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STABILITY ANALYSIS FOR POPLAR (*Populus deltoides*) CLONES ON NEW ALLUVIAL SOIL OF WEST BENGAL

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ABSTRACT

The performance of a particular genotype depends on environmental interactions. Estimation of phenotypic stability, which involves regression analysis, has proved to be a valuable technique for assessing the response of various genotypes under varying environmental conditions. Low magnitude of genotype x environmental (G X E) interaction indicates consistent performance of a population over variable environments. The stability analysis of Poplar (*Populus deltoides*) was done taking the parameter plant height because the height of one year old nursery plants which are called entire transplants (ETPs) is considered most important character for selection and field plantation. The linear regression could simply be regarded as a measure of response of a particular genotype, whereas the deviation around the regression line is the most suitable measure of stability. So, the regression co-efficient (Bi value) and co-efficient of determination (R^2 value) were calculated and the stability analysis was performed. It was necessary to assess the suitability of poplar in the new alluvial soil and agro-climatic regions of West Bengal for selection of better clones. So, the present experiment was performed with 40 clones of *Populus deltoides*.

Keywords: Genotype; ETP; Stability; G X E interaction and Regression co-efficient.

INTRODUCTION

Populus deltoides Bartr. Ex Marsh. (Vern. Eastern cottonwood, poplar) is one of the fast-growing species "Edmonson et al. [1]" producing soft-wood for industrial use. It can be raised as pure or mixed plantation particularly in association with agricultural crops. It is a multipurpose tree species of the family Salicaceae 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 biodiversity and productivity of the land in afforestation programs and in 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]". As poplar naturally and indigenously grow above 28^0 N latitude and in hilly regions of India so, it was necessary to assess the suitability and stability of the species *Populus deltoides* (exotic from North America) in the new alluvial soil and the agro climatic region in Nadia district of west Bengal, India.

Identification and selection of genotypes, in poplar (*Populus deltoides*) at nursery level is necessary to produce good

quality “Entire Transplants” (ETPs), to transplant in the field for new plantation.

Stability analysis was done for plant height as the height of one year old nursery plants is considered for field plantation. It was found that nearly all the genotypes except few ones had significant deviations from the regression.

Present study will be helpful for selecting the clones having better genetic base for new alluvial soils. It was observed that the clonal stand growth and productivity varied considerably with the growing location “Beale and Heywood [4]”. The presence of high genetic variability in poplar species “Heilman and Stettler [5]” lead to the studies of assessment of environmental effects on phenotypic expression of the character as far as stability is concerned.

Phenotypic and genotypic variables of some clones of poplar were also estimated by “Tiwary et al. [6]” 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 [7]”.

For the crop improvement, selection based on the knowledge and direction of association between its economic yield and its attributes is very much useful in identifying characters which can profitably be utilized 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*) was carried out on new alluvial soil in Nadia district of West Bengal (latitude= 22.9ºN and longitude= 88.4ºE), India at above sea level of altitude where average temperature ranges from 25º-30ºC and average rainfall ranges from 150-170mm. Stem cuttings of 40 clones collected from Forest Research Institute, Dehradun in Indiawere used as propagules and were planted in Randomized Block Design (RBD) with four replications in a five-row plot for each genotype over three different years. 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 the character plant height. Height of the nursery plants was measured using a marked bamboo stick. The statistical analysis was done according to “Singh and Choudhury [8]” for 40 clones of poplar and stability analysis using average observations on the trait with four replications over three different years following the model suggested by “Eberhart and Russel [9]” as:

$$Yij = m + biIj + \delta ij \qquad (1)$$

Where, i = no. of genotypes, j= no. of years/location and Yij = Mean of the i^{th} variety in j^{th} environment,

m = Mean of all the genotypes over all the environments,

bi = Regression co-efficient of i^{th} genotypes on the environmental index, measuring its response to varying environments,

Ij = The environmental index, defined as the deviation of mean of all the

genotypes at a given location from the overall mean, and

ij= The deviation from regression of the i^{th} genotype at j^{th} environment.

