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EFFECT OF DIFFERENT GROWING CONDITIONS AND VARIOUS CONCENTRATIONS OF IBA ON THE ROOTING AND SHOOTING OF HARDWOOD CUTTING OF PHALSA (*GREWIA ASETICA* L.) UNDER VALLEY CONDITION OF GARHWAL HIMALAYAS

K. K. Singh, J. S. Chauhan[1], J. M. S. Rawat and D. K. Rana

Dept. of Horticulture, Chauras Campus, H.N.B. Garhwal Univ., Srinagar - 246 174 (Garhwal) (Uttarakhand), India.
[1]Dept. of Seed Sci. and Tech., Chauras Campus, H.N.B. Garhwal Univ., Srinagar-246 174 (Garhwal) (Uttarakhand), India.

Abstract

The effect of different growing conditions and various concentrations of IBA on the rooting and shooting of hardwood cutting of phalsa (*Grewia asetica* L.) under valley condition of Garhwal Himalayas was assessed in an experiment conducted at the Horticulture Research Centre, Chauras Campus. H.N.B. Garhwal University, Srinagar, Garhwal (Uttarakhand), India. The experiment was laid out in Factorial Randomized Block Design (RBD) with three replications. For preparing the rooting media, sandy soil and farm yard manure (FYM) in ratio of 2:1 by v/v were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in root trainers. Properly prepared cuttings of about 15-20 cm length in the month of September were treated with different concentrations of IBA *viz.*, 1000, 1500, 2000 ppm and control for 10 second by concentrated solution dip method and planted in 2 different conditions namely shade house and mist chamber. The mist house growing condition was found effective in increasing the success rate of the cuttings. The cuttings treated with IBA 2000 ppm, performed the best in all aspects, as rooting percentage, survival percentage, length of shoot, length of root, thickening of root and leaf sprouting in shoot. Overall treatment G_2C_3 (Mist chamber with 2000 ppm IBA) treatment combination was found best in all parameters taken.

Key words : Phalsa, growing condition, IBA concentrations, rooting percentage.

Introduction

Phalsa (*Grewia asetica* L.) belongs to family Tiliaceae, is an important minor fruit crop of India. It is native of Central America, but has naturalized very much in India. Phalsa is basically a small statured fruit crop but it is also used as a folklore medicine. It is a minor fruit and is being cultivated on very small scale in India. However, it is cultivated commercially in Punjab, Haryana and Uttar Pradesh. In Punjab, area under Phalsa is only 30 hectares with annual production of 196 tonnes approximately. It is a hardy fruit crop and can withstand diversity of soil and climatic conditions, where some fruit crops cannot be grown successfully (Pujari, 2012).

Morton (1987) reported that unripe Phalsa fruits alleviates inflammation and is administered in respiratory, cardiac and blood disorders, as well as in fever reduction. Ripe fruits of Phalsa are consumed fresh, as desserts, or processed into refreshing fruit and soft drinks enjoyed in India during hot summer months as it has cooling tonic and aphrodisiac effects which overcomes thirst and sensation as well as they are rich source of vitamin A and C with fair amount of minerals major being Phosphorus and Iron. Salunkhe and Desai (1984) reviewed that stems those are pruned serve as garden poles and for basket-making. The wood is yellowish-white, fine-grained, strong, and flexible. It is used for archers' bows, spear handles, shingles, and poles for carrying loads on the shoulders. A mucilaginous extract of the bark is useful in clarifying sugar and the fresh leaves are valued as animal fodder. The root bark is employed in treating rheumatism.

Phalsa is commercially propagated by seeds in India. But the seed lose viability greatly within three months, when stored in ambient condition and hence, fresh seed from fully ripe fruits should only be sown. The Phalsa plant is readily propagated by rooting of hardwood cuttings as well as layering (Samson, 1986). Rooting of phalsa cutting depends upon various factors such as pretreatment of cutting, growing condition, environmental factors, etc. which influence the regeneration ability of cuttings (Jadhav, 2007). Although, phalsa can strike roots but rooting is not appreciable. So, growth regulators are to be used to improve its high rooting ability (Yadav and Rajput, 1969). Type of cutting and planting date influence the rooting of phalsa (Singh *et al*., 1961). The stimulation of adventitious root formation in stem cuttings treated with auxins is well known (Blazich, 1988). In addition, the combination with other compounds has been shown to enhance the root formation (Kling and Meyer, 1983; Singh and Singh, 2005). Hence, it is possible that optimum use of growth regulators and suitable season would help for rapid multiplication in propagating phalsa cuttings. Rooting efficiency would be better when, it is done in controlled conditions such as mist chamber.

