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STUDIES ON CORRELATIONS AND PATH COEFFICIENT ANALYSIS FOR NINE PAIRS OF CHARACTERS IN *Populus deltoides* AT NURSERY LEVEL

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ABSTRACT

Identification and selection of genotypes, in poplar (*Populus deltoides L.*) at nursery level is necessary to produce good quality "Entire Transplants" (ETPs), to transplant in the field for new plantation. Findings from this study can be used to determine prevalence and relationship among the variables (plant traits). It will help in decision- making to improve the quality and selection of desired poplar genotypes. As the genotypic correlation provides the association for the heritable part only, the phenotypic and environmental correlations along with path coefficient analysis were also computed to assess the suitability of poplar clones for better selection on the new alluvial soils in agro-climatic zone of West Bengal. Stem cuttings of 40 clones collected from Forest Research Institute (FRI), Dehradun were planted to produce ETPs in the new alluvial soils. Significant correlations were observed between the characters selected for the study. It was evident from path coefficient analysis that different characters were interrelated, correlated and had direct and indirect effects over plant height. So, the present study may enhance the possibility of selection various traits of importance and growing genotypes of preferred plant height.

Keywords: Phenotypic; genotypic; environmental; ETP; correlation; path coefficient analysis.

INTRODUCTION

Populus deltoides Bartr. Ex Marsh. (Vern. Eastern cottonwood, poplar) is one of the fast-growing species "Edmonson *et al*. [1]" producing softwood for industrial use. It can be raised as pure or mixed plantations particularly in association with agricultural crops. It is a multipurpose tree species and its wood can fulfil industrial demand "Kapur and Dogra [2]" for paper pulp, plywood, matchwood, packing cases etc. *Populus deltoides* is a species which can also play an important role in increasing the productivity of the land in afforestation programs and the conservation of soil due to horizontal massive growth of root system in the sub- upper layer of the soil "as discussed by Joslin and Schoenholtz [3]".

Phenotypic, genotypic and environmental correlation coefficients of variation for various growth parameters were calculated for 40 poplar clones. Plant height was found positively and significantly correlated with collar diameter, the number

of leaf per plant, inter-nodal length and taper. The plant height was correlated positively with leaf area but non-significantly. Phenotypic and genotypic variables of some clones of poplar were also estimated by "Tiwary et *al.* [4]" and similar results were observed**.** Correlation between characters under study could be due to many genetic and environmental effects "as discussed by Yazici and Bilir [5]".

The present study will be helpful for selecting the clones having a better genetic base for new alluvial soils of West Bengal, India. It was observed that the clonal stand growth and productivity varied considerably with the growing location "Beale and Heywood [6]". The presence of high genetic variability in poplar species "Heilman and Stettler [7]" lead to the studies of assessment of environmental effects on phenotypic expressions of the characters.

For the crop improvement, selection based on the knowledge and direction of the association between its economic yield and its attributes is very much useful in identifying characters which can profitably be utilised to achieve the desired level of improvement within a reasonable time period.

MATERIALS AND METHODS

The investigation consisting of 40 clones of poplar (*Populus deltoides L.*) was carried out on new alluvial soils of West Bengal**,** India. Stem cuttings of 40 clones collected from Forest Research Institute, Dehradun in India were used as propagules and were planted in Randomized Block Design (RBD) with four replications in a five-row plot for each genotype. Spacing allowed was 90 cm between the rows and 60 cm between cuttings within a row. Before planting of stem cuttings the pits were dug and filled with a mixture of farmyard manure and soil in 1:1 ratio. The size of the pits was 1ft x1ft x 1ft. All these preparations were completed in the month of December and cuttings were planted in the pits in the month of January. Watering of pits was done timely and flooding of the entire field was done on monthly basis to make water available to horizontally growing roots.

Observations were made for nine characters (plant height, collar diameter, number of branches per plant, inter**-**nodal length, length of branches, the diameter of branches, number of leaves per plant, leaf area and taper). The height of the nursery plants was measured using a marked bamboo stick and the diameter of the stems was measured with the help of slide callipers. Leaf area was measured using the graph papers and taper was calculated by the division of height by collar diameter. Collar diameter is the diameter of the main stem at six inches above the soil.

$$\text{Taper}=\frac{Plant\ height}{Collar\ diameter} \quad (1)$$

The phenotypic, genotypic and environmental coefficients of correlation were computed according to "Singh and Choudhury [8]" for nine pairs of characters involving 40 clones.

