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Nitrogen and phosphorus use efficiency of poplar species under different fertilization levels in Kashmir

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Abstract
The study investigated the nitrogen and phousphours use efficiency of different poplar species under different fertilization doses in nursery stage under temperate conditions of Kashmir. The experiment was carried out employing split plot design (SPD) with 36 treatments having 4 species with 3 levels of N and 3 levels of P replicated three times at Faculty of Forestry, SKUAST-Kashmir, Wadura, Sopore, Baramulla during 2013-14. The investigation on nutrient use was carried out by planting the cuttings of four poplar species *viz., Populus nigra, P. ciliata, P. alba* and *P. balsamifera* at a spacing of 60cm x 30cm in all the treatments. All the treatments of fertilizer either individually or in combination of N and P have significantly differed over control. The nutrient use efficiency (NUE) of N and P decreased with the increase in fertilizer doses while as the maximum NUE for N was recorded at T_6 (75+120 kg ha^{-1}) and Pat T_8 (150+60 kg ha^{-1}) but differed significantly over other treatments. Hence, nitrogen addition rate of T_6 (75+120 kg ha^{-1}) and phosphorus addition rate of at T_8 (150+60 kg ha^{-1}) is the paramount for achieving maximum growth and biomass production of poplar cuttings under the temperate condition of the Kashmir

Keywords: Nitrogen and phosphorus use efficiency, poplar species, fertilization, Kashmir

Introduction
Growing poplars at farm level in the form of woodlot and agroforest has become popular among rural household in Kashmir (Masoodi *et al*., 2014) [1]. The poplar species cultivated in the Kashmir valley are *P. deltoides, P. nigra, P. balsamifera, P. ciliata and P. alba* at present. Among them *P. deltoides* has been introduced in the valley in 1950 s which was later cultivated to every nook and corner of the valley due to its fast growth and adaptability (Gangoo *et al*., 2015) [2]. Although, various clones of the *P. deltoides* have been introduced in the valley but no record is available in the scientific journals.
P. nigra is said to have been introduced by Mughal's during 18th century as an avenue tree which is now-a-days it is found along national highways and roads as an avenue tree and on boundaries of farmlands as an agroforestry tree throughout Kashmir valley (Islam *et al*., 2015) [3]. In an investigation carried out to screen promising clones of *P. nigra* (Gangoo *et al.*, 2015) [2], significant inter-clonal variation has been found for various growth characters among the clones of *P. nigra* cultivated in various districts of Kashmir Valley. The cultivation of the indigenous species *P. balsimifera, P. ciliata* and *P. alba* are diminishing day by day due to non-availability of information of their management practices and quality plant material in the valley (Islam *et al*., 2016) [4]. For poplar farming as in case of all the plant species propagated through nursery raised seedlings healthy and vigours nursery plants are a prerequisite (Islam *et al*., 2015) [3]. The proper nutrition provided at nursery stage is of paramount importance to get healthy and vigorous planting stock (Kaushik *et al*., 2012; Singh *et al*., 2016) [5-6]. Keeping in view the multipurpose uses, rapid increase in growth and demand, it became necessary to determine the nutrient use efficiency of different poplar species with different doses of fertilizers in temperate condition of Kashmir.

Material and Methods
The cuttings were taken from phenotypically superior trees already in cultivation practice in and around Srinagar district. The fresh cuttings of 20cm length with 20mm diameter of uniform size were planted/ raised in the second fortnight of February in a split plot design in a well prepared nursery beds of (3.60m^2) with a spacing of 60cm x30cm in three replicates. The total cuttings of each species planted were five hundred forty (540). Before planting, the cuttings were dipped in a copper-oxy-chloride 150 WP fungicide solution @ 3 g/ liter of water

