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RESEARCH ARTICLE

GENETIC PARAMETERS STUDIES FOR YIELD ATTRIBUTES IN MORINGA GENOTYPES (*Moringa oleifera* Lam.)

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ABSTRACT

Moringa (*Moringa oleifera* Lam.) is given great importance as a vegetable. The leaves, pods and flowers of this tree are used exclusively as nutritious food. The present trend in crop improvement programmes is the development of high yielding cultivars to boost the productivity and profitability. This experiment was conducted with 20 genotypes of drumstick in the randomized block design (RBD) with three replications during 2018-19 at Pt. K.L.S. College of Horticulture and Research Station, Rajnandgaon (C.G.).Genetic parameters studies for variability, correlation and path coefficients analysis of twenty genotypes of Moringa for twelve yield attributes revealed that the characters leaf length, number of pod per plant, plant height, pod girth, number of branches per plant and number of seeds per pod showed high GCV and high heritability along with high genetic advance and these characters are controlled by additive gene. The study of path analysis indicated that the direct selection of number of leaves per rachis, number of branches per plant, number of pods per plant, number of flower per inflorescence, stem girth, leaf length and plant height could be used as selection criteria for improvement. Association analysis revealed that selection criteria based on number of branches per plant, length of pod, leaf length, pod girth and number of pod per plant, pod weight and plant height can provide better result for improvement of pod yield in Moringa.

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INTRODUCTION

Moringa (*Moringa oleifera* Lam.) belongs to the family Moringaceae. The leaves, pods and flowers of this tree are used exclusively as a highly nutritious food. It is a fast-growing and drought-tolerant tree and can be effectively adjusted for various environmental and farming conditions. Drumstick is also known as 4F Plant (food, fodder, fuel and fertility). In hindi, Moringa is also called Sahjan or Munaga. The present trend in crop improvement programmes is the development of high yielding cultivars to boost the productivity and profitability. To meet all the requirements of successful variety, it is necessary to be familiar with the detailed genetic structure of the selected material to be used for varietal development programme. Genetic variability among the parents is a prerequisite to select better segregates for various economic characters (Khanna and Mishra, 1977). Genetically diverse genotypes used as parents for hybrid breeding may lead to development of heterotic cross combinations.

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Knowledge of correlations is equally important in plant breeding for simultaneous and/or indirect improvement of characters that are difficult to quantify especially for those traits, which exhibit low heritability. Therefore, it is essential to make preliminary investigation of the characters of the lines to be used for the development of superior variety. In the light of the above, present investigation were undertaken to study the genetic variability, correlation among different traits and path analysis in Moring genotypes to facilitate the selection of suitable superior genotypes for standard cultivar breeding programmes.

MATERIALS AND METHODS

This experiment was conducted with 20 genotypes of drumstick (Table 1) in the randomized block design (RBD) with three replications during 2018-19 at Pt. K.L.S. College of Horticulture and Research Station, Rajnandgaon (C.G.). Every genotype was planted with 2.5 meter X 1.5 meter spacing. All the recommended cultivation practices were followed to raise a good crop. The statistical analysis was done according to the methods of Ostle (1966) for the analysis of variance, Burton (1952) for genetic coefficients of variation, Allard (1960) for

heritability in broad sense and Johnson *et al.* (1955) for genetic advance. Correlation coefficients were calculated for by the method described by Al-jibouri *et al.* (1958) and path coefficients according to Wright (1921).

Table 1. Promising Lines of Moringa Germplasm

Treatment	Genotype	Place of Collection
T_1	M 2	Rajnandgaon
T_2	M 8	Raigarh
T_3	M 12	Kawardha
T_4	M 20	Rajnandgaon
T_5	M 41	Dhamtari
T_6	M 58	Bilaspur
T_7	M 66	Bemetra
T_8	M 79	Raipur
T_9	M 85	Janjgir -Champa
T10	M 104	Bastar
T11	M 114	Gujrat
T12	M 142	Balod
T13	M 149	Rajnandgaon
T14	M 154	Rajnandgaon
T15	M 175	Mahasamund
T16	M 181	Rajnandgaon
T17	M 204	Sarguja
T18	M 219	Koria
T19	M 234	Tamil Nadu
T20	Check	PKM-1 (TNAU, Coimbatore)

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the genotypes for all the traits under study. In general, phenotypic coefficients of variation were higher than genotypic coefficients of variation indicating that the genotypic influence is lessened under the influence of given environment (Table 2). A close correspondence between GCV and PCV varies in respect of all the character indicated that environment has very little influence on the expression of the characters under study. The estimates of heritability (broad sense) for all the characters were high showing that the genotypes under study have a great scope for the selection based on these characters.

