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Vegetative Propagation of *Wendlandia exserta*: Effects of Season, Auxins, Donor Stage and Position of Shoot on Adventitious Root Formation in Stem Cuttings

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ABSTRACT

The present investigation was conducted to standardize the season and auxin concentration in *Wendlandia exserta* during spring and rainy season. Cuttings of the current year growth were collected from three Donor stages, which were (D_1): Sapling, (D_2): Pole, (D_3): Tree, from two different positions which was (A_1): Apical (excised tip), (A_2): Sub-apical from. Treatments were (T_1): Control - (talc only), (T_2): 2% captan + 2% sucrose – talc, (T_3): 0.25 IBA + 2% captan + 2% sucrose – talc, (T_4): 0.5% IBA + 2% captan + 2% sucrose – talc, (T_5): 0.75% IBA + 2% captan + 2% sucrose – talc, (T_6): 1% IBA + 2% captan + 2% sucrose – talc. Cuttings collected and planted in spring exhibited better sprouting and rooting than those planted in rainy season. Non-apical cuttings produced better sprouting and root length in apical portion in the spring. The highest rooting was only 10.00%.

Keywords:

Auxin, donor, position, season, *Wendlandia exserta*

INTRODUCTION

Wendlandia exserta Roxb. DC. is an important social forestry species which yields fuel, fodder and small timber and agricultural implements in the rural area. Locally, it is known as chila, ratela, tikli etc. belonging to family Rubiaceae. The species has been well distributed throughout the sub-Himalayan tract upto 1400m elevation, in outer Himalaya, Chotanagpur and parts of Indian peninsula (Troup, 1921). It is also prominent in Shivalik hills. It comes gregariously in areas where the area is vulnerable to landslides and soil is exposed due to disturbances or on abandoned agriculture. It prefers to grow in loose soils which are exposed to direct sunlight since the species is light demander. The tree flower in March-April and the seeds of the species are very minute and mature in May-June. The wood of this species is used for construction purposes and fuel. The species is good for soil conservation. This tree species is silviculturely useful in re-clothing the bare hill slopes and newly exposed (clearings) as well as geologically vulnerable areas but its regeneration is very poor due to various reasons. For large scale success there should be adequate means of increasing its propagation potential through seeds and vegetative means.

MATERIALS AND METHODS

The present investigation was carried out in the nursery of Department of Silviculture at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, (H.P.). Cuttings of the current year growth were collected from three Donor stages, which were (D_1): Sapling, (D_2): Pole, (D_3): Tree, from two different positions which was (A_1): Apical (excised tip), (A_2): Sub-apical from the trees growing in Bhojnagar area of Dharampur Range under Solan Forest Division. The 10-15cm long cuttings were selected with atleast 2-3 nodes were given six different treatments. Treatments were (T_1): Control - (talc only), (T_2): 2% captan + 2% sucrose – talc, (T_3): 0.25 IBA + 2% captan + 2% sucrose – talc, (T_4): 0.5% IBA + 2% captan + 2% sucrose – talc, (T_5): 0.75% IBA + 2% captan + 2% sucrose – talc, (T_6): 1% IBA + 2% captan + 2% sucrose – talc. The spacing of 15 cm was used in the experiment. The experiment was conducted in two different seasons, viz. July August (rainy) and Jan-Feb (spring) in Randomised Block Design (Factorial).

The observation on sprouting and its progress was initiated one week after planting and were recorded up to two months. The observations on callusing and rooting were recorded after 120 days of planting the cuttings by removing from planting beds during rainy and spring season.

