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Evaluation of mulberry germplasm for growth and yield contributing characters under sub-tropical conditions of Northern India

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Abstract

Information on the nature and magnitude of genetic variability and heritability of different characters would be highly important for initiation of any mulberry breeding programme. The present study was carried out to estimate the genetic variability, heritability and genetic advance of growth and yield contributing characters in 18 mulberry genotypes at Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu during Autumn, 2019. Analysis of variance for growth and yield contributing characters showed highly significant differences among the genotypes. Phenotypic coefficient of variation was found to be higher than the corresponding genotypic coefficient of variation for all the characters indicating the role of environment in the expression of characters. High heritability coupled with high genetic advance as per cent of mean was observed for number of leaves per meter, internodal distance, leaf area, diameter of shoot, total shoot length, weight of 10 fresh leaves, leaf moisture retention capacity and leaf yield per plant indicating that variation in these traits was most likely due to additive gene effect. The directional selection would be effective to improve these characters. Therefore, number of leaves per meter, internodal distance, leaf area, diameter of shoot, total shoot length, weight of 10 fresh leaves and leaf yield per plant can be considered as selection criterion during mulberry improvement for leaf yield.

Keywords: Heritability, mulberry, genetic advance, variability, leaf yield

Introduction

Mulberry is a perennial crop grows throughout the year. Mulberry is a fast growing deciduous woody perennial plant, normally cultivated as bush or dwarf tree by repeated pruning. It has a tap root system with minimum superficial roots, good coppicing power and is tolerant to lopping and pruning (Koul *et al*., 1980) [1]. Quality and quantity of silk production is directly related with the production high quality mulberry leaves. The silkworm rearing is carried throughout the year. Mulberry leaf yield is a complex character jointly contributed by a good number of component characters and is highly influenced by different genotypes.

The extent of magnitude of genetic variability in the mulberry germplasm helps in the crop improvement through conventional breeding. Genetic variability is the pre-requisite for initiation of any crop improvement programme including mulberry and selection acts upon the variability which is present in the genotypes. The precise information on the nature and degree of genetic diversity helps the plant breeder in choosing the diverse parents for purposeful hybridization. The extent of magnitude of genetic variability in the mulberry germplasm helps in the crop improvement through conventional breeding (Magadum and Singh, 2021) [2]. Prior knowledge of genetics on yield contributing traits is very essential to formulate a breeding strategy of mulberry. Therefore, the present study was undertaken to know extent of genetic variability, heritability and genetic advance for different growth and yield contributing characters among mulberry germplasm under sub-tropical conditions of Northern India.

Materials and Methods

The present study was conducted at Regional Sericultural Research Station, Central Silk Board, CSB Complex, Miran Sahib, Jammu during Spring, 2019. The experimental material comprised of 18 mulberry genotypes *viz*., V-1, K-2, Sujanpur local, TR-10, Chak Majra, Chinese white, S-146, C-4, BR-2, AR-14, AR-12, AR-10, S-41, S-13, BC-259, S-1, MS-9404 and S-1635 maintained at a spacing of 90 cm x 90 cm as bush plantation in randomized block design at mulberry germplasm block of the station and managed by following the recommended agronomic package of practices.

The data on quantitative traits like number of new shoots per plant, longest shoot length (cm), number of leaves per meter of shoot length, internodal distance (cm), leaf area (cm^2), diameter of shoot (cm), total shoot length per plant (cm), weight of 10 fresh leaves (g) and leaf yield per plant (kg) were recorded from randomly sampled three replications. The genotypes were evaluated after 60th day after pruning for growth and yield parameters. The mean data of the above mentioned traits were statistically analyzed, using the standard method suggested by Clewer and Scarisbrick (2001) [3], using TNAUSTAT statistical package. Analysis of variance (ANOVA) was done by the method suggested by Panse and Sukhatme (1985) [4]. The phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) was estimated as suggested by Burton and De vane (1953) [5]. Heritability and genetic advance were calculated by following Lush *et al.* (1945) [6] and Johnson *et al.* (1955) [7] respectively.

