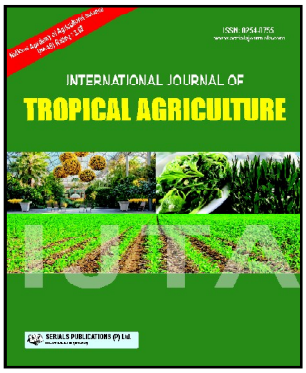

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Effect of Planting time and Indole-3-Butyric Acid (IBA) concentrations on Dormant Cutting of Santa Rosa Plum (*Prunus salicina* L.) under Mist Environment

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Abstract: A study on effect of planting time and indole-3-butyric acid (IBA) concentrations on rooting of Santa Rosa plum (*Prunus salicina* L.) dormant cuttings under mist condition were investigated in Horticulture Research Center, Charuras Campus. HNBGU, Srinagar Garhwal during 2015-16. The experiment was laid out in Factorial RBD with three replications. Cuttings were collected from 15 year old plants during dormant season at six specific date 1st December, 16th December, 31st December, 16th January, 31st January and 15th February and treated with five IBA concentrations (1000, 1500, 2000, 2500, 3000 ppm) by quick dip method before planting. The cuttings treated with IBA @ 1500 ppm and planted in 31st December observed best in all aspects, as rooting percentage, number of roots, root length, field establishment of rooted cuttings, plant height and plant spread. The highest rooting percentage (92.22 %) was recorded when cuttings were planted on 31st December (T_3) followed by 16th January (82.22 %), while the lowest rooting percentage (58.33 %) was recorded when cuttings were planted on 1st December (T_1). The maximum rooting percentage of 92.78 % was recorded in cuttings treated with 1500 ppm IBA (C_2) followed by 2000 ppm (89.44 %) and the minimum rooting percentage (27.22 %) was recorded under control. Therefore it concludes that 1500 ppm of IBA with 31st December planting conditions is recommended as alternative and easiest vegetative propagation method through semi-hardwood cuttings of plum.

Keywords: Cuttings, Vegetative propagation, IBA, Planting Time, Rooting, Santa Rosa Plum.

INTRODUCTION

Plum (*Prunus salicina*) ranks next to the peaches in economic importance among all stone fruits. Plum (*Prunus salicina* L.), also known as Japanese Plum botanically a drupe fruit, belonging to family Rosaceae and subfamily Amygdaloideae, is grown in temperate region of the world. In India plums are grown on a commercial scale in Jammu and Kashmir, Himachal Pradesh and the hills of Uttrakhand. They are also grown to some extent in the Nilgiri hills of South India (NHB, 2015). It requires less chilling hours that is temperature below 7.2°C. It can tolerate frost and high summers both, that is why it can be cultivated in both low temperatures to 0°C and up, highest up to 47°C in summers. 'Santa Rosa' is the most commercial and desirable variety of plum can only be cultivated in higher hills (700-1000 chilling hours) but low chilling requiring cultivars (250-300 chilling hours) are preferred for plains (Anonymous, 2016).

Plums do not produce true from seed. In order to maintain 'true to type' cultivars, they have to be propagated asexually by using grafting or budding methods (tongue grafting and patch budding). Budding or grafted can only be carried out if suitable rootstock material is available. The second most common method of propagation of plum is through semi-hardwood cuttings, but in this method the survival percentage and success rate is less under ordinary field conditions. Under these circumstances, the use of growth regulators and slight modifications of planting date could lead to an increase in the success rate during the propagation of plum by cuttings. Various early workers have reported that effect of IBA on bud sprouting on different plum cultivars. Cutting is the easiest and cheapest technique to mass propagation and production of plants more uniform and genetically similar to the genitors (Hartman *et al.*, 2011). As in most ornamental plants and fruit trees that are propagated by woody cuttings, physiological stage of the mother plant, time of cuttings taking and the type of growth regulators are very important factors for the success of rooting Auxin has the effect of speeding up and increasing the rooting percentage of cuttings. Plants produce natural auxin in young shoots and leaves, but the synthetic auxin should be used for successful rooting to prevent cuttings death (Kasim and Rayya, 2009; Stefanic *et al.,* 2007). Several studies have reported the benefit of auxin application in promoting adventitious root development of cuttings. Indole butyric acid (IBA) has been successfully used to rooting of *Poinsettia pulcherrima L.* (Ramtin *et al.,* 2011), *Shores parvifolia* (Aminah *et al.,* 2006), and Stevia *rebaudiana* (Debnath, 2008).

