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Estimation of correlation coefficient and effect of different growth regulators and potting media on survival and growth parameters of G_{48} poplar clone

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ABSTRACT

The study was conducted on the effect of different growth regulators and potting media on morphological and biomass traits of G_{48} clone of poplar in the Forest Nursery and Research Centre (School of Forestry and Environment) of Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad, UP. The cuttings were obtained with 15 cm length and without any branches and flowers. The experiment was laid out in Completely Randomized Design (CRD). There were six treatments including control replicated four times in which control (distilled water) and growth regulators IBA (100 ppm), IAA (100 ppm), NAA (100 ppm), GA_3 (100 ppm) 2,4-D (100 ppm) were used with 10 cuttings per replication. Among the different treatments T_1 (IBA 100 ppm) proved to be the most effective growth regulator which gave better results with respect to diameter, leaf area, number of roots, shoot length, root length, shoot fresh weight, root fresh weight, root dry weight and total biomass compared to control and other treatments. Hence it can be recommended that IBA was the most effective growth regulator among the all treatments. In potting media there were seven treatments with three replications and the combinations were control soil, soil:FYM:sand 1:1:1, soil:FYM: neem cake 1:1:1, soil:FYM:vermicompost 1:1:1, neem cake:sand: vermicompost 1:1:1, neem cake:soil:vermicompost 1:1:1 and neem cake:FYM:vermicompost 1:1:1. Among all potting media combinations most effective treatment was T_1 (soil:sand:FYM 1:1:1) which showed better results in sprouts/cutting, survival percentage, diameter, leaf area, shoot dry weight, root fresh weight as compared to control or other treatments. Therefore it can be recommended that the combination of (soil:sand:FYM 1:1:1) was an effective treatment for the growth of poplar cuttings. It was concluded that IBA with 100 ppm and combination of soil:sand:FYM 1:1:1 can be recommended to obtain best growth and development for poplar cuttings.

Keywords: Vermicompost; potting media; growth regulators; clone; poplar

INTRODUCTION

The use of vegetative propagation of trees as a tool in their domestication has a long history. In order to meet the huge annual targets there is a need to raise a large amount of seedlings in the nurseries. Therefore quality of planting material is most important for establishment of successful plantation. The production of quality nursery stock constitutes one of the major factors for the success of any tree planting

programme. Poplar (*Populus deltoides*) belongs to the family Salicaceae. It is a very important taxonomical group of tree species in plantation forestry because it is a deciduous fast growing multipurpose tree species and can be harvested at a short rotation of 7-8 years (Chaturvedi 1984). The branches are more or less angled or almost winged, the side branches borne of large branches are shed early. Outer bark forms early, furrowed by cork like ridges and deep fissures. The leaves are fairly large, deltoid on short shoots, very large, cordate on long shoots and light green in color. The tree crown intercepts rains, acts as wind breaks, thus checks soil erosion and minimizes the effects of wind on associated crops.

Poplar is a large tree reaching well over 25 m in height and 100-130 cm in girth (at breast height) in a period of 10-12 years. It is shallow rooted and the root system spreads widely. The tree develops a tall straight bole the main branches from a fairly simple, wide and conical crown. Abundant foliage makes the crown quite dense. The tree is deciduous and remains leafless for 3-4 months. Flowering is normally in the dry season. Poplar species are light demanding plants and are susceptible to drought. Though they grow well on sites with higher water table but cannot withstand water logging. The growth is optimal under irrigated conditions. They prefer deep, well drained, workable and nutrient rich soils. The pH should be between 5.5 to 7.0 and plants do not tolerate acidic soils. They are fire tenders and susceptible even to light fire. Poplar favors inter-cultivation of agricultural crops throughout the rotation.

P deltoides is native of North America grown from southern Quebec westward into South Dakota and southward to Texas and North Western Florida. The clones have been cultivated in a number of countries. In India poplar occupies an important place amongst fast growing tree species due to its multiple uses and its cultivation has specifically gained importance in social forestry and agro-forestry practices.