for ½ an hour. For planting holes were made in the nursery beds with the help of a planting rod, slightly thicker than cuttings with a sharpened lower end.
The cuttings were planted in the holes with thinner end up in such a way that the upper portion was just 2mm above the soil. The soil was firmly pressed around the cutting so that the cuttings come in contact with mineral soil. In order to prevent desiccation losses the cuttings were planted in such a manner that the slanting cut is faced towards east. The cuttings were given flood irrigation just after completion of planting (Chandra, 1986) [7]. The fertilizer was applied in two split doses, first in the second fortnight of April after bud burst in cuttings and the second dose in the second fortnight of June at the time of weeding-cum-hoeing in poplar cutting beds to avoid the losses due to leaching, dinitrification *etc.* The nitrogen was supplemented through urea and diamonium phosphate (DAP), while as phosphorus was supplemented through single super phosphate (SSP) and DAP. The dosage was determined after calculating the percentage of N and P available in different fertilizers. The cultural operations, like irrigation, weeding and singling were carried out from time to time. Uniform irrigation was given to the experimental trial at fortnightly intervals for first two months *i.e.* up to April and from April onwards irrigation was given at ten days intervals (Chandra, 1986) [7]. Weeding and hoeing were done as per the requirement at monthly intervals and utmost care was given to the cuttings to avoid any kind of disturbance. Singling was done in the month of July. Only one promising shoot of each plant was allowed to grow and the additional shoots were detached from the plant with the help of sharp sketchers without causing any splinting damage.

Fig 1: Fresh and dry weight of leaves, roots and shoots (g)

Fresh and dry weight of roots and shoots

The roots and shoots was detached separately and put into sampling bags. Fresh weight of samples was recorded and then oven dried at a temperature of 105±2ºC for 72 hours and weighed again (ASAE, 1994) [8]. The fresh and dry weight obtained on digital balance (Plate 1) was averaged and converted into fresh and dry weight per plant (g). Moisture percentage in shoots and roots was determined by the formula:

$$\text{Per cent moisture} = \frac{\text{Fresh weight-dry weight}}{\text{Fresh weight}} \times 100$$

At the end of each growing season the calculated weight of each treatment of each plot of each species of leaves, roots and shoots on the dry weight basis were added and expressed as biomass plant^{-1}.

Nutrient use efficiency (w/w)

After calculating dry weight/ plant the nutrient use efficiency was calculated on dry weight basis by the formula given by Laxminarayana and Patiram (2006) [9].

$$\text{Nutrient use efficiency (w/w)} = \frac{\text{Treatment yield-control yield}}{\text{Amount of nutrients applied}}$$

Results and Discussion

Nitrogen and phosphorus use efficiency

The data (Table 1&2) revealed that the application of lowest dose of N fertilizer T_4 *i.e.* (75 kg h^{-1}) with the higher dose of P fertilizer T_3 *i.e.* (120 kg ha^{-1}) recorded maximum N use efficiency (10.66, 28.50) while minimum (4.21, 11.56) was recorded at T_7 *i.e.* (150 kg ha^{-1}) nitrogen during the two growing years, respectively. The N use efficiency decreased with increase in N dose either alone or in combination with P. All the treatments differed significantly among each other. Application with lower or higher dose of P fertilizer either alone or in combination with the lower dose of N fertilizer showed the lower P use efficiency. However, by applying with the higher dose of N fertilizer T_7 (150 kg h^{-1}) with the lower dose of P fertilizer T_2 (60 kg ha^{-1}) showed the maximum (17.38, 41.01) P use efficiency while minimum (3.25, 7.97) P use efficiency was recorded by applying individual dose of P *i.e.* T_3 (120 kg ha^{-1}) in both the consecutive years, respectively. All the treatments differed significantly among the treatments in both the years. Hence, it is concluded that P use efficiency increases with the higher level of nitrogen with lower level of phosphorus but decreases with the increase in phosphorus level either individually or in combination with nitrogen level in both years (Fig. 2). So, it is concluded that N and P have synergetic effect with each other with the result NUE of N is increased when lowest dose of N is added with a highest dose of P and PUE is increased when lowest dose of P is added with the highest dose of N. Hence, it clearly indicated that the maximum N use efficiency was obtained at lowest dose of N with highest dose of P (75+120 kg ha^{-1}) and P use efficiency at higher dose of N with lower dose of P (150+60 kg ha^{-1}). While, as the maximum nutrient use efficiency of N and P was observed at lowest individual dose of N and P fertilizer, however, nutrient use efficiency decreased with the increase in fertilizer doses. Results are in conformity with the findings of Hilal *et al.* (2013) [10] who studied the effect of nitrogen fertigation on kail (*Pinus wallichina*) and revealed that nitrogen concentration in shoot and root decreased at lower nitrogen level as seedlings age increased, but increased at higher nitrogen fertigation levels in needles, stem, and roots, whereas, nitrogen use efficiency (NUE) decreased with increasing nitrogen levels. Sunil *et al.* (2005) [11] reported that the nutrient use efficiency in *Azadirachta indica* (Neem) seedlings decreased with the increase in nutrient supply.