Table 2. Genetic variability studies in Drumstick genotypes

Characters	Mean	Range		GCV%	PCV%	h^2% (bs)	Genetic Advance	GA as % of mean
		Min	Max					
Plant height (m)	4.37	2.30	7.52	37.39	37.49	99.48	3.36	76.83
Number of branches per plant	14.29	8.24	22.54	30.27	31.91	89.96	8.45	59.14
Stem girth (cm)	21.27	13.81	28.28	20.80	24.70	70.89	7.67	36.07
Leaf length (cm)	35.30	16.44	62.04	39.70	40.81	94.62	28.08	79.55
Number of leaves per rachis	48.72	21.63	78.34	28.38	37.82	56.33	21.38	43.89
Length of leaf rachis (cm)	13.85	8.73	18.34	19.24	23.14	69.14	4.56	32.96
Number of flowers per inflorescence	29.51	12.89	42.67	27.31	30.61	79.57	14.81	50.18
Length of pod (cm)	47.43	18.61	67.21	29.64	30.74	92.96	27.92	58.87
Pod girth (cm)	7.88	3.55	12.86	35.10	37.53	87.47	5.33	67.63
Pod weight (g)	30.87	21.97	40.00	13.35	21.76	37.65	5.21	16.88
Number of pods per plant	61.39	18.91	98.05	37.62	39.10	92.59	45.79	74.58
Number of seeds per pod	15.39	7.86	23.85	30.25	33.62	80.99	8.63	56.09
Pod yield per plant (kg)	2.56	1.56	3.56	21.65	26.55	66.54	0.93	36.39

High values of GCV and heritability estimates supplemented with greater gains are also indicates additive gene effects regulating the inheritance such traits (Narayan *et al*., 1996). High degree of genotypic (GCV) and phenotypic coefficient of variations (PCV) were recorded for traits *viz* for leaf length, number of pod per plant, plant height, pod girth, number of branches per plant and number of seeds per pod suggested the substantial improvement on drumstick through selection for these traits. Related result was also reported by Prasanthi (2004) and Kumawat *et al.* (2005). Estimates of heritability and genetic advance provide information about the heritable portion and genetic gain expected in the next generation, hence it is desirable to consider these estimates. High heritability with high genetic advance was observed for leaf length, length of pod, number of pods per plant, number of flower per inflorescence and number of leaves per rachis indicated that the additive gene action is involve for these traits. Johnson *et al.* (1955) has also suggested that characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance. These findings are in accordance with the reports of Sharma *et al.* (2007) and Choudhary *et al.* (2010).

The genotypic and phenotypic correlation studies for pod yield and its component in drumstick are presented in Table 3. The genotypic correlation was higher than the phenotypic correlation coefficients indicating the strong association between two characters genetically, but the phenotypic correlation value is lessened by the significant interaction of environment. In present research, yield per plant exhibited the maximum significant positive correlation with number of leaves per rachis, number of branches per plant, number of pods per plant, number of flower per inflorescence, stem girth and leaf length, whereas yield per plant showed negative and highly significantly correlation with plant height. Similar finding was also reported by Venkatesan (2003) and Singh *et al.*(2004). Plant height showed positive association with number of seeds per pod. While, it is highly significantly negatively correlated with number of branches per plant and number of leaves per rachis, which is in agreement with the findings of by Lal *et al.* (2007). Number of branches per plant were found to be positively associated with number of pods per plant, number of flower per inflorescence, length of leaf rachis, number of leaves per rachis, leaf length and stem girth. Stem girth showed significant and positive correlated with number of pods per plant. These results are in accordance with the findings of Patil *et al.* (2005).

