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Characterization of Cashew (*Anacardium occidentale* L.) Genotypes based on Morpho-economic Traits

Rakhee Kumari[1], Kabita Sethi[2], Manasi Dash[3]

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ABSTRACT

Background: An experiment entitled "Characterization of cashew (*Anacardium occidentale* L.) genotypes based on morpho-economic traits" was conducted during the year 2021-2022 at the Cashew Research Station (CRS), Odisha University of Agriculture and Technology, Bhubaneswar, Odisha. Fifteen cashew genotypes planted during the year 2014 were evaluated for various morpho-economic traits.

Methods: The experiment was laid out following the statistical design RBD (Randomized block design) with two replications. All the standard package of practices were adopted throughout the evaluation period. Evaluation of fifteen cashew genotypes for various morpho-economic traits revealed significant variations within the genotypes.

Result: Estimation of variability revealed that high GCV, PCV, heritability, genetic advance and genetic advance (as % mean) were recorded in traits *viz.* shelling %, nut yield, kernel weight, nuts m^{-2} and mean annual nut yield. Flowering laterals m^{-2}, nuts $panicle^{-1}$, nuts m^{-2} and kernel weight recorded significant positive correlation with nut yield $plant^{-1}$ both at genotypic and phenotypic level. Nut weight (1.846) had the highest positive direct effect on nut yield at phenotypic level followed by shelling % (0.837) and nut m^{-2} (0.486). Evaluation of genotypes for nut yield and yield attributing traits revealed that, genotype, RP-2 recorded the highest number of nuts $panicle^{-1}$ (10.50), nuts m^{-2} (61.43) and shelling% (32.55). Significantly highest apple weight (75.0 g) was recorded in genotype VTH-711/4. Number of total laterals m^{-2} (26.99), number of flowering laterals m^{-2} (24.18), duration of flowering (60.5), mean annual nut yield $plant^{-1}$ (12.33 kg) and cumulative nut yield $plant^{-1}$ (40.73 kg) were recorded maximum in genotype, C2-6. The genotype C2-6 recorded (13.70%) higher yield than the check genotype BPP-8 (10.64 kg $plant^{-1}$) at 6th harvest.

Key words: Cashew, Correlation, Genetic variability, Path analysis and *per se* performance.

INTRODUCTION

Cashew (*Anacardium occidentale* L.), an exotic horticultural crop brought to India by Portuguese travellers in 16th century, is now adapted well to Indian conditions. It was used for afforestation and soil conservation at the time of introduction. But later, in the early 1960s, cashew gained the status of a crop with significant economic value and a commodity focused on exports (Mirdha *et al.,* 2019). In India, cashew cultivation spread along the coastal regions of the peninsula. Cashew is mainly grown in states like Maharashtra, Kerala, Karnataka, Tamil Nadu andhra Pradesh, Goa, Odisha, West Bengal and some parts of the North-Eastern region. Maharashtra is the leading state with maximum production share followed by Andhra Pradesh and Tamil Nadu. Eradasappa and Mohana (2016) opined that though cashew has become an important nut crop in India owing to its nutritional value (Dansou *et al.*, 2023) and export earnings. But, the productivity of cashew in India is very low (761.8 kg ha^{-1}) compared to Vietnam (3041.2 kg ha^{-1}). In-spite of low productivity the internal demand for cashew nut is ever increasing hence it is imperative to increase production and productivity to the optimum level. The most appropriate feasible approach of achieving this is to intensify crop improvement efforts and development/identification of high yielding/hybrid cashew genotypes. Thus, an effort has been made to characterize fifteen elite cashew genotypes for vegetative growth, nut yield and yield attributes at Cashew Research Station, Odisha university of Agriculture and Technology, Bhubaneswar, Odisha.

[1]Department of Fruit Science and Horticulture Technology, Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[2]AICRP on Cashew, Directorate of Research, Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[3]Department of Plant Breeding and Genetics, Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.

