

**RESEARCH PAPER****Evaluation of F₁ hybrids of cashew (*Anacardium occidentale* L.)**S. Sahoo¹, K. Sethi*, M. Dash² and P. Tripathy³

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Abstract : An experiment on evaluation of F₁ hybrids of cashew (*Anacardium occidentale* L.) was conducted during the year 2018-2019 at Cashew Research Station, Odisha University of Agriculture and Technology, Bhubaneswar. Five F₁ progenies of cashew (BH-27, BH-105, BH2-6, BH-30 and BH-19) and their, parents (Bhubaneswar-1, Kankadi, M44/3, RP-1, RP-2 and VTH-711/4) and check varieties (Dhana, H-320 and BPP-8) were planted in the year 2014 following a spacing of 7.0 m². The experiment was laid out following the statistical design RBD and was replicated twice. All standard package of practices were followed to raise a good crop. In the present investigation, vegetative parameters, yield attributes and mean annual nut yield plant⁻¹ revealed a spectacular wide array of variations among the tested genotypes. F₁ hybrid, BH2-6 recorded maximum plant height (5.35m), total laterals m⁻² (27.63), flowering laterals m⁻² (26.88) and nut yield (4.25 kg/ plant⁻¹). Duration of flowering was recorded maximum in F₁ hybrid BH-105 (83.5 days). Parent, Kankadi recorded maximum trunk girth (47.62cm), canopy spread (6.90m in E-W direction), canopy area (123.24 m²), apple weight (97.75g) and nut weight (12.3 g), while check variety, Dhana recorded maximum canopy spread (6.44) in North-South direction and minimum duration of flowering (54.50 days). Parent, Bhubaneswar-1 recorded maximum nuts panicle⁻¹ (6.31) as well as shelling per cent (32.75%). Based on mean performance and heterosis, the hybrids BH2-6 and BH-19 were found to be promising for nut yield and shelling per cent.

Key Words : Evaluation, Cashew, Hybrids, Yield attributes, Nut yield

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INTRODUCTIONCashew (*Anacardium occidentale* L.)(Anacardiaceae, 2n=42), a dollar earning crop, is a native of Brazil. It was introduced to India in 16th century by*** Author for correspondence:**

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Portuguese to cover bare hills and for soil conservation. Most importantly, its cultivation is regarded to be economically promising both for rural growers and industrial processors fulfilling the objectives of employment generation and value addition lending a hand to Indian economics. India is the largest producer of raw cashew nut in the world contributing 20 per cent to global production (DCCD, 2017-18). In spite of substantial contribution to the global cashewnut production, the domestic production is not sufficient to meet the requirement of cashewnut processors in the country. Cashew being a highly cross pollinated crop, the plantations raised with non-descript seedling progeny exhibit more variation with respect to growth, yield and other characters. Identification of F_1 progenies with desirable yield contributing traits is necessary to enhance the production and productivity of cashewnut in the state as well as in the country. Thus, the present investigation was undertaken to evaluate the F_1 cashew hybrids with the objective to evaluate the performance of F_1 progenies for vegetative traits, yield attributes and nut yield.

(Bhubaneswar-1, VTH711/4, M44/3, Kankadi, RP-1, RP-2) and three check varieties (Dhana, H-320 and BPP-8) were planted at Cashew Research Station, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha during the year 2014 adopting a spacing of 7m². The experiment was laid out in RBD design with two replications. The observations on the vegetative growth parameters, yield attributes and nut yield per plant were recorded for the fruiting season 2018-19. The evaluated traits were plant height (m), trunk girth (cm), canopy spread (E-W and N-S)(m), flowering laterals (m²), total laterals (m²), nuts panicle⁻¹, nut weight (g), shelling (%) and nut yield plant⁻¹ (kg). Data were recorded by adopting standard procedure as described (Bhat *et al.*, 2005). Statistical procedures were followed for data analysis as stated by Panse and Sukhatme (1985). The selected hybrids were evaluated for heterosis over mid parent (Reletative heterosis), better parent (Heterobeltiosis) and standard variety (Standard heterosis) following the formulae suggested by Briggie (1963) and Hayes *et al.* (1965).