RESULTS AND DISSCUSSION

The mean effect of donor stage, position and auxin concentration on sprouting, callusing and rooting during rainy and spring season is given in Table 1. During rainy season, the cuttings of pole donor (D_2) and non-apical position (A_2) resulted in higher sprouting (39.44%) and (38.89%) respectively. Significantly highest sprouting of 52.78 per cent was registered in T_6 (1.0% IBA + 2% captan + 2% sucrose- talc). During spring season, the sprouting was recorded 66.94% and 60.93 per cent in cuttings collected from tree donor (D_3) and non-apical (A_2) position of cuttings. Maximum callusing of 27.78%, 26.67 % and 43.33 % was observed in tree donor (D_3), apical position (A_1) and T_6 (1.0% IBA + 2% captan + 2% sucrose- talc) formulation respectively during rainy season. Higher callusing per cent of 40.28% and 42.04 % was observed in tree donor D_3 and non-apical position (A_2) and significantly maximum callusing of 55.56 per cent was recorded in T_6 (1.0% IBA + 2% captan + 2% sucrose- talc) formulation during spring season.

In spring season rooting parameters were studied because the cuttings in rainy season could not survive. During spring season, rooting per cent was affected significantly by donor stage, position and auxin concentration with the highest rooting of 3.06 per cent which was observed in the cuttings collected from tree donor (D_3) compared to 1.67 per cent and 1.39% in sapling (D_1) and pole donor (D_2) and a highest rooting of 5.56 per cent was observed in cuttings treated with T_6 (1.0% IBA + 2% captan + 2% sucrose- talc) concentration. Significantly the root number varied from 2.08 roots was recorded when cuttings were taken from tree (D_3) respectively. Similarly, the apical cuttings exhibited significantly higher root number i.e. 1.43 and significantly maximum root number of 3.89 roots was recorded when cuttings were treated with 1.0% IBA + 2% captan + 2% sucrose- talc (T_6) formulation. The maximum root length (2.56cm) was observed in tree donor (D_3) and the non-apical cuttings (A_2) exhibited significant root length of 2.16 cm and maximum root length of 6.01 cm was recorded in T_5 (0.75% IBA + 2% captan + 2% sucrose- talc) respectively.

It had been widely reported that the ability of cutting to root decreases with age of cutting donors (Black 1973; Hartmann et al. 2009 and Nautiyal et al. 1991), but the results obtained were in contradiction in the present findings where the best results were obtained in tree donors than those of sapling and pole donors. The observations are in contrast to the widely held view that rooting propensity of cuttings decreased with increasing age /stage of the donor plants. However, these results are in agreement with the findings of Shamet and Naveen (2005) who reported that tree donor cuttings performed remarkably better than pole and sapling donors in spring season in *Celtis australis*. This work is also corroborated by Ivory (1971) who had indicated that age of the tree did not noticeably affect rooting in *Pinus radiata* cuttings. Similarly, Addullah et al (1988) while working with Sycamore (*Platanus orientalis*) had achieved better results in 8-year than 4-year old donor plants.

The callusing and root length were found with maximum values in non-apical position, but rooting and root number was found more in apical portion during spring season. The results are in contradiction for rooting per cent and root number but for other parameters these are in fovour with the superiority of basal/ lower portions in rooting

Table 1 Mean effect of donor stage, position and auxin concentration on sprouting, callusing and rooting during rainy and spring season.

