



## Potential coconut (*Cocos nucifera*) hybrids for yield and quality for coastal region of Andhra Pradesh (India)

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Received: 30 December 2016; Accepted: 19 April 2017

### ABSTRACT

Coconut (*Cocos nucifera* L.) is a perennial plantation crop which has a very long productive period thus identification of suitable hybrid to a particular agro-climatic region play an important role in achieving higher and sustained yields. In this context, an evaluation trial with different coconut cross combinations involving ECT × MGD (VHC 1), GBGD × ECT (Konkan Bhatye Coconut hybrid-1), GBGD × FJT (Kalpa Ganga), GBGD × PHOT, GBGD × LCOT and ECT × GBGD (Godavari Ganga) was conducted at All India Coordinated Research Project (AICRP) on Palms, Ambajipeta center for a period of two and half decades. The experiment was laid out in randomized block design with four replications maintaining six palms per replication. With regard to growth characters, the cross combination GBGD × FJT recorded significantly the lowest plant height (7.4 m) while the maximum palm girth of 123.8 cm was recorded with VHC 1. Observations on yield and yield attributing traits (average of 6 years) revealed the superior performance of GBGD × PHOT and GBGD × LCOT hybrids over the existing hybrid check (ECT × GBGD) by recording higher nut yield, copra output and oil yield. Significantly higher nut yield per palm was recorded in GBGD × LCOT (135.8 nuts) and it was on par with GBGD × PHOT (125.4 nuts). Copra content per annum and estimated oil yield was the highest in GBGD × PHOT (23.7 kg/palm and 16.2 kg/palm, respectively and it was on par with GBGD × LCOT (22.1 kg/palm and 15.0 kg/palm respectively). GBGD × PHOT recorded significantly maximum tender nut water content (385.0 ml/ tender nut) and TSS of 6.2<sup>0</sup> Brix over other hybrids.

**Key words:** Coconut, Copra out turn, Hybrids, Nut yield, Tender nut water

In Andhra Pradesh, the major area in coconut is confined to the East Godavari (51009 ha and 7153 lakh nuts/ha), West Godavari (21561 ha and 3203 lakh nuts/ha), Srikakulam (13985 ha and 1678 lakh nuts/ha) and Visakhapatnam (8700 ha and 1305 lakh nuts/ha) districts. (CDB 2014). The predominant variety under cultivation in the state is a tall variety East Coast Tall with an average yield potential of 80 nuts/palm/year. Tall cultivars are commonly grown for copra and oil purpose while dwarfs are preferred for tender nut water. Development of high yielding varieties/hybrids is very important to achieve higher production and productivity in coconut. The discovery of hybrid vigour in coconut, first from India in 1937 (Patel 1937), received considerable attention in the production of coconut hybrids, which usually express hybrid vigour in growth, precocity and higher yield.

Hybrid varieties have been developed by combining

the early flowering trait of dwarf cultivar and hardiness and high yielding characters of tall cultivar (Augustine Jerard *et al.* 2015). Heterosis is the superiority of the hybrid over the mid or better parent as standard variety and is the result of allelic or non-allelic interaction of genes under the influence of particular environments (Chapman *et al.* 2000).

Godavari Ganga was the first coconut hybrid (ECT × GBGD) developed and released from Horticultural Research Station, Ambajipeta during 1991 based on its superior performance over its parents for commercial cultivation in Andhra Pradesh state. At present this hybrid is more popular among the farmers and there is huge demand for planting material. To explore more heterosis, different tall and dwarf cultivars were selected and inter-varietal hybridization was done between Dwarf × Tall and Tall × Dwarf types. Parental varieties were selected to produce superior hybrids over existing varieties and hybrids in terms of early bearing, high yield, copra and oil content, tender nut water content and quality. A good number of hybrid combinations of Tall × Dwarf (T × D), Dwarf × Tall (D × T) and Tall × Tall (T × T) have been developed and evaluated over years in different locations. In this context, an evaluation trial of coconut hybrids was undertaken to ascertain their suitability to coastal conditions of Andhra Pradesh for higher yield, copra

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outturn, oil yield and tender nut water.

