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Effect of Cutting Size and Different Doses of Nitrogen on Growth and Biomass of *Salix alba* in Nursery Stock

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ABSTRACT

The field trials on *Salix alba* were conducted during 2015-16. A curvilinear relationship was observed when rates of nitrogen application were regressed with total biomass yield. It indicated that application of 150 kg N ha^{-1} was adequate to get optimum yield from cutting sizes. This signified that *Salix* responded significantly to N application @ 150 kg N ha^{-1} and resulted in 27.66 and 76.74 percent increase in total biomass yield of 0.5-1.5 cm and 1.5-2.5 cm cutting sizes respectively. The growth of *Salix* with cutting size of 1.5-2.5 cm was found to be more superior as compared to 0.5-1.5 cm cutting size. Results show that the stock vigour index increases when nitrogen doses from 50-200 kg N ha^{-1} were applied. The impact is more noticeable from 50-150 kg N ha^{-1} rather than 150-200 kg N ha^{-1}.

INTRODUCTION

Crop diversification from rice-wheat has attracted the attention of government and farmers of Punjab due to continuous decrease in ground water table, and pollution of soil/water. Agroforestry intercropping allows structural and functional diversification of agricultural systems. In Punjab, main tree species raised for agroforestry are *Populus*, *Eucalyptus* and *Melia*. But, an another species willow, which is multipurpose, fast growing and has lots of potential in sports industry, phytoremediation and biomass production can be introduced for farm forestry plantation under diverse climatic and edaphic conditions of Punjab.

Willows are very important tree species for the ecology and economy of countries in temperate and subtropical zones of the world (Anonymous 2010). Willows belong to the genus *Salix*, family *Salicaceae*, are light demanding deciduous trees and shrubs, found primarily on moist soils in cold and temperate regions of the northern hemisphere. Willows provide a wide range of wood products (including industrial roundwood and poles, pulp and paper, reconstituted boards, plywood, veneer, sawn timber, packing cases, pallets and furniture), non-wood products (fodder, fuelwood) and services (shelter, shade, protection of soil, water, crops, livestock and dwellings).

Nitrogen (N) is considered to be the principal soil nutrient influencing willow plantation productivity (Weih and Nordh 2005). The use of inorganic N fertilizers have been used extensively for several decades, in attempts to promote the successful establishment and growth of planted willow but, the reported growth response of numerous willow varieties to added fertilizer N when grown under field conditions has been inconsistent, thereby precluding definitive relationships (i.e., calibrated fertilizer recommendations) between applied fertilizer N rates and subsequent willow biomass yields from being developed and applied universally (Hangs et al 2012).

Work done on Salix in Punjab is very limited and not up to mark. Department of Forestry and Natural Resources have initiated introduction of promising clones from different sources for their testing under farm forestry. Nursery stock of good quality is essentially required, so that it can be provided to farmers of Punjab for better willow timber production.

MATERIALS AND METHODS

The study area is at 247m above mean sea level and lies at 30°45' N latitude and 75°40' longitude, represents central zone of Punjab. Climate is sub-tropical to tropical with a long dry season from late September to early June and wet from July to early September. May and June are the hottest months where, December and January are the coldest. Frost occurrence is not common. On an average site receives 704 mm rainfall, which is not evenly distributed and most of it (i.e. 75-80% is received during July-September. This study was conducted in 2015-16 on nursery area of Department of Forestry and Natural Resources, PAU. Seven hundred Cuttings were collected from University Seed Farm, Ladhowal, Ludhiana of two size i.e. 0.50-1.50 cm and 1.51 to 2.50 cm. Five nitrogen doses i.e. 0 kg N ha-1, 50 kg N ha^{-1}, 100 kg N ha^{-1}, 150 kg N ha^{-1}, 200 kg N ha^{-1} were applied in three split doses i.e. 15 days, 1.5 months and 2.5 months after raising cutting. Cuttings were raised in polythene bags of 20 cm size and cutting were irrigated regularly. Three replications (20 cuttings per replication) were undertaken in this study.