Poplar can produce biomass in a short rotation intensive culture and other deciduous or evergreen species (Dickmann and Stuart 1983). The area coverage and productivity of this species is bound to increase further due to concerted research and development aiming at its genetic improvement. Indigenous poplars occur only in the mountains and are still to acquire greater role in aforestation/reforestation programs and conservation. *P deltoides* is the most widely planted species of poplar in India. It is planted in the plains of North-West India ie Western Uttar Pradesh, Punjab and Haryana and to some extent in outer plains/valleys of Jammu and Kashmir, Uttaranchal and Himachal Pradesh. It has been successfully cultivated

as a forest crop or agro-forestry crop in Punjab plains and in Terai region of UP. Poplars have been raised at slightly lower latitudes also but it is only above 29^0N that they had fair success in experimental plantations and on farms.

Plant growth regulators have been exploited profitably to alter plant archetype to achieve higher yields and quality in intended species. These are the chemical substances which are needed in small quantities for fine tuning of various physiological processes. It has been widely demonstrated that extremely minute concentrations of plant growth substances have the potential to regulate several phases of plant growth and development spanning from seed germination, plant growth, flowering, fruiting and seed formation through senescence and development. Of the different groups auxins were the first class of growth regulators discovered. Notably auxins have been in use for initiation of rooting in cuttings of various plants. Among them the most widely used are indole butyric acid and naphthalene acetic acid. Several horticultural crops have been successfully propagated by cuttings by use of such auxins. The present study was initiated to know the effect of different growth regulators (IBA, NAA, IAA, GA_3, 2,4-D) on cuttings of poplar.

The rate of multiplication via cutting propagation is higher than for any other vegetative propagation technique with the exception of micro-propagation (tissue culture). Vegetative propagation by cuttings has received a lot of attention in recent years in the woody perennials. It is most simple, easiest and widely used tool for establishment of clonal plantations. The nursery plants are raised from cuttings taken from one year old nursery growth. The ability of cuttings to root and their subsequent growth in nursery is determined by number of factors viz time at which cuttings are taken, age of the donor tree, position within the crown where cuttings are taken, treatment and status of rooting/ growth regulators and conditions under which cuttings are rooted (Puri 1993) or the seedling quality is characterized by various morphological parameters which are influenced largely by nursery cultural techniques. In tropical and sub-tropical regions the focus is on containerized plants and the most common containers.

MATERIAL and METHODS

The field experiment was conducted at forest nursery of School of Forestry and Environment, Allahabad, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, UP. The potting media were neem cake, vermicompost and FYM. The growth hormones used for stem cutting were IBA, NAA and GA_3. Solutions of auxins were made and cuttings of G_{48} clone of poplar were soaked in growth regulators for 24 hours before planting. The

cuttings were treated with test compounds by dipping their basal 3.5 cm portions in various rooting regulators solutions for 24 hours at room temperature (20±1^{0}C). The solutions included indol-3-butyric acid (IBA 100 ppm), á-naphthalene acetic acid (NAA 100 ppm) and gibberellic acid (GA_3 100 ppm) and the basal portion of the cuttings was cut off and dipped in the distilled water for 24 h. The potting media were prepared according to different treatments of potting media viz neem cake, vermicompost, soil, sand and FYM in the ratio of 1:1:1. The Observations which were recorded on the morphological and biomass traits were survival percentage, number of roots, root length, root shoot ratio, total biomass, sturdiness quotients and Dickson quality index.

The experiment was laid out by Completely Randomized Design (CRD) replicated 4 times. In each replication 10 cuttings were raised accordingly and data were recorded immediately after the cuttings emerged. The data were recorded during the course of investigations and were subjected to statistical analysis of variance as suggested by Fisher and Yates (1963). Karl Pearson's (simple) correlation coefficient was worked out as per Panse and Sukhatme (1967).

RESULTS and DISSCUSSION

The data given in Table 1 exhibit that maximum survival percentage was shown by T_2 (92.50%) followed by T_1 (90%) and the minimum by T_4 (47.50%). Number of roots showed maximum result of (23.45) in T_1 followed by T_3 (23.35) however minimum was observed in T_5 (17.85). Maximum root length was recorded in T_5 (51.77 cm) followed by T_3 (50.90 cm) and minimum was observed in T_0 (40.85 cm). Maximum total biomass (52.11 g) was in T_1 followed by T_2 (41.37 g) and minimum in T_4 (19.41 g). Maximum value was recorded for sturdiness quotient (14.25) in T_4 followed by T_1 (11.05) and minimum (7.71) in T_2. Dickson quality index showed maximum result of (5.40) in T_1 followed by T_2 (5.26) and minimum was observed in T_4 (1.83).