The estimates of correlation coefficients mostly indicated the degree and direction of association-ship amongst different attributes. The path coefficient analysis provided effective means of estimating the direct and indirect effects of association between variables and was an ideal index f*o*r selection "Solanki and Gupta [9]". So, the genotypic path coefficient analysis was done considering nine traits as dependent variables and genotypes or clones as

Table 1. Analysis of variance for a clonal population of poplar ETPs

Source of variation	d.f.	Sum of squares	Mean sum of squares	F-ratio
Replication	r-1	SS_R	$MS_R=SS_R/r-1$	$MS_R= MS_E$
Genotype	n-1	SS_G	$MS_G=SS_G/n-1$	$MS_G=MS_E$
Error	(r-1)(n-1)	SS_E	$MS_{E=}SS_E/(r-1)(n-1)$	
Total	rn-1	TSS		

Where r = number of replication and
n= number of genotypes used

independent variables. The observations recorded on the various phenotypic (growth parameters) and genotypic parameters were subjected to statistical analysis to assess the direct and indirect effects of other characters on plant height with the help of path analysis.

The statistical analysis of variance (ANOVA) was done to identify the variance due to different sources and to know the significance of variance between the clones for various traits. The adopted ANOVA for the experimental Randomized Block Design (RBD) to assess variability among 40 clones for nine pairs of growth traits was on the basis of (Table 1).

In order to compare the average performance of different entries, standard error of the difference of mean (SE_M) and critical difference (CD) was calculated as:

$$S.E.m.=\sqrt{2MS_E/r} \quad (2)$$

and

$C.D.=\sqrt{2MS_E/r}$ X t at error d.f. = SE_MXt(r-1)(n-1) (3)

Where t = tabulated t value at error d. f. at 5% or 1% level of significance depending on the variance-ratio (F - test).

The correlation coefficient (r) was calculated as:

$$r_{xv=}\frac{Cov(x.y)}{\sqrt{V(x).V(y)}} \quad (4)$$

Where r_{xv} = is the correlation coefficient between x and y
Cov (x, y) is covariance between x and y,
V(x) is the variance of x and
V(y) is the variance of y.

Path coefficient analysis: Genotypic correlations were calculated following the path analysis “as suggested by Dewey and Lu [10]”.

RESULTS AND DISCUSSION

Association of nine plant characters was statistically determined by genotypic and phenotypic correlation coefficients to form the basis for selecting the best clones with desirable traits.

The calculated values of phenotypic, genotypic and environmental correlations are presented (Table 2). Plant height was positively and significantly correlated with collar diameter and the number of leaves per plant at both 5% and 1% level of significance. The increase in plant height also increased the collar diameter might be due to an increase in the number of leaves. The similar result was observed by “Tewari *et al*. [11]” when they conducted correlation studies in Poplar. Plant height was observed positively correlated with leaf area but not so significantly as the diameter and number of leaves. It may be due to variability in size of leaves and consequently the leaf area. Plant height was positively correlated with the

other characters such as inter-nodal length and taper (p=0.005). The genotypic coefficient of correlation in many cases was greater than the phenotypic coefficient of correlation indicating the less effect of environment for total expression of the genotypes. A similar result was reported by "Rajora *et al*. [12]". Statistically significant differences were observed among the clones for different parameters indicating genetic control of studied characters in each clone "Orlovic et *al*. [13]". However, in some cases, the phenotypic coefficient of correlation (0.489) was higher than the genotypic coefficient of correlation (0.371) for plant height and collar diameter. Similarly, between plant height and leaf area, these values were 0.274 and 0.272, indicating the direct role of the environment in the genotypic expression of these traits. In most cases environmental coefficient of correlation has been observed positively correlated except in some cases where it was observed negatively correlated. The negatively correlated characters interfere with the quantitative performance of each trait such as the length and diameter of branches affecting the plant height in a negative way. Another significant and positive correlation was observed between inter-nodal length and leaf area where the genotypic coefficient of correlation was higher than phenotypic indicating the greater expression of genetic factors (genes). A significant correlation between the diameter of branches and number of leaves per plant (Table 2) indicated the high genotypic coefficient of correlation due to the expression of the genotype. A number of leaves per plant were a significant positive correlation with the taper. The positive correlation between the leaf area, height and collar diameter was reported by "Harrington, Radwan and DeBell [14]".