Table 1. Physio-chemical characteristics of the soil

Characteristics	pH (1:2)*	Organic carbon (%)	Sand (%)	Silt (%)	Clay (%)	Texture	Available N	Available P	Available K
Contents	8.2	0.27	71.2	18.0	11.80	Loamy sand	177	15.2	209

Observations for plant height, collar diameter, number of branches, shoot biomass (gm), root biomass and stock vigour index were recorded after six months from the date of planting.

Stock vigour index = Survival % x plant height
Sturdiness quotient = Plant height/ collar diameter.

Available nitrogen was determined by alkaline permanganate method as modified by Subbiah and Asija (1956). Available phosphorus was extracted in 0.5M $NaHCO_3$ adjusted to pH 8.5 (Olsen et al 1954) and phosphorus was determined by phospho-molybdate blue colour method (Jackson 1973).

The statistical analysis of the data was done using a factorial randomized complete block design and least significant differences (LSD) were computed at the 5 per cent probability level (Gomez and Gomez 1984). The statistical analysis was carried out with the help of CPCS-1 software.

RESULTS AND DISCUSSION

Growth performance in response to cutting size and nitrogen fertilization

The growth and biomass parameters *viz.*, plant height, collar diameter, number of branches showed highly significant difference between the cutting sizes and in different N levels.

Plant height

Data depicted in table 2 reveal that the two cutting sizes differs significantly in plant height. Average plant height increases from 1.04 cm to 1.59 cm for lower to higher cutting size. Significant increase in plant height was observed when 150 kg

N ha^{-1} was applied and further increase in nitrogen dose increased plant height but non-significantly (Fig 1). The increase in plant height with nitrogen application may be attributed to the role of nitrogen in development and differentiation of tissue and cell division, which helped to increase the plant height. The increase in plant height with increase in cutting diameter was also recorded by Saini et al (2002) in *Salix*.

Table 2: Effect of cutting size and nitrogen fertilization on growth performance

Cutting size	Plant height (cm)	Collar diameter(cm)	No. of branches/ plant
0.50-1.50cm	1.04	0.52	2.59
1.51-2.50 cm	1.59	0.82	3.33
LSD(p=0.05)	0.13	0.06	0.30
Nitrogen level (kg ha^{-1})			
0	0.94	0.43	0.75
50	1.12	0.52	1.83
100	1.25	0.67	3.42
150	1.56	0.86	4.25
200	1.69	0.88	4.55
LSD(p=0.05)	0.21	0.10	0.48