TREATMENTS	Rainy season		Spring season				
	SPROUTING (%)	CALLUSING (%)	SPROUTING(%)	CALLUSING (%)	ROOTING (%)	ROOT NUMBER	ROOT LENGTH (cm)
DONOR (D)							
D1	3667(36.44)	21.39(24.14)	44.44(41.85	31.67(33.29)	1.67(1.39)	0.97(1.26)	1.77(1.39)
D2	39.44(38.46)	26.94(29.53)	61.39(52.11)	40.28(39.24)	1.39(1.38)	0.86(1.23)	1.24(1.29)
D3	33.06(32.12)	27.78(29.99)	66.94(55.81)	40.28(39.19)	3.06(1.71)	2.08(1.54)	2.56(163)
CD ((0.05)	NS	NS	6.29	4.94	0.26	0.2	0.26
POSITION (A)							
A1	33.89(34.03)	26.67(28.07)	54.26(47.78)	32.78(34.33)	2.22 (1.52)	1.43(1.37)	1.55(1.38)
A2	38.89(37.32)	24.07(27.70)	60.93(52.07)	42.04(40.15)	1.85(1.43)	1.19(1.31)	2.16(1.49)
CD ((0.05)	NS	NS	NS	4.03	0.21	0.16	0.22
AUXIN CONCENTRATION (T)							
T1	17.78(22.26)	9.44(13.81)	45.00(42.07)	28.33(31.62)	0.00(1.00)	0.00(1.00)	0.00(1.00)
T2	29.44(30.88)	16.11(21.44)	50.00(44.88)	33.33(34.79)	0.00(1.00)	0.00(1.00)	0.00(1.00)
T3	35.56(36.35)	22.22(25.31)	55.56(49.10)	32.22(34.10)	0.00(1.00)	0.00(1.00)	0.00(1.00)
T4	40.56(38.52)	27.22(31.08)	58.89(50.69)	39.44(38.38)	1.67(1.38)	0.89(1.25)	1.63(1.37)
T5	42.22(39.33)	33.89(34.57)	63.89(53.55)	40.50(39.17)	5.00(2.16)	3.06(1.82)	6.01(2.38)
T6	52.78(46.72)	4333(41.10)	72.22(59.24)	55.56(45.37)	5.56(2.29)	3.89(2.00)	3.49(1.87)
$CD_{(0.05)}$	8.57	7.6	8.89	6.98	0.37	0.28	0.38

* Figures in parentheses indicate the arc sine transformed values

as reported by many researchers. Similarly, Kanwar et al (1996) got higher rooting in *Ulmus laevigata* (63.3 per cent in winter and 50.00 per cent in rainy season) cuttings prepared from basal portion. The results of present investigation are also in line with the findings of Hamooh (2004) who reported that basal cuttings of *Ficus carica* resulted in highest rooting and root number when treated with 1500 ppm IBA. Similarly, Akoumianaki et al (2004) reported highest rooting when *Bauhinia variegata* cuttings from basal region of shoots, treated with 2000 ppm IBA. Nautiyal et al (2007) and Madhwal et al (2008) reported 4000 ppm to be the best rooting hormone for juvenile shoot cuttings of *Podocarpus neriifolius and Terminalia chebula*. Similarly, Tiwari et al (2004) reported cent per cent rooting and maximum length of roots (30.5cm) in *Vitex negundu* when cuttings were treated with 500 and 1000ppm NAA.

Interaction effect of auxin concentration, position and donor stage (T x A x D)

The data reveals that auxin, position and donor stage interaction had non-significant effect on per cent sprouting in both the seasons (Table 2). Maximum per cent sprouting (66.67%) was observed when non-apical (A_2) cuttings of sapling donor (D_1) were treated with T_6 (1.0% IBA + 2% captan + 2% sucrose- talc) formulation ($T_6A_2D_1$). The interaction effect on callusing was also found to be non-significant. Maximum success rate of 50.00 per cent in $T_6A_2D_3$ interaction was observed during rainy season.

During spring season, sprouting and callusing showed no differences between treatments. However, the significant highest rooting of just 10.00 % was seen in treatments $T_3A_1D_1$, $T_5A_1D_2$ and $T_5A_1D_3$. Most of the interactions were not able to initiate roots in cuttings. The effect of auxin x position x donor stage (T x A x D)

Table 2. Effect of donor stage, position and auxin concentration (interaction) on sprouting, callusing and rooting of *Wendlandia exserta* cuttings during spring season

