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Nutrient Uptake and Productivity Pattern in Wheat Under Populus Deltoides Based Agrisilviculture System

Alka Mishra

Department of Rural Technology, Guru Ghasidas University, Bilaspur (C.G.), India

ABSTRACT

N, P and K uptake and productivity of wheat were studied under five promising clones (G3, G48, 65/27, D121 and S7C1) of Populus deltoides in agrisilviculture system. The yields were highest in sole wheat and reduced under poplar clones from 15 to 30.3% and from 22.7 to 42.5%, respectively. The reduction of wheat yields in different clones was in the order: G3<S7C1<D121<65/27<G48. The total nutrient uptake varied from 34.17 to 66.09 kg N ha-1, 12.04 to 25.32 kg P ha-1 and 35.6 to 67.6 kg K ha-1. After 6 years of poplar planting, N in soil increased by 14.9-24.1%, P by 17.2- 23.3% and K by 3.1-5.1% at 0-20 cm depth. The study suggested adopting lopping, root hoeing and nutrient management practices in poplar clones G48 and 65/27 to minimize yield losses in wheat under these clones

KEYWORDS : Leaf area index (LAI); Lopping; Photosynthetically active radiation (PAR), Poplar, tree crop competition

INTRODUCTION

Tree based land use systems have strong potential to restore the productivity of degraded agro-ecosystems through efficient nutrient cycling, conserving soil moisture besides improving the supplies of fire wood, timber, fibre, medicine, food etc. and secure local and industrial needs of the country. There is growing interest among farming communities to integrate fast growing multipurpose trees in agroforestry systems to obtain early and good economic returns. *Populus deltoides*, is one among such promising species recognized as important tree component in agroforestry / farm plantations of north India above 28^{0}N latitude. Several promising clones of G series, D, Sc and St series, L and WSL series have been identified and planted extensively in farm/agroforestry systems throughout Punjab, Haryana, Tarai region of U.P. and some parts of Bihar, West Bengal and Assam states (Singh *et al.* 2001). Poplar wood is an important source of plywood, paper pulp and match splint industries. It is usually managed in 6-8 year rotation cycle under agroforestry system. Owing to its rapid growth, high biomass, adoptability, early economic returns and compatability with crops prompted to introduce poplars in agroforestry systems in Chhattisgarh, central India. Poplar was first introduced in the state during 1995 (Puri *et al.* 2002). Only limited efforts were made to understand the productivity and eco-physiology of wheat under poplar based agroforestry system in Chhattisgarh. Therefore, the present study was conducted to assess the variation in eco-physiological parameters, nutrient uptake and productivity in wheat under different clones of *P. deltoides* in agrisilviculture system .

MATERIALS AND METHODS

The experiment was conducted at Forestry Research Farm of Indira Gandhi Agricultural University, Raipur Chhattisgarh (Latitude 21^0 12′ N; Longitude 81^0 36′ E).

Five promising clones *viz.* 65/27, G3, G48, D121 and S7C1 of poplar were planted at 4 x 4 m spacing as monoclonal blocks in a randomized block design with three replications. Sixteen trees were maintained for a clone in a given replication. Wheat (*Triticum aesitivum* var. GW-273) was intercropped in rabi (November-March) under 5-and 6-year-old mature clones. The seeds were sown at the rate of 125 kg ha^{-1}. N, P and K were applied in wheat @ 120 kg N ha^{-1}, 35 kg P ha^{-1} and 25 kg K ha^{-1}. Half of the N and full doses of P and K were applied as basal dose. Remaining half dose of N was top dressed at 60 days after sowing (DAS). The observations of three days were averaged to obtain mean values. Yield and its attributes of wheat such as effective tillers, seeds per spike, spike length, grain and straw yields were recorded at the time of harvesting (125 days). The plant samples of wheat such as seeds, straw and roots were randomly collected under different clones and sole crop and were oven dried at 70 ^{0}C and ground in a Willey mill to pass through a 2 mm sieve before chemical analysis. The samples were analyzed for total N, P and K (Jackson, 1967). The uptake of nutrients was calculated as the product of nutrient concentration with their respective dry biomass on ha basis. The uptake by individual crop components was added together to derive total uptake of a given nutrient. Mean data of two years on crop growth and yield were used to compute the average nutrient uptake in wheat. The soil nutrient (N, P and K) status was determined in different clones of poplar and sole crop after the harvest of wheat at 6 years age. Triplicate samples of soils were randomly collected from different treatments at 0-20 cm and 20-40 cm soil depths and analyzed for available N, P and K following the procedures suggested by Jackson (1967). Morphological growth parameters *viz.* dbh, height, clean bole, crown width and crown length of trees were recorded after the harvest of crop. DBH was measured using tree caliper and plant height by Abney's level. Crown diameter was measured in the centre of the crown using a bamboo pole fixed with horizontal marked stick.