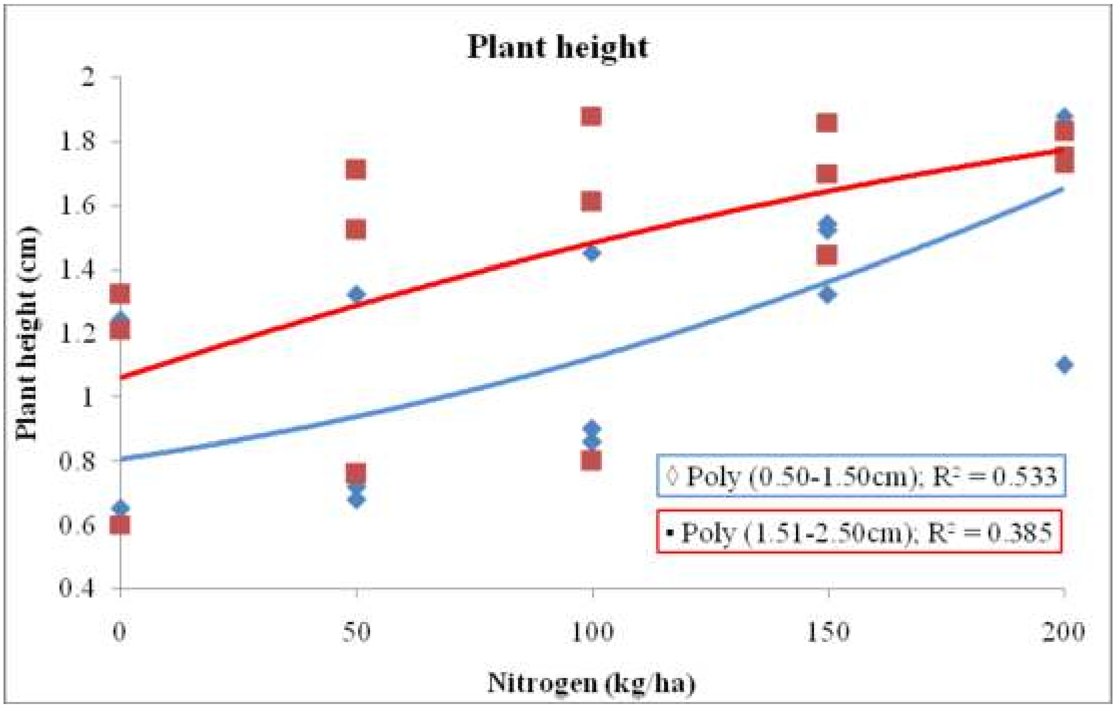

Fig1: Correlation of cutting size and nitrogen fertilization on plant height.

Number of branches/ plant

Number of branches of three randomly selected plants from each plot were counted and their average was calculated. It was observed that mean number of branches per plant followed an increasing trend with increasing application of nitrogen. In control, average number of branches per plant were 0.75, which enhanced to 1.83, 3.42, 4.25 and 4.55 when the rate of nitrogen application was raised to 50, 100, 150 and 200 kg N ha^{-1} respectively (Table 2, Fig 2). Number of branches also increased from 2.59 to 3.33 with increase in cutting size from 0.50-1.50 to 1.51-2.50.

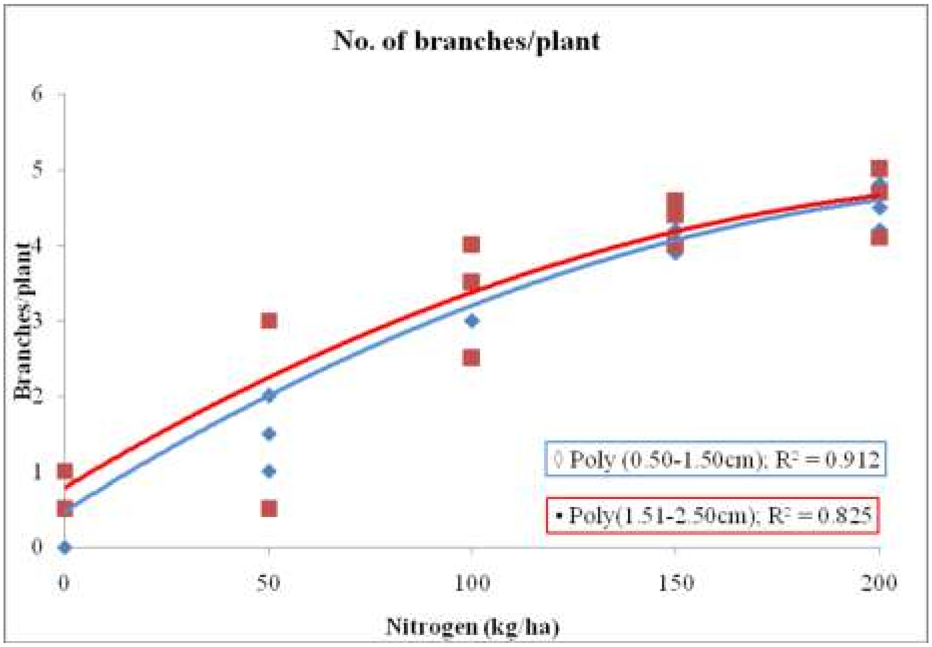

Fig 2: Correlation of cutting size and nitrogen fertilization on number of branches/ plant.