Table 1: Nitrogen use efficiency/plant of various poplar species in the nursery

Treatment	S_1		S_1		S_1		S_1		Mean	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
T_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_4	7.67	20.11	7.79	22.49	7.27	18.49	9.40	21.68	8.03	20.69
T_5	10.24	27.06	10.52	28.91	9.87	26.61	12.00	31.40	10.66	28.50
T_6	13.59	34.83	13.80	38.62	13.59	33.51	15.99	21.17	14.24	32.03
T_7	4.84	9.60	3.68	12.96	3.37	8.89	4.96	14.80	4.21	11.56
T_8	6.95	15.44	6.32	18.53	6.21	15.13	8.34	16.51	6.96	16.40
T_9	7.10	15.28	6.16	18.85	5.97	14.87	8.60	16.51	6.98	16.38
Mean	5.60	13.59	5.36	15.60	5.14	13.06	6.59	13.56		
		Year				1st year	2nd year			
		Fertilizer (A)				0.34	0.52			
CD $p \leq 0.05$		Species (B)				0.13	0.16			
		Factor B at same level of A				0.12	0.20			
		Factor A at same level of B				0.36	0.55			

Note:- $T_1=N_0P_0$ (control), $T_2=N_0P_1$(0, 60 kg/ha), $T_3=N_0P_2$ (0, 120 kg/ha), $T_4=N_1P_0$ (75, 0 kg/ha), $T_5=N_1P_1$ (75, 60 kg/ha), $T_6=N_1P_2$ (75, 120 kg/ha), $T_7=N_2P_0$ (150 kg/ha), $T_8=N_2P_1$ (150, 60 kg/ha), $T_9=N_2P_2$ (150,120 kg/ha) S_1= *P. nigra*, S_2=*P. ciliata*, S_3=*P. alba*, S_4=*P. balsamifera*

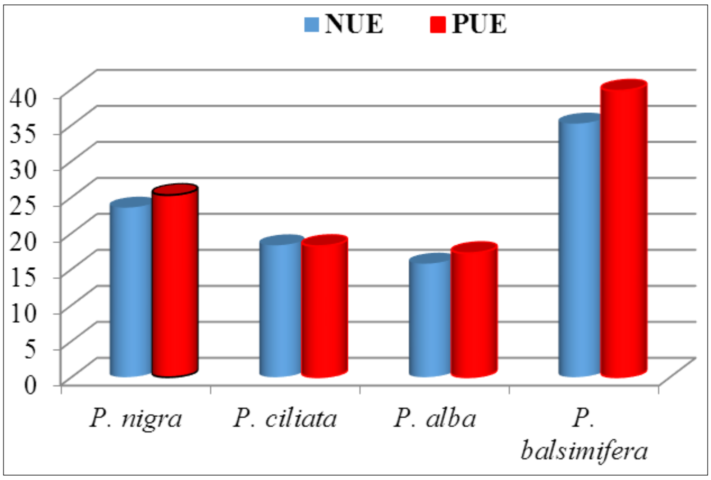

Fig 2: Effect of N and P on nitrogen and phosphorus use efficiency by different *Populus* species