MATERIAL AND METHODS

Five F_1 cashew hybrids *viz.*, BH-27, BH-105, BH2-6, BH-30 and BH-19 along with their parents

RESULTS AND DISCUSSION

Vegetative parameters like plant height, trunk girth, canopy spread (East-West and North South) and total

Table 1: Mean of vegetative growth parameters of in cashew

Genotype	Plant height (m)	Trunk girth (cm)	Canopy spread (E-W)	Canopy spread (N-S)	Canopy area (m ²)	Total laterals m ⁻²
Hybrids						
BH-27	4.52	36.05	5.17	5.08	65.32	21.50
BH-105	4.37	37.82	5.10	4.75	64.60	23.19
BH2-6	5.35	42.90	5.20	5.17	77.68	27.63
BH-30	4.66	39.50	5.31	4.587	68.23	20.06
BH-19	4.4	44.15	5.64	5.587	93.65	22.50
Parents						
Bhubaneswar-1	3.92	39.47	5.56	5.40	80.716	26.00
Kankadi	5.13	47.62	6.90	5.55	123.24	21.56
M44/3	4.10	38.80	4.22	4.45	51.11	24.00
RP-1	4.50	38.17	4.82	4.68	55.10	22.75
RP-2	4.15	41.22	4.72	5.11	61.49	24.14
VTH 711/4	4.10	36.72	5.3	4.55	69.44	19.93
Check varieties						
Dhana	4.30	46.95	6.23	6.44	115.59	23.00
H-320	4.42	32.55	5.32	4.48	62.57	24.50
BPP-8	4.22	38.07	4.62	4.64	60.47	21.88
S.E. ±	0.12	1.09	0.186	0.151	1.946	0.434
C.D. (P=0.05)	0.38	3.37	0.575	0.467	6.008	1.340

number of laterals m² were found statistically significant among hybrids, parents and check varieties. It is revealed from Table 1 that height of the cashew plant varied from 3.31m in parent, Bhubaneswar-1 to 5.35 m in hybrid, BH2-6. Parent, Kankadi recorded maximum trunk girth of 47.62 cm followed by check variety Dhana (46.95 cm). The minimum trunk girth was recorded in check variety H-320 (32.55 cm). Among the genotypes canopy spread in E-W direction varied from 4.22 m (M-44/3) to 6.90 m (Kankadi). In North-South direction, the check variety, Dhana recorded the maximum canopy spread of 6.44 m while parent, M-44/3 recorded the minimum spread (4.45 m). The study also revealed significant variations for number of laterals m² among the tested genotypes. Hybrid, BH2-6 produced significantly highest number of lateral m² (26.0) whereas, lowest number of vegetative laterals were recorded in parent VTH-711/4 (19.93). The number of laterals m², the spread of the plant both in East-West and North-South directions contributed towards canopy spread. Thus, providing maximum area for photosynthesis. The vegetative growth of the plant determines the capacity of the plant for final nut yield and yield attributing characters. Manoj *et al.* (1998) are also of the opinion that plant height, spread (both N-S and E-W direction) primary and