Collar diameter

Collar diameter differs significantly when two cutting sizes were compared to each other. Average collar diameter increases from 0.52 cm to 0.82 cm when cutting size of 0.50-1.50 cm and 1.51-2.50 cm were grown, respectively. In case of nitrogen level, maximum collar diameter of 0.88 was recorded with the application of 200 kg nitrogen/hectare, while minimum (0.43) was recorded in control. Dose of 150 and 200 kg N ha^{-1} differs non-significantly (Table 2). Chmelar (1973) reported that almost any size of cutting can be used in Salix but Mugal (1996) revealed maximum growth and survival in 1.1-1.5 cm diameter class and even higher cutting diameter had lower growth which was in contradiction to earlier studied of Saini et al (2002). However, Kang et al (2015) recorded suitability of 1-1.50 cm cutting size for growth.

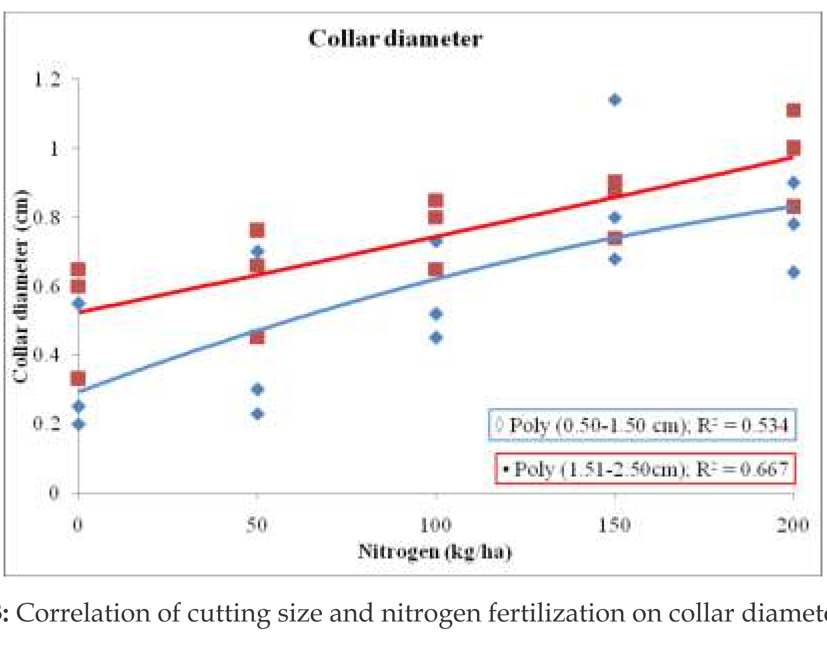

Fig 3: Correlation of cutting size and nitrogen fertilization on collar diameter.

Biomass

All the biomass parameters *viz.*, fresh and dry shoot, root and total biomass varied significantly between two cutting sizes and among five nitrogen levels. Data pertaining to variation in these parameters are presented in table 3.

Table 3: Effect of cutting size and nitrogen fertilization on biomass parameters

Cutting size	Dry shoot biomass (gm)	Dry root biomass (gm)	Total biomass (gm)
0.50 - 1.50 cm	31.14	10.47	51.93
1.51 - 2.50 cm	47.13	13.17	89.74
LSD(p=0.05)	1.50	0.53	2.40
Nitrogen level (kg ha^{-1})			
0.00	24.96	4.99	49.32
50	31.53	7.83	59.85
100	39.18	11.99	71.58
150	48.93	16.79	84.97
200	51.08	17.51	88.46
LSD(p=0.0 5)	2.36	0.84	3.80

Dry root biomass

Dry shoot weight in cutting size of 1.51-2.50 cm was significantly more as compared to cutting size of 0.50-1.51 cm. The mean dry shoot weight was found to be 47.13 gm in cutting size of 1.51-2.50 cm and 31.14 gm in cutting size 0.50-1.50 cm. Data further revealed that the dry shoot biomass differs significantly for increasing level of nitrogen as compared to control. Nitrogen applied @ 200 kg ha^{-1} recorded maximum dry shoot biomass of 51.08 gm and dry shoot biomass for control was found to be 24.96 gm. The nitrogen application of 150 and 200 kg ha^{-1} did not differs significantly. Interaction between cutting size and nitrogen application for the dry shoot biomass showed significant variation (Table 4).

Table 4: Effect of cutting size and nitrogen fertilization interaction on biomass.