Corresponding Author: Kabita Sethi, AICRP on Cashew, Directorate of Research, Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
Email: kabitasethi@ouat.ac.in

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MATERIALS AND METHODS

This experiment was laid out in the year 2014 at the Cashew Research Station, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha using clonal planting materials of five promising hybrids with their parents and check varieties. The research station is located at 20°15′N and 85°52′E latitude which experiences a coastal humid

climate. The soil of the research station is sandy loam with $_{P}$H 5.1. Soil of the experimental site is deficient in organic carbon, available nitrogen and phosphorus. The experiment was laid out using grafted plants which were planted at a spacing of 7.0 m×7.0 m following randomized block design (RBD) with two replications. Four plants were planted for each genotype per replication. All the standard package of practices were adopted uniformly throughout the crop growth period. The present study was undertaken during the year 2022 with an objective to characterize the evaluated genotypes for genetic variability, correlation among component traits and *per se* performance. The evaluated genotypes were characterized for various vegetative growth parameters, yield attributing traits and nut yield adopting standard procedure as described by Swamy *et al*.1998. Statistical procedures were followed for analysis of variance and covariance as stated by Singh and Choudhury, 1985. The simple correlation coefficients for each pair of characters were computed and the path co-efficient (direct and indirect effects) were calculated as per Dewey and Lu (1959). The statistical analysis was done as per the procedure mentioned in Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Genetic variability

In the present investigation genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic gain (as % mean) were recorded maximum for nut weight while genetic advance was recorded maximum for apple weight (Table 1). The economic characters which exhibited high GCV, PCV, heritability, genetic advance and genetic advance (as % mean) were shelling %, nut yield, kernel weight, nuts m^{-2} and mean annual nut yield. An additive gene effect is observed for these characters. Moderate heritability, genetic advance and genetic advance (as % mean) were recorded for the character nuts $panicle^{-1}$ and nuts m^{-2}. The characters which exhibited very low heritability as well as very low genetic advance are plant height, trunk girth and flowering laterals m^{-2} (Table 1). Similar results were reported by Samal *et al*. (2001), Ghatge *et al*. (2009), Dasmohapatra *et al*. (2012), Sethi *et al*. (2016) and Vikram *et al*. (2016).

Table 1: Genetic variability of different morpho-economic traits of evaluated cashew genotypes.

Characters	Range	Mean	Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Heritability (%)	Genetic advance	Genetic advance (as % mean)
Plant height (m)	3.87-6.10	4.83	12.73	22.66	31.57	0.74	14.73
Trunk girth(cm)	44.67-68.12	56.23	11.56	23.62	23.95	6.34	11.65
Flowering laterals m^{-2}	13.32-24.18	18.29	18.52	41.54	19.89	3.35	17.02
Nuts $panicle^{-1}$	1.25-10.5	6.20	40.60	46.79	75.32	4.68	72.59
Nuts m^{-2}	1.3-61.43	29.19	48.70	55.18	77.85	25.78	88.51
Apple wt.(g)	31.7-75.0	47.92	29.06	29.76	95.35	28.54	58.46
Nut wt.(g)	4.06-14.3	7.33	96.42	96.49	99.85	19.58	198.50
Kernel wt.(g)	3.59-1.32	2.12	59.16	59.73	98.08	3.03	120.69
Shelling (%)	24.6-32.55	30.59	26.72	26.83	99.19	15.74	54.83
Nut yield (kg $plant^{-1}$)	0.90-12.33	7.87	73.59	73.97	98.97	13.18	150.82

Character association

Correlation provides useful information for selection of characters in a breeding program. The results of correlation studies presented in Table 2 revealed that plant height had positive significant correlation with trunk girth, apple weight, nut weight, kernel weight and nut yield both at genotypic and phenotypic level. Trunk girth recorded significant positive association with shelling % while it recorded significant negative correlation with nut weight, kernel weight and nut yield at both the levels. Flowering laterals m^{-2} had significant positive correlation with the component traits *viz.* nut $panicle^{-1}$ (0.896 and 0.643), nut weight (1.276 and 0.559), kernel weight (1.077 and 0.495)

Table 2: Genotypic (below diagonal) and phenotypic (above diagonal)association among component characters of evaluated cashew genotypes.