#### MATERIALS AND METHODS

The selected cross combinations were evaluated at All India Co-ordinated Research Project on Palms, Horticultural Research Station, Ambajipeta Centre, which is situated at 16.4° N latitude and 81.5° E longitudes and at an altitude of 34 m pamsl. The soils are coastal alluvial type with a pH 7.8 and impeded drainage. The mean maximum temperature ranges from 26.7 to 36.8°C and the minimum temperature ranges from 22.7 to 42.5°C. The average rainfall and relative humidity during experimentation was varied between 1000 to 1250 mm and 65 to 87% respectively.

The experiment was carried out with six cross combinations including released hybrids, viz. VHC1 (ECT × MGD), Konkan Bhatye Coconut hybrid 1 (GBGD × ECT), Kalpa Ganga (GBGD × FJT), GBGD × PHOT, GBGD × LCOT and Godavari Ganga (ECT × GBGD) as hybrid check (Table 1). The seed nuts were produced through mother palm selection, emasculation and controlled pollination. The seed nuts were sown in poly pots and healthy hybrid seedlings were selected and planted during 1985 with a spacing of 7.5 × 7.5 m (with a density of 175 palms/ha) in randomized block design with four replications @ 6 palms/replication under irrigated conditions. The palms were managed by adopting the standard package of practices as recommended by Dr YSR Horticultural University. The growth parameters like palm height, girth, number of functional leaves on the crown, leaf length and petiole length were recorded during 2013-14 at the age of 28 years. The yield of nuts per palm was recorded periodically at each harvest from July to June and pooled to get nut yield per palm per year. Copra content per nut was recorded by drawing random sample of six nuts per hybrid in each replication. Copra yield per palm was calculated based on the copra content per nut in each treatment. The oil content in copra was analysed using Soxhlet apparatus by drawing pooled samples of each hybrid over replications and oil yield per palm was computed. The yield data of six years from

2008-09 to 2013-14 was used to draw conclusions. The data was analysed statistically as per the procedure given by Gomez and Gomez (1984).

#### RESULTS AND DISCUSSION

##### Growth characters

The palm height and girth varied significantly among different coconut hybrids (Table 2), the cross combinations evaluated, GBGD × FJT recorded the lowest plant height (7.4 m) and was on par with other hybrids with GBGD as female parent and VHC 1 recorded the highest plant height (11.3 m). The girth at one m height was the highest in VHC 1 (123.8cm) and was on par with GBGD × PHOT (117 cm) and GBGD × LCOT (107 cm). The lowest palm height recorded in GBGD × FJT (Dwarf × Tall) could be attributed to the dwarf nature of the female parent. With respect to number of functional leaves, GBGD × PHOT recorded the maximum number of functional leaves on the crown (33.2) and was on par with other hybrids except GBGD × FJT. However, no significant differences were observed among the entries tested for leaf length and petiole length. Similar result of highest number of functional leaves was reported by Basavaraju *et al.* (2011) in GBGD × PHOT cross combination.

Table 2 Performance of coconut hybrids for growth parameters (Age of palms: 28 years)

Hybrid cross combinations	Plant height (m)	Girth at 1 m height (cm)	Functional leaves on crown(no.)	Leaf length (m)	Petiole length (cm)
VHC I	11.3	123.8	32.6	3.7	108.6
GBGD × ECT	7.8	84.4	32.4	3.7	114.6
GBGD × FJT	7.4	84.3	32.3	3.1	106.8
GBGD × PHOT	8.2	117.0	33.2	3.5	107.3
GBGD × LCOT	7.9	107.0	32.9	3.8	110.8
ECT × GBGD	8.6	80.3	32.6	3.7	113.3
SEm ±	0.4	6.0	0.26	0.1	2.2
CD(P=0.05)	1.4	19.3	0.8	N.S.	N.S.