TREATMENT (TXAXD)	Rainy season		Spring season				
	SPROUTING (%)	CALLUSING (%)	SPROUTING (%)	CALLUSING (%)	ROOTING (%)	ROOT NUMBER	ROOTLENGTH (cm)
$T_1A_1D_1$	20.00(26.07)	6.67(8.85)	23.33(28.08)	16.67(23.86)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_1A_1D_2$	20.00(26.07)	13.33(17.22)	43.33(41.16)	30.00(33.21)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_1A_1D_3$	16.67(19.22)	6.67(8.85)	56.67(49.22)	30.00(33.00)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_1A_2D_1$	16.67(19.93)	6.67(12.29)	30.00(33.00)	20.00(26.57)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_1A_2D_2$	23.33(27.29)	6.67(12.29)	56.67(49.14)	33.33(34.22)	0.00(1.00)	0.00(1.00)	0.00(1.00)
T_1A_2D3	10.00(15.00)	16.67(23.36)	60.00(51.85)	40.00(38.86)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_1D_1$	23.33(28.08)	13.33(17.71)	23.33(28.29)	16.67(23.36)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_1D_2$	30.00(33.21)	20.00(26.07)	53.33(47.01)	33.33(35.22)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_1D_3$	23.33(24.15)	16.67(19.93)	56.67(49.14)	33.33(35.22)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_2D_1$	36.67(36.93)	10(15.00)	46.67(43.08)	30.00(33.00)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_2D_2$	33.33(34.93)	16.67(23.86)	56.67(48.93)	46.67(43.08)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_2A_2D_3$	30.00(27.99)	20.00(26.07)	63.33(52.86)	40.00(38.86)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_1D_1$	26.67(31.00)	20.00(21.93)	26.67(30.00)	16.67(23.36)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_1D_2$	36.67(36.93)	26.67(26.16)	56.67(49.22)	33.33(35.22)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_1D_3$	30.00(32.71)	30.00(32.22)	66.67(55.08)	36.67(36.93)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_2D_1$	46.67(43.08)	13.33(17.22)	63.33(57.99)	33.33(35.01)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_2D_2$	40.00(39.15)	20.00(26.07)	56.67(48.93)	40.00(38.86)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_3A_2D_3$	33.33(35.22)	23.33(28.29)	63.33(53.36)	33.33(35.22)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_4A_1D_1$	30.00(33.00)	20.00(26.57)	26.67(31.00)	23.33(28.08)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_4A_1D_2$	43.33(40.78)	36.67(36.93)	70.00(57.70)	36.67(36.93)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_4A_1D_3$	36.67(32.01)	33.33(34.93)	73.33(59.01)	43.33(41.07)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_4A_2D_1$	43.33(41.16)	23.33(28.78)	60.00(51.93)	36.67(36.15)	6.67(2.54)	2.67(1.82)	5.88(2.38)
$T_4A_2D_2$	46.67(43.08)	26.67(31.00)	60.00(51.15)	46.67(43.08)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_4A_2D_3$	43.33(41.07)	23.33(28.29)	63.33(53.36)	50.00(45.00)	3.33(1.77)	2.67(1.67)	3.91(1.85)
$T_5A_1D_1$	40.00(39.15)	33.33(30.00)	16.67(36.15)	26.67(30.29)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_5A_1D_2$	46.67(42.99)	36.67(37.23)	70.00(57.29)	30.67(37.23)	10(3.32)	6.67(2.76)	9.16(3.17)
$T_5A_1D_3$	30.00(28.08)	43.33(41.16)	80.00(63.93)	43.33(40.86)	10(3.32)	5.33(2.48)	7.83(2.92)
$T_5A_2D_1$	50.00(44.71)	30.oo(33.00)	70.00(57.290	50.00(45.00)	6.67(2.54)	4.67(2.21)	7.59(2.68)
$T_5A_2D_2$	46.67(42.99)	36.67(37.23)	63.33(53.86)	50.00(44.71)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_5A_2D_3$	40.00(38.07)	23.33(28.78)	63.33(52.78)	36.67(36.93)	3.33(1.77)	1.67(1.48)	11.50(3.52)
$T_6A_1D_1$	40.00(39.15)	33.33(35.22)	53.33(46.22)	46.67(42.00)	3.33(1.77)	2.00(1.55)	3.05(1.73)
$T_6A_1D_2$	56.67(49.14)	43.33(41.16)	73.33(59.21)	40.00(39.15)	6.67(2.54)	3.67(2.03)	5.77(2.36)
$T_6A_1D_3$	60.00(50.85)	46.67(43.08)	86.67(72.29)	46.67(42.99)	10(3.32)	8.00(2.95)	2.04(1.67)
$T_6A_2D_1$	66.67(55.08)	46.67(43.08)	73.33(59.21)	63.33(52.86)	3.33(1.77)	2.33(1.61)	4.72(1.96)
$T_6A_2D_2$	50.00(45.00)	40.00(39.15)	76.67(61.72)	56.67(48.93)	0.00(1.00)	0.00(1.00)	0.00(1.00)
$T_6A_2D_3$	43.33(41.07)	50.00(44.92)	70.00(56.79)	50.00(45.29)	10(3.32)	7.33(2.87)	5.39(2.52)
$CD_{0.05}$	NS	NS	NS	NS	0.90	0.70	.0.66