Materials and Methods

Study area

The experiment was conducted at Horticulture Research Centre, Chauras Campus. Geographically Srinagar valley is spread between latitude 30^0, 12' 0" to 30^0 13' 4" North and longitude 78^0 0' 45" to 78^0 0' 50" East. The valley is about 6 km long and 1 to 1.2 km wide located on both side of famous Alaknanda river at an elevation 540 m above MSL and about 127 km from Haridwar in Himalayan region. The valley shows a semi-arid and sub-tropical climate. Except during rainy season rest of months are usually dry with exception occasional showers during winter or early spring. The average minimum and maximum temperature, relative humidity and rainfall vary from 7.42^0C to 35.3^0C, 42.24% and 2.50 to 235.24 mm respectively.

Methodology

Hardwood stem cuttings of Phalsa (*Grewia asetica* L.) were collected from 4 to 5 year old plants and 15 cm long stem cuttings with basal portion were prepared. For rooting media, sandy soil and farm yard manure (FYM) in ratio of 2:1 by v/v were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in root trainers. The basal ends of the cuttings were dipped in dilute solutions, 1000 ppm, 1500 ppm, 2000 ppm and Control of Indole-3-Butyric acid by quick dip method for 10 seconds before planting in the rooting medium. After the treatment, the cutting were immediately planted in root trainers 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 120 cuttings were tested in shade house G_1 and 120 cuttings were planted in mist chamber. The mist chamber G_2 has the arrangement for intermittent misting to 60 seconds at every 30 minutes interval between 8 am and 8 pm. The number of sprouted cuttings, number of sprout per cutting, length of sprout per cutting, percentage of root per cutting, number of primary roots per cutting, percentage of secondary rooting, length of root per cutting, diameter of root, fresh weight and dry weight of roots were recorded after three months. The data recorded were subjected to statistical analysis by using Factorial Randomized Block Design (FRBD) as described by Cochran and Cox (1992).

Results and Discussion

The shooting and rooting response of Phalsa (*Grewia asetica* L.) cuttings treated with different growing conditions and various concentrations of IBA in showed in table 1. The maximum mean survival percentage of cutting (50.00%) was observed under the treatment G_2 (Mist chamber) growing condition. Intermittent mist is often used on cuttings because it reduces the temperature of the leaves, lowers respiration and increases relative humidity around the leaf surface (Langhans, 1955). The highest percentage of survival cuttings (56.67%) was recorded under C_3 (2000 ppm of IBA) followed by C_2 (1500 ppm of IBA) and the minimum survival percentage of cutting (25.00%) observed under C_0 (Control). G_2C_3 (Mist chamber with 2000 ppm IBA) treatment was found the best treatment combination with 70.00% of survival cuttings. It may be due the presence of large number of chemically and physiologically unrelated compounds such as phenols, gibberellins, abscisic acid and others have been found to influence the regeneration of roots in cuttings of several plants (Hiss, 1968 and Gerter, 1969). The findings of Shrivastava (1996) in hardwood cuttings of phalsa treated with IBA and Tajbakhsh (2009) in Persian walnut with respect of survival percentage of cuttings are similar to present results.

Data regarding the length of longest sprouts are presented in table 1, which reveals that both the growing condition and IBA concentration had a significant effect on the length of longest sprouts while the interaction between growing conditions and IBA concentrations on the Length of longest sprouts were also not found significant. The longest length of sprout per cutting (6.38 cm) was found under G_3 (2000 ppm IBA) treatment and the minimum length of sprout per cutting (4.49 cm) was recorded under G_1 (Shade house) growing conditions. Among all the IBA treatments, C_3 (2000 ppm IBA) treatment showed the maximum longest length of sprout per cutting (6.77 cm) and the shortest length of sprout per cutting (3.92 cm) was recorded under C_0 (Control)

Table 1 : Effect of Different growing conditions and various concentrations of IBA on the shooting performance of Phalsa (*Grewia asetica* L.) .