RESULTS AND DISCUSSION

Clones exhibited significant ($P \leq 0.05$) variation in growth (Table 1). Between five and six years, dbh increased by 3.9 to 43.1% and total tree height by 3.3 to 26.2% in different clones. Dbh and tree height were consistently higher in clone 65/27 and lowest in clone S7C1. In 6th year, mean annual increments (MAI) in dbh and height were 1.6 and 1.3 times higher in clone 65/27 compared to clone S7C1. Clones D121, G48 and G3 did not show any significant differences in dbh and height with clone 65/27 at this age. Crown diameter and its length were higher in clones 65/27, G48 and G3, and lowest in clones S7C1 and D121 (Table 1). Clonal variations do not seems to be extraordinary in poplars as several studies reported variation in growth and biomass production in clones of *P. deltoides* (Chaturvedi and Rawat, 1994; Singh *et al.* 2001). The better performance of clones 65/27, G3, G48 and D121 was attributed to their intrinsic ability of these clones to cope with the prevailing growing conditions and nevertheless to make best use of the available resources . This attributes wider adaptability of these clones as they can be grown in north as well as in central India (Chhattisgarh). The yield and yield attributes of wheat were significantly influenced by poplar clones in agrisilviculture system (Table2). Grain yield varied from 25.5 to 36.6 q ha^{-1} and straw yield from 34.9 to 60.7 q ha^{-1}. The yields were highest in sole wheat and reduced under poplar clones. The reduction in grain and straw yield of wheat in different clones was in the order: G3<S7C1<D121<65/27<G48. The reduction in grain yield varied from 15 to 30.3% and straw yield from 22.7 to 42.5%. This might be due to detrimental effect of shade exerted by poplar clones on wheat. The clones G48 and 65/27 casted relatively more shade than other clones due to their large crowns and huge amount of foliage.

N, P and K concentrations varied significantly in seed and straw components of wheat grown under different poplar clones (Table3). Concentration of N and P was higher in seeds followed by straw and roots. Nutrient concentrations of wheat were higher in sole crop and also under clone S7C1 in comparison to other poplar clones. Nutrient concentrations were lowest in wheat under clones G48 and 65/27. In seeds, N varied from 0.96 to 1.12%, P from 0.27 to 0.37% and K from 0.28 to 0.39%. Similar to nutrient concentration, its uptake was also