Table 2: Phosphorus use efficiency/ plant of various poplar species in nursery

Treatment	S_1		S_1		S_1		S_1		Mean	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
T_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_2	4.74	13.79	4.58	10.29	3.73	8.20	5.30	6.68	4.59	9.74
T_3	3.36	10.37	3.19	7.47	2.84	6.20	3.59	7.84	3.25	7.97
T_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_5	12.80	36.14	13.15	33.83	12.34	33.26	15.00	39.25	13.32	35.62
T_6	8.49	24.14	8.63	21.77	8.49	20.95	9.99	13.23	8.90	20.02
T_7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_8	17.36	46.33	15.80	38.59	15.53	37.82	20.84	41.28	17.38	41.01
T_9	8.88	23.57	7.70	19.10	7.47	18.59	10.76	20.64	8.70	20.48
Mean	6.18	17.15	5.89	14.56	5.60	13.89	7.28	14.32		
		Year				1st year	2nd year			
		Fertilizer (A)				0.26	0.16			
CD $p \leq 0.05$		Species (B)				0.09	0.15			
		Factor B at same level of A				0.029	0.46			
		Factor A at same level of B				0.36	0.43			

Note:- $T_1=N_0P_0$ (control), $T_2=N_0P_1$(0, 60 kg/ha), $T_3=N_0P_2$ (0, 120 kg/ha), $T_4=N_1P_0$ (75, 0 kg/ha), $T_5=N_1P_1$ (75, 60 kg/ha), $T_6=N_1P_2$ (75, 120 kg/ha), $T_7=N_2P_0$ (150 kg/ha), $T_8=N_2P_1$ (150, 60 kg/ha), $T_9=N_2P_2$ (150,120 kg/ha) S_1= *P. nigra*, S_2=*P. ciliate*, S_3=*P. alba*, S_4=*P. balsamifera*

Among the species the mean N use efficiency was recorded maximum for *P. balsamifera* (6.59) in first growing year and in second growing year by *P. ciliata* (15.60) and minimum in *P. alba* (5.14,13.06) in first and second year, respectively. Among the tested poplar species under study all the species differed significantly among each other for P use efficiency in both the growing years. However, the best P use efficiency in first year was observed in *P. balsamifera* which showed 17.79, 23.59 and 30.00% more efficiency than *P. nigra, P. ciliata* and *P. alba*. During the second growing year *P. nigra* showed 17.78, 19.76 and 23.47% P use efficiency greater than *P. ciliata, P. balsamifera* and *P. alba* in the two growing years, respectively. Among the species NUE differed from first year to second year. So, the differences in nutrient use efficiency of N and P among the species may be due to the result of genetic constituent of the species and environmental factors. Our results collaborate with the findings of Pastor *et al.* (1984) [12] who reported that differences in nutrient use efficiency among tree species were due to inherent nutrient use efficiency rather than a phenotypic response to nutrient availability. In our study some species in first year showed maximum nutrient use efficiency even after the growth was lower than those which have low nutrient use efficiency which indicated that such species have ability to grow in those soils which have exhausted the soil reserves. This conservation strategy may decrease nutrient use efficiency immediately but may be beneficial for growth when the soil reserves are exhausted. These results are in conformity with the findings of Mengel and Kirkby (1982) [13], Bielski and Fergusun (1983) [14] and Chapin (1987) [15] which revealed that the species which absorb nutrients in excess of growth requirements (luxury consumption) may use these reserves to support growth after soil reserves are exhausted. This conservation strategy may decrease nutrient use efficiency (g mass/g nutrient) immediately but may be beneficial for growth when the soil reserves are exhausted and thus ultimately would have the potential to contribute to future productivity.

