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Correlation and path coefficient analysis of growth and yield contributing characters in mulberry (*Morus* spp.) under North West India

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Abstract

The present study was carried out to assess the correlation and path coefficient analysis 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. Correlation analysis revealed that leaf yield per plant was positive and significantly associated with number of new shoots per plant, longest shoot length, number of leaves per meter, diameter of shoot, total shoot length and weight of 10 fresh leaves. Further, number of new shoots per plant, number of leaves per meter, internodal distance, leaf area, total shoot length and weight of 10 fresh leaves had a high direct effect on the leaf yield per plant and these traits can be used for indirect selection. Therefore, number of new shoots per plant, longest shoot length, number of leaves per meter, leaf area, total shoot length and weight of 10 fresh leaves may be given more emphasis during selection in mulberry improvement programme.

Keywords: Correlation, path coefficient, leaf yield, mulberry, selection

Introduction

Sericulture is an important and highly remunerative agro-based occupation of resource poor farmers of the world playing a major role in poverty alleviation by providing employment. Mulberry is a fast growing deciduous woody perennial plant, normally cultivated as bush or dwarf tree by repeated pruning. The productivity and profitability in sericulture solely depends on the quality and yield of mulberry leaves. Mulberry leaf yield is a complex character jointly contributed by a good number of component characters and is highly influenced by different genotypes. The yield as such may not be the best criterion for selection and it is therefore, important to study the genetics of yield components and the degree of their association with yield. Developing a variety, that performs equally well under different environmental conditions is a great challenge to plant breeders. Suitable parent material needs to be identified from large number of germplasm accessions for the purpose (Terefe *et al*., 2018) [1].

Breeding programes to develop high yielding varieties depends on the nature and magnitude of variation in available genotypes or population. Mulberry improvement for leaf yield is possible through selection for desired component traits. Therefore knowledge of the interrelationships among various traits and also their direct and indirect contribution toward yield is necessary, to design appropriate selection criteria in mulberry breeding programme (Vijayan *et al*., 2012) [2]. Correlation coefficient analysis provides information about the degree of relationship between important component traits and when higher numbers of variables are considered in correlation, the interrelationship becomes more complex (Dewey and Lu, 1959) [3]. Use of path coefficient analysis would be more appropriate as it reveals direct and indirect associations and identifies the most reliable yield-contributing traits. Evaluation of any crop is a continuous process to evolve new varieties suitable for specific zones for commercial utilization. Hence, the present study was undertaken to determine the relationship among yield contributing characters and their association with leaf yield.

Materials and Methods

The present study was conducted at Regional Sericultural Research Station, Central Silk Board, CSB Complex, Miran Sahib, Jammu during Autumn, 2019. The experimental material comprised of 18 elite 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 60^{th} day after pruning for growth and yield parameters. The mean data of growth and yield traits were statistically analyzed using TNAUSTAT statistical package. Analysis of variance (ANOVA) was done by the method suggested by Panse and Sukhatme (1985) [4].

Results and Discussion

For any genetic improvement programme in crop plants, the availability of large genetic stocks representing diverse genotypes is a pre requisite. 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) [5], Saini *et al*. (2018) [6], Chanotra *et al*. (2019) [7] and Magadum and Singh (2021) [8].

Phenotypic correlations are estimated directly from values measured in the field and only the genetic portion of it is used to guide breeding programs. Correlation studies enable to quantify indirect gains due to selection on correlated traits, and also to evaluate the complexity of the traits (Tiwari and Upadhyay, 2011) [9]. Correlations are measures of the intensity of interrelationships between traits, whereby selection for a trait results in progress for other positively associated traits. Correlation analysis among yield and its contributing traits are shown in table 2. Correlation among all the yield attributing characters revealed substantial differences between phenotypic and genotypic correlations. Significant correlation of characters suggested that there is much scope for direct and indirect selection for further improvement. Genotypic correlation coefficient provides measures of genetic association between traits and helps to identify the more important as well as less important traits to be considered in breeding program (Tiwari and Upadhyay, 2011) [9]. The magnitude of genotypic correlations was higher than their corresponding phenotypic correlations. This can be interpreted as a strong inherent genotypic relationship between characters studied, though their phenotypic expression was impeded by environmental factors. The present findings are in conformity with Dar *et al.*, (2011) [10], Al-Aysh *et al.*, (2012) [11], Souza *et al.*, (2012) [12], Tasisa *et al.*, (2012) [13], Suresh *et al.*, (2017) [14] and Saini *et al*. (2018) [6].

