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Evaluation of cashew (*Anacardium occidentale* L.) hybrids for vegetative parameters and nut yield

K. SETHI, [1]P. C. LENKA AND [2]S. K. TRIPATHY

All India Coordinated Research Project on Cashew,
[1]Department of Fruit Science and Horticulture Technology,
[2]Department of Plant Breeding and Genetics,
College of Agriculture, OUAT, Bhubaneswar

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ABSTRACT

The field experiment was carried out under All India Coordinated Research Project on Cashew of OUAT, Bhubaneswar, Odisha, India during 2011 and 2012 in ten years old cashew plantations to evaluate the cashew hybrids on the basis of vegetative growth and nut yield. The experiment was laid out by adopting Augmented Statistical Design with 60 hybrids, 8 parents and 3 check varieties. The analysis of results based on adjusted mean and values on vegetative growth parameters and nut yield showed significant variations. Considering the overall vegetative growth parameters as well as nut yield the present study concluded that the hybrids such as A-71, B-27, D-19, G-8 and H-6 may be promising for commercial cultivation. The study also revealed that both KBN and VTH-711/4 were identified as better male parent for hybridization programme in cashew.

Keywords: Cashew, F_1 hybrids, vegetative growth, nut yield

Cashew (*Anacardium occidentale* L.) belonging to the family *Anacardiacea* was introduced from Brazil to India by the Portuguese during 16th century for afforestation as well as soil conservation purposes. Presently, cashew is treated as "wonder nut of the world" having nutrient rich kernel. Cashew kernel is a good source of protein (21%), fat (47%), carbohydrate (22%) and minerals. Cashew nut shell liquid (CSNL), by product of cashew nut is also treated as valuable raw materials for paints and varnish industries. The leading cashew growing state are coastal regions of Maharashtra, Goa, Karnataka, and Kerala in Tamil Nadu, Andhra Pradesh, Odisha and West Bengal in the East. The total production of cashew in India is 7.28 lakh tonnes from an area of 9.82 lakh hectare during 2012-13 (Saroj *et al*., 2014). Although during last 13 years, there is steady increase in both area and production of cashew in India, but the productivity rate is very low ranging from 600 to 800 kg ha^{-1} with an average of hardly 772 kg ha^{-1} as against potential productivity of 2000 kg ha^{-1}. The primary reasons of low productivity of Indian cashew are due to existence of large areas under old senile plantation. Therefore, this low productivity of cashew can be addressed effectively by developing cashew genotypes with high yielding potential and adoption of scientific orchard management practices including proper plant protection measures. Keeping this in view, the present investigation was undertaken to evaluate the developed F_1 hybrids for vegetative as well as nut yield under Odisha condition.

Email: kabita2273@yahoo.com

MATERIALS AND METHODS

The present investigation was carried out at Cashew Research Station of All India Coordinated Research Project on Cashew operating under Orissa University of Agriculture and Technology, Bhubaneswar, India. Ten years old 60 hybrid plants from each cross combination (Table 1) along with their 8 parents and 3 check varieties were planted at a spacing of 4 x 4m by adopting recommended package of practices uniformly. The list of the parents and check varieties along with their source of collections are depicted in table 2. Data on various flowering parameters obtained during 2011 and 2012 were analyzed following Agumented Design (Petersen, 1985) and adjusted mean values were used to calculate the significance of the hybrids.

RESULTS AND DISCUSSION

The adjusted mean results obtained during both the years of experimentation during 2011 and 2012 revealed significant variations among the 60 tested F_1 hybrids for both vegetative growth parameters and nut yield as well (Table 3).

The plant height among the 60 tested F_1 hybrids varied significantly ranging from 3.31m in hybrid, D-15 (M44/3 x VTH-711/4) to maximum of 4.97 m in hybrid, B-5 (RP-1 x VTH-711/4) and I-16 (Vittol- 44/3 x VTH-711/4). However, *statistical parity* were observed among F_1 hybrids such as A-48, A-71, A-95, A-99, B-6, B-27, B-31, B-35, C-14, E-12, E-16, H-8, I-3, I-12 and I-20 (4.50m to 4.7m) with B-5 and I-16. Similarly, statistical parity was also recorded in D-10, G-25 with lowest plant height in hybrid D-15. The present study

also indicated that although VTH-711/4 was used as male parent for 'B', 'D' and 'I' series hybrids (Table 2), but significantly higher plant height were recorded for both 'B' and 'I' series hybrids as compared to 'D' and 'F' series hybrids indicating the dominance of female parent towards induction of height in cashew. In the present study, the female parent M-44/3 for 'B' series while RP-2 for 'F' series hybrids showed relatively dwarf plant height of 2.77m and 3.49m, respectively. The results also showed the exploitation of hybrid vigour on plant height. Similar reports on heterosis of plant height has also been reported by Manivannan *et al.* (1989), Shankarnarayan and Shah (1999).

