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RESEARCH ARTICLE

Performance of Exotic and Indigenous Coconut Genotypes for Growth, Fruit Yield, Fruit and Nut Characters under Assam Conditions of North East Region of India

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Abstract

Coconut is an important plantation crop grown in India. Considering the value of this crop which provides food, drink, medicine, shelter and a variety of raw materials, besides sustaining the livelihood of many small and marginal farmers of North East region of the country, it is essential to improve the productivity of coconut in North East region to ensure higher income and profitability to growers. A lot of research has been carried out to improve coconut in many of India's major coconut-growing states. However, systematic work on coconut improvement in the Northeast region has been limited. A few varieties are grown in Northeast India, especially Assam, but not much work has been done on the suitability of different coconut varieties. Therefore, the present study was undertaken to evaluate four exotic and eleven indigenous coconut genotypes, including released varieties for their growth, nut yield and fruit characters under Assam conditions. The data on growth characters were recorded for five years, from 2015 to 2019, and nut yield (number of nuts per palm) was recorded for seven years (2016–2022), while observations on, fruit component characters were recorded four years from 2017–2020 and the mean data was used for analysis. Significant differences were observed between the genotypes for most of the characters recorded. Nut yield varied from 35.34 (Malayan Yellow Dwarf) to 109.32 (Kera Sankara). The hybrid variety Kera Sankara recorded a higher nut yield (109.32) than other varieties. Fruit weight among the varieties varied from 605.04 to 1173.47 g. Variety Assam Green Tall recorded higher fruit weight (1173.47 g), husked fruit weight (832.04 g) and endosperm weight (379.50 g). Maximum husk thickness (2.87 cm) and husk-to-fruit percentage was observed in Fiji tall variety (45.97%). Considering the nut yield, the hybrid Kera Sankara can be recommended for cultivation in the northeastern region of India. Therefore, The present study indicates the importance of characterization and evaluation of coconut germplasm suited for the northeastern region of India.

Keywords: Coconut, fruit yield, fruit, growth, nut characters

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Introduction

Coconut (*Cocos nucifera* L.) is an important plantation crop grown in Assam, cultivated in an area of 20.80 thousand hectares with a production of 148.51 million nuts and productivity of 7,140 nuts/ha (Thamban *et al*., 2023). It is mainly grown for its nutritious endosperm (kernel), which provides food, drink, medicine and a variety of products of commercial importance. Coconut is grown in all 33 districts, covering the upper, middle and lower parts of Assam: Nagaon, Barpeta, Kamrup, Sonitpur, Nalbari, Golaghat, Cachar, Karimganj, Morigaon, Udalguri, Darang, Bongaigaon, Baksa and Shivsagar are the leading coconut growing and producing districts in Assam (Gopalakrishnan, 2013). However, most of the coconuts grown are of the local type, and there is scope for increasing production and productivity in the state by planting more productive varieties. Assam Green Tall is the most common cultivar of coconut grown in this region. A higher average yield of about 105 nuts per palm per year has been reported in an Assam Green Tall selection. This indicates the potential for improving

coconut productivity in the state and the need to identify more improved varieties for cultivation in Assam. Towards developing improved varieties for specific agro-climatic zones, it is necessary to characterize and evaluate the coconut genetic resources to identify their yield potential and adaptive features for utilization in the coconut improvement programme. Characterization of coconut populations/ cultivars/germplasm has been undertaken based on fruit traits (Whitehead, 1968; Harries, 1978; Niral *et al*., 2009), botanical and agronomic traits (Sugimura *et al*., 1997; Niral *et al*., 2008). Using the coconut descriptor traits, morphological characterization was undertaken and descriptors have been published, not only in India (Ratnambal *et al*., 1995, 2000) but also internationally for conserved coconut germplasm (Bourdeix et al., 2010) as well as farmer's varieties (Bourdeix and Batugal, 2005). Research on crop improvement work is in progress in southern parts of India, where coconut is grown commercially. However, in North East region of India, limited work has been conducted to study the suitability of coconut varieties in this region. So far, Assam Green Tall and Kalpa Samrudhi are the only coconut varieties/hybrid which were found to be suitable for the region. Therefore, the present investigation was undertaken to study the performance of fifteen coconut varieties for growth, nut yield, and fruit and nut characteristics to enhance the coconut germplasm suitable for Assam.