Data appended in Table 2 show that maximum value was recorded for survival percentage (70%) in T_1 followed by T_3 (66.67%) and minimum survival percentage (10.00%) was observed in T_4 and T_5. Number of roots showed maximum result of (24.53) in T_3 followed by T_6 (18.37) however minimum was observed in T_5 (4.00). Maximum root length was recorded in T_3 (35.00 cm) followed by T_1 (27.93 cm) and minimum was observed in T_2 (6.87 cm). However maximum value was recorded for root/shoot ratio (0.85) in T_4 followed by T_1 (0.80) and minimum root:shoot ratio (0.31) was observed in T_6. Total biomass showed maximum result of (21.63 g) in T_1 followed by T_3 (19.83 g) and minimum was observed in T_5 (3.70 g). Maximum value (17.77) for sturdiness

Table 1. Effect of growth regulators on various traits of G_{48} clone of poplar

Treatment	Survival (%)	Number of roots	Root length (cm)	Root/ shoot ratio	Total biomass (g)	Sturdiness quotient	Dickson quality Index
T_0 – control	80.00	19.50	40.85	0.71	36.07	10.12	3.34
T_1 – IBA	90.00	23.45	50.00	0.52	52.11	11.05	5.40
T_2 – IAA	92.50	22.85	46.40	0.49	41.37	7.71	5.26
T_3 – NAA	82.50	23.35	50.90	0.85	26.36	8.63	3.74
T_4 – GA_3	47.50	18.56	43.94	0.74	19.41	14.25	1.83
T_5 – 2, 4-D	87.50	17.85	51.77	0.89	33.38	8.52	3.95
F–test	S	S	S	S	S	S	S
SEd (±)	7.64	1.52	5.32	0.23	8.06	1.61	1.22
$CD_{0.05}$	16.04	3.20	10.84	0.48	16.93	3.39	2.57

Table 2. The effect of potting media on the various traits of G_{48} clone of poplar

Treatment	Survival (%)	Number of roots	Root length (cm)	Root/ shoot ratio	Total biomass (g)	Sturdiness quotient	Dickson quality Index
T_0	60.00	15.93	24.20	0.60	13.61	6.97	1.82
T_1	70.00	17.33	27.93	0.80	21.63	8.17	2.34
T_2	11.67	4.97	6.87	0.74	4.37	17.77	0.24
T_3	66.67	24.53	35.00	0.50	19.83	10.34	1.81
T_4	10.00	4.97	8.13	0.85	4.37	13.74	0.47
T_5	10.00	4.00	9.30	0.76	3.70	12.77	0.28
T_6	53.33	18.37	25.33	0.31	15.34	8.49	1.98
F-test	S	S	S	S	S	S	S
SEd (±)	11.02	1.96	2.80	0.11	5.42	2.03	0.50
$CD_{0.05}$	23.14	4.12	5.88	0.23	11.39	4.26	1.04

T_0- control, T_1- soil:sand:FYM, T_2- soil:sand:neem cake, T_3- oil:sand:vermicompost, T_4- vermicompost:sand:neemcake, T_5- vermicompost:soil:neemcake, T_6- vermicompost:FYM:neemcake

quotient was recorded in T_2 followed by T_4 (13.74) and minimum (6.97) was observed in T_0. Dickson quality index showed maximum result of (2.34) in T_1 followed by T_6 (1.98) with minimum observed in T_2 (0.24). The best performance of the rooted cuttings in the medium might be due to nutritionally better

medium containing organic material that resulted in maximum survival and length of root. Mathad and Nalwadi (1989) reported that decomposed organic material improved soil fertility by increasing soil aeration, water holding capacity, water infiltration and lower surface crusting. Similarly the poorest performance of rooted cuttings in control might be due to nutritionally poor medium lacking in organic material that resulted in minimum survival thereby reducing the plant survival and growth. Ahmad and Qasim (2003) found that potting media containing FYM poultry manure as main source of organic matter with sand, silt and saw dust were better than sole factor of soil itself as these combinations presented more growth and vigor of the plants improving total available nitrogen and phosphorus. Similar findings have been reported previously by Rahman and Ishtiaq (1996).

The correlation is one of the most important tools which measures the degree and magnitude of association between various characteristics in tree improvement programme. A clear understanding of association among different traits is of great importance as it shows whether the choice of one character confirms the appearance or disappearance to the other thus it is useful indirect selection.