Table 1 : List of sixty hybrids with their cross combinations

Sl. No.	Name of hybrid series	Cross combinations	Details of the hybrids used in the study
1.	'A'	RP-1X Kalyanpur Bold Nut(KBN)	A-33, A-48, A-62,A-71, A-95, A-99
2.	'B'	RP-1 x VTH -711/4	B-5, B-6, B-27, B-31, B-35, B-58
3.	'C'	RP-2 x Kankadi	C-7, C-14, C-30, C-41, C-44, C-52
4.	'D'	M-44/3 x VTH- 711/4	D-9, D-10, D-15, D-19, D-29, D-47
5.	'E'	RP-1 x Kankady	E-2, E-3, E-12, E-16, E-22, E-28
6.	'F'	RP-2 x VTH-711/4	F-16, F-20, F-27, F-28, F-32, F-38
7.	'G'	RP-2 x Kalyanpur Bold Nut	G-8, G-9, G-16, G-17, G-23, G-25
8.	'H'	M-44/3 x Kalyanpur Bold Nut	H-2, H-6, H-8, H-10, H-20, H-26
9.	'I'	Vittol- 44/3 x VTH-711/4	I-3, I-7, I-12,I-16, I-20, I-22
10.	'J'	BPP-30/1 x Kalyanpur bold Nut	J-1, J-6, J-12, J-13, J-14, J-20

Note: *Six hybrids selected from each cross combination.*

Table 2: Details of parents and checks varieties used in the study

Sl. No.	Parents	Source of collection
1.	RP- ,1, RP- 2	Ranasinghapur, Bhubaneswar, Odisha
2.	Kalyanpur bold nut	Khurda, Odisha
3.	VTH- 711/4, Vittol- 44/3	DCR, Puttur, Karnataka
4.	Kankady	CRS, Vengurla, Maharastra
5.	M-44/3	Regional Cashew Research Station, Vridhachalam, Tamil Nadu
6.	BPP- 30/1	CRS, Bapatala, Andhra Pradesh
	Standard checks	
7.	BPP- 8(H-2/16)	CRS, Bapatala, Andhra Pradesh
8.	Jagannatha(BH- 6), Balabhadra(BH-85)	CRS, Ranasinghapur, Bhubaneswar, Odisha

Note: *CRS-Cashew Research Station; DCR- Directorate of Cashew Research*

Table 3:Mean performance of vegetative parameters and nut yield (kg plant^{-1}) of cashew

Sl. No.	Cashew types	Plant height (m)	Trunk girth (cm)	Canopy spread (m)		Total laterals m^{-2}	Nut yield (kg plant^{-1})
				E-W	N-S		
Hybrids							
1	A-33	4.09	46.43	3.27	4.55	18.02	3.42
2	A-48	4.65	58.43	4.00	4.58	22.22	3.80
3	A-62	4.26	58.65	4.02	4.29	21.92	3.57
4	A-71	4.67	63.23	4.37	5.22	24.64	4.03
5	A-95	4.50	60.43	4.15	4.20	19.41	3.09
6	A-99	4.60	51.39	4.12	3.81	20.62	2.46
7	B-5	4.97	62.66	3.77	4.57	18.11	2.99
8	B-6	4.53	57.12	3.99	4.14	15.87	2.39
9	B-27	4.81	65.96	4.07	4.65	22.17	4.13
10	B-31	4.55	64.31	3.54	4.36	20.25	3.08
11	B-35	4.54	56.54	4.02	4.23	17.09	2.41
12	B-58	4.21	55.00	3.92	4.14	16.41	2.38
13	C-7	4.35	64.16	4.07	3.66	20.15	2.08
14	C-14	4.20	54.97	3.81	4.06	16.39	2.55
15	C-30	4.21	55.05	3.97	4.59	20.45	3.81
16	C-41	4.66	73.52	4.15	4.68	18.47	3.65
17	C-44	3.63	62.42	3.51	4.01	17.87	1.88

Contd.

Contd.

