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Growth and Productivity of Wheat (*Triticum aestivum)* Varieties Under Different Poplar (*Populus deltoides* Bartr.) Clones in *Tarai* Region of Uttarakhand

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Key Words:

Dry matter, Grain and straw yield, Poplar clone, *Tarai* region, Tillers, Wheat variety, Yield attributes

ABSTRACT

Field experiments were carried out at Agroforestry Research Ceneter, of G.B.P.U.A. & T., Pantnagar, Uttarakhand (29°N Latitude, 79° 30' E longitude and at an altitude of 243.84 masl) during *rabi* seasons of 2013-14 and 2014-15 to study the performance of diverse varieties of wheat under different types of poplar clones. The field comprised sandy loam soil with 1.17% of organic carbon, 259, 20 and 195 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively. The experiment was designed in split plot with four poplar tree clones *viz.,* S_7C_8, G-48, W-39 and Kranti in main plots and wheat varieties *viz.,* DBW-17, PBW-502, UP-2748 and HD-2967 in sub-plots. Poplar clones were planted in the year 2012 at spacing of 7.0 m x 3.0 m, having total 476 trees ha^{-1}. Different poplar clones (age 2 and 3 years) did not affect significantly the growth (tiller m^{-2} and plant dry matter m^{-2}), yield attributes (spikes m^{-2}, grain weight/spike, grain number/spike and 1000 grain weight) and productivity of wheat. However, under clone Kranti and S_7C_8, higher values of these parameters were recorded. Wheat varieties HD-2967 and DBW-17 out yielded varieties UP-2748 and PBW-502 for grain yield, straw yield and biological yield. Variety PBW-502 was the lowest yielder during both the years. Variety HD-2967 recorded higher values of grain weight/spike and grain number/spike. The number of spikes (productive tillers m^{-2}) was the maximum with variety DBW-17 in 2013-14 (443 m^{-2}) and HD-2967 (404 m^{-2}) in 2014-15. Variety UP-2748 recorded the lowest number of spikes m^{-2} during the years, but higher grain weight/spike than other varieties except HD-2967 in 2014-15.

INTRODUCTION

In India, increase in population and consequent increase in demand for various kinds of papers and the emphasis on papers as an environment-friendly packaging material has increased the demand of wood. Agroforestry is an ideal land use option as it optimizes tradeoffs between increasing food production, poverty alleviation and environmental conservation (Izac and Sanchez 2000). Agriculture across the world is witnessing a very typical situation. On one hand, demand for food, fuel, fodder and raw materials

are increasing but on the other, natural resources are shrinking and deteriorating. Further, the environmental pollution is also increasing day by day. To arrest this decline and sustain the capacity of natural resources, moving toward agro-forestry system is a viable proposition, as this system has numerous advantages over the sole cultivation of arable crops.

In north India, Poplar cultivation has become the major choice of the growers. Due to deciduous nature of the tree, many field crops can successfully be integrated with it. Wheat is most common crop grown in inter-tree spaces of the poplar trees upto rotation age of 6-8 years. The yield of wheat however decreases with increase in age of trees. Expansion of tree canopy (branches and leaves) takes place with advancement of age, leading to increased shaded area. Chauhan et al. (2011) observed decrease in wheat growth and yield with the increase in poplar age ranging from 17% under one year old plantation to 52.2% under five year old plantation. Wheat varieties too have different growth pattern and habits owing to variable plant architecture. Gill et al. (2009) found variable response in different varieties tested in poplar based system in Punjab. However, limited work has been done on this aspect in *tarai* region of uttarakhand and Uttar Pradesh. The present study therefore was undertaken to study the productivity of different wheat genotypes in combinations with different clones of polar in *tarai* region of the Uttarakhand State.

MATERIALS AND METHODS

The field experiment was conducted at Agroforestry Research Center (AFRC), G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (29°N Latitude, 79° 30' E longitude and at an altitude of 243.84 masl) during *rabi* seasons of 2013-14 and 2014-15. The site is characterized by a humid sub-tropical, cold and hot dry summers with 1400 mm mean annual rainfall, of which 80 to 90% is received between June and September. The remaining 10 to 20% rainfall is received during wheat-growing season (November to April). The soil of the study site is sandy loam soil with 1.17% of organic carbon, 259, 20 and 195 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively.

