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Effects of media and indole butyric acid (IBA) concentrations on hopbush (*Dodoneae viscosa* L.) cuttings in green house

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Abstract. Hopbush (*Dodoneae viscosa* L.) is an evergreen bush type tree; that is used for hedges and green walls in parks, gardens and houses, in South East of Iran. Propagation by stem cuttings is quicker and cheaper than seed, if the cuttings set in convenient media and rooting hormone. In order to investigate the effects of different media and different concentrations of indole 3-butyric acid (IBA) on rooting of hopbush (*Dodonea viscosa* L.) cuttings, an experiment was conducted using mist system in greenhouse in spring 2010. The treatments were 3 different media: sand, perlite, and sand + perlite, (1+1 by volume), with 4 levels of IBA concentrations (0 ppm, 2000 ppm, 4000 ppm, and 6000 ppm). A randomized complete block with factorial design was used with 5 replications. The average and the means were compared by Duncun's multiple range test (1% and 5%); M STAT-C was used for comparing the interaction effects. The effect of medium on number of roots, percentage survival of stem cutting, root fresh weight and dry weight was significant, but on root length was not significantly affected. The effects of different concentrations of hormone on number of roots, percentage survival of stem cutting, root fresh weight and dry weight was significant. The interaction effect of media and hormone on root length was significant, too. The best result was obtained in perlite, with 4000 ppm IBA. The results showed that perlite medium and 4000 ppm IBA concentration can be suggested for soft wood cutting of hopbush.
Keywords Hopbush (*Dodaneae viscosa* L.), Indole 3-Butyric Acid (IBA), Medium, Mist, rooting.

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Introduction

Hopbush, sand olive or native hop (*Dodoneae viscosa*, L.) is called natarak in Persian; is from Sapindaceae family, with almost 60 species (Pollock et al. 2005). It is a bush type tree (3-5 m height), evergreen and sometimes climbing (Mozaffarian 2004). The alternative leaves are bright green with dark green or reddish veins. The pretty flowers can be one or in clusters, yellow to green in color; the female flowers turn to beautiful golden capsules with 3 wrings in summer (Mobin 1996, Bryant et al. 1999). This ornamental tree has more than 5 years of longevity, and is resistant to hot and dry climate and is used for hedges and green walls in parks, gardens and houses specially in south East of Iran (Sabeti 2006, Rohani 2005). It has been adapted to hard climate situation of South East of Iran with very to low requirement to irrigation and salt stress conditions (Bryant et al. 1999). But, it is not resistant to low temperature and will die at -5 °C.

Hopbush can be propagated by seed in spring; the dry seed should be kept stratified in 4-5 °C for one year. Sexual propagation with stratified seeds in not usual in Iran; seed vigor is low, and it is a long time procedure. The plant can be propagated by semi hard wood cuttings at last summer; although percent rooting and survival is not high enough in common soil, without rooting hormone. This would be of considerable commercial value, more quickly and cheaply in South East of Iran. The cuttings (1.4-1.8 inches tall) should be taken from branches without fruits or flowers; and they should set under mist.

Mother stock should be fertilized specially with N, P, K before vegetative propagation (Fathi et al. 2000, Hartman et al. 1999) and under no water stress; the cuttings should be cut from mother stock in early morning cool weather, and kept in humid cotton bags before using (Hartman et al. 1990). It has been shown that if mother stock was under low light; emergence of new adventious root in cuttings, is easier (Hartman et al. 1990).

When the stem cuttings set in a convenient situation for rooting. First adventious roots appear from callus and they are main roots for cuttings. Callus contains high amount of auxines (Khoshkhooy 2000, Khoshkhooy et al. 2006).

Auxin is one of the factors for stimulating root production in cuttings (Hartman et al. 1990). In Carnation (*Dianthus caryophyllus* L.), auxin increased rooting in cuttings (Cheever, 1967). Positive correlation between IAA amount and the number of adventious roots was found in *Chrysanthemum morifolium* cuttings (Weigel et al. 1984).

It has been reported that 3-butyric acid IBA has the most effect on producting adventions roots in stem cuttings. IBA with 2500 to 4000 mg L^{-1} has been used in semi hard wood cuttings in apples, prunes and olives (Al-Saqri et al. 1996, Bhattacharya & Balakrishna 1986). In *Ginkgo biloba* L. IBA at 4000 ppm, increased percent of rooting in stem cuttings, but higher concentration decreased it (Barzgar 2003).

In rose *(Rosa centifolia)* perlite medium was more effective in rooting the cuttings, than vermiculite, mostly because of higher water absorbtion (Al-Saqri et al. 1996).