Sl. No.	Cashew types	Plant height (m)	Trunk girth (cm)	Canopy spread (m)		Total laterals m^{-2}	Nut yield (kg $plant^{-1}$)
				E-W	N-S		
18	C-52	4.10	58.00	3.97	3.90	16.59	2.00
19	D-9	4.05	58.61	3.72	4.52	16.60	2.15
20	D-10	3.50	61.37	4.07	4.72	18.81	2.47
21	D-15	3.31	68.84	3.93	3.73	20.07	2.24
22	D-19	4.36	56.56	4.30	4.45	20.88	4.34
23	D-29	4.24	55.22	4.10	4.39	18.53	2.09
24	D-47	3.76	55.82	3.85	4.09	20.13	3.09
25	E-2	3.72	62.35	3.95	3.34	16.43	2.11
26	E-3	4.33	73.26	4.00	4.46	17.75	2.36
27	E-12	4.69	60.70	4.40	4.17	13.79	2.10
28	E-16	4.50	73.91	4.56	4.45	15.23	2.99
29	E-22	3.96	59.57	3.90	4.01	16.21	2.09
30	E-28	4.06	61.72	3.78	3.49	14.62	2.15
31	F-16	4.16	58.48	4.41	3.74	13.59	2.01
32	F-20	4.06	51.43	3.75	3.38	18.35	2.17
33	F-27	4.16	54.48	3.57	4.03	15.11	2.14
34	F-28	4.31	57.37	4.56	4.39	19.75	3.24
35	F-32	3.61	53.29	4.35	3.62	13.59	2.18
36	F-38	4.02	58.67	4.55	4.12	15.37	2.42
37	G-8	4.28	64.68	4.40	4.69	19.48	3.99
38	G-9	3.52	54.23	4.30	4.67	18.13	3.31
39	G-16	4.12	52.52	3.98	4.09	18.77	2.41
40	G-17	3.71	51.58	3.78	3.96	14.86	1.94
41	G-23	3.94	59.68	3.98	4.28	16.67	3.47
42	G-25	3.64	51.67	3.39	3.82	16.43	2.21
43	H-2	3.78	59.14	4.02	3.51	17.74	2.38
44	H-6	4.36	69.11	4.68	4.91	19.49	4.28
45	H-8	4.59	67.63	4.22	4.86	18.09	3.87
46	H-10	4.18	59.87	4.12	4.44	18.12	2.83
47	H-20	4.28	59.14	4.25	4.33	17.33	3.51
48	H-26	4.13	56.48	4.46	4.52	18.34	3.32
49	I-3	4.41	56.04	3.91	4.25	14.77	2.32
50	I-7	4.34	58.98	3.65	3.87	15.24	2.04
51	I-12	4.70	69.35	4.20	4.64	11.99	3.11
52	I-16	4.97	58.64	3.92	4.44	10.71	2.93
53	I-20	4.75	58.98	4.07	4.35	17.04	2.99
54	I-22	4.21	48.23	3.60	3.78	13.99	1.83
55	J-1	3.78	56.46	4.10	4.15	17.28	3.12
56	J-6	4.03	61.63	4.43	4.39	19.12	3.61
57	J-12	4.34	69.12	4.65	4.50	18.29	3.74
58	J-13	4.08	61.63	4.33	4.36	19.65	3.28
59	J-14	4.28	63.36	4.25	4.15	17.81	3.19
60	J-20	4.38	61.63	4.57	4.30	19.09	3.63
Parents							
61	RP -1	3.35	50.67	3.57	3.91	16.71	2.49
62	KBN	3.35	50.22	3.82	4.07	13.86	1.85
63	VTH -711/4	4.07	70.91	4.26	4.45	14.94	1.77
64	RP- 2	3.49	57.98	3.74	3.97	16.71	2.32
65	Kankady	3.71	58.70	4.25	4.40	14.22	1.59
66	M-44/3	2.77	54.19	3.57	3.52	17.90	2.57
67	Vittol- 44/3	4.16	60.51	3.90	4.28	17.36	2.66
68	BPP -30/1	3.79	52.25	3.68	3.90	17.60	2.46
Standard checks							
69	BPP- 8	3.86	66.87	4.17	4.05	17.09	3.16
70	BH -6	3.41	55.83	3.35	3.98	14.51	2.26
71	BH- 85	3.39	55.77	3.56	4.20	15.31	2.67
CD (0.05)		**0.57**	**5.66**	**0.55**	**0.44**	**2.89**	**0.46**

Regarding trunk girth, the result also showed significant variations among all the tested hybrids. Significantly maximum trunk girth of 73.91cm was recorded in hybrid, E-16(RP-1 x Kankady) while that of minimum of 46.43cm in A-33(RP-1 x KBN). However, statistical parity was observed in hybrids like C-41, D-15, E-3, H-6, H-8, I-12, J-12(69.11 to 73.52cm) with E-16. Among the parents, only male parents, VTH-711/4 recorded higher trunk girth of 70.91cm than rest of the parents. The study also revealed the role of male parent, either KBN or Kankady towards higher trunk girth in cashew.