Cutting propagation preserves the characteristics of the parent plant and true-to-type plants may be produced more quickly. The purpose of treating cuttings with IBA is to increase the percentage of cuttings that forms roots, to hasten root initiation and to increase uniformity of rooting. IBA can be applied to cuttings either in powder formulation, in aqueous solution or in organic solvent such as alcohol. The last method is favoured for fruit hardwood cuttings because of speed and apparent uniformity of treatment (Hatcher and Garner, 1951). Adventitious root formation and survivility has a lot of commercial interests because there are many plant species cutting that are difficult to root. In some plant species, adventitious root formation initiate without any treatment, while others required different growth regulators usually auxin (Syros *et al.,* 2004). Auxin induces root formation by breaking root apical dominance induced by cytokinin (Cline, 2000). Although, there is a lot of work done on different aspects of propagation of plum fruits but the availability of literature on the use of auxins along with the modification of planting time under valley areas of Uttarakhand is scanty in the literature. The present investigation was therefore undertaken to study the effect of IBA and modified planting time on the success rate and vegetative growth characteristics of plum cuttings under valley conditions of Garhwal Himalaya.

MATERIALS AND METHODS

The experiment was carried out at the Horticulture Research Centre (HRC), at Chauras Campus of HNB Garhwal University, Srinagar (Garhwal) during 2016-17. The Srinagar valley shows a semi-arid and sub-tropical climate. Except during rainy season rest of months are usually dry with exception of occasional showers during winter or early spring. Geographically the experimental site is lying between 30°122 to 30°132 North latitude and 78° 452 to 78° 502 East longitudes while altitudinally located at 570 m above msl. The site in the valley area of Garhwal Himalaya and experience a wide range of temperature variation ranging from 0°C in winter to a maximum of 40°C during summer. The relative humidity varies from 39.24 to 79.83 % and mean annual rainfall from 2.50 to 235.24 mm.

Stem cuttings of plum (*Prunus salicina* L.) were collected from Healthy, uniform and mature 15 year old plants during dormant and 16 cm long pencil thickness cuttings were prepared. For rooting media, coco peat, vermin-compost, sand and soil in ratio of 2:2:1:1 by v/v were mixed thoroughly, cleaned for stones and grasses, and then the mixture was filled in disposal glass having capacity of 250 ml. Cuttings were collected during dormant (1st December, 16th December, 31st December, 16th January, 31st January and 15th February) and were treated with five IBA concentrations (1000, 1500, 2000, 2500, 3000 ppm) by quick dip method for 10 seconds before planting in the rooting medium. Cuttings used for control (check) were dipped in tap water only. After the treatment, the cuttings were immediately planted in disposal glass and inserted 7.5 cm deep in the rooting media. The experiment was replicated thrice with 10 cuttings in each treatment and a total of 180 cuttings were planted in mist chamber. The mist chamber has the arrangement for intermittent misting to 20 seconds at every 30 minutes interval between 8 am and 8 pm. The rooting percentage, number of roots and length of longest root were measured after three months of planting cutting and after 3 month of planted cutting the cuttings were transplanted to main field. Field establishment of rooted cuttings, plant height and plant spread were measured after one month after transplanting to main field. For bud initiation and development studies, the histological analysis was carried out by using standard protocol (Johansen, 1940). Standard methodology was used to record the observations on root characteristics (Hartmann *et al.*, 2002). The experiment was laid out in the factorial randomised block design (FRBD) with 3 replications. The data recorded were subjected to statistical analysis by using standard methods Factorial Randomized Block Design (FRBD) as described by Cochran and Cox (1992).

RESULTS AND DISCUSSION

The result obtained on rooting percentage (%), number of roots and root length (cm) of cuttings are shown in Table 1, whereas Field establishment, plant height (cm) and plant spread (cm) significantly influenced by time of planting and IBA treatment shown in table 2.

Rooting Percentage

IBA concentrations and planting time of cuttings significantly influenced rooting percentage of Santa Rosa plum cutting under mist environment as shown in table 1. The highest rooting percentage (92.22 %) was recorded when cuttings were planted on 31st December (T_3) followed by 16th January (82.22 %), while the lowest rooting percentage (58.33 %) was recorded when cuttings were planted on 1st December (T_1). The maximum rooting percentage of 92.78 % was recorded in cuttings treated with 1500 ppm IBA (C_2) followed by 2000 ppm (89.44 %) and the minimum rooting percentage (27.22 %) was recorded under control. Treatment combination of T_3C_1, T_3C_2, T_3C_3, T_3C_4, T_4C_2 and T_5C_2 was found to be the best by producing 100 % of rooting of Santa Rosa plum cutting. The possible reason behind

the increase and decrease in percentage of rooted cuttings of Santa Rosa plum as observed during this experiment can be attributed as enhanced hydrolytic activity in presence of applied IBA coupled with appropriate planting time. High carbohydrate and low nitrogen have been reported to favors root formation. The findings of Parvez *et al.* (2007) in peach are in agreement to present results.