highest in sole wheat and decreased under poplar clones. The uptake of nutrients in wheat was lowest under clones G48 and 65/27 (Table 3). N and P uptake was higher in seed, while K uptake in straw. The total nutrient uptake varied from 34.17 to 66.09 kg N ha^{-1}, 12.04 to 25.32 kg P ha^{-1} and 35.6 to 67.6 kg K ha^{-1}. Although nutrient status in the soil was quite higher under *P. deltoides* clones but uptake was lower due to root competition between tree and crops for available nutrients. Puri *et al.* (1994) demonstrated that poplar is a shallow rooted tree where the bulk of the roots were concentrated in top 0-20 cm soil profile. The presence of tree and crop roots in same ecological niche resulted strong competition and facilitated the efficient absorption of nutrients by trees than crops. Lack of root competition increased the uptake of nutrients in the sole wheat. The higher concentrations of nutrients coupled with more seed, straw and root biomass resulted in higher nutrient uptake in sole wheat. The nutrient uptake in wheat was lowest especially under poplar clones G48 and 65/27 indicates the strong competition for nutrients between these clones and wheat, which could be minimized through root management or supplementing additional amount of nutrition. The strong competition for both light (PAR interception) and soil nutrients declined the wheat yield under poplar clones G48 and 65/27. The study indicates that poplar clones *viz.* G3, D121 and S7C1 were quite promising and despite competition for light and nutrients, both these clones showed promising growth and adoptability in agroforestry system. Therefore, it is suggested to adopt lopping, root hoeing and nutrient management practices in clones G48 and 65/27 to minimize yield losses in wheat under these clones.

Table 1: Variation in growth of *Populus deltoides* clones in agrisilviculture system

Clone	Dbh (cm)		Total height (m)		Clean bole (m)		Crown length (m)		Crown diameter (m)	
	5th year	6th year	5th year	6th year	5th year	6th year	5th year	6th year	5th year	6th year
G3	14.6	19.3	10.9	13.6	4	5.0	6.9	7.3	2.2	3.6
G48	16.1	19.7	12	14.5	4.9	5.3	7.3	8.2	2.5	3.8
65/27	15.1	21.6	13.1	14.3	4.8	5.6	9.1	9.4	3.3	4.3
D121	14.7	20.1	10.3	13.0	3.6	3.8	6.7	7.4	2.8	3.1
S7C1	12.8	13.3	10.8	11.16	3.4	3.9	7.4	8.2	2.1	2.5
LSD (P<0.05)	0.06	3.57	0.1	1.85	0.1	1.03	0.07	0.84	0.02	1.3

Note : LSD- Least significant difference , Dbh- Diameter at breast height (1.37 m on trunk)

Table 2: Variation in yield and its attributes of wheat under *P. deltoides* based agrisilviculture system

Clones		Grain yield (q ha -1)			Straw yield (q ha-1)		
	5th yr	6th yr		Mean	5th yr	6th yr	Mean
G3	30.2	32.1		31.1	53.5	40.4	46.9
G48	24.2	26.7		25.5	36.3	33.6	34.9
65/27	27.2	28.7		27.9	44.9	29.7	37.3
D121	29.1	30.3		29.7	42.8	34.4	38.6
S7C1	30.1	31.4		30.8	44.9	35.3	40.1
Sole crop	37.5	35.1		36.6	79.1	42.4	60.7
LSD (p<0.05)	0.44	NS		0.41	0.74	5.94	4.35

Table 3: Nutrient (N, P and K) concentration (%) in wheat under *P. deltoides* based agrisilviculture system

Clone	Seed N (%)	Stover N (%)	Root N (%)	Seed P (%)	Stover P (%)	Root P (%)	Seed K (%)	Stover K (%)	Root K (%)
G3	0.96	0.36	0.27	0.33	0.16	0.07	0.33	0.83	0.17
G48	0.92	0.31	0.25	0.27	0.14	0.06	0.28	0.79	0.14
65/27	0.83	0.30	0.22	0.27	0.14	0.06	0.28	0.76	0.13
D121	0.96	0.37	0.27	0.31	0.15	0.07	0.34	0.81	0.15
S7C1	1.05	0.39	0.29	0.34	0.16	0.09	0.36	0.83	0.18
Sole crop	1.12	0.40	0.30	0.37	0.19	0.09	0.39	0.87	0.20
LSD (P<0.05)	0.15	0.05	NS	0.05	NS	NS	0.05	0.06	NS

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