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Evaluation of Growth Performance in Different Clones of Willow under Nursery Conditions in Punjab

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ABSTRACT

Willow has much potential to exploit due to its demand in local sports market. Also, the species is easy to propagate and can be inter-planted with rice-wheat cropping system. Twenty selected exotic arborescent *Salix* clones were tested in the nursery and a large scale variability was recorded among the clones for their growth characters. In the nursery, Jeolikot sources outperformed the other introductions but field performance of selected clones was at par to each other.

INTRODUCTION

Salix is a multipurpose agroforestry species producing fodder, fuelwood and small timber. Cricket bats willow *Salix alba* cv. *coerulea* is a female cultivar of hybrid origin between *S. alba* and *S. fragilis* (Desch and Dinwoodie 1996), which was introduced by Britishers during 1916-17 at Kitriteng, Bejbehara in Jammu and Kashmir (Masoodi et al. 2008; Putto 2010). Cultivation of the same is practiced in the temperate as well as subtropical parts of northern India. The average estimated yield of willow is 65 t ha^{-1} at a rotation of 12 years. The yield of about 194 m^3ha^{-1} has also been reported by Ghosh and Singh (1975) in a plantation of 16 year rotation. Masoodi et al. (2008) highlighted the economic viability of *Salix* for basketry. Willows are comparatively better adapted than poplar for monoculture as well as in agroforestry systems under short rotation forestry for veneer, pulp, plywood, laminated wood, reconstituted wood products, artificial limbs, fruit boxes, agricultural implements, furniture, tool handles and sports goods like cricket bat and polo balls. Due to continuous disturbances in Jammu and Kashmir state of India, which is the major supplier of willow wood, the industries producing willow wood cricket bat in Punjab, Delhi and Uttar Pradesh are facing great wood shortage. The lack of availability of suitable and more productive clones further reduce the productivity, while there is a stupendous increase in the demand for wood. The ability of the willow species to adapt in different climatic/soil conditions, coupled with its fast growth, higher productivity, suitability in agroforestry systems and available market, offer ample possibility to meet increasing demand of wood. The arborescent willow species are able to grow on various types of soil, even compacted, swampy, acidic or alkaline, provided the roots have sufficient moisture content. Willows are easy to propagate and grow. They love moist soil and complete sunshine. The willows are very much suitable for the biological control of soil erosion,

nutrient recycling, phytoremediation, carbon sequestration and filtering of sewage and polluted water (Verjwist 2001). The global area of planted willows has been reported to be 1,76,000 ha of which 90,000 ha were for wood production (51%) and the remaining for environmental benefits (Bal et al. 2005). Considering the suitability of willows to diversify rice-wheat rotation under agroforestry systems in irrigated agro-ecosystem and the low supply of raw wood material for sports industries in Punjab, it is becoming essential to introduce and test the growth performance of the exotic clones.

MATERIALS AND METHODS

Nineteen test clones were collected from different parts of North India viz., Solan (Himachal Pradesh), Nainital/Pantnagar (Uttarakhand), and Ganderbal/Tangmarg (J&K). Additionally, local source of willow was used as check clone. The clonal cuttings of standard size were planted in nursery beds at a spacing of 50 cm x 50 cm during the month of February, 2008 and the selected clones during February 2009. The details of the clonal material are given in Table 1.

The study was carried out in the teaching area nursery of Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana. The study area is at 247m above mean sea level and lies at 30° 45' N latitude and 75° 40' E 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, whereas, December and January are the coldest. Frost occurrence is not common. On an average site receives 704mm rainfall, which is not evenly distributed and most of it (75-80%) is received during July-September. Physiochemical properties of the study site were determined (Sand - 82%, Silt - 10.7%,Clay - 6.3%,Texture -Loamy sand, pH - 8.0, EC - 0.20 mmhos/cm, Organic carbon - 0.15%, available N - 33.02 kg/acre, available P - 4.6 kg/acre, available K - 66.0 kg/acre). Completely Randomised Design with three replications and plot size of five was taken up for the present study.