Number of roots per cutting: Among various concentrations of IBA, 1500 ppm IBA resulted in the higher number of roots per cutting (21.67) followed by 2000 ppm (17.35). The interaction of planting time and IBA concentration T_6C_2 (15th February with 1500 ppm IBA) was found to be best by producing maximum number of roots per cutting (38.33). This may be due to enhanced hydrolysis of carbohydrates caused by auxin treatment (Rajarama, 1997; Singh *et al.,* 1961).These results are in agreement with Bal *et al.* (2000) who reported that plum cuttings treated with IBA at 3000 mgL^{-1} gave best rooting when taken on 15th January. The higher fresh weight of roots may be attributed to the increased number of roots and roots length (Ingle and Venugopal, 2009).

Length of Longest Root

Amongst IBA levels, the maximum average length of roots per cutting (7.95 cm) was recorded significant under 1500 ppm which might be due to enhanced histological features like formation of callus and tissues and differentiation of vascular tissues due to auxin (Mitra and Bose, 1954). The longest root per cutting (13.33 cm) was produced by interaction of T_3C_2 (31st December planting with 1500 ppm IBA). These results are in agreement with Panwar *et al.* (1999) who reported that IBA at 2000 mgL^{-1} increased root length in Bougainvillea cuttings. Ajaykumar (2007) expressed that the increase in length of the roots might be due to an early initiation of roots at higher concentrations of IBA and therefore more utilization of the nutrients due to early formation of the roots.

Field Establishment of Rooted Cuttings

It is evident from table 2 that the interaction of planting time IBA levels indicated that the maximum field establishment of rooted cutting (83.33%) was recorded under 31st December planting time (T_3) whereas, 1500 ppm (C_2) IBA level shown maximum field establishment (77.78%) of rooted cuttings. The possible reason for maximum field establishment may due to the fact of appropriate climatic requirement and active growth period of the rooted cuttings. The maximum of survival percentage related to the environment conditions of the field, and also can be favoured by the increasing number of roots and their length, which has increased the contact area of the roots with the soil, and therefore roots absorb more water and nutrients, and by this increase the survival percentage (Mobli and Baniansab, 2009; Nair *et al.*, 2008).

Plant Height

Among various concentrations 1500 ppm recorded as maximum plant height (35.54 cm). Treatment combination T_3C_2 (43.00 cm) was highest in plant height followed by T_3C_3 – (41.13 cm). 31st December (T_3) was highest in plant height i.e., 30.93 cm. Growth difference may be due to suitable climatic condition and active growth period.

Plant Spread

Maximum plant spread 20.66 cm was recorded in 31st December (T_3) and 22.83 cm in 1500 ppm. Whereas, treatment combination T_3C_2 (32.00 cm) was highest in plant spread followed by T_3C_4 (29.67 cm). Plant spread variation may be due to suitable climatic condition and active growth period. Studies of Mehta (2010) in pear rootstocks support the findings.

CONCLUSION

From the above discussion, it may be concluded that time of planting and various levels of IBA had a large impact on the rooting, field establishment and growth in cuttings of Santa Rosa plum (*Prunus*

Table 1
Effect of planting time and IBA levels on rooting percentage, number of roots and root length of dormant cuttings of Santa Rosa plum under mist environment.