Table 3. Correlation coefficients studies between various yield traits of Drumstick genotypes

Character		Plant height (mt.)	Number of branches/ Plant	Stem Girth (cm)	Leaf length (cm)	Number of leaves per rachis	Length of leaf rachis (cm.)	Number of flower per Inflorescence	Length of pod (cm.)	Pod girth (cm.)	Pod weight (gm)	Number of pods per plant	Number of seeds per pod	Pod yield per plant (kg.)
Plant height (mt.)	P	1.000	-0.562**	-0.256	-0.396	-0.670**	-0.360	-0.366	0.174	-0.186	-0.100	-0.344	0.470*	-0.567**
	G	1.000	-0.588**	-0.305	-0.405	-0.738**	-0.433	-0.417	0.182	-0.193	-0.136	-0.359	0.522*	-0.694**
Number of branches/plant	P		1.000	0.523*	0.460*	0.811**	0.450*	0.593**	0.009	-0.070	-0.112	0.755**	-0.118	0.776**
	G		1.000	0.605**	0.506*	0.942**	0.631**	0.689**	0.002	-0.065	-0.235	0.829**	-0151	0.935**
Stem girth (cm.)	P			1.000	0.116	0.420	0.158	0.277	0.060	-0.026	0.099	0.492*	-0.030	0.397
	G			1.000	0.139	0.508*	0.234	0.334	0.078	-0.013	0.312	0.61**	-0.032	0.668**
Leaf length (cm.)	P				1.000	0.587**	0.627**	0.147	0.003	0.014	-0.121	0.237	0.024	0.459*
	G				1.000	0.668**	0.791**	0.158	0.010	-0.001	-0245	0.262	0.038	0.601**
Number of leaves per rachis	P					1.000	0.564**	0.441*	-0.072	0.068	-0.027	0.611**	-0.202	0.674**
	G					1.000	0.778**	0.528*	-0.112	0.125	-0.144	0.697**	-0.240	0.949**
Length of leaf rachis (cm.)	P						1.000	-0.030	-0.033	0.128	-0.197	0.199	-0.152	0.368
	G						1.000	0.013	-0.057	0.116	0.351	0.282	-0.163	0.526*
Number of flower per	P							1.000	0.214	-0.168	- 0.154	0.693**	-0.005	0.558*
inflorescence	G							1.000	0.237	-0.020	-0.23	0.781**	0.04	0.800**
Length of pod (cm.)	P G								1.000	-0.696**	-0.137	-0.070	0.737**	-0.010
									1.000	-0.741**	-0.228	-0.067	0.84**	0.016
Pod girth (cm.)	P									1.000	0.077	-0.021	-0.578**	-0.038
	G									1.000	0.105	-0.011	-0.673**	-0.056
Pod weight (g.)	P										1.000	0.011	-0.262	0.005
	G										1.000	0.092	-0.255	0.016
Number of pods per plant	P											1.000	-0.187	0.756**
	G											1.000	-0.215	0.909**
Number of seeds per pod	P												1.000	-0.123
	G												1.000	-0.201
Yield per plant (kg.)	P													1.000
	G													1.000