The characters like a number, length and diameter of branches have negative effects on plant height. Clones with less number of branches should be preferred during the selection of genotypes for further production of ETPs.

The correlation coefficient values can only reflect the degrees of association-ship amongst different attributes, but never the basis for such association. This is one of the reasons for the failure in the utility of selection indices. Under such a situation, identification of the ideal selection index could be made through path coefficient analysis. The results of the path coefficient analysis were based on the genotypic correlation coefficient (Tables 2, 3 and Fig. 1).

The highest direct contribution to plant height was revealed from taper and collar diameter. The direct effect in a negative direction was exerted through the inter-nodal length, length and diameter of branches. The direct and positive effect was exerted on plant height by leaf area, a number of branches, and number of leaves per plant. The indirect effect of taper on plant height through a number of leaves per plant, leaf area indicated the importance of plant height in the selection program. The positive indirect effect on plant height was also contributed by collar diameter through the leaf area, a number of branches and number of leaves per plant. The total indirect effects were in considerable amounts against a number of branches per plant, inter-nodal length, length and diameter of branches and leaf area, which indicated that selection of poplar genotypes for potentially high plant height could effectively be done on the basis of these traits. The residual effect was very low (0.122) suggesting the inclusion of all the parameters sufficient for path analysis.

Table 2. Genotypic, phenotypic & and environmental correlations between nine pairs of characters

Characters		Plant height (cm)	Collar diameter (cm)	Number of branches/ plant	Internodal length (cm)	Length of branches (cm)	Diameter of branches (cm)	Number of leaves per plant	Leaf area (Sq. cm.)	Taper
	P		0.489**	-0.182	0.075	-0.011	-0.078	0.458**	0.274	0.60*
Plant height(cm)	G		0.371 *	-0.348	0.043	-0.214	-0.280	0.582**	0.272	0.87*
	E		0.653**	0.042	0.130	0.052	-0.039	0.287	0.280	0.14
	P			0.111	-0.076	0.150	0.033	0.116	0.062	-0.38
Collar diameter (cm)	G			0.033	-0.134	-0.115	-0.201	0.257	0.223	-0.10
	E			0.164	-0.052	0.188	0.063	0.052	-0.017	-0.64
	P				-0.211	0.123	0.195	0.002	-0.302	-0.29
No of branches/ plant	G				-0.391	0.050	0.058	0.008	-0.498	-0.41
	E				0.040	0.172	0.278	-0.004	-0.077	-0.12
	P					0.005	-0.022	-0.162	0.335	0.16
Inter-nodal length(cm)	G					-0.138	-0.245	-0.265	0.448*	0.15
	E					0.056	0.042	-0.013	0.179	0.19
	P						0.258	0.069	-0.052	-0.14
Length of branches (cm)	G						1.660	0.004	0.186	-0.14
	E						0.167	0.105	-0.131	-0.19
	P							0.070	-0.054	-0.08
Dia. of branches (cm)	G							0.386*	-0.099	-0.16
	E							0.001	-0.055	-0.09
	P								-0.050	0.36*
Leaves per plant	G								-0.214	0.47*
	E								0.137	0.19
	P									0.24

Characters		Plant height (cm)	Collar diameter (cm)	Number of branches/ plant	Internodal length (cm)	Length of branches (cm)	Diameter of branches (cm)	Number of leaves per plant	Leaf area (Sq. cm.)	Taper
Leaf area	G									0.19
	E									0.31
	P									
Taper	G									
	E									

**Significant at 5 % level*
*** Significant at 1% level*

Table 3. Path analysis showing direct and indirect effects of different characters on plant height of poplar ETPs (based on genotypic correlation)