The stability parameters are used as follows:

1) Regression Co- efficient, which is estimated as:

$$Bi = \sum Yijlj / \sum l^2 j \quad (2)$$
jj

where, $\sum Yijlj$ is the sum of products and $\sum l^2 j$is the sum of squares.

2) Mean square deviations (s^2d) from linear regression =

$$\frac{\Sigma^2}{(s-2)} - \frac{s^2 e}{r} \quad (3)$$

where, s^2e = The estimate of pooled error

3) Computation of environmental index (Ij):

$$Ij = \frac{\Sigma Yij}{t} - \frac{\Sigma\Sigma Yij}{ts}$$

$$= \frac{\text{Total no. of all the varieties at jth location}}{Number\ of\ varieties} - \frac{\text{Grand total}}{total\ number\ of\ observations} \quad (4)$$

RESULTS AND DISCUSSION

Populus deltoides being the fast growing agroforestry species, though exotic in India, needs two steps for its successful establishment in field. First one is the production of ETP and second one is field plantation.

Quality ETP depends on many parameters. The most important parameter considered for this study on stability of different clones is plant height. Accordingly the stability analysis has been done on the basis of records over three seasons (years).

Different measures of stability have been used by different workers. “Finlay and Wilkinson [10]” proposed first to consider linear regression slopes as a measure of stability. Subsequently “Eberhart and Russel [7]” emphasised the need of considering both linear and non-linear components of genotype x environment (G X E) interaction in judging stability of genotypes. At a later stage “Breese [11], “Samuel et al. [12]”, “Paroda and Hayes [13]” and “Jatasra and Paroda [14]” emphasised that linear regression could simply be regarded as a measure of response of a particular genotype, whereas the deviation around the regression line (S^2di) is the most suitable measure of stability, genotypes with lowest standard error or deviation around the regression line (S^2di) being the most stable and *vice versa*.

Table 1. Pooled ANOVA for stability for plant height

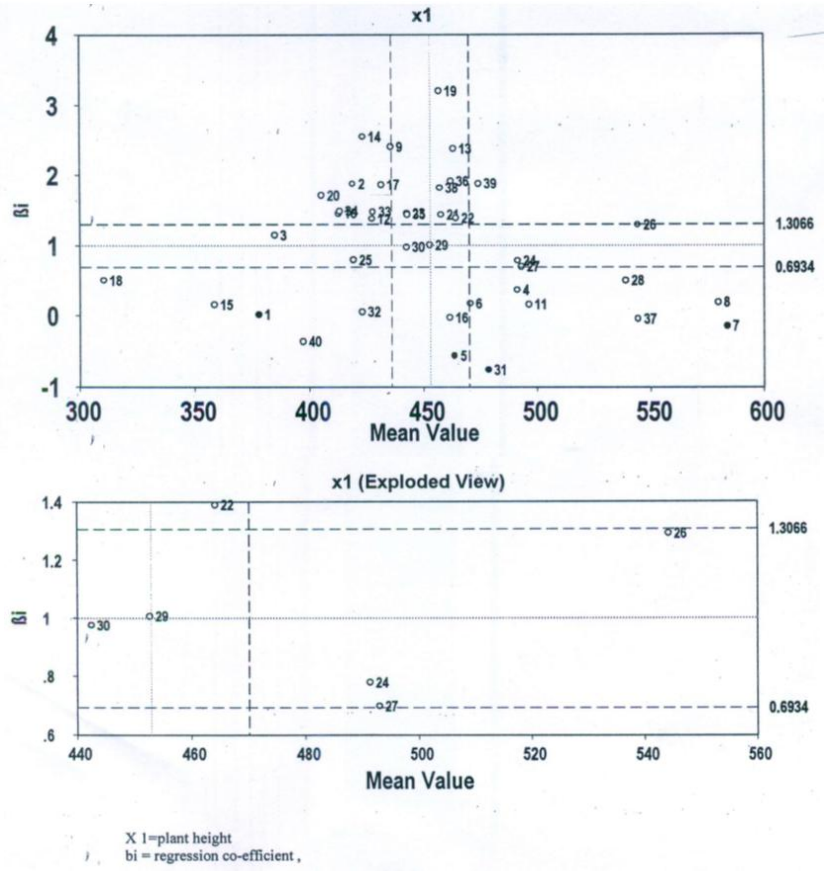
Source of variation	d. f.	Characters plant height MS
Replication within Environment	9	338.250
Genotypes (Varieties)	39	9244.210*
Environments	2	123739.406***
Environment (Linear)	1	247478.810***
Genotype x Environment	78	2965.460***
Genotype x Environment (Linear)	39	208049.700***