All growth and biomass parameters except leaf emergence, complete leaf senescence and leaf area were recorded during December 2008 (11 months of planting in nursery) and June 2009 (4 months after field planting of ten selected clones). The height of the main shoot was recorded from the ground level to the apex of the leading shoot by using measuring scale. Shoot diameter of the plant in the nursery was measured with the help of digital calliper at the collar region. The average number of branches per plant was recorded on the basis of two randomly selected plants from each replication of clones. The data was recorded when the vegetative swollen bud emerged started transforming into leaves. For leaf area (cm^2), two plants from each replication were selected. The data recorded was suitably analysed.

RESULTS AND DISCUSSION

Growth characters

The growth and biomass parameters viz. plant height, collar diameter, number of branches, total leaf display days and leaf area showed highly significant differences among the clones (Table 2). However, the differences in six month growth increment in different selected clones after field planting was far better than local clone (Table 3).

Data depicted in the Table 2 revealed that the clones differed significantly for plant height. The clone PN-227 recorded maximum height (259.87 cm) and 17-93-A recorded the minimum height (66 cm). Seven other clones viz., NZ-1002 (227.27 cm), SI-64-017 (237.02 cm), Kashmiri (231.13 cm), Bhimtal (235.33 cm), Pantnagar (221.15cm), Jeolikote-2 (233.93 cm) and Jeolikote-3 (255.5 cm) were found statistically similar to PN-227 in height. The maximum collar diameter (14.02 mm) was noticed in the clone Jeolikote-3, which was at par with NZ-1002 (11.67 mm), PN-227 (12.60 mm), SI-64-017 (12.60 mm), Local (13.03 mm), Kashmiri (12.41 mm), Bhimtal (12.60 mm), Pant Nagar (12.08 mm) and Jeolikote-2 (12.68 mm). The minimum (5.72 mm) value was exhibited by 17-93-A clone, which was at par to SI-62-096, 84/21, SA, Kashmiri-I and Kashmiri-II clones.

The results of the present study clearly indicate a large range of variation in height and collar diameter among clones (Tunctaner 2002; Weih and Nordh 2002; Stolarski et al. 2008; Huse

Table 1: Details of clonal material for evaluation in Punjab

Clone code	Clone name	Scientific name	Source Country/Place*
T1	SI-62-096	*Salix alba*	Italy
T2	17-93-A	*Salix alba*	Solan
T3	NZ-1002**	*Salix udensis*	Italy/Japan
T4	PN-227**	*Salix alba*	China
T5	84/21	*Salix alba*	Solan
T6	84/11	*Salix alba*	Solan
T7	SI-64-017**	*Salix alba*	Italy
T8	SE-75-001	*Salix matsudana*	Italy/China
T9	212/03**	*Salix alba*	Solan
T10	Local**	*Salix alba*	Ludhiana
T11	Kashmiri**	*Salix alba* cv *coerulea*	Solan
T12	SA	*Salix alba*	Italy
T13	NZ-1179	*Salix udensis*	Italy/Japan
T14	Bhimtal**	*Salix alba*	Pantnagar (Bhimatal)
T15	Pant Nagar**	*Salix alba*	Pantnagar
T16	Jeolikote-1	*Salix tetrasperma*	Nainital
T17	Jeolikote-2**	*Salix alba*	Nainital (Kashmir)
T18	Jeolikote-3**	*Salix alba*	Nainital (Kashmir)
T19	Kashmiri – I	*Salix alba* cv *coerulea*	Ganderbal, Southern Kashmir
T20	Kashmiri – II	*Salix alba* cv *coerulea*	Tangmarg, Northern Kashmir

***** Country/place name in parentheses indicates the origin of the clone
** clones selected for field trial

et al. 2008). Robinson et al. (2004) categorized willow clones into fast growing and slow growing, on the basis of mean stem height, mean stem diameter and biomass yield. They reported that the maximum height and diameter of clones varied significantly from 83 to 110 per cent and diameter from 120 to 160 per cent of the check clone, respectively.

