

Growth Response of Male and Female Clones of *Populus ciliata* Wall. ex Royle to Nitrogen Fertilizer

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Populus ciliata is an important early successional and fast growing dioecious tree in temperate Himalaya; it is extensively planted as an agroforestry species. Growth response of male and female clones of this species to different levels of nitrogen (30,60,90 kg/ha) was investigated on sandy-loam soil in the nursery. Male and female clones did not reveal any significant difference in growth and other related characteristics at juvenile stage (up to six months after raising the plants from cuttings). However, male clones tended to have longer internodes, higher plant dry weight, higher concentration of nitrogen in the foliage and heavier wood as compared to the female clones. Application of nitrogen significantly influenced plant height, collar diameter, internodal length, dry matter production, foliar nitrogen, specific gravity and fibre length; female clones gave a positive response up to 90 kg N/ha but male clones only up to 60 kg N/ha and showed a decline with higher level. Significant nitrogen $\times$ clone interaction was observed for internodal length and collar diameter.

Key Words: *Populus ciliata*, Growth, Nitrogen, Male and female clones

Introduction

Populus ciliata like other poplars, is a dioecious tree of temperate Himalaya. Its fast growth rate and short rotation period along with multiple uses, both industrial and local, make this species an important component of social forestry and agroforestry systems. The natural phenotypic variation in the species is extensive (Khosla et al. 1979) which is influenced both by biotic interference and ecological factors. A provenance trial of *P. ciliata* has been established at H. P. Agricultural University, Solan to screen the promising clones. Being a dioecious tree the information on growth

characteristics of male and female clones is useful for any breeding programme and for commercial exploitation of the species. Khosla et al. (1979) noticed non-significant growth differences between male and female trees in natural stands, though females were slightly better in growth. The present study reports the growth response of male and female clones to different levels of nitrogen fertilization.

Materials and Methods

Branch cuttings from ten trees of uniform dbh (40-45 cm) of male and female *P. ciliata*

growing in Kulu Forest Division (31.01–33.30°N latitude and 75.20–77.50°E longitude) were collected and raised at Shilli nursery (1300 m; 30.57°N; 77.06°E) Solan during the first week of March, 1981.

The male and female clones were treated with three levels of nitrogen (30, 60, 90 kg/ha) in a randomized block design with six replications. Stem cuttings were planted at a spacing of 40 × 30 cm in well-prepared beds (1.5 × 1.5 m). The required quantity of the fertilizer in the form of calcium ammonium nitrate was applied in two equal splits; first dose was given after three months (June) of planting and the second one two months thereafter (August). Weeding and watering were done regularly.

Ten randomly selected plants from each bed were harvested at the end of the study period during September 1981 and plant height, collar diameter, internodal length and plant dry matter were recorded. Composite samples of leaves were analysed for total nitrogen by the Kjeldahl's method (Jackson 1967). Wood samples of randomly selected trees were taken for determining specific gravity with maximum moisture method (Smith 1954) and wood fibre length with the method outlined by Pandeya et al. (1968). Data were statistically analysed following Panse and Sukhatme (1967).

Results and Discussion

Male and female clones showed non-significant differences for all the characters observed viz., plant height, collar diameter, internodal length, dry matter production, foliar nitrogen specific gravity and fibre length (tables 1 and 2). However, male clones tended to have higher dry matter, longer internodes, higher foliar nitrogen and heavier wood in unfertilized clones and clones fertilized up to a level of 60 kg/ha. This is in contrast to what is observed in adult plants (Khosla et al. 1979) of female trees of *P. ciliata* which are slightly better in growth

than male ones though the differences were not statistically significant.

IL'IN (1972) while studying the male and female clones of *Populus tremula* also observed that male trees had 4–5 per cent higher wood density and higher foliage nitrogen during the period of maximum foliage than female clones. Wood density was found to be directly related to the stored nutrients. Randall and Blackman (1977) observed that foliar nitrogen as well as leaf weight increased with increasing rates of nitrogen application in *P. deltoides*. But in the present study there was no significant difference in wood specific gravity as a result of nitrogen fertilization in either of the clones.

As a result of nitrogen application up to 60 kg/ha, apparently male clones showed better height and production of organic matter than female clones up to an age of six months after raising the plants. Similar observations were also taken by Einspahr (1960) in *P. tremula*. However, Pauley (1948), Muhle (1954), Farmer (1964) reported male trees to be superior in growth and form than female ones in natural stands. For meaningful comparison, the growth performance of male and female trees needs to be studied in plantations for a period at least half of the rotation age of the crop.