Leaf yield per plant was positively and significantly correlated with number of new shoots per plant, longest shoot length, number of leaves per meter, diameter of shoot, total shoot length and weight of 10 fresh leaves at both phenotypic and genotypic level. Similarly, Doss *et al.,* (2012) [15], Biradar *et al*. (2015) [5], Suresh *et al*. (2017) [14] and Saini *et al*. (2018) [6] reported leaf yield per plant association with other quantitative traits in mulberry. Whereas, leaf yield per plant was negatively and significantly correlated with internodal distance and leaf moisture content and similar results have been reported by Suresh *et al*. (2017) [14]. Weight of 10 fresh leaves showed positive and significant correlation with number of new shoots per plant, internodal distance, leaf area, total shoot length and leaf yield per plant. Similarly, length of longest shoot showed positive and significant correlation with number of leaves per meter, diameter of shoot, total shoot length and leaf yield per plant. Similar observations were also made by Birader *et al.*, (2015) [5], Suresh *et al*. (2017) [14] and Saini *et al*. (2018) [6]. Since, in sericulture mulberry leaf productivity is a multifactorial trait which depends upon a number of quantitative traits like plant height, number of shoots, length of shoot, leaf size and weight, moisture retention capacity, total biomass, the association between these traits appears to be reasonable that improvement in these traits through selection will enhance the leaf productivity which will have great impact on sericulture industry (Saini *et al*., 2018) [6].

The path coefficient analysis provides more realistic evidence of the interrelationship, as it partitions into direct as well as indirect effects via various yield contributing traits. The path coefficient analysis (Table 3) showed that total shoot length had maximum direct effect (4.809) followed by weight of 10 fresh leaves (2.187) and longest shoot length (0.262) on leaf yield per plant. The highest direct positive effect of total shoot length on leaf yield per plant may be attributed to its influence on numbers of leaves indicating that selection for this trait should be done considering its positive indirect effects. Number of new shoots per plant (-5.103), leaf area (-2.002), internodal distance (-1.184), number of leaves per meter (-0.879) and diameter of shoot (-0.800) showed negative direct effect on leaf yield per plant and supported with the similar findings of Doss *et al.*, (2012) [15], Suresh *et al*. (2017) [14] and Saini *et al*. (2018) [6].

Direct selection for the leaf yield might be more effective if indirect selection via yield contributing traits with high heritability is considered. Number of new shoots per plant (4.647), longest shoot length (3.565), diameter of shoot (1.626), weight of ten fresh leaves (1.529) and number of leaves per meter (1.450) had high positive indirect effect *via* total shoot length on leaf yield per plant. Thus for developing high yielding mulberry genotypes emphasis should be placed on. Considering the overall direct and indirect effects of various growth parameters on leaf yield in mulberry, number of new shoots per plant, longest shoot length, number of leaves per meter, leaf area, total shoot length, diameter of shoot and weight of 10 fresh leaves may be given more emphasis during selection in mulberry improvement programme.

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

Source of variation	df	Number of new shoots / plants	Longest shoot length (cm)	Number of leaves/ meters	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: Genotypic (G) and phenotypic (P) correlation coefficients between leaf yield with growth and yield contributing characters

