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Rooting Response of Hardwood Cuttings of MM111 Apple Clonal Rootstock to Indolebutyric Acid and Rooting Media

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ABSTRACT

This study was conducted with the main purpose of determining the most suitable Indolebutyric acid (IBA) concentrations and rooting media for MM111 hardwood cuttings. Treatments comprised of four concentrations of IBA (0, 1500, 2500 and 3500 mg L^{-1}) as quick dip (10 sec) and three rooting media (cocopeat, perlite, cocopeat+perlite 1:1 by volume). Twenty centimeter-long cuttings were prepared and treated with a commercial fungicide, Captan, by being dipped in a liquid solution for 5 sec. This experiment had a Completely Randomized Design (CRD) with factorial arrangement in three replications. The highest rooting percentage (37.03%) was obtained in the concentration of 2500 mg L^{-1} IBA and cocopeat+perlite medium. Also the greatest root number (11.33) was acquired in the concentration of 2500 mg L^{-1} IBA and cocopeat+perlite medium. But the highest root length (9.83 cm) was attained in 1500 mg L^{-1} IBA and cocopeat+perlite medium.

Key words: Cocopeat, perlite, rooting percentage, root length, root number

INTRODUCTION

Iran is located in a dry climate thus using dry resistant rootstocks is of great importance. Since MM111 apple rootstock is good for dry areas, its propagation in the area is vital. In apple, rootstocks are used to gain uniformity and precocity, to control tree size (vigor), to enable the tree to adapt to adverse soil conditions (pH, drought, texture, drainage), to tolerate soil pests (nematodes, insects, diseases) and to increase cold hardiness of the tree (Dolgov and Hanke, 2006). MM111 apple clonal rootstocks (semi-vigorous) are good for poor soils and arid areas (Wertheim, 1998).

The shoot cutting has been commonly used for propagation of some fruit species and clonal rootstocks (Hartmann *et al.*, 2002). Factors such as cultivar and age of the source tree; the collection date, length, diameter and degree of hardening of the cuttings; injury and heat treatments of the cuttings and the treatment concentrations of auxin-like compounds (Tsipouridis *et al.*, 2003), rooting hormones, planting time, maturity of the stock plants and propagation environment might be among the important factors affecting the rooting of stem cuttings (Bhusal *et al.*, 2001). Also, the genetic variation was reflected in the differences observed among the varieties in their response to IBA concentration (Owais, 2010). And choice of an appropriate substrate is crucial for rooting of cuttings (Tofanelli *et al.*, 2003).

The effect of IBA on root formation was reported in several apple rootstocks. Tajbakhsh *et al.* (2009) also reported rooting percentage in apple cuttings (31.5%) was in 3000 mg L^{-1} concentration. Fukuda *et al.* (1988) also reported that the rooting percentage in M.26 and MM106 rootstock cuttings was 7.2 and 25%, respectively with 2000 mg L^{-1}.

A good growing medium would provide sufficient support for the plant, serve as a reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between roots and atmosphere (Argo, 1998; Richards and Beardsell, 1986). A lack of one or more of these beneficial characteristics can result in lower percentages of rooting of the cuttings or undesirable root configuration.

Coir, a coconut processing by-product and renewable substitute for peat (Prasad, 1997). Coconut coir has been shown to increase rooting of several woody ornamentals (Stoven and Kooima, 1999). Ma and Nichols (2004) reported that the problems with coir extend beyond its high salinity. Their data indicate that high concentrations of phenolic compounds in fresh coir are at least partly responsible for the growth reduction observed in other studies. Cocopeat has been recognized to have high water holding capacity which causes poor air-water relationship, leading to low aeration within the medium, thus affecting the oxygen diffusion to the roots (Abad *et al.*, 2002).