	Collar diameter	Number of per plant	Inter nodal length	Length of branches	Diameter of branches	Leaves per plant	Leaf area	Taper
Collar diameter	0.4259	0.0143	-0.0571	-0.0491	-0.0859	0.1096	0.095	-0.0437
Number of br. per plant	0.0006	0.0184	-0.0072	0.0009	0.0011	0.0002	-0.0092	-0.0076
Inter nodal length	0.0061	0.0177	-0.0453	0.0062	0.0111	0.012	-0.0203	-0.0068
Length of branches	0.0056	-0.0024	0.0066	-0.0481	-0.0803	-0.0002	-0.009	0.0069
Diameter of branches	0.0008	-0.0002	0.0009	-0.0062	-0.0037	-0.0014	0.0004	0.0006
Leaves per plant	0.012	0.0004	-0.0124	0.0002	0.018	0.0466	-0.01	0.0223
Leaf area	0.0119	-0.0266	0.0239	0.01	-0.0053	-0.0114	0.0534	0.0103
Taper	-0.0917	-0.3704	0.1341	-0.1283	-0.1439	0.4268	0.1721	0.8936
Plant height	0.3711	-0.3488	0.0436	-0.2144	-0.2889	0.5822	0.2725	0.8756
Partial R^2	0.1581	-0.0064	-0.002	0.0103	0.0011	0.0272	0.0145	0.7824

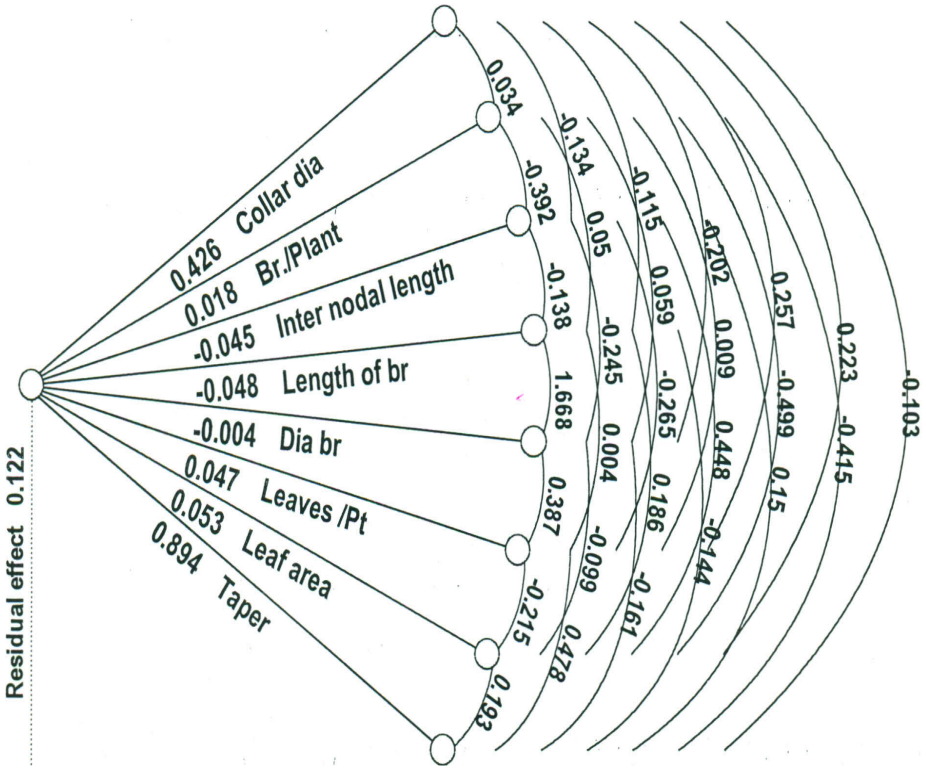

Fig. 1. Genotypic path diagram for plant height

CONCLUSION

The present investigation was performed to assess the variation in different characters, their interrelationship and to know how other characters directly or indirectly affect the plant height of poplar nursery plants.

This study will help to assess the growth pattern of nursery plants which will help in decision making for selection of better genotypes for desired plant height. So, it can be suggested that in West Bengal on alluvial soil the poplar nursery plants (ETPs) having more height and collar diameter and less number of branches should be selected for field plantation as inter-nodal length, number, length, and diameter of branches had negative effect on the height of the plant.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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