The experiment was designed in split plot with tree species in main plots and varieties in sub-plots and treatments were replicated thrice. Four different clones of poplar *viz.,* S7C8, G-48, W-39 and Kranti were planted in the year 2012 at spacing of 7.0 m x 3.0 m, having total 476 trees ha^{-1}. Four diverse wheat varieties (DBW- 17, PBW-502, UP-2748 and HD-2967) were sown at a uniform row-to-row distance of 20 cm on both sides of the tree line using 100 kg seed ha^{-1}. The wheat was supplied with 120:60:40 kg N- P_2O_5- K_2O ha^{-1}. Half dose of nitrogen and full dose of phosphorus and potassium were applied as basal. The remaining nitrogen in equal splits was applied after crown root initiation stage and pre-heading stage, respectively. Three irrigations were applied to the crop coinciding with crown root initiation (21 days after sowing), late jointing (65 DAS) and milking stage (105 DAS) during both the years. For weed control, Clodinafop + MSM @ 150 g ha^{-1} was applied in 5^{th} week after sowing.

Growth parameters *viz.,* tiller number and dry matter were recorded at 60 and 90 days after sowing. Yield attributes were recorded on 50 cm row samples (25 + 25 cm) from both sides of the tree line. A net plot of 2.0 x 2.0 m was harvested from both sides of the tree line and biological; grain and straw yields were recorded. Data were analyzed by using standard statistical procedure for split-split plot design (Panse and Sukhatme 1967) with the help of OP stat statistical package.

RESULTS AND DISCUSSION

Wheat crop growth

During both the years of study at both the stages of growth determination (60 and 90 DAS), tiller production by wheat was not affected significantly under different poplar clones (Table 1). However, clones S_7C_8 and Kranti exhibited superiority over other clones in test. Wheat varieties differed for tiller number except at 60 DAS in 2014-15. During both the years at 60 DAS, variety HD-2967 produced the highest and

significantly higher tillers than UP-2748 but at par with DBW-17 and PBW-502. At 90 DAS in 2014-15, variety HD-2967 was significantly superior to other varieties for tiller number m^{-2}. Variations in tiller production among varieties may be credited to variable genetic potential of different varieties. Chauhan and Dhiman (2002) also found variable tillering pattern among different varieties of wheat grown in agroforestry system with poplar trees. Research findings of Jain (1998) are also in accordance with present results.

The dry matter accumulation was also not affected significantly under different poplar clones (Table 1). Under clone Kranti, highest value of plant dry matter at 60 DAS was recorded. At 90 DAS, under clone Kranti in 2013-14 and clone S_7C_8 in 2014-15, highest plant dry matter m^{-2} was observed The plant dry matter accumulation varied significantly among wheat varieties (Table 1). At 60 DAS, variety UP-2748 produced significantly higher plant dry matter than variety PBW-502 but remain at par with variety HD-2967 during both the years. At 90 DAS, variety HD-2967 produced significantly higher dry matter than PBW-502 but remain at par with UP-2748 and DBW-17. At early crop stage (60 DAS); the dry matter accumulation was the maximum in the variety UP-2748, while at later stage (90 DAS) it was with variety HD-2967. The higher dry matter in former was mainly due to its larger leaves, as it is has drooping leaf. In other varieties, the variations in dry matter accumulation may be owing to variable tillering ability. Variable trend of dry matter accumulation among the wheat varieties across the growth stages is in line with Malik et al. (2012), who found higher dry matter in variety Sonalika at 30 DAS, while in UP-262 at 50 and 70 DAS. Variety HD-2967 recorded the maximum dry matter at this stage owing to its high tillering ability. Al-musa et al. (2012) also noted variations in wheat genotypes in growth pattern particularly

Table 1. Tiller production and dry matter accumulation in wheat under different poplar clones.

Treatment	Tiller number (m^{-2})				Dry matter accumulation (g m^{-2})			
	60 DAS		90 DAS		60 DAS		90 DAS	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Poplar clone								
S_7C_8	649	586	459	407	244.3	210.7	958.8	859.5
G-48	644	581	452	400	242.5	214.0	948.9	846.6
W-39	650	587	464	404	245.6	213.8	947.0	854.8
Kranti	658	588	460	411	250.9	219.6	987.8	858.8
SEm±	13.8	2.3	11.6	4.8	11.2	1.6	10.3	7.6
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Wheat variety								
DBW-17	668	593	465	403	249.8	213.0	956.2	839.0
PBW-502	648	588	460	400	220.7	209.9	935.4	818.9
UP-2748	608	558	444	396	265.4	223.8	972.4	874.3
HD-2967	678	602	465	422	247.4	219.4	978.6	887.5
SEm±	13.9	6.8	6.6	5.7	5.7	2.5	8.7	15.2
CD 5%	41	20	NS	17.0	16.8	7.2	25.5	44.7

