5	442.0	960.5	33.25	192.5	6.4	11.5
GBGD × LCOT	18.2	27.7	1294.0	444.0	850.0	34.15	151.0	4.1	11.4
Tiptur Tall	22.1	20.2	1186.5	400.2	786.3	31.02	120.0	5.3	12.5
SEm±	0.41	0.40	19.13	8.58	10.89	0.50	2.65	0.07	0.18
CD (P=0.05)	1.24	1.20	57.27	25.70	32.61	1.51	7.93	0.26	0.55

Table 5 Tender nut traits of hybrids involving GBGD as female parent

Parameter	GBGD × PHOT	GBGD × LCOT	GBGD × FJT
Volume of water (ml)	395.4	346	390
TSS (°Brix)	6.20	5.6	5.9
Total sugars (g /100 ml)	6.1	5.8	5.95
Sodium (ppm)	26.0	316	24.0
Potassium (ppm)	2034.6	2110.1	2025.1

and agronomic practices. The average quantity of tender nut water ranged from 346.0 ml to 395.4 mL. Based on the organoleptic test; the tender nut water was classified as 'good' in taste with a TSS of 5, 6 to 6.2°Brix, total sugar (5.8 to 6.1). The tender nut water had 24.0 to 31.56 ppm of Na and 2025.1 to 2034.56 ppm of K content. Apshara *et al.* (2007) observed that COD × WCT (Chandra Sankara) and LCOT × COD (Chandra Laksha) were better performing hybrids for tender nut purpose as they recorded higher amounts of water, TSS and optimal levels of sodium and potassium.

Nut yield: The annual nut yield is a character of great economic importance. In the present study, the average nut yield recorded over 10 years from 2006 to 2016 and the estimated mean copra yield of hybrids and TPT (check) are given in Table 6. Among the nine hybrid combinations, the average nut yield per palm per year over 10 years ranged from 61.5 to 128.6. Significantly higher nut yield per palm was recorded in GBGD × LCOT (128.6 nuts palm^{-1} year^{-1}) which was followed by GBGD × PHOT (124.3 nuts palm^{-1} year^{-1}). The local check (TPT) recorded 87.2 nuts palm^{-1} year^{-1}. Hybrids under favourable weather and optimum management conditions have performed better than the local Tall. The high yield potential of the hybrids mainly due to precocity conferred on the hybrids by their dwarf parents (Bourdeix 1999; Ohler and Magat 2001). The number of nuts harvested to the number of female flowers produced is the most important yard stick for consideration and the study indicated that the nut yield in coconut palm (Table 3) can be increased by increasing the number of female flowers per inflorescence (Patel 1938). Similar results of higher nut yield per palm in hybrids was reported by Shinde *et al.* (2018), Ramanandam *et al.* (2017), Nath *et al.* (2016), Basavaraju *et al.* (2011) and Rao *et al*. (2002).

Copra output per palm was significantly the highest under GBGD × LCOT (22.0 kg palm^{-1} year^{-1}) and followed by GBGD × PHOT (19.8 kg palm^{-1} year^{-1}), whereas it was significantly the lowest in CCNT × LCOT (7.5 kg palm^{-1} year^{-1}). The copra yield in coconut was strongly and positively correlated with nut yield, copra weight, kernel weight, whole nut weight and dehusked nut weight. The higher copra output in Dwarf × Tall cross combinations can be ascribed to higher nut yield and copra content compared to other hybrids (Table 4). The enormous variability in coconut cultivars is due to continued cultivation since so many years. It is well established that the performance of the cultivar in a locality is a function of its genotype and environment. Therefore, the performance will vary under different agro-climatic conditions. Similar results of higher copra output per palm in Dwarf × Tall hybrids (planted during 1985 at ICAR- AICRP on palms centres) was reported by Rao *et al.* (2002) and Ramanandam *et al.* (2017) in Andhra Pradesh, Jayabose *et al.* (2008) and Anon. (2008) in Tamil Nadu and Basavaraju *et al.* (2011) in Karnataka. The highest oil yield (13.8 kg palm^{-1} year^{-1}) was recorded in GBGD × LCOT and it was on par with GBGD × PHOT (13.2 kg palm^{-1} year^{-1}). The oil content ranged from 64.2 to 66.5 %. However, no significant differences were observed among the entries tested for oil content (%).

