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Short Communication

Effect of inorganic fertilizers and growth performance in Poplar tree - *Populus deltoides,* Tamilnadu, India

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Abstract

Nutrient management is one of the prime factors which play a pivotal role on the growth, development and successful completion of life cycle in all green plants. It is very essential to establish alternate and fast growing tree species to meet the raw material demand of various wood based industries. Poplar occupies an important place amongst fast growing species due to their multiple uses as an industrial raw material in pulp and paper. In this study, three levels of nitrogen (50, 75 and 100 g N plant^{-1}), three levels of phosphorus (75, 100 and 125 g P plant^{-1}) and three levels of potassium (50, 75 and 100 g K plant^{-1}) were applied to standardize the fertilizers schedule for the Populus deltoides tree species. Randomized block design with three replications and twenty eight (including control T_{28}) different treatment levels of NPK were used as experimental design. Growth components viz., plant height, collar diameter, volume index, leaf area, leaf area index and total biomass were observed and recorded. The performances of growth were influenced by N, P and K at different levels. From the study, it is revealed that among N, P and K levels, the application of 75:125:75 g NPK plant^{-1} (T_{17}) influenced significantly the growth performance of poplar followed by 100: 125:75 g NPK plant^{-1} (T_{26}). The total biomass was also altered by different levels of N, P and K and it was significantly influenced due to application of 75:125:75 g NPK plant^{-1}(T_{17}). These treatments are standardized and applied for Poplar species to enhance the growth for alternative pulp and paper species.

Keywords: *Populus deltoides*, Nitrogen, Phosphorus, Potassium, Growth attributes, Industrial uses.

Introduction

In India, decrease of forest areas have highly affected the supply of raw materials to the pulp and paper industries and it is necessary to develop alternative and fast growing species plantations outside the forest areas[1]. According to Indian Paper Mills Association, the production of paper in India accounts for 3 percent of worldwide production and during the year 2014-15, the domestic consumption of paper was 13.9 million tonnes. The average consumption of paper in India is at 11 kg, which is comparatively lower than other developed and developing countries[2]. And also with the rapid increase in population, the demand for pulp and paper has highly increased and on the other side, with the enactment of the Forest Conservation Act (1980) and subsequently with the National Forest Policy (1988) stated that, a forest-wood based industry (ply wood, matchwood, pulp and paper, etc) should raise the raw materials for their own requirements outside the natural areas, the industries should establish a direct relationship between the factory and the individuals supporting with inputs including credit, constant technical advice, harvesting and transport services. Hence it is very essential to establish alternate and fast growing tree species to meet the raw material demand of various wood based industries. Poplar occupies an important place amongst fast growing species due to their multiple uses as an industrial raw material in pulp and paper, particle board, match box[3].

Populus deltoides (Poplar), belonging to the family Salicaceae and commonly known as Eastern cottonwood. It is native to North America, Eastern part of Canada, and north eastern Mexico and the fastest growing commercial tree species. It is deciduous, a large tree growing with 25- 45m height (80–140 ft) and with girth of 1.9 m (6.3ft) diameter. Simple leaves with alternate, triangular shaped, coarse toothed, deltoid, flattened petioles at right angles to the blade[4]. Flowers are dioecious and occur from February to April before leaves appear. Application of inorganic fertilizers is one of the easy tools to enhance the growth of *Populus deltoides* and also shorten the rotation period. It has been proved to be a viable and economically feasible technology for enhancing the initial growth and development of the tree. With the above background, the study was contemplated to explore the effect of inorganic fertilizers *viz*., N, P and K at different nutrient level on growth attributes.

Materials and methods

The study was conducted at Forest College and Research Institute, Mettupalayam, Tamilnadu, India which is located at 11°19’ N latitude and 77°56’ E longitudes with attitude of 300

m Mean Sea Level (MSL) during the year 2013 -2014. The soil is red sandy loam, non-calcareous, neutral in reaction with low in nitrogen and phosphorus and medium in potassium. Treatments consisted of three levels of nitrogen (50, 75 and 100 g per plant), three levels of phosphorus (75, 100 and 125 g per plant) and three levels of potassium (50, 75 and 100 g per plant) to standardize the fertilizers schedule for the tree species. Randomized Block Design with three replications and twenty eight (including control T_{28}) were used as experimental design and different treatment levels of NPK are given below in Table-1.

Populus deltoides clones were planted at the espacement of 2x2m in the pits of 60 cm^3 dimension. Irrigation was given after planting and subsequent irrigation based on the soil moisture content. The observations on height, collar diameter, volume index, total biomass, leaf area and leaf area index were recorded. The data on the various parameters were subjected to statistical scrutiny[5]. The stage-wise data were analyzed separately in single factor analysis, using AGRESS software.

Results and discussion

The results and discussion of the growth attributes of inorganic fertilizers of *Populus deltoides* are given below. The parameters were recorded at 2 month interval of planting. The observations at 6 month after planting (MAP) are given in the Table-2.