Wheat yield attributes

Yield contributing parameters of wheat viz., spikes m^{-2}, grain weight/spike, grain number/spike and 1000 grain weight did not vary significantly due to association with different poplar clones (Table 2). Higher values of these parameters were found under the clones Kranti and S_7C_8. Except number of grains/spike, all other parameters differed significantly among the wheat varieties (Table 2). Variety HD-2967 recorded higher values of grain weight/spike and grain number/spike except UP-2748 in 2014-15. The number of spikes (productive tillers m^{-2}) was maximum with variety DBW-17 in 2013-14 (443 m^{-2}) and HD-2967 (404 m^{-2}) in 2014-15. All the yield contributing parameters were the lowest with the variety PBW-502 except the number of spikes m^{-2}. Variety UP-2748 recorded the lowest number of spikes m^{-2} during the years, but higher grain weight / spike than other varieties except HD-2967 in 2014-15.

Jain (1998) observed significant differences among wheat varieties for number of spikes, grain weight per spike, 1000-grain weight. Higher values of growth parameters, particularly the dry matter accumulation and tillering resulted in increased yield contributing components at harvest of the crop. Differences among wheat varieties for number of grains per spike (Puri and Bangarwa 1992 and Kumar et al. 2010) and the number of effective tillers and seeds per spike (Puri et al. 2001) have been reported by many researchers.

Wheat yield

During both the years, the grain yield of wheat did not vary significantly under different clones of poplar (Table 3). The grain yield was lower during the 2014-15 as compared to 2013-14. Reduction in grain yield with advancement of the tree age (increasing shading) is in accordance with Sharma and Dadhwal (2007). During both the years, the grain yield was the highest under the clone Kranti, respectively being 4216 kg ha^{-1} in 2013-14 and 3879 kg ha^{-1} in 2014-15. In 2013-14, as compared to clone Kranti, the grain yield of wheat decreased by 0.7, 0.9 and 4.1% under the clone W-39, S_7C_8 and G-48, while in 2014-15 the reduction was to the tune of 5.2, 2.7 and 4.4%, respectively. Puri and Sharma (2002), and Swami and Mishra (2014) also observed variation in grain yield of wheat due to presence of different clones of poplar owing to their variable canopy growth. Non-significant effect of poplar clones on wheat performance may further be attributed to young age of poplar trees (2 and 3 years) having less shading effect.

During both the years, the wheat grain yield differed significantly among the varieties (Table 3). During first year, variety DBW-17 recorded the maximum grain yield (4383 kg ha^{-1}), which was statistically at par with variety HD-2967 (4285 kg ha^{-1}). Also, both these varieties produced significantly higher grain yield than varieties PBW-502 (3855 kg ha^{-1}) and UP-2748 (4099 kg ha^{-1}). During 2014-15, the highest grain yield of 3895 kg ha^{-1} was recorded by the variety HD-2967, which was statistically at par with the variety DBW-17. Both these varieties were found significantly superior to the variety PBW-502. Among all the varieties the lowest grain yield was recorded by the variety PBW-502 (3594 kg ha^{-1}). During second year also, this variety produced 301 kg ha^{-1} lower grain yield as compared to HD-2967 and 261 kg ha^{-1} compared to variety DBW-17. The variation in grain yield may be ascribed to variation in yield attributes. Variety HD-2967 recorded the highest values for grain weight/spike, grain number/spike, and 1000-grain weight, besides having the second highest number of spikes m^{-2}. Variety DBW-17 recorded the highest number of spikes m^{-2} and was second in order for grain number/spike.

The straw yield of wheat was not affected significantly under different clones of poplar during both the years (Table 3). During 2013-14, the highest straw yield (5868 kg ha^{-1}) was recorded under the clone S_7C_8, followed by under the clone Kranti. The straw yield got decreased by 184, 278 and 364 kg ha^{-1} under the clones Kranti, G-48 and W-39, respectively as compared to the highest producing clone S_7C_8. During second year, the

maximum straw yield was found under the clone Kranti (5498 kg ha^{-1}), followed by under the clone S_7C_8. During both the years, wheat varieties differed significantly for straw yield (Table 3). Among the wheat varieties, significantly the highest straw yield (5835 and 5697 kg ha^{-1}), was recorded by the variety HD-2967, which was statistically at par with DBW-17 (5824 and 5618 kg ha^{-1}). During both the years, the lowest straw yield was produced by the variety UP-2748. The straw yield of variety HD-2967 got increased by 510 and 610 kg ha^{-1} compared to variety UP-2748 during 2013-14 and 2014-15, respectively.