Conclusion

In order to produce high-quality entire tree plants (ETPs) of *Populus nigra, P. ciliata, P. alba* and *P. balsamifera*, the producers must secure cuttings of phenotypically high-quality trees. Nitrogen addition rate of T_6 (75+120 kg ha^{-1}) and phosphorus addition rate of at T_8 (150+60 kg ha^{-1}) is the paramount for achieving maximum growth and biomass production of poplar cuttings which is often poorly understood and poorly treated.

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References

1. Masoodi TH, Ahmad H, Gangoo SA, Sofi PA, Bhat MA, Islam MA. Ecological occurrence of Himalayan Poplar (Populus ciliata Wallich. Ex. Royle.) and its nursery evaluation under temperate conditions of Kashmir. The Bioscan. 2014; 9(2):85-588.
2. Gangoo SA, Masoodi TH, Shah M, Islam MA. Management of exotic poplars for production of quality timber and reducing cotton menace in Kashmir. The Indian Forester. 2015; 141(5):514-519.
3. Islam MA, Masoodi TH, Gangoo SA, Sofi PA, Bhat GM, Wani AA *et al*. Perceptions, attitudes and preferences in agroforestry among rural societies of Kashmir. India. Journal of Applied and Natural Science. 2015; 7(2):976-983.
4. Islam MA, Sofi PA, Bhat GM, Wani AA, Gatoo AA, Singh A *et al*. Prediction of agroforestry adoption among farming communities of Kashmir valley, India: a logistic regression approach. Journal of Applied and Natural Science. 2016; 8(4):2133-2140.
5. Kaushik A, Negi R, Barthwal S and Singh YP, Mapping Research on Poplar (*Populus spp*.) in ‘Forest Science Database’, Forestry Bulletin. 2012; 12(1):151-156.
6. Singh H, Mavi HK. Economic analysis of poplar based agroforestry system under riparian wet land conditions of Punjab. Indian Journal of Economics and Development. 2016; 12(1):191-196.
7. Chandra JP. Poplar-A cash crop for North Indian Farmers. Indian Forester. 1986; 112(8):698-710.
8. ASAE. (American Society of Agricultural Engineers), Moisture measurements-forage, ASAE standards. 1994; 358:92-93.
9. Laxminarayana K, Patiram. Effect of Integrated use of inorganic, Biological and Organic manures on Rice productivity and soil fertility in Ultisols of Mizoram. Journal of the Indian Society of Soil Science. 2006; 54(2):213-220.
10. Hilal A, Masoodi TH, Bashir A, Hassan GI, Mir SA, Sofi PA *et al*. Biomass allocation and nitrogen distribution of Pinus wallichiana Jackson seedlings under different nitrogen fertigation levels. African Journal of Agricultural Research. 2013; 8(13):1166-1173.
11. Sunil P, Swamy SL. Nutrient use efficiency N and P in Azadirachta indica seedlings grown under diffused and complete light conditions. Indian Forester. 2005; 131(11): 1437-1448.
12. Paster J, Aber JD, Mc-Claugherty CA, Melillo JM. Aboveground production and N and P cycling along a Nitrogen mineralization gradient on Blackhawk Island, Wisconsin. Ecology. 1984; 65:256-268.
13. Mengel, Kirkby, Principles of Plant Nutrition, 3rd Edn. International PottashInstitute, Worblaufen-Bern, Switzerland. 1982.
14. Bielski RL, Fergusun IB. Physiology and metabolism of phosphates. In: Inorganic Plant Nutrition, Encycloedia of Plant Physiology (Eds. A. Launchi and R. L. Bielski). Springer-Verlag, New York. 1983; 15:422-429.
15. Chapin FS. Adaptation and Physiological response of wild plants to nutrient stress. Genetic aspects of Plant Mineral Nutrition (Eds. H. W. Gableman, and B. C. Loughman). Martinus Nijhopff, Dordrecht, The Netherlands, 1987, 15-25.