Table 1 Details of parental palms used in hybridization programme

Hybrid/cross combination	Parental information	Abbreviation
VHC 1	Selection from East Coast Tall as female parent and Malayan Green Dwarf as male parent	ECT × MGD
Konkan Bhatye Coconut hybrid-1	Selection from Gangabondam Green Dwarf as female parent and East Coast Tall as male parent	GBGD × ECT
Kalpa Ganga	Selection from Gangabondam Green Dwarf as female parent and Fiji Tall as male parent	GBGD × FJT
D × T cross (New)	Selection from Gangabondam Green Dwarf as female parent and Philippines Ordinary Tall as male parent	GBGD × PHOT
D × T cross (New)	Selection from Gangabondam Green Dwarf as female parent and Laccadive Ordinary Tall as male parent	GBGD × LCOT
Godavari Ganga (Check)	Selection from East Coast Tall as female parent and Gangabondam Green Dwarf as male parent	ECT × GBGD

Table 3 Performance of coconut hybrids with respect to yield, yield attributing and quality parameters

Hybrid cross combinations	Age at first flowering (months)	Inflorescence Production per annum (no.)	Average no. of female flowers per inflorescence (no.)	No. of nuts harvested / palm	Tender nut water content (ml)	TSS ( $^{\circ}$ Brix)	Sodium content (ppm)	Potassium content (ppm)
VHC I	50.7	14.8	29.1	111.3	218.0	5.9	23.0	2000.7
GBGD $\times$ ECT	37.1	10.2	30.1	104.6	296.7	5.9	24.5	2011.5
GBGD $\times$ FJT	39.4	10.0	27.7	108.6	267.7	6.0	24.0	2025.2
GBGD $\times$ PHOT	40.3	14.5	31.3	125.4	385.0	6.2	26.0	2034.6
GBGD $\times$ LCOT	38.9	14.2	33.4	135.8	342.0	5.8	28.5	2110.1
ECT $\times$ GBGD	42.9	12.2	29.4	115.8	286.0	5.3	25.2	2005.2
SEm $\pm$	1.7	0.6	0.7	3.09	4.3	0.08	0.08	1.8
CD (P=0.05)	3.7	2.1	2.1	9.31	12.8	0.2	0.2	5.6

#### Yield, yield attributing and quality parameters

Regarding age at first flowering, the hybrids showed significant differences for the trait (Table 3), and the earliest to flower was noticed in GBGD  $\times$  ECT cross combination (37.1 months after planting) and it was on par with GBGD  $\times$  LCOT (38.9 months) and GBGD  $\times$  FJT (39.4 months). Number of inflorescences produced per palm per annum and mean number of female flowers per inflorescence exhibited significant differences among the hybrids evaluated. The highest number of inflorescences per palm per annum were produced in VHC 1 (14.8) and it was on par with GBGD  $\times$  PHOT (14.5) and GBGD  $\times$  LCOT (14.2). The highest number of female flowers per inflorescence were observed in GBGD  $\times$  PHOT (31.3) and the lowest was in VHC 1 (29.1). The earliest flowering was noticed in cross combinations wherein dwarf cultivar GBGD was involved as female parent as it comes to flowering within 36 months under agro-climatic conditions of Andhra Pradesh. In this context, the hybrids involving GBGD as female parent flowered earlier compared to others as early inflorescence emergence is the characteristic feature of dwarf coconut types.

A wide variation was observed for nut yield in coconut hybrids (Table 3, Fig 1). Among the different hybrid combinations, the mean nut yield per palm over six years was significantly higher in GBGD  $\times$  LCOT (135.8 nuts) which was followed by GBGD  $\times$  PHOT (125.4 nuts). Similar results of higher nut yield per palm was reported by Basavaraju *et al.* (2011), Rao *et al.* (2002) and Anon. (2008). Heterotic effects with respect to nut yield in coconut were also reported earlier by Satyabalan *et al.* (1970), Ramachandran *et al.* (1975), Satyabalan and Rajagopal (1987), Natarajan *et al.* (2006) and Jayabose *et al.* (2008).

Coconut improvement through production of hybrids is a tedious and time consuming process mainly because of its long gestation period, larger area, and complex resources required for experimentation and low seed multiplication ratio. The Indian coconut cultivars population is comprised enormous variability 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

Tender nut water content was significantly the highest in GBGD  $\times$  PHOT (385.0 ml/nut), followed by GBGD  $\times$  LCOT (342.0 ml/nut) and it was significantly the lowest in GBGD  $\times$  FJT (267.7 ml/nut). The TSS was maximum in GBGD  $\times$  PHOT (6.2 $^{\circ}$ Brix) followed by GBGD  $\times$  FJT (6.0 $^{\circ}$ Brix). The sodium and potassium contents of 28.5 ppm, 2104.5 ppm and 26.0 ppm and 2034.6 ppm, respectively were recorded in GBGD  $\times$  LCOT and GBGD  $\times$  PHOT cross combinations. The quality and acceptability of tender coconut water is governed by the maturity of the nuts, variety, agro-climatic conditions and agronomic practices. Apsara *et al.* (2007) observed that COD  $\times$  WCT and LCOT  $\times$  COD were better performing hybrids for tender nut purpose as they recorded higher amounts of water, TSS and optimal levels of sodium and potassium.

