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Effect of Fertilization on Growth of Poplar Clones in Nursery

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Abstract

The effect of N, P and K fertilizer treatments was observed on poplar plants in nursery. The nutrients applied in combination to poplar had significant effect on height and collar diameter of entire transplants of poplar (ETP'S) produced in nursery. The nutrient treatment $N_{225}P_{150}K_{75}$ was effective to increase in plant height, collar diameter, average leaf area and biomass of ETP's produced. Among different clones studied clone no. L-47/48 and PL-6 attained maximum height, collar diameter, average leaf area and biomass. The minimum height was recorded in clone PL-1 and Collar diameter in clone PL-2. The average leaf area varied differently in the nine clones studied in the present investigation. The nutrient applied had significant effect on average leaf area of poplar in nursery. The maximum leaf area was recorded with the application of $N_{150}P_{100}K_{50}$. The biomass produced by the poplar clones under the influence of nutrient applied to Poplar clones in nursery had similar response as to average leaf area. The interaction effect (clone×nutrients) shows that each clone has differential response to nutrient applied in different combinations of N, P and K treatment ($N_0P_0K_0$), ($N_{75}P_{50}K_{25}$), ($N_{150}P_{100}K_{50}$) and ($N_{225}P_{150}K_{75}$) for plant height, collar diameter, average leaf area and biomass growth. This interaction effect is reflection of genetic potential of clones under favourable G×E interaction.

Keywords: Fertilization, height, collar diameter, leaf area, clones, nursery

1. Introduction

Populus deltoides Bartr ex. Marsh is a one of the commercial agroforestry tree species grown in India, owing to its multiple industrial uses, fast growth, short rotation and suitability for agroforestry (Jones and Lal, 1989), this species has been extensively adopted by the farmers. The farmers grow this species on farmlands along with agricultural crops as boundary or block plantation. The cultivation of poplar has generated huge employment in the rural sector in India and has overall improved the rural economy (Chandra et al., 2011). The benefits of poplar cultivation which has also created a wood industry providing cheaper products to consumers, and reducing India's wood import. Along with clonal eucalypts, poplars are seen as the 'green gold' in the countryside (Raina et al. (2011). Poplars are used for solid wood, pulp and plywood production. Poplar based agroforestry has been found to give better economic returns than sole annual crops. Net photosynthesis, stomatal conductance and transpiration in two crops viz, turmeric (*Curcuma longa* L.) and moong (*Vigna radiata* L.) were higher in open areas than in shade under poplar based agrihortisilviculture system. Agronomic crops showed initially better performance under partial shade in yield and yield contributing parameters, and decreased as poplar canopy advanced in age. To minimize resource competition and improve physiological processes of crops, canopy management is essential to ensure better yield under poplar based agri-horti-silviculture system (Chauhan et al., 2013). Growth increment of poplar was significantly higher when planted with fruit crops as compared to sole poplar planting. In Punjab, poplar is reliable option for agroforestry. Profits to the tune of 38.8% and 100.9% of investments are reported from rising of nursery stock within one year. Benefit: cost ratio of 1.92:1 and 2.13:1 has been estimated with pure poplar and with poplar+intercropping in a pay-back period of 7 years (Dhillon et al., 2001).

The yield of clone G-3, which once used to be the most popular clone, is declining due to attack by leaf blight disease. This clone is giving way to other clones, e.g., S7C8, Uday, L-34/82 etc. Individual plantations are, however, monoclonal (Kumar et al., 1999). Luna et al. (2011) reported that clone WSL - 39 achieved the best growth and maximum volume in Punjab, attaining diameter of 14.74 cm; height 14.42 m and volume 0.1040 m^3/tree. This clone outperformed the clones for growth and volume since the beginning. The volume production of clone Udai was at par with WSL–39 at 2 and 3 years of age in Punjab. However, intensive cultivation of extensively

followed traditional paddy-wheat rotation is creating many complications in the agro-ecosystem of the state as it has resulted in lowering the ground water table, development of compact sub-soil layer and nutrient imbalance, and is thus no longer ecologically sustainable although economically profitable. The situation is at an alarming stage, which calls for a need to diversify rotation with superior profit through sustainable land use system while maintaining the status as well as increasing the production of agricultural crops in the state as well as in country.