Material and Methods

Study was conducted for five years from 2015 to 2022 at ICAR-Central Plantation Crops Research Institute, Research Centre, Kahikuchi, Guwahati, Assam, situated at 20° 18' N latitude and 91° 78' E longitude with an altitude of 50 m above the mean sea level (MSL). The mean maximum temperature varies from 15 to 3°C and the mean minimum temperature ranges between 8 and 22°C. The station enjoys a sub-tropical climate with an annual rainfall of about 1,500 mm. The soil of the experimental site was alluvial clay loam, with a pH range of 4.8 to 5.5. The study involved 15 coconut genotypes, including released varieties/hybrids planted during May 2004 at a spacing of 7.5 x 7.5 m (Table 1). The experiment was laid out in Randomized Blocks Design (RBD) with three replications. Six palms per replication were taken for observations. Vegetative growth parameters and fruit and nut characters *viz*., palm height, stem circumference (measured at the height of 1.0 m from ground level), number of leaves, number of leaf scars per meter (measured at the height of 1 to 2 m from ground level), fruit weight, fruit length, fruit circumference, nut weight (husked fruit weight), nut length (husked fruit length), nut circumference (husked fruit circumference), husk thickness, shell thickness, shell weight, endosperm (fresh kernel) thickness and endosperm weight were recorded. The fruit length and nut length (husked fruit length) were measured at the polar zone, while the fruit circumference and nut circumference (husked nut circumference) were measured at the equatorial zone of the fruit. The husked weight was divided by the whole fruit weight to calculate the husk percentage. The annual nut yield per palm was recorded during each harvest and used to compute the annual nut yield (number of nuts per palm per year). Individual fruit component characters were recorded in thirty fruits from each variety harvested during the September harvest and data were statistically analyzed using MSTAT software.

Results and Discussion

Vegetative growth characters

Vegetative growth characters of 15 coconut genotypes recorded during the course of the present investigation have been presented in Table 2. Vegetative growth characters *viz*., palm height, number of leaves, circumference, number

Table 1: Place of origin of 15 coconut genotypes investigated during the present study

Name	Abbreviation	Description/origin
Assam Green Tall	AGT	Local tall from Assam
West Coast Tall	WCT	Indigenous tall from Kerala
Lakshadweep Ordinary Tall	LCT	Indigenous tall from the Lakshadweep Islands
Fiji Tall	FJT	Indigenous tall from Fiji
Malayan Green Dwarf	MGD	Exotic dwarf from Malaysia
Chowghat Orange Dwarf	COD	Indigenous dwarf from Kerala
Malayan Orange Dwarf	MOD	Exotic dwarf from Malaysia
Malayan Yellow Dwarf	MYD	Exotic dwarf from Malaysia
Gangabondam Green Dwarf	GBGD	Indigenous dwarf from Kerala
Kera Sankara	HKS	WCT x COD - Hybrid variety from ICAR-CPCRI
Chandra Sankara	HCS	COD x WCT - Hybrid variety from ICAR-CPCRI
Chandra Laksha	HCL	LCT x COD - Hybrid variety from KAU
Kera Ganga	HKG	WCT x GBGD - Hybrid variety from KAU
Laksha Ganga	HLG	LCT x GBGD - Hybrid variety from KAU
Kera Sree	HKS	WCT x MYD - Hybrid variety from KAU

Table 2: Vegetative growth characters of 15 coconut genotypes evaluated under Assam condition