* Significant at 5% level,** Significant at 1% levelP Phenotypic,G Genotypic

Table 4. Path coefficient analysis for various characters in Drumstick

Characters	Plant height (mt.)	No. of branches / plant	Stem girth (cm.)	Leaf length (cm)	Number of leaves per rachis	Length of leaf rachis (cm.)	Number of flowers per inflorescence	Length of pod (cm.)	Pod girth (cm)	Pod weight (g.)	Number of pods per plant	No. of seeds per pod	Pod Yield per plant (Kg.)
Plant height (m)	-0.356	-3.198	0.289	-0.709	1.744	1.107	0.942	0.352	-0.233	-0.036	-0.165	-0.43	-0.694**
Number of branches per plant	0.209	5.444	-0.574	0.885	-2.227	-1.613	-1.558	0.003	-0.078	-0.063	0.383	0.124	0.935**
Stem girth (cm)	0.108	3.292	-0.949	0.242	-1.201	-0.598	-0.755	0.150	-0.015	0.084	0.281	0.026	0.668**
Leaf length (cm)	0.144	2.753	-0.131	1.751	-1.578	-2.022	-0.357	0.019	-0.001	-0.066	0.120	-0.031	0.601**
Number of leaves per rachis	0.262	5.130	-0.482	1.169	-2.364	-1.990	-1.193	-0.216	0.151	-0.039	0.322	0.198	0.949**
Length of leaf rachis (cm)	0.154	3.435	-0.222	1.385	-1.840	-2.556	-0.030	-0.109	0.140	-0.095	0.130	0.134	0.526**
Number of flowers per inflorescence	0.148	3.752	-0.317	0.227	-1.247	-0.340	-2.260	0.459	-0.242	-0.062	0.360	-0.032	0.800**
Length of pod (cm)	-0.064	0.010	-0.73	0.018	0.263	0.144	-0.535	1.938	-0.898	-0.061	-0.030	-0.693	0.016
Pod girth (cm)	0.0.68	-0.351	0.012	-0.002	-0.294	-0.296	0.451	-1.435	1.212	-0.028	-0.005	0.555	-0.056
Pod weight (g)	0.048	-1.276	-0.296	-0.428	0.341	0.897	0.520	-0.442	0.127	0.271	0.042	0.210	0.016
Number of pods per plant	0.127	4.513	-0.579	0.458	-1.647	-0.720	-1.764	-0.129	-0.013	0.025	0.461	0.177	0.909**
Number of seeds per pod	-0.185	-0.823	0.030	0.065	0.567	0.416	-0.089	1.628	-0.816	-0.069	-0.099	-0.825	-0.201

Residual value: 0.3008Diagonal and bold underline figures shows direct effect on fruit yield

Leaf length showed significant positive association with length of leaf rachis and number of leaves per rachis at genotypic level and phenotypic levels. Number of leaves per rachis had a significant positive association with length of leaf per rachis number of pods per plant and number of flower per inflorescence. Number of flower per inflorescence exhibited an important positive association with number of pod per plant at genotypic and phenotypic level. Similar result were also reported by and Suganthi and Murugan (2008) and Karunakar *et al.* (2018). Length of pod showed highly significant positive association with number of seeds per pod), whereas it showed negative significant correlation with pod girth at genotypic and phenotypic level. Pod girth showed highly significant negative correlation with number of seeds per pod, which is similar to the findings of Lal *et al.* 2007. On the basis of association analysis studies, it can be concluded that the selection criteria based on number of leaves per rachis, number of branches per plant, number of pods per plant, number of flower per inflorescence, stem girth, leaf length and plant height can provide better result for improvement of pod yield in drumstick.

Path coefficient analysis of different characters (Table 4) contributing towards pod yield per plant revealed that number of branches per plant, length of pod, leaf length, pod girth and number of pod per plant expressed high positive direct effect on pod yield per plant, whereas, lowest positive direct effect on pod yield per plant was observed for pod weight. Among the negative direct effects, stem girth, no of seed per pods, plant height and length of leaf rachis showed high negative direct effect on pod yield per plant, whereas lowest negative direct effect on pod yield per plant was observed for number of leaves per rachis. Positive direct effect of various characters on pod yield per plant observed in the present study are according to the findings of Choudhary and Sharma (2003), Mittal and Singh (2005), Saini *et al.* (2005) and Lal *et al.* (2007). The study of path analysis indicated that the direct selection of number of branches per plant, length of pod, leaf length, pod girth and number of pod per plant, pod weight and plant height could be used as selection criteria for improvement.

Conclusion

Analysis of variance revealed significant differences among the genotypes for all the traits under study. High degree of genotypic (GCV) and phenotypic coefficient of variations (PCV) were recorded for traits *viz* for leaf length, number of pod per plant, plant height, pod girth, number of branches per plant and number of seeds per pod suggested the substantial improvement on drumstick through selection for these traits. High heritability with high genetic advance was observed for leaf length, length of pod, number of pods per plant, number of flower per inflorescence and number of leaves per rachis indicated that the additive gene action is involve for these traits. On the basis of association analysis studies, it can be concluded that the selection criteria based on number of leaves per rachis, number of branches per plant, number of pods per plant, number of flower per inflorescence, stem girth, leaf length and plant height can provide better result for improvement of pod yield in drumstick.

The study of path analysis indicated that the direct selection of number of branches per plant, length of pod, leaf length, pod girth and number of pod per plant, pod weight and plant height could be used as selection criteria for improvement.

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