Results and Discussion

The analysis of variance among 18 mulberry genotypes indicated highly significant differences among them for all the growth and yield contributing characters indicating presence of sufficient amount of variability in respect of all the traits studied (Table 1). The genotypic differences were significant at P=0.01. Similar results are reported by Biradar *et al.* (2015) [8], Saini *et al.* (2018) [9], Chanotra *et al.* (2019) [10] and Magadum and Singh (2021) [2].

The variability and genetic estimates for growth and yield contributing characters are presented in Table 2. Analyzed data indicated the presence of wide range of variability for all the characters studied. Maximum range of variation was observed for total shoot length (540 cm to 6460 cm) followed by leaf area (141.7 cm^2 to 381.8 cm^2) and longest shoot length (133 cm to 300 cm). Similar results were reported by Murthy *et al*. (2010) [11], Saini *et al*. (2018) [9] and Magadum and Singh (2021) [2]. The wide range of variation obtained may be due to divergent genotypes included in the study. The presence of such wide variability in mulberry with respect to all the traits indicating that significant variation existed among the genotypes.

The genotypic variance measures the magnitude of genetic variability present in the crop and phenotypic variance indicates the amount of variation which is due to the phenotypic values. The estimated phenotypic variance for all the traits was higher than genotypic variance. Higher variance was observed for total shoot length followed by leaf area and longest shoot length which indicates the presence of high environmental influence on these characters. Similar kind of results were also reported by Murthy *et al*. (2010) [11], Suresh *et al.* (2017) [12], Saini *et al*. (2018)[9] and Magadum and Singh (2021) [2].

Yield being a quantitative character is influenced by many genes and are highly controlled by environmental factors. Observed variability is the sum total of hereditary effects from concerned genes as well as the environment. Hence the variability is partitioned into heritable and non-heritable components with suitable genetic parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA). These genetic parameters help the breeders in selection of genotypes and crop improvement (Magadum and Singh, 2021) [2].

The phenotypic coefficient of variation was also found to be higher than genotypic coefficient of variation for all the characters studied. High level of phenotypic and genotypic coefficient of variation (>20%) was observed for number of new shoots per plant, total shoot length, weight of 10 fresh leaves and leaf yield per plant indicated that these traits are governed by genetic factors and existence of greater magnitude of genetic variability among the genotypes and selection will be rewarded for the improvement of these traits. Whereas, moderate PCV and GCV (<20%) was recorded for longest shoot length, number of leaves per meter of shoot length, internodal distance, leaf area and diameter of shoot indicated high influence of environment than genetic factors and selection for these traits will be less effective. These results are in line with the observations made by Biradar *et al.* (2015) [8], Suresh *et al.* (2017) [12], Saini *et al*. (2018) [9] and Magadum and Singh (2021) [2].

The selection efficiency was higher when the parameters had higher heritability. The heritability estimates (broad sense) was ranged from 26-86%. All the characters studied had high heritability estimates (64-86%) except longest shoot length (26%) which exhibited moderate level of heritability. Occurrence of high heritability for all the characters studied suggests the influence of additive gene effects and indicated high rate of trait transmissibility into the future generations. Hence, simple phenotypic selection for these characters may lead to fast genetic improvement. These findings are in line with results of Biradar *et al.* (2015) [8], Suresh *et al.* (2017) [12], Saini *et al*. (2018) [9] and Magadum and Singh (2021) [2].

For heritability estimates to be reliable, it must be in conjunction with high genetic advance as a reliable index for selection of traits. Johnson *et al*. (1955) [7] have proved that heritability estimates along with genetic gain is more useful than heritability alone in predicting the resultant effects of selection. Earlier studies in mulberry also stated that certain quantitative traits having high heritability as well as genetic advance respond better to simple phenotypic selection as they contribute to additive gene action, which will aid in effective selection for aiding genetic improvement of quantitative traits in mulberry (Magadum and Singh, 2021) [2].