The biological yield of what was not affected significantly under different poplar clones (Table 3). In 2013-14, the highest biological yield (10047 kg ha^{-1}) was recorded under the clone S_7C_8 closely followed by under the clone Kranti (9900 kg ha^{-1}). Under the poplar clones G-48 (9632 kg ha^{-1}) and W-39 (9690 kg ha^{-1}), the biological yield was almost comparable. Poplar clones G-48 and W-39 recorded 4.3 and 3.7% lower biological yield compared to the highest yielding clone S_7C_8. In 2014-15, it was the highest under the clone Kranti (9377 kg ha^{-1}) followed by under the clone S_7C_8 (9215 kg ha^{-1}). During second year also, the biological yield was comparable under the clones G-48 (9158 kg ha^{-1}) and W-39 (9095 kg ha^{-1}). Under the clone Kranti, the wheat biological yield increased by 3.1% over the clone W-39 (9095 kg ha^{-1}) and 2.3% over the clone G-48.

Table 2. Yield contributing characters of wheat under different poplar clones

Treatment	Spikes (m^{-2})		Grain weight/spike (g)		Grains/spike (No.)		1000 grain weight (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Poplar clone								
S_7C_8	437	399	1.84	1.96	42.8	47.5	42.6	42.8
G-48	427	389	1.82	1.97	41.5	45.9	42.2	42.0
W-39	434	397	1.80	1.98	43.0	43.8	42.7	42.3
Kranti	439	396	1.88	1.99	44.4	45.6	43.2	42.7
SEm±	6.0	6.4	0.02	0.04	0.62	0.86	0.3	0.25
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Wheat variety								
DBW-17	443	399	1.77	1.92	42.7	46.3	41.3	41.2
PBW-502	433	393	1.70	1.86	39.8	43.8	43.3	42.8
UP-2748	418	385	1.82	2.06	41.8	45.4	42.5	43.0
HD-2967	423	404	2.04	2.05	47.6	47.3	43.5	42.8
SEm±	4.5	4.8	0.02	0.05	0.80	0.91	0.52	0.44
CD 5%	13	14	0.07	0.13	2.3	NS	1.54	1.30

Table 3. Productivity and harvest index of wheat under different poplar clones and wheat varieties.

Treatment	Biological yield (kg ha^{-1})		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest index (%)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Poplar clone								
S_7C_8	10047	9215	4179	3738	5868	5477	41.5	40.6
G-48	9632	9158	4042	3684	5590	5473	42.0	40.3
W-39	9690	9095	4185	3709	5504	5386	43.2	40.8
Kranti	9900	9377	4216	3879	5684	5498	42.6	41.4
SEm±	218	83.2	103	63	150	109	0.65	0.8
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Wheat variety								
DBW-17	10207	9474	4383	3855	5824	5618	43.0	40.7
PBW-502	9517	9026	3855	3594	5662	5432	40.5	39.8
UP-2748	9424	8754	4099	3667	5325	5087	43.5	41.9
HD-2967	10120	9592	4285	3895	5835	5697	42.1	40.6
SEm±	169	114	77	56	120	92	0.51	0.5
CD 5%	495	336	226	164	351	269	1.5	NS

The wheat varieties differed significantly for biological yield (Table 2). Variety DBW-17 (10207 kg ha^{-1}) in 2013-14, and variety HD-2967 (9592 kg ha^{-1}) in 2014-15, produced the highest biological yield. However, these varieties did not differ significantly from each other during both the years but were significantly superior to varieties UP-2748 and PBW-502. Wide variations in grain, straw and biological yields of wheat varieties under poplar clones have also been reported by Singh et al. (1993), Jain (1998) and Kumar et al. (2010).

Different clones of poplar did not influence significant the harvest index of wheat during both the years (Table 3). The highest harvest index value was recorded under the clone W-39 which was followed by under the clone Kranti in 2013-14. During the second year (2014-15) among the clones, the highest harvest index of 41.4 % was recorded under the clone Kranti, which was comparable to clone W-39. The lowest harvest index was noted for clone G-48.

Among different wheat varieties, the maximum harvest index was found with the variety UP-2748 (43.5%), which remained statistically at par with varieties PBW-17 and HD-2967 (Table 3). All these three verities were found significantly superior to the variety PBW-502. During 2014-15 too, wheat variety UP-2748 registered the maximum harvest index, while the minimum was found with the variety PBW-502 (39.8%). Malik et al. (2012) also did not find significant difference for HI in two wheat varieties.

CONCLUSION

Findings of present investigation suggests that poplar clones *viz.*, Kranti or S_7C_8 and wheat varieties DBW-17 or HD-2967 may be followed for a high productive agroforestry

system in *tarai* region of Uttarakhand.

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