secondary branches contribute significantly to the nut yield of cashew. Similar variations in plant height, trunk girth and canopy spread were reported by Sidoni *et al.* (2005); Singh *et al.* (2008); Sharma *et al.* (2009); Hanumanthapa *et al.* (2014) and Tripathy *et al.* (2015). The flowering lateral m² was found significant among the genotypes studies which ranged from 13.43 (VTH-711/4) to 26.8 in (BH2-6). The highest number of flowering laterals m² were recorded in parent, M-44/3 (17.04) followed by check variety, H-320 (15.44). The results of present study indicated that the duration of flowering was recorded maximum in hybrid, BH-105 (83.5 days) followed by BH2-6 (77.5 days) and parent Bhubaneswar-1 (75 days). Significantly lowest duration of flowering was recorded in check variety, Dhana (54.5 days). Similar observation of variation in duration of flowering ranging from 53.3 to 90 days in different cultivars was reported by Sena *et al.* (1995) and Samal *et al.* (2006). The sex ratio which contributes towards fruit set was significantly maximum in parent, M-44/3 (0.67%) while the significantly minimum sex ratio was recorded in parent, VTH-711/4 (0.12%). Sena *et al.* (1995) also observed wide sex ratio among different cashew types which varied from 0.093 per cent to 1.038 per cent under Bhubaneswar condition. Since higher per

Table 2 : Mean of flowering parameters in cashew

Genotype	Flowering laterals m ²	Duration of flowering (days)	Sex ratio (Number of hermaphrodite flowers : total number of flowers)
Hybrids			
BH-27	20.38	73.00	0.27
BH-105	22.06	83.50	0.26
BH2-6	26.88	77.50	0.41
BH-30	16.44	62.50	0.42
BH-19	21.63	62.00	0.36
Parents			
Bhubaneswar-1	21.75	75.00	0.41
Kankadi	16.75	64.00	0.22
M44/3	23.18	69.00	0.67
RP-1	20.12	68.50	0.35
RP-2	21.62	65.00	0.28
VTH 711/4	13.43	70.50	0.12
Check varieties			
Dhana	20.75	54.50	0.28
H-320	22.06	68.00	0.22
BPP-8	17.93	73.00	0.28
S.E.±	0.741	2.418	0.021
C.D. (P=0.05)	2.287	7.464	0.066

cent of hermaphrodite flower is expressed by wider sex ratio, the varieties having border sex ratio would be potential higher yielders. This result corroborates the findings of Dashmohapatra *et al.* (2012) who reported that the sex ratio can be used directly for selection in improvement of cashew. The flowering characters such as duration of flowering, sex ratio and number of flowering laterals m^{-2} contributed towards nut set and yield per unit area. The results are also in confirmatory with the findings of Sapkal (1998) and Lekna *et al.* (2003) and Dorajeerao *et al.* (2002). The total number of nuts produced per plant was found to be most important character, positively and highly significantly correlated with nut yield as compared to all other yield attributing characters. In the present investigation, parent, Bhubaneswar-1 recorded significantly maximum number of nuts panicle⁻¹ (6.31) while parents VTH-711/4 and Kankadi recorded the lowest number of nuts panicle⁻¹ (1.5). Number of nut m^{-2} was recorded significantly highest in parent, RP-2 (39.61) while significantly lowest was recorded for the parent, Kankadi (1.25). Significantly maximum apple weight was recorded in parent, Kankadi (97.75) while minimum was recorded in parent, RP-1 (18.40g). Greater than 28 shelling per cent is considered to be the ideal. In the present study, among the tested

genotypes highest shelling per cent was recorded in parent Bhubaneswar-1 (32.75%) and minimum was recorded in parent Kankadi (22.65%). Aliyu and Awopetu (2011) are of the opinion that significant variations exist in yield related traits of cashew genotypes. Similar type of wide variations for nuts panicle⁻¹, nuts m^{-2} , nut weight and shelling per cent in cashew has also been reported by Reddy *et al.* (2002); Singh *et al.* (2010); Poduval (2015) and Sethi *et al.* (2015). The average annual nut yield revealed significant variations (kg plant⁻¹) among the tested genotypes. Significantly highest nut yield (kg plant⁻¹) was recorded in hybrid, BH2-6 (4.25 kg plant⁻¹) followed by BH-19 (3.86 kg plant⁻¹), BH-105 (3.68 kg plant⁻¹) and check variety, Dhana (3.54 kg plant⁻¹) which were statistically at par. The lowest nut yield plant⁻¹ was recorded in genotype parent VTH-711/4 (0.4 kg plant⁻¹). It is revealed that maximum cumulative nut yield (kg plant⁻¹) for 3rd harvest was recorded by the hybrid BH2-6 (10.20 kg plant⁻¹) followed by BH-19 (9.03 kg plant⁻¹). Parent Kankadi recorded the minimum cumulative nut yield (0.81 kg plant⁻¹) for 3rd harvest. Similar variations in mean annual nut yield and cumulative nut yield were reported by Vishnuvardhana *et al.* (2003); DCR (2010) and Poduval (2015).