The mist system in cutting grapes was a favorite choice (Moss et al. 1985). In *Bougainvillea*, Hibiscus and Keiapple the same advantage has been shown (Mudge et al. 1995). In hopbush cutting propagation it has been used in 2001, and the research was very successful (Khoshkhooy 2002). In white mulberry *(Morus alba* L.) and black mulberry (*Morus nigra* L.) 4000 ppm IBA with enough humidity, significant increase in callus formation and rooting (Koyunca et al. 2003).

The effects of IBA and cutting dates was investigated in kiwifruit (Omer et al. 2004), IBA at 6000 and 8000 ppm had the same positive effects on rooting ability of semi hardwood cuttings; but it was 100% in July, 80% in September, and 70 to 90 percent in August. At 6000 ppm IBA caused 76% rooting ability of hard

wood cutting of Hayward cultivar of kiwifruit (Congi et al. 2001), but cutting treatment in 5-15 seconds in hormone, had no effects on rooting. IBA in concentration of 3000-4000 mg L^{-1}, had positive effects on rose (*Rosa centifolia*) cuttings (Al-Saqri et al. 1996).

The effect of medium, IBA, and season, on fever tea (*Lippia javanica* L.) has been investigated, the researchers reported that pine compost, IBA, and cool season had positive effects on fever tea stem cuttings (Arya et al. 2008). In adult pistachio (*Pistacia vera*), soft wood cuttings stimulated with auxin, and % rooting and root number was increased (Al-Barazi et al. 1982).

Hopbush sexual propagation with stratified seeds is not usual in Iran; because it is time consuming. But, asexual propagation by semi hard wood cutting is popular; although percent rooting and survival is not high enough in common soil, without rooting hormone. To find out the best rooting media presented in the area, and the best concentration of IBA, for cheaper and quicker propagation of hopbush, this experiment investigated the effect of different rooting media: sand, perlite, and sand+perlite (1+1 by volume), and three different concentrations of IBA (2000, 4000, and 6000 ppm) on rooting semi hardwood cutting of *Dodoneae viscosa* L.

Materials and methods

This research was done from March 10th to June 12th (122 day) of 2010, in Research greenhouse, College of Agriculture, Univ. of Shahid Bahonar Kerman, Iran, with over head misting condition, containing reverse-osmosic water; air temperature and relative humidity of 27 ± 2°C and 70-80%, respectively, under a 12-hour photoperiod. The 12-hour photoperiod consisted of a 10-hour natural day extended with light from soft-white fluorescent lamps (≈3 μ mol. $m^{-2} \cdot s^{-1}$ at canopy level).

The plastic bags (30×30×30 cm approximately) were filled with 100% sand, 100% perlite, and sand and perlite (1+1 by volume). The leafy softwood cuttings (15 cm length) were selected from softwood parts of branches, the additional leaves were trimmed and the cuttings dipped at different concentrations of hormone for 3-4 seconds up to 7-8 cm height and then in fungicide; then planted in above medium. The cuttings pinched to inhibit vegetative growth; and could stimulate rooting. Fungicide was Benomyl and talk powder in 1:10 ratio.

A randomized complete block with factorial design was used with 5 replications (3 medium, 4 hormone concentrations, 5 replication = 60 cuttings).

On June 12th all cuttings were taken out of the bags (bags were cut carefully to protect the cuttings) and the below components were investigated: (i) the number of buds per cutting, (ii) the number of leaves per cutting, (iii) the number, weight and length of roots (primary and secondary), (iv) percentage survival of stem cutting. After calculating root fresh weight, they were wrapped aluminum foil and in oven dried at 80 ˚C for 24 hours to calculate dry weight.

The results analyzed with ANOVA; and the average results analyzed by SPSS and Duncun's multiple range test (1% and 5%). M STAT-C was used for comparing the interaction effects.

Results

The effect of different medium and hormone concentration on number of leaves per stem cutting, in hopbush is shown in table 1. According to this different medium ane hormone concentration, had significant effects on leaf number of hopbush cuttings; but, the interaction effects of medium and hormone was not significant.

The effects of medium on the numbers of roots/stem cutting is presented in table 2: dif-

ferent medium, hormone concentrations and the interaction effects of medium and hormone had significant effects on root numbers of hopbush cuttings.

Effects of different medium and hormone concentrations on root fresh weigh of hopbush cuttings (tables 4 and 5), white the effects of different medium and hormone concentration on roots dry weight of hopbush cutting are shown in table 6: different medium and hormone concentrations had significant effect on hophush roots dry weight; but the interaction effects of medium×hormone was not significant.