Table 2. Stability parameters for plant height

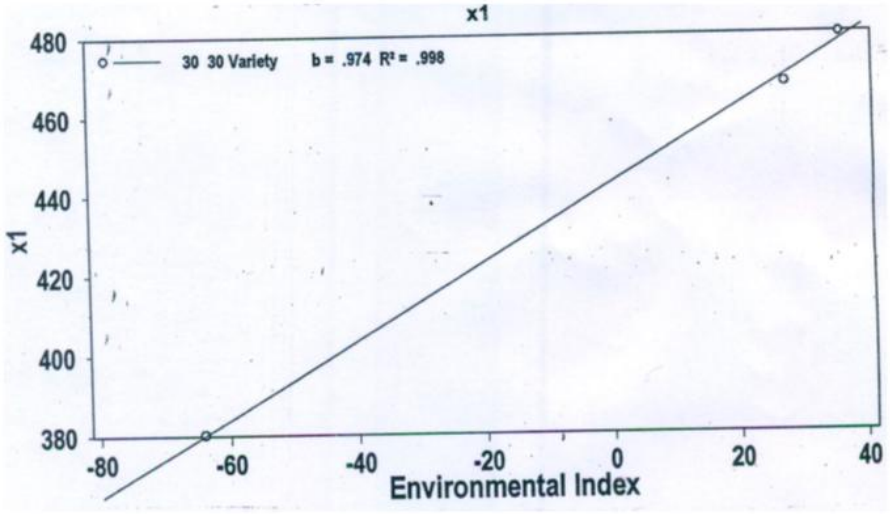
Clones	Env1	Env2	Env3	General mean	S^2Di	Rank	Bi	Rank
S7C1	380.00	340.50	412.50	377.66	2203.17	39	0.015	30
S7C2	300.00	460.00	496.50	418.91	-186.40	70	1.871	26
S7C4	310.00	430.00	414.25	384.75	-61.01	2	1.149	3
S7C8	467.50	505.00	500.75	491.08	-367.95	26	0.363	18
S7C15	495.00	500.00	395.75	463.58	4569.75	40	-0.561	38
S7C20	460.00	470.00	481.50	470.50	-345.31	22	0.171	22
G-3	590.00	612.50	448.25	583.58	1600.09	38	-0.145	33
G-48	566.50	595.00	577.25	579.58	-206.03	11	0.191	20
3167	281.00	507.50	518.50	435.66	-344.89	21	2.409	36
82-33-3	320.00	447.50	417.50	412.66	-342.39	20	1.45	12
82-35-4-1	485.00	512.50	491.25	496.25	-137.68	3	0.16	23
82-26-5	340.00	455.00	487.00	427.33	-195.27	8	1.37	8
421-2	310.00	537.50	542.00	463.16	-261.96	15	2.38	35
S13C11	260.00	495.00	512.00	423.33	-393.05	32	2.54	37
S4C2	350.00	342.50	382.50	358.33	354.82	24	0.15	24
D121	462.50	470.00	452.00	461.50	-237.10	12	-0.02	31
ST-124	310.00	510.00	474.50	431.50	952.18	35	1.86	25
113520	280.75	295.50	355.00	310.41	1132.27	36	0.5	16
3324	250.00	570.00	550.50	456.83	736.22	34	3.19	40
111828	297.00	437.50	481.00	405.16	14.73	1	1.71	19
L-34	365.00	505.00	502.75	457.58	-285.50	17	1.43	10
L-49	375.00	505.00	512.50	464.16	-384.80	30	1.38	9
L-200	350.00	475.00	503.00	442.66	-278.50	16	1.45	13
L-62	440.00	530.00	504.00	491.33	145.65	4	0.77	5
WSL-45	370.00	422.50	465.00	419.16	240.85	13	0.79	4
22-N	460.00	505.00	575.00	544.16	138.30	6	1.29	6
23-N	449.00	452.50	525.00	493.00	-298.33	19	0.69	7
25-N	507.75	460.00	566.50	538.91	-201.90	9	0.5	17
26-N	390.00	467.50	508.00	452.66	377.50	27	1.0	1
34-N	380.25	425.00	479.75	442.50	-388.66	31	0.97	2
36-N	530.00	420.00	480.25	478.41	1535.35	37	-0.76	39
37-N	420.00	460.00	429.00	423.00	-358.99	25	0.05	29
38-N	334.00	430.00	489.25	427.75	-261.10	14	1.47	14
39-N	320.00	490.00	489.50	413.16	692.02	33	1.48	15
40-N	350.00	510.00	488.50	442.83	-295.90	18	1.44	11
41-N	340.00	540.00	536.00	462.00	-352.20	23	1.91	28
42-N	547.50	540.00	545.50	544.33	-378.18	28	-0.04	32
43-N	340.00	517.50	513.75	457.08	-202.26	10	1.81	21
63-N	350.00	537.50	532.00	474.16	-154.37	5	1.87	27
UD-88	420.00	390.00	381.00	397.00	-378.60	29	-0.36	37