IBA Concentrations	Survival percentage			Length of longest sprouts (cm)			Diameter of thickest sprouts (mm)			Number of leaves		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean
1000 ppm (C_1)	33.34	46.67	40.00	4.51	6.39	5.45	1.33	1.78	1.55	2.44	3.00	2.72
1500 ppm (C_2)	26.67	56.67	41.67	4.30	6.91	5.60	1.16	2.00	1.58	2.16	2.78	2.47
2000 ppm (C_3)	43.34	70.00	56.67	5.37	8.16	6.77	1.44	2.41	1.92	2.84	3.96	3.40
Control (C_0)	23.34	26.66	25.00	3.80	4.05	3.92	1.66	1.00	1.33	1.33	1.33	1.33
Mean	31.67	50.00		4.49	6.38		1.40	1.79		2.19	2.76	
C D 0.5%												
Growing condition (G)		4.61			1.34			0.39			0.64	
IBA Conc. (C)		6.53			1.90			0.55			0.91	
G × C		9.23			2.69			0.78			1.28	

treatment. Sprout length may be due to better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators. The maximum average length of longest sprout per cutting (8.16 cm) was observed under G_2C_3 (Mist chamber with 2000 ppm IBA) treatment combination It may be due to species, favorable climatic conditions to the length of sprout. Better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators causes length of sprout.

The maximum average diameter of thickest sprout per cutting (1.79 mm) was observed under G_2 (Mist chamber) treatments while, the average diameter of thickest sprout per cutting (1.40 mm) was lowest under G_1 (Shade house) growing conditions, which probably supply more nutrients and water to shoot. The highest average diameter of thickest sprout per cutting (1.92 mm) was observed under C_3 (2000 ppm IBA). Panwar *et al.* (1994) observed that best diameter of thickest sprout was observed in hardwood cuttings of bougainvelllea cv. Alok treated with IBA 2000 ppm. The minimum average diameter of thickest sprout per cutting (1.33 mm) was recorded under C_0 (control) treatment. The maximum average diameter of thickest sprout per cutting (2.41mm) was showed under G_2C_3 (Mist chamber with 2000 ppm IBA) treatment combination while, the minimum average diameter of thickest sprout per cutting (1.00 cm) was observed under G_2C_0 (Shade house with control) treatment combinations. These findings also agree with the findings of Kumar (1973) with respect to thickness of sprout per cutting of guava.

The maximum average number of leaves on the new sprout per cutting (2.76) was obtained with G_2 (Mist chamber) treatment. The average number of leaves on new sprout per cutting (3.40) was highest under C_3 (2000 ppm IBA) treatment, followed by C_1 (1000 ppm IBA) treatment. Koremastu and Shinno (1975) stated that mist propagation increased the percent of rooting and reduced rooting time in many garden trees and shrubs. The average number of leaves on new sprout per cutting (1.33) was lowest under C_0 (Control) treatment. Treatment combination G_2C_3 (Mist chamber with 2000 ppm) obtained first position in the average number of leaves on new sprout per cutting (3.96) while, minimum the average number of leaves on new sprout per cutting (1.33) was shown under G_1C_0 (Shade house with control) and G_2C_0 (Mist chamber with control) treatment combination, during present investigations. Favourable climatic conditions play an important role to increase the number of leaves. The appropriate planting time, application of IBA as well as genetic makeup of genotype use might have played some role in augmenting the number of leaves per cutting (Singh and Singh, 2002). These findings are agreed with the findings of Saroj *et al*. (2007) in pomegranate.

Data regarding percentage of rooted cutting are presented in table 2, which states that percentage of rooted cutting was significantly affected by both growing conditions and IBA concentrations, while the interaction between the growing conditions and IBA concentrations was significant. The highest percentage of rooted cuttings (46.66%) was obtained under G_2 (Mist chamber) growing conditions and the minimum percentage of rooted cuttings (31.66%) was recorded under G_1 (Shade house) growing conditions. Among all the treatments, C_3 (2000 ppm IBA) treatments showed the maximum percentage of rooted cuttings (53.33%). Kumar (1995) recorded that the 2000 ppm IBA was found to be the most promising dose in rooting of *Acacia mangium* cuttings with a rooting success of 76.0%. The enhance hydrolytic activity in present of applied IBA coupled with appropriate planting time might be responsible for the increased percentage of rooted cuttings. High carbohydrate and low nitrogen have been reported to favour root formation (Carlson, 1929). The minimum percentage of rooted cuttings (23.33%) was obtained under C_0 (Control) treatment. Treatment combination G_2C_3 (Mist chamber with 2000 ppm) obtained first position in percentage of rooted cuttings (63.33%) while, minimum percentage of rooted cuttings (23.33%) was shown under G_1C_0 (Shade house with control) and G_2C_0 (Mist chamber with control) treatment combination, during present investigations. These findings all agree with the finding of Singh *et al*. (2011) in bougainvillea.