The effects of medium and hormone on root length cuttings of hopbush was not significant; but the interaction effect of hormone×medium was significant (tables 7 and 8), different medium and hormone concentrations had not significant effects on root length, but the interaction effects of medium×hormone was significant at $p \leq 0.01$

Percentage survival of the cuttings showed substantial variations among different media and hormone concentrations figure 1. The highest survival percentage with a mean value of 94 was obtained among perlite media with 4000 ppm hormone concentration; while sand media at 0ppm IBA had the least (51%) survival percentage.

Discussion

The results of this experiment indicated the important role of determining the optimal rooting medium and growth hormone in the process of vegetative propagation. Perlite followed by perlite + sand and IBA hormone with 4000 ppm concentration were able to serve this purpose in hopbush. Sand was too porous and could not keep enough humidity required by the cuttings. The use of external hormone in stimulating root, or production of massive or long roots was useful. The findings from this study agree with weigel et al. (1984) who reported positive correlation between IAA amount and the number of root per cutting in *Chrysanthemum morifolium*.

Barzgar (2003), also reported that IBA at 4000 ppm increased percent of rooting in stem cutting in *Ginkgo biloba* L., but highest con-

Table 1 Analysis of variance (ANOVA) of medium and hormone concentrations, on leaf numbers of hopbush cuttings (M.S. = Mean Square, df = degree of freedom, S.O.V. = Variable).

(M.S.)	(df)	(S.O.V.)
63.01**	2	Medium
32.00*	3	Hormone
13.72ns	6	Medium×Hormone
9.75	48	Error

Note: *- significant at 5% ($P \leq 0.05$), **-significant at 1% ($P \leq 0.01$), and ns is not significant.

Table 2 A analysis of variance (ANOVA) of medium and hormone concentration's on root numbers of hopbush cuttings (M.S. = Mean Square, df = degree of freedom, S.O.V. = Variable).

(M.S.)	(df)	(S.O.V.)
412.200**	2	Medium
217.880*	3	Hormone
191.200*	6	Medium×Hormone
77.508	48	Error

Note: *-significant at 5% ($P \leq 0.05$), **-significant at 1% ($P \leq 0.01$), and ns is not significant.

Table 3 The interaction effects of different IBA concentration and different medium on the number of roots in stem cuttings of hopbush

Medium	Hormone concen. (ppm)	Root number
Sand	0	6.6 ± 3.93[d*]
	2000	5.8 ± 3.93[d]
	4000	4.6 ± 3.93[d]
	6000	7.2 ± 3.93[d]
perlite	0	4.4 ± 3.93[d]
	2000	17.4 ± 3.93[b]
	4000	28.2 ± 3.93[a]
	6000	9 ± 3.93[c]
Sand+pelite (1+1 by volume)	0	4 ± 3.93[d]
	2000	11.4 ± 3.93[c]
	4000	8.4 ± 3.93[c]
	6000	8.8 ± 3.93[c]

Note: *Any two numbers followed by the same letter are not significantly different at $P \leq 0.05$ level.

Table 4 Analysis of variance (ANOVA) of medium, and hormone concentration, on root fresh weight of stem cutting of hopbush (M.S. = Mean Square, df = degree of freedom, S.O.V. = Variable).

(M.S.)	(df)	(S.O.V.)
4.88**	2	Medium
3.29**	3	Hormone
3.49**	6	Medium×Hormone
9.48	48	Error

Note: *- significant at 5% ($P \leq 0.05$), **-significant at 1% ($P \leq 0.01$).

Table 5 The Interaction effect (ANOVA) different medium and hormone concentration on root fresh weight of stem cutting of hopbush.

Medium	Hormone concentration. (ppm)	Root fresh weight (gr)
Sand	0	0.212 ± 0.2[d*]
	2000	0.234 ± 0.2[d]
	4000	0.214 ± 0.2[d]
	6000	0.400 ± 0.2[c]
perlite	0	0.280 ± 0.2[d]
	2000	1.500 ± 0.2[a]
	4000	1.460 ± 0.2[a]
	6000	0.532 ± 0.2[b]
Sand+pelite (1+1 by volume)	0	0.220 ± 0.2[d]
	2000	0.586 ± 0.2[b]
	4000	0.694 ± 0.2[b]
	6000	0.372 ± 0.2[c]

Note: *Any two numbers followed by the same letter are not significantly different at $P \leq 0.05$ level.

Table 6 Analysis of variance (ANOVA) of the results with different medium and hormone concentration, on the dry weight of roots in hopbush stem cuttings (M.S. = Mean Square, df = degree of freedom, S.O.V. = Variable).