Characters	Level	Number of new shoots / plants	Longest shoot length (cm)	Number of leaves/ meters	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)
Number of new shoots/ plants	G	1.000	0.724**	0.206^{NS}	-0.196^{NS}	0.038^{NS}	0.211^{NS}	0.966**	0.354**	-0.190^{NS}	0.596**	0.821**
	P	1.000	0.462**	0.100^{NS}	-0.109^{NS}	0.128^{NS}	0.115^{NS}	0.952**	0.292*	-0.169^{NS}	0.391**	0.806**
Longest shoot length (cm)	G		1.000	0.431**	-0.353**	-0.123^{NS}	0.651**	0.741**	0.208^{NS}	-0.595**	0.379**	0.578**
	P		1.000	0.167^{NS}	-0.132^{NS}	-0.071^{NS}	0.337*	0.517**	0.207^{NS}	-0.535**	0.139^{NS}	0.435**
Number of leaves/ meters	G			1.000	-0.984**	-0.532**	0.770**	0.302*	-0.363**	-0.304*	0.083^{NS}	0.471**
	P			1.000	-0.981**	-0.460**	0.692**	0.182^{NS}	-0.308*	-0.246^{NS}	0.108^{NS}	0.302*
Internodal distance (cm)	G				1.000	0.561**	-0.712**	-0.265^{NS}	0.373**	0.304*	-0.084^{NS}	-0.439**
	P				1.000	0.480**	-0.618**	-0.171^{NS}	0.309*	0.251^{NS}	-0.115^{NS}	-0.299*
Leaf area (cm^2)	G					1.000	-0.429**	0.047^{NS}	0.770**	0.236^{NS}	0.261^{NS}	0.112^{NS}
	P					1.000	-0.393**	0.108^{NS}	0.669**	0.172^{NS}	0.184^{NS}	0.183^{NS}
Diameter of shoot (cm)	G						1.000	0.338*	-0.073^{NS}	-0.284*	-0.226^{NS}	0.523**
	P						1.000	0.214^{NS}	-0.085^{NS}	-0.232^{NS}	-0.187^{NS}	0.333*
Total shoot length (cm)	G							1.000	0.318*	-0.198^{NS}	0.510**	0.877**
	P							1.000	0.298*	-0.180^{NS}	0.356**	0.863**
Weight of 10 fresh leaves (g)	G								1.000	-0.003^{NS}	0.109^{NS}	0.456**
	P								1.000	-0.015^{NS}	0.084^{NS}	0.420**
Leaf moisture content (%)	G									1.000	-0.045^{NS}	-0.324*
	P									1.000	-0.096^{NS}	-0.265^{NS}
Leaf moisture retention capacity (%)	G										1.000	0.331*
	P										1.000	0.206^{NS}
Leaf yield/plant (kg)	G											1.000
	P											1.000

Table 3: Path coefficient analysis of leaf yield with growth and yield contributing characters (Bold values in diagonal indicate direct effects and other values indicate indirect effect on leaf yield)

Characters	Number of new shoots/ plants	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)
Number of new shoots/ plant	-5.103	0.190	-0.181	0.232	-0.075	-0.168	4.647	0.775	-0.038	0.541	0.821
Longest shoot length (cm)	-3.696	0.262	-0.379	0.418	0.247	-0.521	3.565	0.455	-0.118	0.344	0.578
Number of leaves/ meter	-1.049	0.113	-0.879	1.166	1.065	-0.616	1.450	-0.793	-0.060	0.075	0.471
Internodal distance (cm)	1.002	-0.093	0.866	-1.184	-1.122	0.569	-1.276	0.816	0.060	-0.076	-0.439
Leaf area (cm^2)	-0.192	-0.032	0.468	-0.664	-2.002	0.343	0.224	1.683	0.047	0.237	0.112
Diameter of shoot (cm)	-1.075	0.171	-0.678	0.843	0.858	-0.800	1.626	-0.161	-0.056	-0.205	0.523
Total shoot length (cm)	-4.931	0.194	-0.265	0.314	-0.093	-0.270	4.809	0.695	-0.039	0.463	0.877
Weight of 10 fresh leaves (g)	-1.809	0.055	0.319	-0.442	-1.541	0.059	1.529	2.187	-0.001	0.099	0.456
Leaf moisture content (%)	0.971	-0.156	0.268	-0.360	-0.472	0.227	-0.952	-0.006	0.198	-0.041	-0.324
Leaf moisture retention capacity (%)	-3.042	0.099	-0.073	0.099	-0.523	0.181	2.452	0.239	-0.009	0.908	0.331

Residual effect = 0.123

Conclusion

Based on the studies on correlation and path coefficient analysis, it can be concluded that number of new shoots per plant, longest shoot length, number of leaves per meter, leaf area, total shoot length, diameter of shoot and weight of 10 fresh leaves may be given more importance during selection process to develop high yielding mulberry genotypes.

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