The result of canopy spread, both East-West (E-W) and North-South (N-S) also showed significant variations among all the F_1 hybrids evaluated. These parameters are very important not only for canopy management under high density planting system but also towards production of quality nut yield in cashew. The canopy spread in East-West direction ranged from 3.27m in hybrid A-33(RP-1 x KBN) to 4.68m in H-6(M-44/3 x KBN). The hybrids such as A-71, A-95, C-41, D-19, D-29, E-12, E-16, F-16, F-28, F-32, F-38, G-8 , G-9, H-8, H-20, H-26, I-12, I-20, J-6, J-12, J-13, J-14, J-20 (4.15m to 4.65m) showed statistical parity with H-6, the highest spread hybrid in E-W direction. The result clearly demonstrated the dominance of KBN as male parent towards E-W direction. Canopy spread to the extent of 33.33% in 'A' and 'G' series, 66.67% in 'H' series, 83.33% in 'J' series F_1 hybrids as compared to other male parents. Similarly, the canopy spread in N-S direction among the tested F_1 hybrids varied from 3.34m in hybrid E-2(RP-2 x Kankady) to 5.22m in A-71(RP-1 x KBN). However, statistical parity was observed in H-6 and H-8(M-44/3 x KBN) with A-71. The result on canopy spread in N-S direction also indicated the dominance of KBN as male parent towards vigorous growth, the canopy spread.

The results on total laterals m^{-2} an important parameter contributing towards nut yield in cashew also showed significant variations among the tested F_1 hybrids (Table 3). The results revealed minimum of 13.59 numbers of laterals m^{-2} in F_1 hybrids, F-16 (Vittol-44/3 x VTH-711/4) to maximum of 24.64 numbers in F_1 hybrids, A-71(RP-1 x KBN). The F_1 hybrids such as A-48, A-62, and B-27 also showed statistical parity with A-71. The results of present study also clearly demonstrated the better efficacy of KBN as a male parent towards inheritance of total laterals per square meter in cashew. This findings corroborates with the findings of Parameswaran *et al.* (1984) and Nawale and Selvi(1990).

The result data on performance of parent used in the present study revealed that both VTH-711/4 as well as KBN as male parent induced better vegetative growth parameters in the tested hybrids as compared to the other male parents. Similarly, the parents such as RP-1, RP-2 and M-44/3 were found to be better as female parents for exploitation of heterosis, as evidence in the present study. These parents may be breeding objectives in future as per the breeding objectives towards exploitation of heterosis. Similar findings also reported by Shankarnarayan *et al.* (1996).

The adjusted mean results of two years 2011 and 2012 revealed significant variations among the 60 tested F_1 hybrids (Table 3). Comparatively low nut yield(kg $plant^{-1}$) recorded in the present study was due to high density planting of genotypes at a spacing of 4 x 4m instead of normal standard spacing of 7.5 x 7.5m. The results on nut yield varied significantly from minimum of 1.83 kg $plant^{-1}$ in hybrid I-22(Vittol-44/3 x VTH-711/4) to maximum of 4.34 kg $plant^{-1}$ in hybrid D-19(M-44/3 x VTH-711/4). However, the F_1 hybrids such as A-71, B-27, G-8 and H-6(3.99 to 4.28 kg $plant^{-1}$) recorded nut yield statistically *at par* with highest yielder in D-19. Considering at least nut yield of 3.0 or more than 3.0 kg $plant^{-1}$ as standard, the present results clearly demonstrated that when KBN was used as male parent irrespective of female parents, relatively higher nut yield was produced by the corresponding F_1 hybrids such as 50.00% in 'G', 66.67% in 'H', 83.33% in 'A' as well as 100% in 'J' series F_1 hybrids. The next best male parent identified in the present study was VTH-711/4 ranging from 16.67 to 33.33% Nawale (1983), (Nawale and Salvi 1990).

Considering the overall results, observed in the present study, we concluded that the F_1 hybrids such as A-71, B-27, D-19, G-8 and H-6 may be promising for commercial cultivation for increasing the production and productivity in cashew. The study also revealed the possibility of utilizing KBN and VTH-711/4 as well as parent in hybridization programme to evolve better cashew types.

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