Environmental index	-64.30	27.64	36.38
Mean	388.91	480.58	489.32
C.V.	5.13	9.93	9.33
S.E.	14.12	33.77	32.29
C.D. 95%	27.96	66.88	63.95
C.D. 99%	36.97	88.42	84.56

The pooled analysis of variance for stability with respect to plant height (Table 1) showed that the mean differences between genotypes or clones, the environments or the seasons, the interaction of the clones with the seasons and both the linear components of environments as well as genotype x environment (G X E) were significant. It is clearly indicated thus that the genotypes (clones) and environments (seasons) showed considerable variability character concern. The significance of genotype x environment (G X E) interaction for plant height indicated that the clones or the genotypes interacted strongly with environments.



Graph 1. Stability graph showing distribution of clones in respect of plant height



Graph 2. Showing stability graph of plant height with respect to environmental index

Significant mean square due to environments (linear) indicated that seasons differed considerably from year to year. In this analysis linear component of genotype x environment (G X E) interaction was significant and greater than the nonlinear component for plant height, suggesting that the performance of clones for plant height could be predicted across the environments or seasons.

In the present study all the genotypes or clones except the clones S7C1, S7C15, G-3, 113520 and 36-N had significant deviations from regression (Table 2). The confidence band of Bi values as well as mean values ranged from 0.6934 to 1.3066 and the clone 22-N though ranked sixth according to Bi value but had higher mean value as indicated in the graph found to perform better under favourable environmental condition as reflected by higher regression value (Bi>1.0). Similarly the clones L-62/84 and 23-N, lower performer with respect to plant height in comparison to clone 22-N, were found to perform better under unfavourable conditions. On further analysis of the genotypes with respect to their coefficient of determination (R^2), the clone 34-N was found to be best clone as shown in the graph below due to its 'Bi' value (0.974) nearly equal to R^2 value (0.998) meaning thereby its perfect fitness over the seasons. It is also evident from the confidence band of the Graph 1 that clone number 29 and 30 are more suitable in the region.

In the present study on stability analysis on plant height, the environmental index was observed negative in the first season and positive in other two seasons. As the character plant height is the most imminent component for selecting ETPs, the clones showing stability on this parameter is given priority for identification.

CONCLUSION

As a major objective, identification of quality ETP and its stability over the years in respect to most important character was

investigated. The study revealed that plant height was most important parameter which can be utilised for selection of clones for ETP production. This study will help in decision making for selecting of better genotypes with desired character. So, it can be suggested that in West Bengal on alluvial soil the poplar nursery plants (ETPs) having more height should be preferred and selected for field plantation. In the present study, clone marked as N-34 was found best among 40 clones.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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