Availability of macro-nutrients (N, P, K) and organic carbon was determined at different depths of soil and a decrease in availability of nutrients with increasing depth was recorded (Dhillon et al., 2012). Han et al. (2016) reported that the NPK chemical fertilizer decreased the soil pH and exchangeable calcium concentration, did not affect the soil concentrations of nitrogen and magnesium and increased the concentrations of available phosphorus and exchangeable potassium. Fertilization treatments increased the seedling height and root collar diameter by 21% and 29%, respectively and the mean dry weight of the stems and a leaf by 72% and 123%, respectively; but a synergistic effect of the organic manure and NPK fertilizer were not observed. Application of organic and inorganic fertilizers produced significantly higher fresh and dry weight of shoot and root and total biomass. The performances of growth were influenced significantly by N, P and K at different levels in Poplar (Saravanakumar and Shanthinipriya, 2017). The application of fertilizers about 20 cm from the poplar cuttings enhanced growth compared to untreated cuttings and was about twice as effective as banding of fertilizers (Van den Driessche, 1999). Similarly, the application of fertilizers applied to the base of a planted tree positively influenced its growth (Bilodeau-Gauthier, 2011). Since poplars are sensitive to competing vegetation (Fang and Badong, 2008) and fertilizing whole areas increases the growth of competing vegetation also. Durai et al. (2009) emphasized that the deliberately planted trees for enhanced economic gains will certainly exploit more natural resources including inherent nutrients of soil profile as compared to sole crop. Effect of fertilization on poplars during its growing phase applied as single nutrient in nursery has been known to be positive. However, detail of appropriate nutrient combinations and specific amounts vary according to soil type and clones responses to fertilization are not known. Therefore, the present study was conducted to assess the affect of NPK in combination on the growth of Poplar in nursery.

2. Materials and Methods

An experiment was conducted during the year 2015–16 and data on plant parameters were recorded during 2016. The texture and initial status of the soil was viz., Silty loam in texture, having pH 7.4, EC 0. 52, O.C. 0.45%, available N 180kg ha^{-1} and P 10kg ha^{-1} and K 298 kg ha^{-1}. Treatments consist Nine genotypes viz. PL-1, PL-2, PL-3, PL-4, PL-5, PL-6, PL-7, L-47/88, L- 48/89 and Four combinations of N, P and K applied as treatment viz, ($N_0P_0K_0$), ($N_{75}P_{50}K_{25}$), ($N_{150}P_{100}K_{50}$) and ($N_{225}P_{150}K_{75}$) with three replications were planted in the fields of department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana. The study site is situated at an elevation of 244 masl with a latitude of 30° 56' North and longitude of 75° 52' East. May and June were the hottest months whereas; December and January are the coldest. Frost occurrence is not common. On an average site received 704 mm rainfall, which is not evenly distributed and most of it i.e. 75-80% is receives during July and September. Three plants of each clone from each treatment were selected randomly. Further from each plant fully expanded leaves (5^{th} or 6^{th} leave from tip) were selected during of September and leaf area measurement was done by using portable leaf area meter (CID 110, CID INC, USA). The data was analyzed statistically two factor factorial design for the assessment of analysis of variance for morphological characters and plant nutrient analysis (Panse and Sukhatme, 1989). Data was analyzed with OPSTAT software.

3. Results and Discussion

The data presented in Table 1 related to plant height and collar diameter of poplar clones respectively, revealed that nutrients in different doses had significant effect on poplar growth plant height and collar diameter. Different recommended clones under study were recorded to be significant due to genotypes and their interaction effect with nutrients also recorded as significant (Table 1 and 2). The interaction effect shows that each clone has differential response for height and collar diameter growth to nutrient applied. Data reveals that among the nutrients maximum mean plant height 4.88m was recorded in treatment ($N_{225}P_{150}K_{75}$) followed by ($N_{75}P_{50}K_{25}$) 4.84m and the lowest mean height 4.56m was recorded in control ($N_0P_0K_0$). Among the clones the maximum mean height (5.42 m) was recorded in clone L-47/48 followed by clone PL-6 (5.25 m) and lowest mean height 4.12 m was recorded in PL-1 and the interaction between nutrient and clone was also found significant. Maximum plant height (5.62 m) was recorded in interaction between and clone L-47/48 and minimum plant height (3.62 m) was recorded in interaction between and clone PL-1.

However, maximum mean collar diameter 2.59 cm was recorded in treatment ($N_{225}P_{150}K_{75}$) followed by ($N_{150}P_{100}K_{50}$) 2.55 cm and the minimum mean collar diameter 2.53 cm was recorded in ($N_{75}P_{50}K_{25}$). Among the clones the maximum mean collar diameter was recorded in clone L-47/48 (2.78) followed by clone PL-6 (2.76 cm) and minimum mean collar diameter was recorded in PL-2 (2.31 cm) and the interaction between nutrient and clone was also found significant. Maximum collar diameter 2.92 cm was recorded in interaction between ($N_{150}P_{100}K_{50}$) and clone L-47/48 and minimum collar diameter 2.22cmwas recorded in interaction between ($N_{225}P_{150}K_{75}$) and clone PL-2 (Table 1). Baker and Randal (1975) reported

Table 1: Effect of different doses of N, P & K on Plant height and collar diameter of different poplar clones in nursery