	IBA Concentration						
Planting Time	*$C_1$1000 ppm*	*$C_2$1500 ppm*	*$C_3$2000 ppm*	*$C_4$2500 ppm*	*$C_5$3000 ppm*	*C_0 Control*	*Mean*
Rooting Percentage (%)							
T_1(1st Dec)	60.00	73.33	70.00	63.33	56.67	26.67	58.33
T_2(16th Dec)	76.67	86.67	83.33	80.00	70.00	36.67	72.22
T_3(31st Dec)	100.00	100.00	100.00	100.00	96.67	56.67	92.22
T_4(16th Jan)	93.33	100.00	96.67	93.33	90.00	20.00	82.22
T_5(31st Jan)	83.33	100.00	96.67	93.33	86.67	16.67	79.44
T_6(15th Feb)	76.67	96.67	90.00	83.33	73.33	6.67	71.11
Mean	81.67	92.78	89.44	85.55	78.89	27.22	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	1.93		1.93			4.73	
CD (0.05%)	5.45		5.45			13.35	
Number of roots per cutting							
T_1(1st Dec)	7.89	10.67	10.33	10.11	6.44	1.78	7.87
T_2(16th Dec)	8.78	10.55	9.89	8.00	7.89	3.33	8.07
T_3(31st Dec)	16.44	30.11	17.89	17.78	13.44	0.78	16.07
T_4(16th Jan)	10.67	17.67	13.33	11.00	11.00	1.44	10.85
T_5(31st Jan)	15.89	22.67	19.44	13.11	12.00	2.11	14.20
T_6(15th Feb)	27.67	38.33	33.33	30.67	27.33	0.67	26.33
Mean	14.55	21.67	17.37	15.11	13.02	1.68	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	0.71		0.71			1.74	
CD (0.05%)	2.01		2.01			4.92	
Length of longest root (cm)							
T_1(1st Dec)	2.63	3.17	3.01	2.64	2.45	0.57	2.41
T_2(16th Dec)	4.40	4.68	4.52	4.30	4.12	0.53	3.76
T_3(31st Dec)	9.87	13.33	11.78	10.31	8.44	0.08	8.97
T_4(16th Jan)	6.30	7.70	7.62	6.87	6.54	0.17	5.87
T_5(31st Jan)	8.19	9.67	8.38	8.02	6.23	1.59	7.01
T_6(15th Feb)	6.49	9.13	8.31	6.67	6.28	0.62	6.25
Mean	6.31	7.95	7.27	6.47	5.68	0.59	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	0.26		0.26			0.63	
CD (0.05%)	0.73		0.73			1.79	

Table 2: Effect of planting time and IBA levels on field establishment percentage, plant height and plant spread of transplanted Santa Rosa plum cuttings.

	IBA Concentration						
Planting Time	*$C_1$1000 ppm*	*$C_2$1500 ppm*	*$C_3$2000 ppm*	*$C_4$2500 ppm*	*$C_5$3000 ppm*	*C_0 Control*	*Mean*
Final field establishment of rooted cutting (%)							
T_1(1st Dec)	55.56	88.89	66.67	55.56	33.33	11.11	51.85
T_2(16th Dec)	33.33	55.56	44.44	33.33	33.33	11.11	35.18
T_3(31st Dec)	100.00	100.00	100.00	100.00	88.89	11.11	83.33
T_4(16th Jan)	77.78	100.00	100.00	77.78	55.56	11.11	70.37
T_5(31st Jan)	44.44	66.67	66.67	44.44	33.33	0.00	42.59
T_6(15th Feb)	33.33	55.56	44.44	33.33	22.22	0.00	31.48
Mean	57.41	77.78	70.37	57.41	44.44	7.41	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	3.18		3.18			7.79	
CD (0.05%)	8.97		8.97			21.98	
Plant height (cm)							
T_1(1st Dec)	21.43	34.80	26.73	23.13	21.43	6.40	22.32
T_2(16th Dec)	27.00	32.23	28.00	25.23	23.60	3.17	23.20
T_3(31st Dec)	32.83	43.00	41.13	39.33	25.47	3.83	30.93
T_4(16th Jan)	22.87	37.17	36.07	33.30	27.77	4.00	26.86
T_5(31st Jan)	27.13	35.37	34.00	27.10	22.83	0.00	24.40
T_6(15th Feb)	22.00	30.70	28.20	21.13	12.47	0.00	19.08
Mean	25.54	35.54	32.35	28.20	22.26	2.90	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	1.00		1.00			2.46	
CD (0.05%)	2.83		2.83			6.94	
Plant Spread							
T_1(1st Dec)	10.75	17.41	12.11	10.83	9.92	2.78	10.63
T_2(16th Dec)	15.17	19.15	16.28	14.23	11.94	0.97	12.95
T_3(31st Dec)	19.67	32.00	29.67	24.00	14.63	4.00	20.67
T_4(16th Jan)	17.56	25.83	22.00	19.42	17.89	1.75	17.41
T_5(31st Jan)	15.17	25.50	20.33	15.78	13.83	0.00	15.10
T_6(15th Feb)	14.06	17.11	15.33	13.00	8.06	0.00	11.26
Mean	15.39	22.83	19.29	16.21	12.71	1.58	
	Planting Time (T)		*IBA Concentration (C)*			*(T × C)*	
Sem±	0.60		0.60			1.48	
CD (0.05%)	1.70		1.70			4.17	

Salicina L.). Number of root maximum in 15th February but the vegetative growth and fiend establishment was poor in comparison to 31st December and 16th January. Hence time of planting in 31st December (T_3) to 16th January (T4) and IBA @ 1500 to 2000 ppm was found to be the best treatments may be recommended for the propagation of Santa Rosa plum by stem cuttings. The results of this investigation are expected to prove the way for substantially augmenting natural regeneration through seeds; in addition, this has the advantage clonal or true to type propagation of elite trees.

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