Under potting media Table 3 reveals that survival percentage showed positive and significant correlation with root length (0.799), total biomass (0.929) and Dickson quality index (0.892). Number of roots showed positive and significant correlation with root length (0.989), total biomass (0.937) and Dickson quality index (0.901). Root length showed positive and significant correlation with total biomass (0.960) and Dickson quality index (0.922). However with sturdiness quotient it showed negative but significant correlation (-0.786). Total biomass showed positive and significant correlation with correlation with Dickson quality index (0.959) but with sturdiness quotient it showed significant but negative correlation (-0.766). Sturdiness quotient showed negative but significant correlation with Dickson quality index (-0.884). Dickson quality index showed positive and significant correlation with survival per cent (0.892), number of roots (0.901), root length (0.922) and total biomass (0.959) but with sturdiness quotient it shows significant but negative correlation (-0.884). However rest of the correlation coefficients showed non-significant correlation with each other.

Under growth regulators Table 4 reveal that survival percentage showed positive and significant correlation with Dickson quality index (0.906) but with sturdiness quotient it showed significant but negative correlation (-0.863). Dickson quality index showed positive and highly significant correlation with number of roots (0.981), root length

(0.956) and total biomass (0.961). However with sturdiness quotient it showed negative but highly significant correlation (-0.951). Rest of the correlation coefficients showed non-significant correlation with each other. The significant and positive correlations among various morphological and biomass traits suggest and emphasize their utilization in indirect selection. Negative correlation suggests that selection made for one trait may prove contrary to the other. The above results support the findings of Kumar (2003) in *Bauhinia variegata.*

CONCLUSION

From this study it was concluded that the most effective growth regulator was T_1 (IBA 100 ppm) which gave better results as compared to control T_0 and other treatments. It can be recommended that IBA (IBA 100 ppm) is the most

Table 3. Simple correlation coefficient among seven traits in potting media of G_{48} poplar clones

Treatment	Survival (%)	Number of roots	Root length	Root/ shoot ratio	Total biomass	Sturdiness quotient	Dickson quality index
Survival (%)	1.000	0.754	0.799*	-0.260	0.929**	-0.681	0.892**
Number of roots		1.000	0.989**	-0.679	0.937**	-0.736	0.901**
Root length			1.000	-0.605	0.960**	-0.786*	0.922**
Root/shoot ratio				1.000	-0.464	0.483	-0.533
Total biomass					1.000	-0.766*	0.959**
Sturdiness quotient						1.000	-0.884**
Dickson quality index							1.000

* Significant at 5% level of significance
**Significant at 1% level of significance

Table 4. Simple correlation coefficient among seven traits in growth regulators of G_{48} poplar clones

Treatment	Survival (%)	Number of roots	Root length	Root/ shoot ratio	Total biomass	Sturdiness quotient	Dickson quality index
Survival (%)	1.000	0.512	0.466	-0.286	0.763	-0.863*	0.906*
Number of roots		1.000	0.309	-0.559	0.509	-0.350	0.981**
Root length			1.000	0.249	0.192	-0.420	0.956**
Root/shoot Ratio				1.000	-0.701	-0.012	-0.603
Total biomass					1.000	-0.355	0.961**
Sturdiness quotient						1.000	-0.951**
Dickson quality index							1.000

* Significant at 5% level of significance
**Significant at 1% level of significance

effective growth regulator among the all treatments. Whereas in case of survival per cent T_2 (IAA 100 ppm) was the most effective treatment for G_{48} poplar clones at Allahabad conditions. Among all potting media combinations most effective treatment was T_1 (soil:sand:FYM 1:1:1) which showed better results as compared to control T_0 so it can be recommended that the combination of soil:sand:FYM 1:1:1 is an effective treatment for the growth of G_{48} poplar clones. However in case of number of roots and root length the most effective treatment in potting media was T_3 (soil: sand:vermicompost 1:1:1). Under potting media survival percentage showed positive and significant correlation with root length, total biomass and Dickson quality index. Root length showed positive and significant correlation with total biomass and Dickson quality index. However sturdiness quotient showed negative but significant correlation. Under growth regulators Dickson quality index showed positive and highly significant correlation with number of roots, root length and total biomass. However with sturdiness quotient it showed negative but highly significant correlation. The significant and positive correlations among various morphological and biomass traits suggest and emphasize their utilization in indirect selection. Negative correlation suggests that selection made for one trait may prove contrary to the other one.

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