The studies on heterosis also revealed wide

Table 3 : Mean of yield attributes and nut yield in cashew

Genotype	Nuts panicle ⁻¹	Nut weight (g)	Nuts m^{-2}	Shelling %	Yield (kg plant ⁻¹)	Cumulative yield (kg plant ⁻¹)
Hybrids						
BH-27	3.38	7.14	21.80	29.96	1.25	5.17
BH-105	4.63	7.78	20.48	30.64	3.68	7.05
BH2-6	4.38	8.175	30.32	31.57	4.25	10.2
BH-30	5.31	5.80	20.28	31.67	2.42	6.67
BD-19	5.44	6.31	20.98	31.86	3.86	9.03
Parents						
Bhubaneswar-1	6.31	5.28	23.11	32.75	2.28	6.96
Kankadi	1.50	12.30	1.25	22.65	0.40	0.81
M44/3	5.00	4.62	27.72	27.53	3.02	7.08
RP-1	5.31	4.22	21.98	31.05	2.42	6.6
RP-2	4.50	4.18	39.61	32.54	2.65	7.16
VTH 711/4	1.50	14.22	2.34	32.00	0.44	0.99
Check varieties						
Dhana	3.50	7.23	21.81	30.54	3.54	8.04
H-320	2.94	7.125	17.73	29.19	1.28	3.55
BPP-8	3.94	7.76	21.09	29.98	3.67	7.62
S.E. \pm	0.807	0.114	2.191	0.947	0.734	-
C.D. (P=0.05)	0.262	0.351	0.71	0.307	0.238	-

variations among the genotypes. Relative heterosis, heterobeltiosis and standard heterosis estimates for nut weight is presented in Table 4a. The relative heterosis ranged from -33.02 per cent (BH-19) to 19.44 (BH-105) with an average value of -13.31 per cent. The heterobeltiosis ranged from -171.08 per cent (BH-19) to 0.52 per cent (BH-105) with an average value of -118.56 per cent. All the hybrid genotypes showed negative relative heterosis and heterobeltiosis except BH-105. The standard heterosis ranged from -25.28 per cent (BH-30) to 5.31 per cent (BH2-6) with an average value of -9.27 per cent. Hybrid, BH2-6 and BH-105 showed positive standard heterosis of 5.31 per cent and 0.322 per cent, respectively.

Relative heterosis, heterobeltiosis and standard

heterosis estimates for shelling per cent of five hybrids is presented in Table 4b. The relative heterosis ranged from -4.95 (BH-27) to 14.78 (BH-30) with an average value of 5.79 per cent. It was revealed that hybrids, BH-30, BH-19 and BH2-6 showed positive relative heterosis except BH-27 and BH-105. The heterobeltiosis ranged from -6.44 per cent (BH-105) to 15.73 per cent (BH-19) with an average value of 0.03 per cent. All the hybrids showed negative heterobeltiosis except hybrid, BH-19. The standard heterosis ranged from -0.06 per cent (BH-27) to 6.26 per cent (BH-19) with an average value of 3.87 per cent. Genotype, BH-27 showed negative standard heterosis whereas rest hybrids exhibited positive standard heterosis. Among the five hybrids, BH-30 and BH2-6 recorded highest positive heterobeltiosis and