High heritability coupled with high genetic advance as per cent of mean was observed for number of leaves per meter, leaf area, internodal distance, diameter of shoot, total shoot length, weight of 10 fresh leaves and leaf yield per plant indicating the prevalence of additive gene action in the expression of these traits and effective progress in improvement through selection could be achieved for leaf yield. Whereas, moderate heritability coupled with high genetic advance as per cent of mean was observed for number of new shoots per plant indicated the presence of intra and inter allelic interactions in the expression of these characters. These results are in agreement with the findings of Biradar *et al*. (2015) [8], Suresh *et al*. (2017) [12], Saini *et al*. (2018) [9] and Magadum and Singh (2021) [2] in mulberry.

Table 1: Analysis of variance for growth and yield contributing characters in mulberry germplasm

Source of variation	df	Number of new shoots/ plant	Longest shoot length (cm)	Number of leaves / meter	Internodal distance (cm)	Leaf area (cm^2)	Diameter of shoot (cm)	Total shoot length (cm)	Weight of 10 fresh leaves (g)	Leaf moisture content (%)	Leaf moisture retention capacity (%)	Leaf yield/ plant (kg)
Replication	2	11.24	120.40	0.79	0.05	1131.22	0.12	139459.6	0.66	3.81	23.13	0.05
Treatments	17	87.54**	2543.80*	23.01**	1.24**	6226.29**	1.55**	5614639**	131.38**	27.41**	305.93**	0.98**
Error	34	12.45	1225.52	1.13	0.06	610.01	0.08	402447.1	11.55	4.23	19.03	0.07
CD at 5%		5.85	58.09	1.76	0.42	40.98	0.48	1052.66	5.64	3.41	7.24	0.45

*&** indicates significant at 5% and 1% level of probability, respectively.

Table 2. Genetic parameters for growth and yield contributing characters in mulberry germplasm

Sl No.	Characters	Mean ± SEm	Range		σ^2p	σ^2g	σ^2e	PCV (%)	GCV (%)	h^2 (%)	Genetic advance	GA as % of mean
			Minimum	Maximum								
1	Number of new shoots/plant	13.81±2.03	4	29	37.48	25.03	12.46	44.32	36.21	66.77	8.42	60.96
2	Longest shoot length (cm)	222.44±20.21	133	300	1664.95	439.43	1225.52	18.34	9.42	26.39	22.18	9.97
3	Number of leaves/ meter	20.57±0.61	15	29	8.42	7.29	1.13	14.11	13.13	86.59	5.17	25.16
4	Internodal distance (cm)	4.96±0.14	3.45	6.67	0.46	0.39	0.06	13.60	12.60	85.84	1.19	24.05
5	Leaf area (cm^2)	273.58±14.26	141.7	381.8	2482.12	1872.09	610.03	18.21	15.82	75.42	77.41	28.29
6	Diameter of shoot (cm)	3.98±0.17	3	6.5	0.58	0.49	0.09	19.07	17.58	84.99	1.33	33.38
7	Total shoot length (cm)	2609.94±366.26	540	6460	2413027.56	1804124.68	608902.88	58.69	50.74	74.77	2392.50	90.39
8	Weight of 10 fresh leaves (g)	36.16±1.96	20	52	51.49	39.94	11.55	19.84	17.48	77.57	11.46	31.71
9	Leaf moisture content (%)	72.17±1.18	0.208	2.45	11.96	7.73	4.23	4.79	3.85	64.61	4.60	6.38
10	Leaf moisture retention capacity (%)	70.66±2.52	65.06	79.84	143.23	119.48	23.75	16.46	15.04	83.42	20.56	28.29
11	Leaf yield/plant (kg)	1.16±0.16	40.67	90.81	0.51	0.35	0.16	59.59	49.39	68.72	1.01	84.35

σ^2p = Phenotypic variance; σ^2g = Genotypic variance; σ^2e = Environmental variance; PCV = Phenotypic coefficient of variation; GCV = Genotypic coefficient of variation; h^2 = Heritability (Broad sense); GA = Genetic advance

Conclusion

The present study indicated that there is adequate genetic variability present in the genotypes studied. High heritability along with high genetic advance as per cent of mean was observed for number of leaves per meter, number of new shoots per plant, leaf area, total shoot length, weight of 10 fresh leaves and leaf yield per plant suggested that these characters can be considered as selection criterion during selection of parents for improvement and development of promising mulberry genotypes through successful breeding programmes.

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