Treatment (kg N ha^{-1})	Dry shoot biomass (gm)		Dry root biomass (gm)		Total biomass (gm)	
	0.50 - 1.50 cm	1.51 - 2.50 cm	0.50 - 1.50 cm	1.51 - 2.50 cm	0.50 - 1.50 cm	1.51 - 2.50 cm
0.00	11.10	38.83	2.23	7.76	20.92	77.73
50	22.26	40.79	6.68	8.98	41.21	78.48
100	28.60	49.77	10.02	13.95	51.04	92.13
150	45.40	52.46	15.76	17.81	70.85	99.09
200	48.36	53.79	17.68	17.34	75.63	101.29
LSD(p=0.05)	3.34		1.19		5.37	

Dry root biomass

Dry root weight in cutting size of 1.51-2.50 cm differed significantly with cutting size 0.50-1.50 cm. The mean dry root weight was found to be 13.17 gm in cutting size of 1.51-2.50 cm and 10.47 gm in cutting size 0.50-1.50 cm. Average dry root biomass increases from 4.99 to 17.51 gm when 200 kg N ha^{-1} was applied as compared to control respectively. Significant increase in dry root biomass was observed upto the application of 150 kg N ha^{-1} and non-significant increase was observed with further increase in nitrogen level i.e. 200 kg N ha^{-1}.

Total biomass

The data depicted in table no. 3 and 4 showed that total dry biomass varied significantly among the cutting size, which were found higher in 1.51-2.50 cm cutting size. The maximum was registered in 1.51-2.50 cm (89.74 gm) which was statistically lower with 0.50-1.50 cm (51.93 gm). Biomass is the most important parameters for selection of nursery stock. The nitrogen level of 200 kg ha^{-1} recorded maximum total biomass of 88.46 gm and for control, it was found to be 49.32 gm. The total biomass with nitrogen dose of 150 and 200 kg ha^{-1} does not differ significantly. Interaction between cutting size and nitrogen application for the total biomass showed significant trend.

Stock vigour index

Liner relationship was obtained when stock vigour index was regressed with increasing nitrogen level. Correlation coefficient of 0.995 was found with the linear curve of 1.51-2.50 cm cutting size, which was higher as compared to 0.911 in case of 0.50-1.50 cm cutting size. This is represented in fig 4.

Table 5: Effect of cutting size and nitrogen fertilization on Stock vigour index.

Treatment (kg N ha^{-1})	volume index	
	0.50- 1.50 cm	1.51-2.50 cm
0.00	61.67	75.40
50	72.00	107.18
100	85.33	130.63
150	143.33	164.81
200	156.00	200.80

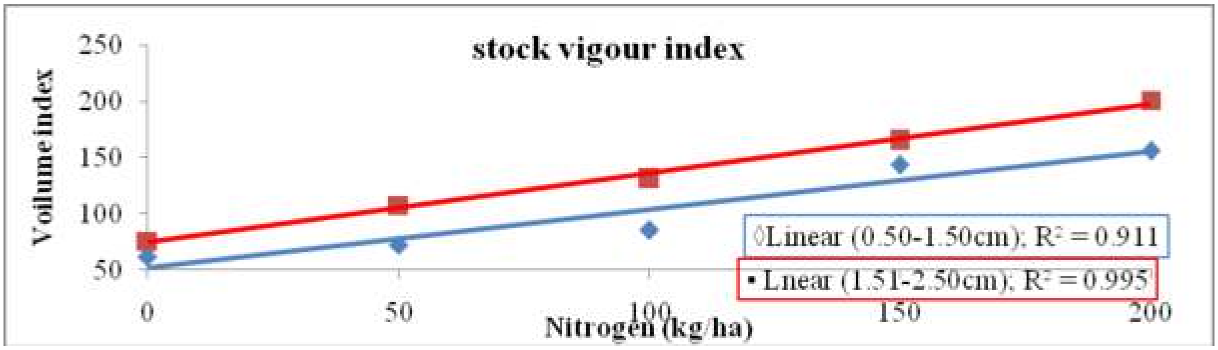

Figure 4: Effect of cutting size and nitrogen fertilization on Stock vigour index.