Varieties/ Hybrid	Palm height (m)	No. of leaves	Circumference (cm)	No. of leaf scar/m	Leaf stalk length (cm)	Length of leaflets bearing portion (cm)	No. of leaflets (L)	No. of leaflets (R)	Leaflet length (cm)	Leaflet breadth (cm)
AGT	3.96	23.25	85.25	16.42	104.95	3.16	102.16	103.04	122.41	4.36
MGD	4.30	24.16	92.16	13.00	111.58	3.18	103.58	104.08	95.91	5.40
COD	2.21	22.41	60.67	27.74	92.51	2.11	96.85	96.96	93.52	4.05
HCS	4.63	27.16	77.49	22.97	125.73	3.10	107.65	108.31	138.09	5.02
MOD	2.79	22.76	60.12	26.80	120.11	2.69	86.64	87.44	87.92	4.96
HCL	4.64	21.06	80.60	18.67	110.88	3.04	102.46	102.93	94.42	5.54
WCT	5.17	24.72	85.73	15.28	112.24	3.31	111.21	112.40	100.60	5.61
FJT	5.71	22.18	95.16	13.85	119.81	3.23	107.41	107.81	94.50	5.89
MYD	3.21	22.43	66.10	28.32	98.27	2.85	85.38	85.99	86.70	4.69
HLG	4.23	25.67	94.16	19.67	122.27	3.73	118.66	118.88	111.54	5.79
HKS	5.31	27.32	95.15	18.33	116.41	3.74	103.00	103.83	114.91	5.65
HKG	5.53	23.50	93.00	15.50	119.75	3.59	106.50	107.50	130.49	5.66
LCT	5.86	22.50	107.50	12.67	136.08	3.67	111.50	109.99	128.41	5.60
HKS	4.67	24.67	101.00	14.33	119.83	3.26	106.00	106.16	109.65	5.18
GBGD	2.43	22.67	70.00	19.50	104.49	2.76	90.16	91.25	99.49	4.11
SEm (+/-)	0.48	0.69	3.49	0.67	6.49	0.11	3.56	3.71	5.32	0.24
CD (0.05%)	1.40	2.01	10.11	1.96	18.81	0.32	10.33	10.76	15.43	0.70

of leaf scar per meter, leaf stalk length, length of leaflets bearing portion, number of leaflets and leaflet length and breadth showed significant differences among the genotypes studied. Palm height among the tall types and hybrid varied from 3.96 to 5.86 m. Greater palm height was observed in the Lakshadweep Ordinary (5.86 m) variety, which was statistically at par with most of the varieties except for Assam Green Tall and Hybrid Laksha Ganga. Among dwarf types, the Malayan Green Dwarf recorded higher palm height (4.30 m) followed by Malayan Yellow Dwarf (3.21 m). Regarding the number of leaves produced, hybrid Kera Sankara was found to produce more (27.32) on the crown. The Present study shows that although higher palm height was observed in Lakshadweep Ordinary variety, a significantly higher number of functional leaves were observed in hybrid Kera Sankara. Nath *et al*. (2017) also reported production of 28.8 numbers of leaves in hybrid Kera Sankara in an experiment conducted at Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati, Assam. In an adult palm, the presence of about 25 to 35 opened leaves have also been reported by Niral and Jerard (2017). Stem circumference showed significant differences among the varieties studied. Lakshadweep Ordinary produce higher stem circumference as compared to other varieties. Tall types and hybrids were found to produce higher stem circumference than the dwarf types, except in Malayan Green Dwarf variety, showing high variability as compared to other dwarf types. Sudha *et al*. (2019), Sudha *et al*. (2021), Zhang *et al*. (2021) and Sudha *et al*. (2023) also reported significant variability among the genotypes for stem circumference. Higher stem circumference might be varietal characters. A recent study has also reported variation in trunk girth among varieties, with higher trunk girth in tall types like Andaman Giant and Zanziber Tall coconut types in an experiment conducted at Coconut Research Station, TNAU, Aliyarnagar (Tripura *et al*., 2018). In the current study, dwarf types were found to produce more leaf scar per meter than tall and hybrid coconut types. Ratnambal *et al*. (1995) and Kumaran et al. (2006) have also reported more leaf scar in dwarf coconut types than tall coconut varieties. Regarding the length of the leaflet bearing portion, number of leaflets and leaflet size, shorter length of leaflet bearing portion and fewer leaflets were seen in most of the dwarf types except Malayan Green Dwarf. Niral and Jerard (2017) also reported variations in leaf length, number of leaflets and leaflet size in coconut palms depending on variety, growing condition and age of the palm.