Characters	PH	TG	FL/m^2	N/P	N/m^2	AW	NW	KW	SH%	NY
PH		-0.371*	0.736**	0.370*	-0.297NS	0.146NS	0.617**	0.631**	-0.582**	0.555**
TG	0.810**		-0.597**	-0.432*	0.201NS	0.131NS	-0.400*	-0.350NS	0.422*	-0.367*
FL/m^2	0.225^{NS}	0.065^{NS}		0.643**	0.043NS	-0.164NS	0.559**	0.495**	-0.569**	0.726**
N/P	0.123^{NS}	-0.316^{NS}	0.896**		0.568**	-0.489**	0.295NS	0.197NS	-0.335NS	0.713**
N/m^2	0.074^{NS}	-0.381*	1.044**	0.947**		-0.694**	-0.310NS	-0.437*	0.241NS	0.300NS
AW	0.471**	0.074^{NS}	-0.123^{NS}	-0.487**	-0.865**		0.363*	0.486**	-0.265NS	-0.169NS
NW	1.115**	-0.824**	1.276**	0.344^{NS}	-0.356^{NS}	0.371*		0.970**	-0.976**	0.734**
KW	1.080**	-0.648**	1.077**	0.209^{NS}	-0.471**	0.508**	0.979**		-0.905**	0.642**
SH%	-1.025**	0.886**	-1.263**	-0.392*	0.283^{NS}	-0.267^{NS}	-0.981**	-0.922**		-0.733**
NY	0.992**	-0.793**	1.660**	0.824**	0.337^{NS}	-0.171^{NS}	0.740**	0.649**	-0.741**	

*: Significant at 5% level, ** : Significant at 1% level.

PH: Plant height (m), TG: Trunk girth (cm), FL/M^2: Flowering laterals m^{-2}, N/P: Nuts panicle^{-1}, N/M^2: Nuts m^{-2}, AW: Apple weight (g), NW: Nut weight(g), KW: Kernel weight (g), SH%: Shelling %, NY: Nut yield (kg plant^{-1}).

Table 3: Direct and indirect effect of component traits on nut yield at phenotypic level.

Characters	PH	TG	FL/m^2	N/P	N/M^2	AW	NW	KW	SH%	Correlation with NY
PH	0.095	0.001	0.133	0.006	-0.139	-0.019	1.138	-0.175	-0.487	0.555**
TG	-0.035	-0.005	-0.108	-0.007	0.094	-0.017	-0.738	0.097	0.353	-0.367*
FL/m^2	0.069	0.003	0.181	0.011	0.020	0.021	1.032	-0.137	-0.476	0.726**
N/P	0.035	0.002	0.116	0.018	0.266	0.063	0.545	-0.054	-0.281	0.713**
N/m^2	-0.028	-0.001	0.007	0.010	0.468	0.090	-0.571	0.121	0.202	0.300^{NS}
AW	0.013	-0.001	-0.029	-0.009	-0.325	-0.130	0.669	-0.135	-0.222	-0.169^{NS}
NW	0.058	0.002	0.101	0.005	-0.145	-0.047	1.846	-0.269	-0.817	0.734**
KW	0.060	0.001	0.090	0.003	-0.204	-0.063	1.790	-0.278	-0.757	0.642**
SH%	-0.055	-0.002	-0.103	-0.006	0.113	0.034	-1.802	0.251	0.837	-0.733**

R=0.07426

PH: Plant height (m), TG: Trunk girth (cm), FL/M^2: Flowering laterals m^{-2}, N/P: Nuts panicle^{-1}, N/M^2: Nuts m^{-2}, AW: Apple weight (g), NW: Nut weight (g), KW: Kernel weight (g), SH%: Shelling %, NY: Nut yield (kg plant^{-1}).

and nut yield (1.660 and 0.726) both at genotypic and phenotypic level. A positive significant correlation was observed between nut panicle^{-1} with nuts m^{-2} (0.947 and 0.568) and nut yield (0.824 and 0.713) at both the levels. Nuts m^{-2} recorded positive non-significant correlation with nut yield (0.337 and 0.300) while apple weight exhibited significantly positive associated with nut weight (0.371 and 0.369) and kernel weight (0.508 and 0.486) both at genotypic and phenotypic level. Nut m^{-2} exhibited significantly negative association with apple weight (-0.865 and -0.694) and kernel weight (-0.471 and -0.437) at both levels. Nut weight recorded significantly positive association with kernel weight (0.979 and 0.970) and nut yield (0.740 and 0.734) both at phenotypic and genotypic level. Similarly, kernel weight (0.649 and0.642) was significantly positively associated with nut yield at both the levels. Nut yield recorded significant positive correlation with plant height (0.992 and 0.555), flowering laterals m^{-2} (1.660 and 0.726), nut panicle^{-1}(0.824 and 0.713), nut weight (0.740 and 0.734) and kernel weight (0.649 and 0.642) both at genotypic and phenotypic level during evaluation. Similar findings were reported by Faluyi (1987), Lenka *et al.* (2001) Samal *et al*. (2001), Ghatge *et al*. (2009), Dasmohapatra *et al*. (2012), Sethi *et al*. (2016), Vikram *et al*. (2016), Dadzie *et al*. (2020), Adu-Gyamfi *et al*. (2020), Sethi *et al*. (2020) and Jena *et al.* (2024) while working in cashew.