Sturdiness index

Sturdiness quotient decreases linearly as the nitrogen level increases from 0 kg N ha^{-1} to 200 kg N ha^{-1}. The decreases in sturdiness quotient was due to increase in collar diameter with increasing level of nitrogen (Table 6 and Fig. 5). The sturdiness quotient was highly correlated in the cutting size of 1.51-2.50 cm (R^2=0.803) as compared to cutting size of 0.50-1.50 cm (R^2=0.410).

Table 6: Effect of cutting size and nitrogen fertilization on sturdiness index.

Treatment (kg N ha^{-1})	Sturdiness index	
	0.50 -1.50 cm	1.51 -2.50 cm
0.00	237.19	209.45
50	220.39	214.62
100	158.02	207.58
150	193.69	173.98
200	188.70	164.96

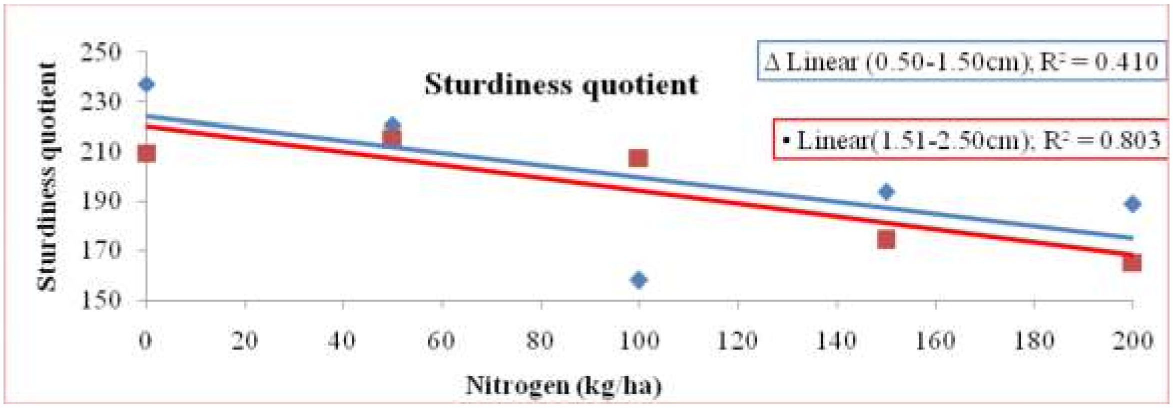

Figure 5: Effect of cutting size and nitrogen fertilization on sturdiness index.

CONCLUSIONS

Present investigations were conducted to notify the effect of cutting size and nitrogen fertilizer on nursery stock of *Salix alba*. Results revealed that with increasing rate of nitrogen application, a significant and progressive increase in available nitrogen was noticed in both the cutting sizes, which resulted in improved nitrogen content in foliage of *Salix alba*. It implied that the increase in yield attributes were the consequence of beneficial effect of nitrogen emanating from the increased availability of nitrogen in soil and plants. A curvilinear relationship was observed when rates of nitrogen application were regressed with total biomass yield indicating that application of 150 kg N ha^{-1} was adequate to get optimum yield for both the cutting sizes. This signified that Salix responded significantly to N application @ 150 kg N ha^{-1} and resulted in 27.66 and 76.74 per cent increase in total biomass yield of 0.5-1.5cm and 1.51-2.50 cm cutting sizes, respectively. The growth of salix with cutting size of 1.5-2.5 cm was found to be more superior as compared to 0.5-1.5 cm cutting size . So it is concluded that cuttings size of 1.5-2.5 cm gave better performance in all growth parameters as compared to cuttings size of 0.5-1.5 cm. Results revealed that the stock vigour index increases when nitrogen doses from 50-200 kg N ha^{-1} were applied. The impact is more noticeable from 50-150 kg N ha^{-1} rather than 150-200 kg N ha^{-1}.

It can be concluded from this study that application of 150 kg N ha^{-1} to Salix was adequate to get optimum total biomass yield and good quality planting stock for both the cutting sizes.

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