Table 6 Mean yield performance of coconut hybrids and a variety over 10 years (2006 to 2016)

Hybrid cross combination	Nut yield palm^{-1} year^{-1}	Copra content (g nut^{-1})	Copra yield (kg palm^{-1} year^{-1})	Oil yield (kg palm^{-1} year^{-1})	Oil content (%)
CCNT × LCOT	61.5	131.0	7.5	4.9	65.8
LCOT × PHOT	76.5	138.8	10.6	7.5	66.0
LCOT × CCNT	82.5	150.0	12.2	7.9	64.2
WCT × COD	89.6	164.8	15.5	10.8	65.9
WCT × GBGD	86.5	169.8	14.5	9.4	65.4
WCT × MYD	96.1	159.6	14.6	10.6	66.0
GBGD × FJT	110.3	155.8	16.3	11.5	64.8
GBGD × PHOT	124.3	154.0	19.8	13.2	65.6
GBGD × LCOT	128.6	156.8	22.0	13.8	65.6
Tiptur Tall	87.2	163.2	14.3	10.8	66.5
SEm±	1.59	2.65	0.25	0.17	1.08
CD (P=0.05)	4.78	7.95	0.75	0.51	NS

Economic heterosis

In the present study, four hybrids showed yield superiority over standard check wherein heterosis of the hybrids for yield ranged from 28.25 to 46.83% over the check (Table 7). A wide variation for yield was observed in the study and the hybrid GBGD × LCOT and GBGD × PHOT was found to be a good performer for yield, copra content and oil yield. The hybrids combination in which GBGD used as maternal parent were observed to be high yielding (GBGD × LCOT, GBGD × PHOT and GBGD × FJT) hybrids and as better option over the ruling variety Tiptur Tall. Shinde *et al.* (2018) reported, GBGD × ECT showed yield superiority over standard check wherein heterosis of the hybrids for yield (40.8%). When two different alleles of various genes are brought together, there is a combined allelic expression as reported by James *et al.* (2003). Besides, the complementation of alleles in different genes has cumulative effect in phenotype characters resulting in heterosis (Jayabose *et al.* 2008). Heterosis for oil yield in various crosses between high and low oil content parents was

Table 7 Economic heterosis (%) for selected characters in coconut hybrids

Hybrid cross combination	Coconut yield	Copra content	Copra yield	Oil yield
CCNT × LCOT	-34.35*	-18.78*	-46.49*	-47.36*
LCOT × PHOT	-12.19*	-15.12*	-21.80*	-26.39*
LCOT × CCNT	-10.06*	-8.60*	-19.68*	-23.17*
WCT × COD	0.37	1.16*	8.78*	-1.08
WCT × GBGD	-1.33*	**1.39***	5.50*	-5.45*
WCT × MYD	6.75*	-4.04*	8.41*	-1.35
GBGD × FJT	28.25*	-6.17*	23.90*	17.95*
GBGD × PHOT	44.89*	-6.71*	46.68*	35.18*
GBGD × LCOT	**46.83***	-5.06*	**51.29***	35.97*

*Significant at 5% level

also accompanied, for distinct improvement oil percentage. However, economic heterosis for oil content was positive and significant in three hybrids, *viz.* GBGD × LCOT, GBGD × PHOT and GBGD × FJT. Most of the hybrid tests that were conducted using different Dwarf × Tall, Tall × Dwarf and Tall × Tall crosses have revealed the superiority of hybrids over local tall cultivars under better management conditions. The negative heterosis observed in some crosses may be attributed to non allelic interaction which can either increase (or) decrease the expression of heterosis.

Development of hybrids with an aim to combine the early flowering trait of dwarfs with the hardiness and high fruit yielding character of tall parents and also to exploit the potential hybrid vigour for desirable traits. Among the nine coconut hybrids evaluated, the cross combinations involving dwarf as female parent (Gangabondam) and tall cultivars as male parent, *viz.* GBGD × PHOT, GBGD × LCOT and GBGD × FJT performed superior and recorded significantly higher nut yield, copra output, oil yield and tender nut water traits over other cross combinations and Tiptur Tall (local variety). These three hybrids studied presently expressed economic heterosis for commercially important characters. Hence these three hybrid combinations considered to be more suitable and recommended for cultivation in the southern dry track of Karnataka under irrigated condition by the XXI AICRP on Palms Annual Group Meeting.

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