Clone	Plant height (m)				Mean	Collar diameter (cm)				Mean
	Nutrients (kg ha^{-1})					Nutrients (kg ha^{-1})				
	($N_0P_0K_0$)	($N_{75}P_{50}K_{25}$)	($N_{150}P_{100}K_{50}$)	($N_{225}P_{150}K_{75}$)		($N_0P_0K_0$)	($N_{75}P_{50}K_{25}$)	($N_{150}P_{100}K_{50}$)	($N_{225}P_{150}K_{75}$)	Mean
PL-1	3.71	4.62	3.62	4.54	4.12	2.38	2.26	2.47	2.47	2.36
PL-2	4.05	4.10	4.38	3.95	4.12	2.26	2.33	2.42	2.22	2.31
PL-3	4.05	4.41	4.69	4.69	4.46	2.23	2.44	2.34	2.56	2.39
PL-4	5.25	4.55	4.56	4.93	4.82	2.58	2.41	2.46	2.54	2.50
PL-5	4.53	4.56	4.99	5.35	4.86	2.35	2.36	2.72	2.65	2.52
PL-6	5.32	5.56	5.05	5.08	5.25	2.74	2.88	2.69	2.74	2.76
PL-7	5.22	5.07	5.06	5.04	5.10	2.81	2.49	2.52	2.78	2.65
L-47/88	5.46	5.46	5.62	5.13	5.42	2.71	2.73	2.92	2.74	2.78
L-48/89	5.21	5.25	5.14	5.16	5.19	2.77	2.85	2.56	2.59	2.69
Mean	4.56	4.84	4.79	4.88		2.54	2.53	2.55	2.59	
CD (p=0.05)		Nutrients	0.019				CD (p=0.05)	Nutrients	0.02	
		Clones	0.024					Clones	0.03	
	Nutrients×Clones		0.058				Nutrients×Clones		0.05	

Table 2: Effect of different doses of N, P & K on average leaf area and above ground biomass of different Poplar in nursery

Clone	Average leaf area (cm^2)				Mean	Above ground biomass (kg plant^{-1})				Mean
	Nutrients (kg ha^{-1})					Nutrients (kg ha^{-1})				
	($N_0P_0K_0$)	($N_{75}P_{50}K_{25}$)	($N_{150}P_{100}K_{50}$)	($N_{225}P_{150}K_{75}$)		($N_0P_0K_0$)	($N_{75}P_{50}K_{25}$)	($N_{150}P_{100}K_{50}$)	($N_{225}P_{150}K_{75}$)	Mean
PL-1	369.27	318.34	419.28	377.33	371.06	2.72	2.65	2.68	3.20	2.81
PL-2	298.42	355.78	321.08	353.39	332.16	2.96	3.03	3.10	2.84	2.98
PL-3	350.33	382.46	331.77	365.58	357.53	2.88	2.91	2.78	2.82	2.85
PL-4	389.57	311.89	370.23	359.61	357.82	3.42	3.10	3.18	3.29	3.25
PL-5	375.47	368.95	388.28	341.99	368.67	2.98	3.02	3.12	2.93	3.01
PL-6	371.13	401.22	334.30	375.91	370.64	2.99	3.65	3.25	3.33	3.31
PL-7	382.31	382.01	377.06	394.30	383.92	3.42	3.18	3.21	3.19	3.25
L-47/88	345.47	377.09	405.39	339.75	366.92	3.02	3.09	3.77	3.32	3.30
L-48/89	379.29	396.22	382.52	378.25	384.07	3.41	3.51	3.25	3.29	3.37
Mean	362.36	365.99	369.99	365.12		3.09	3.13	3.15	3.13	
CD (p=0.05)		Nutrients	0.019				CD (p=0.05)	Nutrients	0.01	
		Clones	16.60					Clones	0.02	
	Nutrients×Clones		31.66				Nutrients×Clones		0.03	

that fertilization would not affect all poplar clones in the same way, so nutrient additions should be tailored to clonal requirement. Martin and Cater (1967) reported that height of *Populus deltoides* increased with higher fertilization doses of NPK. Nitrogen is known to increase the height of poplar clones (Nakos, 1979). Application of NPK fertilization has also reported to increase plant height in different poplar species by Jobling (1960), Satoo (1960), Blackmon and White (1972), Chen (1974), Denev (1974); Liani (1978). Clonal variation in plant height in poplar has been reported by several workers (Sidhu, 1994, 1996, Singh and Negi, 1996, Thakur et al., 1998). Gangoo et al. (1997) also reported increase in collar diameter in *Populus deltoides* with the application of 150 kg N ha^{-1} and 120 kg P_2O_5 ha^{-1} and 10 t manure ha^{-1}. Singh (2001) reported a significant increase in mean collar diameter with increasing levels of nutrients up to N_{100} P_{50} K_{25}. Isaiah (2013) reported that height and girth of Moringa were best supported by increased doses up to 120 kg ha^{-1} of N:P:K (15:15:15) fertilizers.