Fruit and Nut Characters

Fruit and nut characters of 15 coconut genotypes recorded during the course of present investigation have been presented in Table 3. Significant differences were observed for the fruit weight, fruit length, fruit circumference, husked nut weight, husked nut length, husked nut

circumference, husk thickness, shell thickness, shell weight, fresh endosperm (kernel) thickness and fresh endosperm weight. Fruit weight among the genotypes varied from 605.04 to 1173.47 g. Assam Green Tall produced greater fruit weight (1173.47 g) followed by Fiji Tall (1079.71 g) compared to other varieties. The lowest fruit weight was recorded in Malayan Yellow Dwarf (605.04 g). The present study has revealed that the fruit weight of coconut varieties was lower under Assam conditions than in other South Indian states. In an experiment conducted at the East Coast region of Andhra Pradesh, fruit weight of hybrid and varieties varied from 971 to 1464.7 g. Hybrid Chandra Laksha (1464.7 g) recorded higher fruit weight (Ramanandam *et al*., 2018). Similarly, in another experiment conducted at Coconut Research Station, TNAU, Aliyarnagar, higher fruit weight (1064.50 g) was observed in Malayan Green Dwarf (Tripura *et al*., 2018). Significant fruit weight variation among coconut varieties was also reported (Ramanandam *et al*., 2018). Though Assam Green Tall recorded the maximum fruit weight among the varieties, higher fruit length and fruit circumference was observed in Fiji Tall. With regards to husked fruit weight, variety Assam Green Tall was found to produce greater husked fruit weight (832.04 g), which was found to be statistically at par with hybrid Kerasree (711.54 g). Husked fruit weight is an important trait required for the recovery of the kernel. In the present study, the husked fruit weight among the varieties varied from 359.78 to 832.04 g. Interestingly, though the fruit weight is less compared to South Indian conditions, the husked fruit weight was found to be on higher side. The dehusked nut weight of promising hybrids and varieties of coconut in East Coast region of Andhra Pradesh showed a varying range from 357.85 to 607.84 g (Ramanandam *et al*., 2018). Chandra Sankara produce nut weight of 569.20 g. However, at the Research Centre, Kahikuchi, nut weight (665.75 g) was found to be higher in hybrid Chandra Sankara. The percentage of husk to fruit ratio among the varieties varied from 31.70 to 45.97%. Fiji Tall variety was found to produced a higher husk-to-fruit ratio percentage (45.97%) followed by hybrid Laksha Ganga (44.09%). Lesser husk to fruit ratio percentage was found in Malayan Orange Dwarf (29.38%). This might be attributed to thicker husk in Fiji tall variety as compared to other varieties. With respect to husked fruit length and circumference, maximum husked fruit length was observed in Fiji Tall variety (17.19 cm) followed by Assam Green Tall (17.06 cm). Whereas maximum husked fruit circumference was observed in the Assam Green Tall variety (35.22 cm). Husk thickness among the varieties was found to vary from 1.11 to 2.87 cm. Fiji tall variety recorded the maximum husk thickness (2.87 cm). Shell thickness and shell weight were also found to vary across the variety. Higher shell thickness was observed in hybrid Kera Ganga (0.35 cm). In terms of shell weight, Assam Green Tall was higher (182.79 g) followed by hybrid Kera Ganga (162.90 g). Fresh endosperm weight showed that variety Assam Green Tall was found to produce significantly higher endosperm weight (379.50 g), followed by hybrid Chandra Sankara (317.48 g) and Kera Sree (316.56 g). Genetic variability in fruit size, husked fruit weight, husk thickness, endosperm thickness and endosperm weight among coconut genotypes were also reported by Natarajan *et al*. (2010).