Table 4a : Heterosis for nut weight in F₁ cashew hybrids

Name of hybrid	Relative heterosis %	Heterobeltiosis %	Standard heterosis %
BH-27	-22.63	-167.75	-8.05
BH-30	-29.59	-155.69	-25.28
BH-19	-33.02	-171.08	-18.68
BH2-6	-0.76	-98.80	5.31
BH-105	19.44	0.52	0.32

Check variety (BPP-8) exhibited 7.0 g nut weight

Table 4b : Heterosis for shelling % in F₁ cashew hybrids

Hybrid	Relative heterosis %	Heterobeltiosis %	Standard heterosis %
BH-27	-4.95	-3.47	-0.06
BH-30	14.78	-2.67	5.64
BH-19	7.03	15.78	6.26
BH2-6	14.41	-2.98	5.30
BH-105	-2.31	-6.44	2.19

Check variety (BPP-8) exhibited 29.98 shelling %

Table 4c : Heterosis for nut yield in F₁ cashew hybrids

Hybrid	Relative heterosis %	Heterobeltiosis %	Standard heterosis %
BH-27	-11.99	-48.06	-65.81
BH-30	58.61	-8.74	-34.05
BH-19	123.15	27.66	5.18
BH2-6	178.32	60.15	15.72
BH-105	23.89	61.65	0.40

Check variety (BPP-8) exhibited 3.671 kg/plant

Table 5 : Best heterotic hybrid for nut weight, shelling% and nut yield

Heterosis Characters	Best heterotic hybrid		
	Relative heterosis	Heterobeltiosis	Standard heterosis
Nut weight	BH-105	BH-105	BH-26
Shelling %	BH-30	BH-19	BH-19
Nut yield	BH2-6	BH-105	BH2-6

standard heterosis for shelling per cent.

Relative heterosis, heterobeltiosis and standard heterosis estimates for nut yield is presented in Table 4c. The relative heterosis ranged from -11.99 per cent (BH-27) to 178.32 (BH2-6) with an average of 74.39 per cent. Hybrids, BH-30, BH-19, BH2-6 and BH-105 showed positive relative heterosis of 58.61 per cent, 123.15 per cent, 178.32 per cent and 23.89 per cent, respectively. Heterobeltiosis ranged from -48.05 per cent (BH-27) to 61.65 per cent (BH-105) with an average value of 18.53 per cent. Hybrids, BH-19, BH2-6 and BH-105 showed positive heterobeltiosis of 27.65 per cent, 60.14 per cent and 61.65 per cent, respectively. The standard heterosis ranged from -65.81 per cent (BH-27) to 15.72 per cent (BH2-6) with an average value of -15.72 per cent. Hybrids, BH-19, BH2-6 and BH-105 exhibited positive standard heterosis of 5.18 per cent, 15.72 per cent and 0.4 per cent, respectively. The hybrid, BH2-6 showed highest significant relative heterosis and standard heterosis for this character followed by BH-105.

Based on the relative heterosis, heterobeltiosis and standard heterosis, superior genotypes for nut yield, nut weight and shelling per cent were identified (Table 5). For nut weight, hybrid BH-105 exhibited maximum relative heterosis, heterobeltiosis and standard heterosis. For shelling per cent, BH-30 is the best heterotic hybrid for mid parent, whereas BH-19 is for better parent and standard heterosis. Hybrid, BH2-6 is the best heterotic hybrid for nut yield with respect to mid parent and standard check whereas hybrid BH-105 exhibited best heterobeltiosis.

In the present study the hybrid, BH2-6 recorded highest positive significant relative heterosis and standard heterosis for the important character *i.e.* nut yield. Based on mean performance and heterosis, the hybrids BH2-6 and BH-19 were found to be promising for nut yield and shelling per cent. The findings are in accordance with Manivannan *et al.* (1989); Sankaranarayan *et al.* (2015) and Sethi *et al.* (2016).

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