The association between yield and its nine component traits was further subjected to path analysis to partition into direct and indirect effect of the component traits on nut yield at phenotypic level (Table 3). Nut weight (1.846) had the highest positive direct effect on yield at phenotypic level followed by shelling % (0.837) and nut m^{-2}(0.486) while at genotypic level highest positive direct effect was recorded by kernel weight (1.091). Similarly, kernel weight (-0.278) exhibited highest negative direct effect at phenotypic level and nut weight (-0.562) at genotypic level.

Plant height recorded positive direct effect as well as positive significant correlation with mean annual nut yield (r=0.99) and it had negative indirect effect on shelling percentage at both genotypic and phenotypic level. Trunk girth (-0.135) and shelling % (-0.348) had negative direct effect and showed negatively significant correlation with nut yield (r=-0.79 and -0.74) genotypic level while trunk girth, apple weight and kernel weight had negatively direct effect on nut yield at phenotypic level. Apple weight had negative direct effect as well as non-significant correlated with nut yield at both levels. Nut panicle^{-1}(-0.441) and nut wt. (-0.562) had negatively direct effect on nut yield as well as positively significantly correlated with nut yield (r=0.82 and 0.74 respectively) at genotypic level while it had positive direct effect as well as positively correlated with nut yield at phenotypic level during evaluation.

Shelling % (0.837) had positive direct effect as well as negatively correlated with nut yield (-0.733) at phenotypic level. Trunk girth and apple weight exhibited negatively direct effect as well as negatively correlated with nut yield at both the levels. Kernel weight (-0.278) recorded highest negative direct effect as well as positively correlated with nut yield (0.642) at phenotypic level while it had exhibited highest positive direct effect with nut yield at genotypic level. Thus, it is evident from both direct and indirect effects of the characters at genotypic and phenotypic level reported similar results by Piria *et al*. (2001), Aliyu (2006), Abraham *et al.* (2007), Sethi *et al*. (2016), Toppo *et al*. (2017), Mandal S, (2018) and Sethi *et al*. (2020).

Performance of cashew genotypes

Data recorded on nut yield and various yield attributing characters presented in Table 4 and 5 revealed significant

Table 4: Yield attributing traits of evaluated cashew genotypes.

Genotype	Number of total laterals m^{-2}	Number of flowering laterals m^{-2}	Duration of flowering (days)	Sex ratio
B-27	20.12	16.87	50.50	0.11
C-30	19.06	16.72	54.00	0.19
D-19	19.06	17.31	58.50	0.15
C2-6	26.99	24.18	60.50	0.20
BH-105	23.27	18.40	54.00	0.12
Bhubaneswar-1	20.93	19.62	59.50	0.19
RP-1	19.62	19.00	57.50	0.21
RP-2	23.31	23.12	59.00	0.19
M-44/3	17.98	13.32	58.00	0.20
Kankadi	15.00	12.75	46.50	0.05
VTH-711/4	18.81	14.18	49.50	0.11
NRCC Sel.-2	22.30	21.11	57.50	0.12
H-320	18.33	16.87	55.00	0.09
Dhana	23.86	22.93	52.00	0.14
BPP-8	18.74	17.98	57.00	0.14
SEm (±)	1.68	2.13	2.85	0.01
CD (0.05)	5.09	6.46	8.62	0.05

Table 5: Yield attributing traits and nut yield of evaluated cashew genotypes.