Fruit Yield

The yield of 15 coconut genotypes recorded in terms of the number of nuts during the present investigation is presented in Table 3. The mean value showed that coconut varieties' yield varies from 35.34 to 109.32 nuts per plant per year. Significant differences were observed among the genotypes for the number of nuts recorded per palm per year. Hybrid Kera Sankara recorded the maximum yield per palm per year (109.32) followed by hybrid Chandra Sankara (75.48). The lowest mean yield was recorded in Malayan Yellow Dwarf (35.34). The yield data revealed that coconut hybrids gave higher nut yields as compared to other genotypes, which could be attributed to their hybrid vigor and higher yield potential (Ramanandam *et al*., 2018). Better performance of hybrid *viz.,* Kalpa Samrudhi over Assam tall variety was also reported by Nath *et al*., (2017) in an experiment conducted at Horticultural Research Station (AICRPP), Assam Agricultural University, Kahikuchi, Guwahati. Though Assam Green Tall variety is recommended for cultivation under Assam conditions, in the present study, hybrid Kera Sankara was also found to produce more nuts with an average nut yield of 109.32 nuts per palm per year. This may be due to better morphological growth, such as a higher number of functional leaves per palm. Tripura *et al*. (2018) have earlier reported the importance of more leaves as an important trait in increasing yield of coconut since it increases the photosynthetic efficiency of the palm. Variation in fruit yield among different coconut genotypes was also reported in the Coconut Research Station, Aliyarnagar, Tamil Nadu (Subramanian *et al*., 2019).

Correlation among fruit and nut characters

Correlation among fruit and nut characters of 15 coconut genotypes recorded during the course of present investigation has been presented in Table 4. Fruit weight exhibited a significant positive correlation with most of the fruit parameters *viz*., fruit length, fruit circumference, nut weight, nut length, nut circumference, husk thickness, shell thickness, shell weight, fresh kernel thickness and fresh kernel weight. Similar results were obtained by Baudouin *et al*. (2006), indicating that such a positive correlation was due to the interdependence between the different fruit parts. Shell thickness was not correlated with fresh kernel thickness and fresh kernel weight. Geethanjali *et al*. (2014) also reported that kernel thickness and shell thickness were

Table 3: Fruit yield and nut characters of 15 coconut genotypes evaluated under Assam conditionz

Varieties/ Hybrid	Yield (Nuts/ palm/year)	Fruit weight (g)	Fruit length (cm)	Fruit circumference (cm)	Husked fruit weight (g)	Fruit:Husk ratio	Husked fruit length (cm)	Husked fruit circumference (cm)	Husk thickness (cm)	Shell thickness (cm)	Shell weight (g)	Endosperm thickness (cm)	Endosperm weight (g)
AGT	37.79	1173.47	26.57	48.15	832.04	33.49	17.06	35.22	1.62	0.32	182.79	1.16	379.50
MGD	41.60	857.44	24.75	46.74	561.72	35.75	15.31	32.34	1.52	0.28	135.67	1.17	271.46
COD	43.86	665.52	20.84	39.69	446.17	31.78	14.82	29.67	1.24	0.24	116.17	1.00	227.50
HCS	75.48	976.34	25.22	44.98	665.75	31.70	16.78	32.40	1.44	0.30	162.40	1.18	317.48
MOD	43.22	650.04	21.00	39.67	433.68	29.38	15.71	29.17	1.11	0.23	117.11	1.02	230.01
HCL	65.49	937.11	26.10	42.84	595.69	35.16	16.30	31.91	1.76	0.34	138.81	1.16	284.02
WCT	58.37	781.75	22.92	43.91	475.02	39.24	15.24	28.92	2.14	0.27	113.15	1.19	248.57
FJT	48.42	1079.71	29.23	52.15	522.71	45.97	17.19	29.03	2.87	0.31	152.14	1.20	261.07
MYD	35.34	605.04	22.20	38.90	359.78	40.38	14.21	29.15	1.15	0.25	104.03	0.93	183.92
HLG	62.84	765.18	23.49	41.44	426.10	44.09	15.08	29.48	1.59	0.29	118.02	1.01	223.38
HKS	109.32	836.30	24.71	44.35	508.54	36.20	15.26	30.68	1.82	0.33	131.50	1.09	249.96
HKG	71.63	955.90	24.54	44.48	659.30	33.61	16.44	32.33	1.65	0.35	162.90	1.15	309.35
LCT	44.69	806.15	23.10	41.40	521.21	36.03	15.36	30.96	1.38	0.32	134.84	1.12	274.39
HKS	50.05	937.24	23.91	39.13	711.54	32.13	16.08	32.02	1.30	0.34	143.52	1.01	316.56
GBGD	53.85	944.84	25.26	42.25	612.03	40.81	16.92	32.44	1.23	0.24	123.75	1.11	314.05
SEm (+/-)	6.22	64.59	0.54	1.16	52.01	2.71	0.45	1.14	0.12	0.02	9.83	0.03	21.82
CD (0.05%)	18.01	187.11	1.58	3.36	150.68	7.85	1.32	3.31	0.35	0.06	28.48	NS	63.22