Incorporation of coarser materials into cocopeat could improve the aeration status of the media (Richards and Beardsell, 1986; Sambo *et al.*, 2008). Burnt rice hull, kenaf core fiber and perlite are among the possible coarser materials could be used to improve the air-water relationship of cocopeat (Islam, 2008; Sambo *et al.*, 2008; Tsakaldimi, 2006). Inorganic materials were found to be more suitable for rooting. However, organic materials were more effective in root growth (Bender Ozenc and Nedim, 2007).

Perlite is recognized to have a unique capillary action which makes it a superior growing medium for hydroponic cultures (Robbins and Evans, 2004). It is very useful for increasing aeration and drainage within the container because of its uniformity and lightness (Paradiso and Pascale, 2008).

The purpose of this study was to determine the most suitable IBA concentration and rooting media for MM111 hardwood cuttings.

MATERIALS AND METHODS

This study was conducted in Khorasan Razavi Natural Resource and Agricultural Research Center, in Mashad, Iran during 2009 and 2010. Hardwood cuttings were collected in February. Treatments consisting of four concentrations of IBA (0, 1500, 2500 and 3500 mg L^{-1}) and three rooting media (cocopeat, perlite, cocopeat + perlite 1:1 by volume) in a factorial design were applied to stem cuttings. Twenty centimeter-long cuttings were prepared and treated with a commercial fungicide, Captan, by being dipped in a liquid solution for 5 sec. After surface drying, the cuttings were dipped for 10 sec in one of four concentrations of IBA which was dissolved in a solvent composed of 50% ethanol and 50% distilled water. The control cuttings were treated with distilled water. After treating, the cuttings were planted in cocopeat, perlite, or perlite+cocopeat (1:1 by volume) to a depth such that the third node below the terminal whorl was 1 cm below the surface of the medium. The cuttings were maintained under mist for 45 days on a rooting bench in a greenhouse. The bottom of the rooting bench was heated at 24°C and the temperature and relative humidity in the greenhouse were kept at 21±2°C and 70-80%, respectively.

In the experiment, the percentage of rooting, the number and length of rooted cuttings were measured and the percentage of rooting was calculated (Hartmann *et al.*, 2002).

This experiment had a Completely Randomized Design (CRD) with factorial arrangement in three replications including 15 cuttings per each replicate. Data were analyzed with SPSS (SPSS Inc., Chicago, USA) and means were separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Table 1 indicated that media and IBA concentrations has significant effect, while interaction has non significant effect on rooting percentage. Based on the result, the highest rooting percentage (37.03%) was obtained in the concentration of 2500 mg L^{-1} IBA (Table. 2). Our results were close to those of Tajbakhsh *et al.* (2009). Our finding showed that the exogenously applied IBA and its levels were both very critical in the present experiments to increase the percentage of rooting. IBA may enhance rooting via increase of internal-free IBA, or may synergistically modify the action of IAA or the endogenous synthesis of IAA. IBA can enhance tissue sensitivity to IAA and increase rooting (Vander Krieken *et al.*, 1993).

Rooting media and IBA concentrations significantly affected the number of main roots per cutting (Table 2). More roots were produced in cocopeat + perlite than the other media ($p<0.01$). All IBA treated cuttings, except those treated in 3500 mg L^{-1}, gave more roots than the controls ($p<0.01$). The 2500 mg L^{-1} IBA was the best treatment in terms of the main root number and rooting percentage (except the root length) per cutting in all of the media. The results of this experiment

Table 1: Analysis of Variance (ANOVA) of rooting percentages, root length and root number of MM111 apple cutting

		MS		
SOV	df	Rooting (%)	Root length (cm)	Root No.
Media	2	114.039**	40.597**	4.111**
Concentration	3	1013.295**	41.035**	130.852**
Media×Concentration	6	8.864^{ns}	4.806**	1.741**
Error	24	5.143	1.012	0.250
CV (%)		12.35	15.72	11.69

ns: Not significant. * and ** significant at 5% and 1% levels respectively.