Mean values of table 2 also reveals that the highest number of primary roots (15.54) recorded under G_2 (Mist chamber) growing condition and the minimum number of primary roots (9.58) produce under G_1 (shade house) growing condition. Langhans, (1955) reported that intermittent mist is often used on cuttings because it reduces the temperature of the leaves, lowers respiration, and increases relative humidity around the leaf surface. The maximum number of primary roots (15.50) was recorded under C_3 (2000 ppm IBA) treatment. The minimum number of primary roots (5.83) produced under C_4 (Control). It may be due to the action of auxin which might have caused hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings and resulted in accelerated cell elongation and cell division in suitable environment (Hartmann *et al*., 2007). The interaction between different growing conditions and IBA concentrations was also found significant. The maximum number of primary roots (20.33) were observed under G_2C_3 (Mist chamber growing condition with 2000 ppm of IBA) treatment combination. Similar findings were observed by Thomson (1984), who reported that cuttings inter-mittent mist showed enhanced rooting.

The growing condition G_2 (Mist chamber) was found best, to recorded the maximum length of root (6.18 cm), while the minimum length of root (3.62 cm) produce under G_2 (Shade house) growing condition. The highest length of the longest root (5.89 cm) was found under C_3 (2000 ppm IBA) while, the lowest length of longest root (3.35 cm) was recorded under C_0 (control). Auxin application has been found to enhance the histological features like formation of callus and tissue and differentiation of vascular tissue (Mitra and Bose, 1954). These findings all agree with the finding of Galavi *et al*. (2013) in Grape and Singh *et al*. (2013) in *Thuja compecta* with respect to average length of root per cutting. Treatment combination G_2C_3 (Mist chamber with 2000 ppm IBA) were found equally good in term of producing the maximum length of longest root (7.84 cm), while the minimum length of root (3.33 cm) recorded under G_1C_0 (Shade house with control)

Table 2: Effect of Different growing conditions and various concentrations of IBA on the rooting performance of Phalsa (*Grewia asetica* L.)

IBA Concentrations	Rooting percentage			Number of primary roots			Length of longest root (cm)			Diameter of thickest roots (mm)			Fresh weight of roots per cutting (g)			Dry weight of roots per cutting (g)		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean
1000 ppm (C_1)	33.33	43.33	38.33	10.66	18.99	14.83	3.55	6.75	5.15	1.00	1.33	1.16	0.45	0.80	0.62	0.21	0.38	0.30
1500 ppm (C_2)	26.66	56.66	41.66	10.33	17.83	14.08	3.66	6.76	5.21	1.00	1.44	1.22	0.54	0.81	0.68	0.28	0.42	0.35
2000 ppm (C_3)	43.33	63.33	53.33	10.66	20.33	15.50	3.94	7.84	5.89	0.77	2.00	1.38	0.59	1.18	0.89	0.29	0.73	0.51
Control (C_0)	23.33	23.33	23.33	6.66	5.00	5.83	3.33	3.38	3.35	0.66	0.66	0.66	0.46	0.28	0.37	0.18	0.15	0.16
Mean	31.66	46.66		9.58	15.54		3.62	6.18		0.86	1.36		0.51	0.77		0.24	0.43	
C D 0.5%																		
Growing condition (G)		6.38			2.36			2.34			0.25			0.14			0.06	
IBA Conc. (C)		9.02			3.34			3.31			0.35			0.19			0.08	
GxC		12.76			4.72			4.68			0.50			0.28			0.12	

G_1 = Shade house, G_2 = Mist chamber C_1 = 1000 ppm IBA, C_2 = 1500 ppm IBA, C_3 = 2000 ppm IBA and C_0 = Control.

treatment combination. The increase in length of roots in cuttings treated with growth regulators may be due to the enhanced hydrolysis of carbohydrates, accumulation of metabolites at the site of application of auxins, synthesis of new proteins, cell enlargement and cell division induced by the auxins (Strydem and Hartman, 1960). The present findings are similar to the findings of Singh (1979) in *Jasminum sambac*.