Data for number of branches, leaf display and leaf area is presented in Table 2. The results revealed that among 20 clones, eight clones were statistically similar for number of branches per

Table 2: Mean values of growth parameters for twenty arborescent willow clones

Clones	Clone code	Height (cm)	Collar diameter (mm)	No. of branches	Leaf display (days)	Leaf area (cm^2)
SI-62-096	T1	130.00	5.96	1.00	262.67	22.65
17-93-A	T2	66.00	5.72	1.00	265.00	24.72
NZ-1002	T3	227.27	11.67	8.75	298.67	42.13
PN-227	T4	259.87	12.60	11.25	286.33	25.80
84/21	T5	152.58	7.57	2.83	255.67	23.99
84/11	T6	181.56	7.82	2.67	251.00	39.23
SI-64-017	T7	237.02	12.60	4.13	292.33	29.29
SE-75-001	T8	197.87	9.22	9.87	297.00	30.22
212/03	T9	215.92	10.49	4.94	302.00	27.54
Local	T10	206.94	13.03	2.78	278.33	72.55
Kashmiri	T11	231.13	12.41	6.73	287.67	34.08
SA	T12	129.94	8.15	3.33	286.33	32.54
NZ-1179	T13	133.38	9.15	3.03	297.67	35.23
Bhimtal	T14	235.33	12.60	7.88	300.00	44.63
Pant Nagar	T15	221.15	12.08	6.00	302.00	51.94
Jeolokote-1	T16	88.80	10.03	1.94	258.33	38.89
Jeolikote-2	T17	233.93	12.68	9.98	311.00	49.71
Jeolikote-3	T18	255.50	14.02	12.31	314.67	48.54
Kashmiri-I	T19	167.00	8.92	1.67	253.33	22.42
Kashmiri-II	T20	128.14	7.20	1.33	253.33	16.80
Mean		184.57	10.20	5.17	282.67	35.64
CD0.05		42.18	3.20	6.88	7.69	4.87

plant. The clone Jeolikote-3 recorded highest value (12.31), which was at par with NZ-1002 (8.75), PN-227 (11.25), SE-75-001 (9.87), Kashmiri (6.73), Bhimtal (7.88), Pant Nagar (6.00) and Jeolikote-2 (9.98). The minimum value (1.00) was recorded for the clones SI-62-096 and 17-93-A, which was at par to all the clones excepting NZ-1002, PN-227, SE-75-001, Kashmiri, Bhimtal, Jeolikote-2, and Jeolikote-3. The data in Table 2 also revealed that the clone Jeolikote-3 retained leaf for maximum

Table 3: Mean increment (six month) in growth of ten selected clones on field planting*

Clones	Height increment (cm)	Collar diameter increment (mm)	Volume (cm^3)**
NZ-1002	40.50	4.55	8.38
PN-227	36.67	5.59	11.46
SI-64-017	24.67	5.28	6.88
212/03	17.50	6.06	6.42
Local	7.50	4.54	1.55
Kashmiri	25.33	5.63	8.03
Bhimtal	43.33	4.47	8.66
Pant Nagar	26.67	4.66	5.79
Jeolikote-2	29.00	5.05	7.39
Jeolikote-3	35.00	4.49	7.06

* Increment differences were non-significant
**Volume = $diameter^2$*height

314.67 days. The clone Jeolikote-2 was statistically similar with Jeolikote-3. Minimum (251 days) leaf display was recorded in 84/11. Maximum leaf area (72.55cm^2) was recorded in local clone and minimum (16.80cm^2) in Kashmiri-II. These three parameters are very important for selection because clones with higher number of branches, leaf display and leaf area, yield better at the end of growing season. However, more number of branches has to be pruned for maintaining the timber quality, clones with less branches are preferred for round wood production but are appropriate for energy purposes and phyto-remediation for enhanced transpiration. In consonance with present study, Vhera-Aaarnio and Sarsaalmi (1994) and Huse et al. (2008) had also noticed a large variation in leaf display among willow clones. The rapid starting and late senescence clones might be most promising for biomass production on moist sites due to a higher production of total shoot biomass (Weih and Nordh 2002) but lower values are favourable and preferred for agroforestry. Robinson et al. (2004) conducted a study on leaf traits and growth characteristics of willow clones and reported that the individual leaf area of six willow clones significantly varied between 140 mm^2 to 574 mm^2. The present study also confirmed the earlier findings for significant variation in branch and leaf parameters.

The differences in values of height and collar diameter ranged from 7.50-43.33 cm and 4.47-6.06 mm (Table 3). Since the selection of the clones was made on the basis of their growth performance, therefore all the clones exhibited better volume than the local clone. However, further field performance is required to ascertain the superiority of clones.

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