(M.S.)	(dF)	(S.O.V.)
0.020^{**}	2	Medium
0.010^{*}	3	Hormone
0.008^{ns}	6	Medium×hormone
0.0004	48	Error

Note: *- significant at 5% ($P \leq 0.05$), **- significant at 1% ($P \leq 0.01$), and ns is not significant.

Table 7 Analysis of variance (ANOVA) of the results with different medium and hormone concentration on root length of hopbush stem cuttings (M.S. = Mean Square, df = degree of freedom, S.O.V. = Variable).

(M.S.)	(df)	(S.O.V.)
2.74^{ns}	2	Medium
16.25^{ns}	3	Hormone
23.57^{**}	6	Medium×Hormone
6.77	48	Error

Note: *- significant at 5% ($P \leq 0.05$), **- significant at 1% ($P \leq 0.01$), and ns is not significant.

Table 8 The interaction effect of different medium and hormone concentration on root length of hopbush stem cutting.

Medium	Hormone concen. (ppm)	Root length (cm)
Sand	0	$5.48 \pm 1.16^{e*}$
	2000	6.83 ± 1.16^{d}
	4000	8.29 ± 1.16^{c}
	6000	10.11 ± 1.16^{a}
perlite	0	6.28 ± 1.16^{d}
	2000	10.48 ± 1.16^{a}
	4000	8.25 ± 1.16^{c}
	6000	8.46 ± 1.16^{b}
Sand+pelite (1 + 1 by volume)	0	8.59 ± 1.16^{b}
	2000	10.26 ± 1.16^{a}
	4000	9.13 ± 1.16^{b}
	6000	4.76 ± 1.16^{e}

Note: *Any two numbers followed by the same letter are not significantly different at $P \leq 0.05$ level.

centration decreased it. Majeed et al. (2009) recorded the highest rooting rate (50%) for *Aesculus indica* cuttings treated with IBA at 2000 ppm. Baul et al. (2008) observed a similar trend in the vegetative propagation of *Stere-ospermum suaveolens*. Contrary to the above findings, Oni and Ojo (2002) reported that *Massularia acuminatea* is amenable to cloning with or without auxin treatment; in Akinyele research (2010), the best result was obtained in

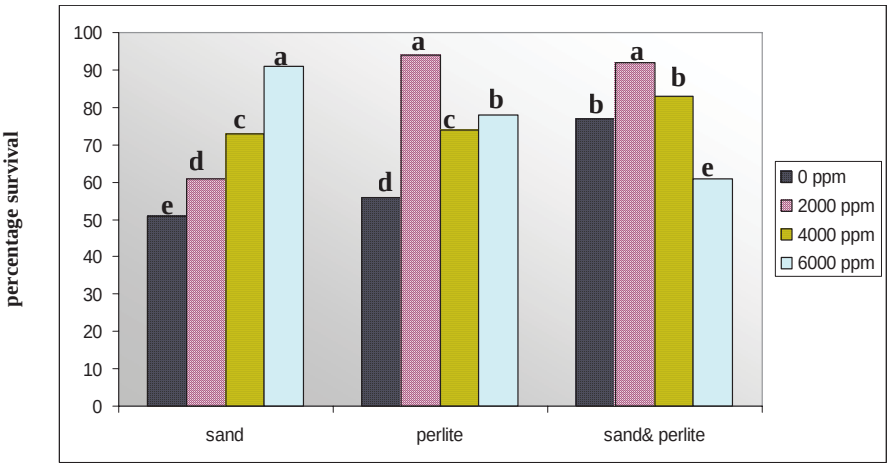

Figure 1 Effect of rooting media and IBA concentration on percentage survival of stem cutting in *Dodoneae viscosa* L. Columns followed by the same letter are not significantly different at $p \leq 5\%$ level (ANOVA test).

cutting with no hormone. The effects of different IBA concentrations, and propagation media on rooting ability of stem cuttings of *Miliacea excelsa* were also investigated by Ofori et al. (1996). They indicated that IBA had no significant effect on the rooting; but sawdust, as media, had the highest rooting percentage in stem cuttings.

Conclusion

The results show that perlite is the best medium for hopbush stem cuttings; as the highest leaf numbers, root numbers, root length, fresh and dry weigh and percentage survival; were obtained in this medium. This medium seems a convenient bed for hopbush; as it has good drainage, good aeration, and is a good water absorbent. Auxin seems a convenient root initiation hormone; and in this research the highest number of leaves and percentage survival in cuttings was observed in 2000 ppm of IBA concentration; but 4000 ppm, IBA concentration, caused higher number of roots, and higher root fresh weight and dry weight. It is recommended to use perlite and 4000 ppm IBA concentration in hopbush stem cuttings. More research on time and season of cutting production and the effects of cutting length on root initiation is recommended in this ever green bush.

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