Plant height: The plant height of *Populus deltoides* are given in the Table-2 at 6 month after planting (MAP) which showed significant variation at different treatments. Highest plant height (247.13 cm) was recorded with the application of 75:125:75 g NPK $plant^{-1}$ (T_{17}) followed by the application of 100:125:75 g NPK $plant^{-1}$ (T_{26}) compared to the control (T_{28}). The plant was higher due to application of 75:125:75 g NPK $plant^{-1}$ (T_{17}) indicating the optimal levels of fertilizer dose. The increase in height might be due to better utilization of nutrients as evidenced by higher nutrient uptake. It was found that application of different fertilizer levels helps in stimulating the plant growth in moderate or good soils and within three months of planting produces the maximum response of growth[6]. The present findings are in tune with the findings INM in teak applied at eight month old seedling along with the fertilizer dose of 200: 100: 200 N: P_2O_5: K_2O kg ha^{-1} increased significantly the plant height[7]. Application of fertilizer 200: 100: 50 NPK kg ha^{-1} at planting to *Populus deltoides* registered higher plant height[8].

Collar diameter: Collar diameter exhibited significant variation among the treatments given in the Table-2. The highest value (22.92 mm) due to application of 75:125:75 g NPK $plant^{-1}$ (T_{17}) and it was significantly superior to the rest of the treatments followed by T_{26} (19.49 mm) which received the nutrients of 100:125:75 g NPK $plant^{-1}$ compared to the control (T_{28}) recorded the lowest value of 7.27 mm. The effect of fertilizer levels on plant growth and biomass production in *Acacia auriculiformis* of eight months old seedlings, application of fertilizer dose of 120: 160: 80 NPK g $plant^{-1}$ at planting resulted in increase basal diameter (3.86 cm)[9]. The effect of fertilizers in *Eucalyptus pellita* with nutrient levels of 75g of N, 150g of P and 75 g of K investigated higher collar daimater at two year old plantation[10].

Table-1: Treatments Schedule for *Populus deltoides.*

Treatments	Nutrient Levels	Treatments	Nutrient Levels
T1	50:75:50 NPK g $plant^{-1}$	T15	75:100:100 NPK g $plant^{-1}$
T2	50:100:50 NPK g $plant^{-1}$	T16	75:125:50 NPK g $plant^{-1}$
T3	50:125:50 NPK g $plant^{-1}$	T17	75:125:75 NPK g $plant^{-1}$
T4	50:75:75 NPK g $plant^{-1}$	T18	75:125:100 NPK g $plant^{-1}$
T5	50:100:75 NPK g $plant^{-1}$	T19	100:75:50 NPK g $plant^{-1}$
T6	50:125:75 NPK g $plant^{-1}$	T20	100:75:75 NPK g $plant^{-1}$
T7	50:75:100 NPK g $plant^{-1}$	T21	100:75:100 NPK g $plant^{-1}$
T8	50:100:100 NPK g $plant^{-1}$	T22	100:100:50 NPK g $plant^{-1}$
T9	50:125:100 NPK g $plant^{-1}$	T23	100:100:75 NPK g $plant^{-1}$
T10	75:75:50 NPK g $plant^{-1}$	T24	100:100:100 NPK g $plant^{-1}$
T11	75:100:75 NPK g $plant^{-1}$	T25	100:125:50 NPK g $plant^{-1}$
T12	75:125:100 NPK g $plant^{-1}$	T26	100:125:75 NPK g $plant^{-1}$
T13	75:75:50 NPK g $plant^{-1}$	T27	100:125:100 NPK g $plant^{-1}$
T14	75:100:75 NPK g $plant^{-1}$	T28	Control

Table-2: Effect of NPK on plant height, collar diameter and volume index in *Populus deltoides.*