Genotype	Nuts panicle^{-1}	Nut weight (g)	Nuts m^{-2}	Kernel weight (g)	Shelling %	Mean yield annual nut (kg plant^{-1})	Cumulative nut yield (kg plant^{-1}) for 6 harvest
B-27	4.35	7.15	21.50	2.25	32.50	5.74	22.68
C-30	6.35	6.45	34.81	2.01	30.50	9.06	29.54
D-19	7.40	8.61	26.66	2.78	30.34	10.72	35.36
C2-6	5.75	8.62	35.28	2.38	30.65	12.33	40.73
BH-105	8.25	6.69	34.42	2.14	30.58	9.35	29.17
Bhubaneswar-1	7.80	5.46	39.06	1.71	31.55	7.04	25.79
RP-1	9.50	4.46	47.85	1.40	31.40	9.23	26.99
RP-2	10.50	4.06	61.43	1.32	32.55	9.78	31.07
M-44/3	5.60	5.10	26.15	1.55	30.45	5.38	20.81
Kankadi	1.25	14.30	1.30	3.52	24.60	0.90	3.73
VTH-711/4	2.00	12.40	2.25	3.59	29.20	1.14	6.43
NRCC Sel.-2	5.75	7.50	26.68	2.34	31.80	9.21	25.95
H-320	4.87	7.27	24.00	1.50	28.50	5.38	15.84
Dhana	4.45	7.72	31.11	1.90	29.68	10.36	32.63
BPP-8	7.25	7.65	25.37	1.93	30.22	10.64	32.96
SEm (±)	0.76	0.24	6.77	0.14	0.48	0.48	-
CD (0.05)	2.32	0.72	20.50	0.43	1.48	1.46	-

variations during the period of evaluation. Number of total laterals (26.99) and flowering laterals m^{-2}(24.18) were recorded maximum in genotype, C2-6. Sex ratio was recorded maximum in genotype RP-1(0.21) while minimum was recorded in genotype, Kankadi (0.05). Duration of flowering was recorded maximum in genotype, C2-6(60.50 days) and the minimum duration was observed in genotype, Kankadi (46.50 days). Nuts m^{-2} (61.43) and nuts panicle^{-1} (10.50) were recorded maximum in genotype RP-2. The minimum value for nuts m^{-2} and nuts panicle^{-1} were recorded in genotype, Kankadi (1.3 and 1.25 respectively). The shelling was recorded maximum in genotype, RP-2 (32.55%) followed by B-27 (32.50) and D-19 (30.34%) which were statistically at par. The minimum shelling was recorded in genotype Kankadi (24.6%). Apple wt. was recorded maximum in genotype VHT-711/4 (75 g) followed by Kankadi (72.25 g). The minimum apple weight was recorded in genotype, M-44/3 (31.7 g). Genotype, Kankadi recorded maximum nut weight (14.3 g) while the minimum was recorded in genotype RP-2 (4.06 g). The mean annual nut yield and cumulative were recorded maximum for the genotype C2-6 among the fifteen evaluated cashew genotypes. Genotype, C2-6 recorded significantly maximum mean annual nut yield (12.33 kg plant^{-1}) and cumulative nut yield (40.73 kg plant^{-1}) at 6th harvest during evaluation. Similar variations with regard to flowering laterals m^{-2}, nuts per panicle, nut weight, kernel weight, apple weight and shelling % were reported by Chandrasekhar *et al.* (2018a,b), Gajbhiye *et al*. (2015), Tripathy *et al*. (2015), Hore *et al.* (2015), Venkataramana *et al.* (2015), Mohapatra *et al.* (2017), Poduval *et al.* (2015), Roy *et al.* (2018) and Sahoo *et al.* (2020).

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CONCLUSION

Estimation of variability revealed that high GCV, PCV, heritability, genetic advance and genetic advance (as % mean) were recorded in characters *viz.* shelling %, nut yield, kernel weight, nuts m^{-2} and mean annual nut yield. Nut weight (1.846) had the highest positive direct effect on nut yield at phenotypic level followed by shelling % (0.837) and nut m^{-2} (0.486). The genotype C2-6 recorded (13.70%) higher yield than the check genotype BPP-8 (10.64 kg plant^{-1}) at 6th harvest among the tested cashew genotypes.

Conflict of interest

The authors declare that they have no conflict of interest.

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