*Figures in parentheses indicate the arc sine and square root transformed values interaction on primary number of roots, primary root length and survival was found to be significant. The maximum number of roots (8.00) was however, observed in $T_6A_1D_3$combination.

The better performance of apical type cuttings of *Wendlandia exserta* may be attributed to the better status of growth regulators (auxins) in comparison to those of lower /non-apical ones. It has also been suggested that the endogenous auxin levels decrease as the distance from the apices of branches within the same plant increases (Jacobs 1979). Bonga (1982), on the other hand, was of the view that such variations in the performance of cutting types is due to the presence of some juvenile cells/ tissues even in mature tissue. In case of tree species, the degree of juvenility is inversely proportional to the distance along the trunk and branches between the root shoot junction and branches (Razdan 1993). The enhancement of bud sprouting in IBA treated cuttings might be due to the stimulation of hydrolysis of nutrient reserves and their mobilization. The high rooting success can be attributed to the complimentary interaction of the applied auxin with endogenous counterpart (Sparks and chapman 1970). Nanda (1970) and Hassig and Davis (1994) also reported that auxins induce hydrolysis and mobilization of nutritional factors to the site of application, thereby promoting root initiation in the cuttings. Limbasiya et. al. (2007) suggested that accumulation of certain substances at the base of cuttings enhanced the interaction between applied hormone and rhizocaline thus stimulating the meristem to divide quickly and form roots. Van Overbeek et. al. (1946) demonstrated that the rooting of *Hibiscus rosa-sinensis* was dependent upon rooting factors produced in the leaves and the effect of these factors could be replaced by 2% sucrose solution and nitrogenous substances. Captan also increases the per cent rooting and the survival of cuttings as increase in rooting was related to the fungicide concentration used, however high levels inhibit rooting (Grigsby 1965; Hansen and Hartmann 1967). The increased rooting effect obtained with fungicides is probably due to the control of disease and/or a synergistic hormonal effect on rooting by the fungicide (Couvillon 1988).

CONCLUSION

Wendlandia exserta is difficult- to- root species based on its rooting behaviour. However, it can be made to root under nursery (shaded) conditions. Maximum per cent sprouting (66.67%) was observed when non-apical (A_2) cuttings of sapling donor (D_1) were treated with T_6(1.0% IBA + 2% captan + 2% sucrose- talc) formulation ($T_6A_2D_1$). Maximum callusing success rate of 50.00 per cent was in $T_6A_2D_3$ interaction during rainy season. The root length was higher in tree donor with 0.75% IBA + 2% captan + 2% sucrose- talc treatment and non-apical position. Spring season gave the best results for rooting behaviour in the species.

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