Data regarding diameter of thickest root are presented in table 2, which states diameter of thickest sprout were significantly affected by growing condition and IBA concentrations. The interaction between the growing condition and IBA concentrations was also significant. In case of growing condition, maximum (1.36 mm) diameter of thickest sprout were observed in G_2 (Mist chamber), while minimum (0.86 mm) was observed in shade house. In case of the IBA concentrations , maximum (1.38 mm) diameter of thickest roots were produced by the cuttings treated in C_3 (2000 ppm IBA), while minimum (0.66 mm) diameter of thickest roots were observed in cuttings treated in C_0 (control). According to Thimmappa and Bhattacharjee (1990), auxins naturally occurring or exogenously applied are required for initiation of adventitious roots on stems. It appears probable that the success of IBA is due to its low auxin activity and its slow degradation by auxin destroying enzyme. The maximum diameter of thickest root (2.00 mm) were observed under G_2C_3 (Mist chamber with 2000 ppm of IBA) treatment combination. The findings of Kathrotia and Singh (1995) match these results in respect of thickness of rooting in phalsa.

The data regarding the fresh weight of roots per cutting are presented in table 2, which states that fresh weight of roots were significantly affected by the growing conditions and IBA concentrations and the interaction between the growing conditions and IBA concentrations was also significant. Among all the average fresh weight of roots per cutting the maximum (0.77 gm) was observed under G_2 (Mist chamber) growing condition and the minimum average fresh weight of roots per cutting (0.51 g) was shown by G_1 (Shade house) growing condition. It may be due to the temperature, soil, nutrition and relative humidity prevailing during this period is responsible for the fresh weight of roots. The highest average fresh weight of roots per cutting (0.89 g) was produced by C_3 (2000 ppm IBA) treatment, while the minimum average fresh weight of roots per cutting (0.37 g) was observed under C_0 (control). Auxin increases the fresh weight of plant by producing large number of longer roots. Treatment combination G_2C_3 (Mist chamber with 2000 ppm) obtained first position in average fresh weight of roots per cutting (1.18 g) during present investigations. The findings of present study are similar to the findings of (Leonel *et al*., 1995) litchi (*Litchi chinensis* Sonn.).

Data regarding the dry weight of roots per cutting are presented in table 1, which states that dry weight of roots per cutting were significantly affected by the growing conditions and IBA concentrations. In case of growing conditions, maximum dry weight of roots per cutting (0.43 g) was observed in G_2 (Mist chamber), while minimum (0.24 g) was observed in G_1 (shade house) growing conditions. It may be due the species, favorable environmental conditions that increases dry weight of roots. Greater average dry weight of roots per cutting (0.51 g) was observed under treatment T_3 (2000 ppm IBA) and the minimum average dry weight of roots per cutting (0.16 g) shown under C_0 (control) treatments. The interaction between the growing conditions and IBA concentrations was also significant. The maximum average dry weight of roots per cutting (0.73 gm) was found under G_2C_3 (Mist chamber with 2000 ppm IBA) treatment combination while the minimum average dry weight of roots per cutting (0.15 g) was obtained under G_2C_0 (Mist chamber with control) treatment combination. It is obvious that auxin treatment induced higher number of primary and secondary roots which might have resulted in elongation of these roots through cell division (Debnath and Maiti, 1990). The above findings also agree with the finding of Sulusoglu and Cavusoglu (2010) in Cherry laurel.

CONCLUSION

Phalsa (*Grewia asetica* L.) cv. dwarf type propagated through hardwood cuttings show maximum success of cuttings in mist chamber growing condition while, IBA 2000 ppm gives most effective success rate of cuttings. Based on the findings of current investigation it is recommended that phalsa propagated through hardwood cuttings under G_2C_3 (Mist chamber with 2000 ppm of IBA) treatment combination produced best results within a short period of time and is recommended for commercial vegetative propagation especially under valley region of Garhwal Himalayas.

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