Table 2: The effect of media, IBA concentration on rooting, root length and number of main root per cutting of apple 'MM111'

Media	IBA conc. (mg L^{-1})	Rooting (%)	Rooting length (cm)	Root No.
Cocopeat	0	11.11ef	5.067cd	1.667gh
	1500	18.51d	7.33bc	3.333ef
	2500	27.77b	4.500d	8.333c
	3500	5.550f	3.400d	1.333gh
Perlite	0	11.11ef	3.667d	2 gh
	1500	22.22cd	10a	3.667de
	2500	29.62b	5 cd	9.667b
	3500	7.403ef	3.833d	2 gh
Cocopeat+Perlite	0	12.96e	8.333ab	2.333fg
	1500	25.92bc	10.50a	4.667d
	2500	37.03a	9.833a	11.33a
	3500	11.11ef	5.333cd	1h

Values followed by the same letter in the same column are not significantly different at the 99% level according to Duncan's test were similar to those of Iqbal *et al.* (1999) who reported that the number of roots are enhanced by increasing the IBA concentration to 3000 mg L^{-1}. The induction of maximum number of roots in the treated cuttings may be due to the fact that cambial activity involved in root initiation is stimulated by growth regulators in many species (Ullah *et al.*, 2005).

Both rooting media and IBA concentrations significantly affected root length ($p<0.01$) (Table 2). Cuttings in perlite+cocopeat medium had longer roots than they had in other media. IBA treated cuttings, except those treated with 3500 mg L^{-1}, gave longer roots than control did in all medium types.

The best treatment in terms of rooting length was in 1500 mg L^{-1} concentration (10.5 cm). But the best treatment in terms of rooting number was in 2500 mg L^{-1} concentration (11.33). This showed that by increasing IBA concentration, root length decreased, but root number increased. Wagner and Oprita (1985) reached the same conclusion in sweet cherry, they showed that low auxin concentrations cause lower root number but increase its length and high concentration increases the root number and decreases its length. The application of auxin causes the enhancement of ethylene synthesis (Hansen, 1987) which inhibits root length growth (Etri, 1991).

Our findings showed that rooting decreased by increasing IBA concentration (3500 mg L^{-1}). Our data are consistent with a study suggesting IBA treatment with high concentration reduced rooting percentage in cuttings of MM106 (Sun and Bassuk, 1991). Moreover, Karakurt *et al.* (2009) reported that the best concentration of IBA for rooting was 1000 mg L^{-1} for MM106 apple rootstock but by increasing IBA concentration to 2000 mg L^{-1} and 4000 mg L^{-1} no rooting occurred.

Our result revealed that rooting was significantly higher in cuttings in cocopeat + perlite medium than other media ($p<0.01$). Improved rooting in this medium can be due to the improvement of both aeration and water holding capacity (Islam, 2008).

Our experiment showed that the lowest rooting percentage was obtained from cocopeat medium. This might be because of its phenolic compounds which cause phytotoxicity, its high salinity (Ma and Nichols, 2004) and high water holding capacity leading to low aeration (Abad *et al.*, 2002).

In perlite medium, rooting percentage was also low. It seems that it is due to its low water retention capacity. Most of the granular inorganic substrates such as perlite have low water retention capacity (Martyn and Szor, 2001).

This result suggests that cocopeat medium retains more water and less air space than the 100% perlite.

CONCLUSION

In conclusion, the results confirmed the importance of exogenous IBA applications and that choosing the right concentrations of IBA for rooting was of critical importance. The application of IBA with a concentration of 2500 mg L^{-1} and cocopeat + perlite medium were found to be the most suitable for rooting of hardwood cuttings of MM111 apple clonal rootstock. However, apart from IBA and rooting media, other factors such as the temperature of rooting media, cutting type and the timing of cutting sampling should be taken into consideration. When this method is compared to other methods of propagation such as grafting and layering, it saves time and is a more economical way of propagation than these alternatives.

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