Table 4: Correlation among fruit traits recorded in 15 coconut genotypes evaluated under Assam condition

Traits	*FW*	*FL*	*FC*	*HFW*	*HFL*	*HFC*	*HT*	*ST*	*SW*	*ET*	*EW*
FW	1										
FL	0.898**	1									
FC	0.880**	0.844**	1								
HFW	0.714**	0.553*	0.467NS	1							
HFL	0.805**	0.766**	0.612**	0.760**	1						
HFC	0.511*	0.420NS	0.279NS	0.928**	0.577*	1					
HT	0.551*	0.674**	0.746**	-0.038NS	0.346NS	-0.236NS	1				
ST	0.552*	0.546*	0.354NS	0.474NS	0.376NS	0.453NS	0.256NS	1			
SW	0.823**	0.675**	0.638**	0.874**	0.774**	0.765**	0.198NS	0.676**	1		
ET	0.807**	0.690**	0.801**	0.584*	0.643**	0.393NS	0.567*	0.413NS	0.603*	1	
EW	0.706**	0.556*	0.477NS	0.976**	0.783**	0.896**	-0.004NS	0.357NS	0.816**	0.568*	1

FW- Fruit weight (g), FL-Fruit length (cm), FC-Fruit circumference (cm), HFW- Husked fruit weight (g), HFL- Husked fruit length (cm), HFC- Husked fruit circumference (cm), HT- Husk thickness (cm), ST- Shell thickness (cm), SW- Shell weight (g), ET- Endosperm thickness (cm), EW- Endosperm weight (g)

not correlated with any of the fruit components. A negative correlation was observed with nut length, shell thickness, fresh kernel thickness, fruit circumference, and nut length. No correlation was seen for fruit length with nut weight, nut length, nut circumference, shell thickness and shell weight. Fresh kernel thickness and fresh kernel weight were found to be significantly and positively correlated with each other.

Conclusion

Coconut, a vital plantation crop in India, supports the livelihood of many small and marginal farmers in the North East region. Despite its importance, there has been limited systematic effort to boost coconut productivity in this area. This study evaluated fifteen coconut genotypes, both exotic and indigenous, to understand their growth, nut yield, and fruit characteristics in Aasam conditions from 2015 to 2022. Significant variations were found, particularly in nut yield and fruit attributes. The hybrid variety Kera Sankara showed promising nut yield, indicating its suitability for cultivation in the North East. Additionally, Assam Green Tall displayed superior fruit characteristics. This research underscores the need for more focused coconut improvement studies in the Northeast and emphasizes the importance of tailoring coconut germplasm to the region's unique conditions. The insights gained from this study can guide local farmers, extension services, and policymakers toward improved coconut cultivation practices, ultimately contributing to increased income and profitability for coconut growers in the region.

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