Nitrogen application showed significant ($P < 0.5$) effect on all the growth characters as compared to the control. Specific gravity of wood was significantly increased with the application of nitrogen up to 30 kg N/ha and thereafter, it declined with higher doses of nitrogen. All other growth character viz., plant height, collar diameter, internodal length, plant dry matter, nitrogen concentration in foliage and fibre length were enhanced only up to the application of 60 kg N/ha (table 1 and 2). However, the growth response declined with higher dose of 90 kg/ha as compared to 60 kg/ha. Similar observations were also taken on plant height and diameter (Jobling 1960, Alibert 1964,

Table 1 Effect of different levels of nitrogen on plant height, diameter, internodal length and dry weight of male and female clones of *Populus ciliata*

Character	Clone	Level of nitrogen (kg/ha)			
		N ₀ (Control)	N ₃₀	N ₆₀	N ₉₀
Height (m)	Male	1.30C*	1.62B (24%)	1.76A (85%)	1.74B (33%)
	Female	1.22C	1.64B (49%)	1.80A (48%)	1.91A (56%)
	Av.	1.26c	1.62b	1.88a	1.82a
Diameter (cm)	Male	1.02D*	1.19C (17%)	1.51A (48%)	1.32B (29%)
	Female	1.02D	1.20C (18%)	1.37B (34%)	1.49A (46%)
	Av.	1.02d	1.19c	1.44a	1.40a
Internode length (cm)	Male	3.67C*	4.41B (20%)	4.83A (32%)	4.27B (16%)
	Female	3.56C	4.04B (13%)	4.68A (31%)	4.78A (34%)
	Av.	3.61c	4.23b	4.75a	4.52a
Dry weight (kg/plant)	Male	0.18C*	0.28B (55%)	0.41A (127%)	0.37A (105%)
	Female	0.18C	0.24B (33%)	0.33A (116%)	0.41A (127%)
	Av.	0.18c	0.26b	0.40a	0.39a

*Character means with the same letter are not significantly different at 0.5 level. Capital letters are for treatment and small letters for individual treatment. Figures in parenthesis represent the difference over control

Table 2 Effect of different levels of nitrogen on foliar nitrogen concentration, wood fibre length and wood specific gravity of male and female clones of *Populus ciliata*

Character	Clone	Level of nitrogen (kg/ha)			
		N ₀ (Control)	N ₃₀	N ₆₀	N ₉₀
Foliar nitrogen (%)	Male	3.24C*	3.45AB (6%)	3.57A (10%)	3.52A (9%)
	Female	3.09C	3.35B (8%)	3.46A (12%)	3.52A (14%)
	Av.	3.16b	3.40a	3.52a	3.52a
Wood specific gravity (g/c.c.)	Male	0.40BC*	0.44A (10%)	0.41B (3%)	0.39BC (—3%)
	Female	0.39BC	0.42AB (8%)	0.41B (5%)	0.39C (0%)
	Av.	0.39c	0.43a	0.41b	0.39c
Wood fibre length (mm)	Male	0.39C*	0.42B (8%)	0.44A (13%)	0.42B (8%)
	Female	0.38C	0.42B (10%)	0.44A (16%)	0.43AB (13%)
	Av.	0.39c	0.42b	0.44a	0.43b

*Character means with the same letter are not significantly different at 0.5 level. Capital letters are for treatment and small letters for individual treatment. Figures in parenthesis represent the difference over control

Sheedy 1976, Brar & Katoch 1980), foliar nitrogen (Dykstra 1973) and fibre length (Foulger et al. 1971) in different poplar species, under nursery conditions.

Significant nitrogen $\times$ clone interactions were noticed for collar diameter and internodal length indicating differential response of male and female clones to nitrogen fertilization. Female clones showed a positive response up to 90 kg N/ha, but male clones attained maximum growth at a lower dose (60 kg N/ha) and application of higher doses did not show further increase in collar diameter. Similar responses, though insignificant ($P > 0.5$) were also observed for plant height, dry matter and foliar nitrogen. It may be assumed that stem cuttings of female trees might have adapted to the nutri-

tional stress during seed production stage and might have lower concentration of nitrogen as compared to male clones, thus giving response at higher fertilization level. However, the detailed studies to confirm the hypothesis are required. IL'IN (1973) reported the effect of site and relief on distribution of male and female trees of *P. tremula*. Female trees predominated on flood plains and ravines and males on drier sites, but, the growth differences were non-significant. The slightly better performance of female trees of *P. ciliata* was attributed to their occurrence on exposed and open places (Khosla et al., 1979). The female clones may thus perform better on fertile sites, whereas, male clones possess better adaptability to harder edaphic sites.

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