#### Fruit component traits

The average dehusked fruit weight showed significant variation among different hybrids (Table 4) and it was maximum in GBGD  $\times$  LCOT (591.6g) and was on par with GBGD  $\times$  FJT (586.7 g) and GBGD  $\times$  PHOT (583.3g). The dehusked fruit weight was significantly the lowest in GBGD

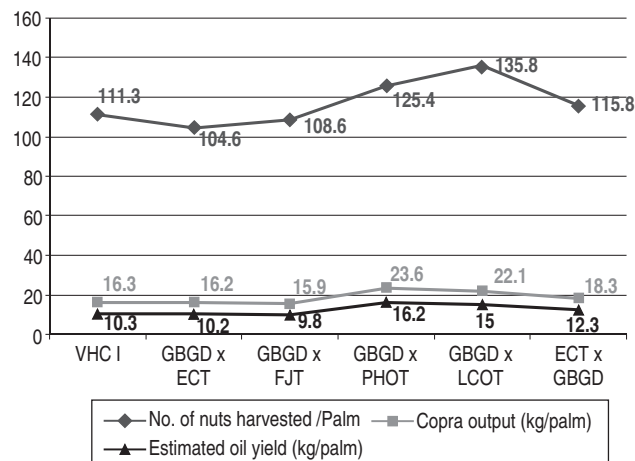


Fig 1 Performance of coconut hybrids with respect to yield, copra output and oil yield.

Table 4 Fruit component traits of coconut hybrid cross combinations

Hybrid cross combinations	Dehusked fruit weight (g/nut)	Husk weight (g/nut)	Copra content (g/nut)	Copra output (kg/palm)	Oil content (%)	Estimated oil yield (kg/palm)
VHC I	517.5	803.3	141.0	16.3	63.5	10.3
GBGD × ECT	445.0	671.6	148.4	16.2	63.0	10.2
GBGD × FJT	586.6	830.0	143.5	15.9	62.0	9.8
GBGD × PHOT	583.3	773.3	188.7	23.6	68.5	16.2
GBGD × LCOT	591.6	768.3	165.0	22.1	68.0	15.0
ECT × GBGD	505.0	703.3	155.0	18.3	67.0	12.3
SEm±	29.4	44.1	3.1	0.6	1.4	0.4
CD (P=0.05)	93.9	N.S	9.5	2.0	4.3	1.2

× ECT (445 g). Husk weight among the hybrids showed non-significant variations.

The cross combination GBGD × PHOT recorded significantly the highest copra content (188.7g/nut) and it was the lowest in VHC 1 (141 g). Copra output per palm was significantly the highest under GBGD × PHOT (23.6 kg/palm) and was on par with GBGD × LCOT (22.1 kg/palm), whereas it was significantly the lowest in GBGD × FJT (15.9 kg/palm). The highest oil content and estimated oil yield (68.5% and 16.2 kg/palm) was recorded in GBGD × PHOT and it was on par with GBGD × LCOT (68.0% and 15.0 kg/palm respectively) (Fig1). The higher copra output in cross combinations GBGD × PHOT and GBGD × LCOT can be ascribed to higher nut yield and copra content compared to other hybrids. Similar results of higher copra output per palm in dwarf × Tall hybrids was reported by Rao *et al.* (2008) in Andhra Pradesh and in Tamil Nadu (Anon. 2008).

Among the coconut hybrids evaluated, the cross combinations involving dwarf as female parent and tall cultivars, viz. GBGD × PHOT and GBGD × LCOT performed superior and recorded significantly higher nut yield, copra output, oil yield and tender nut water traits over other cross combinations. Hence these two hybrid combinations considered to be more suitable for cultivation in coastal districts of Andhra Pradesh.

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