Similar response in *Populus deltoides* has also been reported by Brar and Katoch (1980), Deol (1982). Saravanakumar and Shantinipriya (2017) reported that the growth performance was influenced by NPK Levels significantly in *Populus deltoides*. Clonal variation in collar diameter of poplar has been reported by Nelson and Tauer (1987) Sidhu (1996) in *Populus deltoides*. Similar results have been drawn by Satoo (1960), Blackmon (1977), Brar and katoch (1980) Gangoo et al. (1997) in poplar, Bhardwaj et al. (1986) in *Bauhinia variegate* and Shivaprakash et al. (2000) in mulberry.

The data presented in Table 2 revealed average leaf area of poplar clones in the month of September revealed that nutrients in different doses showed non-significant effect on poplar growth (average leaf area). Different recommended clones under study were recorded to be significant due to genotypes and their interaction effect with nutrients also recorded as significant. Barigah et al., 1994 also reported that average leaf area of five poplar clones differed significantly due to their genotypes and related to higher biomass production in clones with higher average leaf area. The interaction effect shows that each clone has differential response to nutrient supplied in different combinations of N, P and K treatment ($N_0P_0K_0$), ($N_{75}P_{50}K_{25}$), ($N_{150}P_{100}K_{50}$) and ($N_{225}P_{150}K_{75}$). The affect of applied nutrients on leaf area revealed that maximum mean leaf area 369.99 cm^2 was recorded in treatment ($N_{150}P_{100}K_{50}$) followed by ($N_{75}P_{50}K_{25}$) (365.99 cm^2) and the minimum mean average leaf area 362.36 cm^2 was recorded in control T_0 ($N_0P_0K_0$). Among different clones the maximum average leaf area 384.07 cm^2 was recorded in clone L-48/89 followed by clone PL-7 (383.92 cm^2) and minimum leaf area 332.16 cm^2 was recorded in PL-2 and the interaction between nutrient and clone was found significant. Maximum leaf area 419.28 cm^2 was recorded in interaction between ($N_{150}P_{100}K_{50}$) and clone PL-1 and minimum average leaf area 298.42 cm^2 was recorded in interaction between in control ($N_0P_0K_0$) and clone PL-2.

Biomass of poplar clones in revealed that nutrients applied in different doses had significant effect on poplar biomass. Different recommended clones under study were recorded to be significant due to genotypes and their interaction effect with nutrients. The interaction effect showed that each clone has differential response to nutrient supplied in different combinations of N, P and K treatment ($N_0P_0K_0$), ($N_{75}P_{50}K_{25}$), ($N_{150}P_{100}K_{50}$) and ($N_{225}P_{150}K_{75}$) (Table 2). Further, among the nutrients treatments maximum biomass 3.15kg was recorded in treatment ($N_{150}P_{100}K_{50}$) followed by ($N_{225}P_{150}K_{75}$) and ($N_{75}P_{50}K_{25}$) (3.13 kg) and the minimum mean biomass 3.09 kg was recorded in control ($N_0P_0K_0$). Among different clones the maximum mean biomass 3.37 kg was recorded in clone L-48/89 followed by clone PL-6 (3.31 kg) and minimum mean biomass 2.81 kg was recorded in PL-1 and the interaction between nutrient and clone was also found significant. Maximum biomass 3.77 kg was recorded in interaction between ($N_{150}P_{100}K_{50}$) and clone L-47/88 and minimum biomass 2.65 kg was recorded in interaction between ($N_{75}P_{50}K_{25}$), and clone PL-1. DesRochers (2006) also reported the similar significant result of fertilization dosages of NPK on total biomass of *Populus deltoides*. Mohan (1992) also reported similar result in of effect of NPK fertilization on total biomass of *Terminalia myriocarpa* in nursery stage. Verlinden et al. (2013) reported that among the 12 genotype studied with genotype Hees showing the highest biomass production. Further, a strong interaction between clone (genotype) and fertilizer was observed for diameter, height and volume growth (Curlin, 1967). Such clonal differences may be the reflection of differential genetic potential of clones of favorable G×E interaction.

4. Conclusion

The application of fertilizer (nutrients) increases the growth parameters and nutrient uptake in leaf of ETPs when applied in combination (NPK in 3:2:1 ratio), resulted increase growth for most of the characters. It can be concluded from the present investigations that application of nutrient in combination increased growth and improved nutrient uptake in *Populus deltoides* leaves. Further, the result of present studies inferred that NPK in combination (3:2:1 ratio) should be used to increase the growth of Poplar.

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