Treatments	Plant height (cm)	Collar diameter (mm)	Volume index	Leaf Area	Leaf area index	Total biomass (g plant^{-1})
T_1	143.08	12.82	235.04	2090.97	4.27	629
T_2	141.97	12.65	227.06	2030.73	4.05	459
T_3	180.80	15.94	458.68	2278.30	4.77	949
T_4	178.95	15.89	459.39	2276.43	4.76	939
T_5	163.22	14.61	350.90	2234.77	4.56	771
T_6	143.40	13.10	245.58	2101.57	4.30	638
T_7	163.88	14.80	360.94	2239.60	4.57	800
T_8	181.63	16.03	474.13	2279.00	4.84	963
T_9	167.48	14.91	376.84	2251.23	4.59	848
T_{10}	159.92	14.37	332.94	2200.70	4.47	760
T_{11}	148.35	13.17	258.09	2125.47	4.44	652
T_{12}	177.58	15.88	446.18	2274.00	4.68	879
T_{13}	154.10	13.93	301.05	2191.60	4.47	708
T_{14}	175.02	15.73	441.34	2272.70	4.66	879
T_{15}	186.60	16.85	540.66	2294.83	4.93	1322
T_{16}	184.83	16.67	527.06	2286.03	4.87	1254
T_{17}	247.13	22.92	1490.25	2600.73	5.40	1621
T_{18}	185.05	16.70	533.22	2293.50	4.90	1290
T_{19}	175.00	15.61	435.97	2272.30	4.63	865
T_{20}	172.80	15.42	417.01	2270.20	4.63	855
T_{21}	145.03	13.16	251.16	2104.20	4.39	651
T_{22}	164.25	14.84	365.33	2243.70	4.57	838
T_{23}	184.00	16.46	516.87	2282.87	4.84	1119
T_{24}	172.07	15.08	397.39	2257.33	4.60	853
T_{25}	152.43	13.50	279.56	2185.60	4.46	654
T_{26}	221.20	19.49	899.47	2295.27	4.94	1362
T_{27}	183.27	16.11	483.69	2281.40	4.84	984
T_{28}	86.27	7.27	45.66	1706.30	3.64	111
Mean	169.2613	15.139	433.98	2222.19	4.609	880.4
SEd	11.171	1.188	194.135	117.810	0.033	6.5
CD (p=0.05	22.397	2.381	389.217	236.193	0.066	13.1

Volume index: The results revealed that the various nutrient applications significantly influenced the volume index in *Populus deltoides.* The volume index recorded higher in the treatment of 75:125:75 g NPK plant^{-1} (T_{17}). The optimal level of N, P and K might have improved the nutrient content and uptake in the plant resulting in an increased metabolic activity which led to quick growth of plant. The present findings are in tune with the effect of manures and fertilizers increased the growth of *Acacia auriculiformis* of twelve month old seedlings and indicated that application of 200:100:100 NPK kg ha^{-1}and FYM 2.5 t ha^{-1} at planting increased volume index to the tune of (23.95 m^{3}ha)[11]. The stand volume of *Acacia mangium* at the age of 5 years and results showed that maximum tree volume of 222 m^3 ha^{-1} in 13.7:17.3: 9 g NPK per tree[12]. The effect of inorganic and organic nutrient management study in *Acacia auriculiformis* higher recorded the stem volume (8.97cm^3) in application of FYM @ 2 kg plant^{-1} + N:P:K at 20:10:20 g and enhanced the growth rate of crop[13].

Leaf area (LA) and Leaf area index (LAI): The higher value of LA (2600.73) was due to the application of 75:125:75 g NPK plant^{-1} (T_{17}) followed by the application of 100:125:75 g NPK plant^{-1} (T_{26}) with a value of 2295.27 compared to the control (T_{28}).

The higher value of LAI (5.40) 75:125:75 g NPK plant^{-1} (T_{17}). This was followed by the application of 100:125:75 g NPK plant^{-1}(T_{26}) with a value of 4.94 and control (T_{28}) recorded which did not receive any nutrients registered the lesser value of 3.64. The increased of LAI was due to the optimum quantity of Nitrogen, Phosphorus and Potassium fertilizers, further application of N have influenced the formation of chlorophyll content in the plants, which helps to improve the photosynthetic activity and resulted in vigorous growth and development of plant[7]. The integrated nutrient management on *Hydnocarpus pentandra* seedlings revealed that maximum leaf area index was recorded in treatment receiving Mycorrhizae (5g) + NPK (1:1:1) 1g[14]. The response of growth, fertilization, above ground biomass increment in young Douglas fir plantation registered improvement of LAI low 2.8, medium 4.4 and high 10.7 at seven years old[15].

Total biomass: The increase in total biomass was reflected from the favorable growth of tree crop promoted by the application of N, P and K at optimum levels. Application of 75:125:75 g NPK plant^{-1} (T_{17}) recorded 1621 g plant^{-1} of biomass followed by the application of 100:125:75 g NPK plant^{-1}(T_{26}). This present findings are tune with many workers, the reported in teak the treatment imposed with 200: 100: 200 NPK kg ha^{-1} on eight month old seedling significantly increased the total biomass[7]. The stand volume of *Acacia mangium* biomass yield of 154.4 t ha^{-1} in 13.7:17.3:9 g NPK per tree[12]. The study conducted in *Dalbergia sissoo* (7.81 g plant^{-1}) was observed in 200 kg N, 50 kg P_2O_5 and 150 kg K /ha[16]. The biomass recorded (17.54g plant^{-1}) in 250:30:150 kg NPK /ha[17]. The seedlings recorded in 6.04 g/seedlings in *Pterocarpus santalinus* in 0.5 NPK/seedlings[18].

Conclusion

From the investigations, the application of 75g of N per plant, 100g of P per plant 75g of K per plant of can enhance plant height, collar diameter, volume index, leaf area, leaf area index and total biomass. It is suggested that treatment (T_{17}) is sufficient to increase the growth of *Populus deltoides* in red sandy soils. The treatments vary from soil to soils.

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