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Short communication

EFFECTS OF DIFFERENT CONCENTRATIONS OF AUXINS ON ROOTING AND ROOT CHARACTERS OF AIR AND GROUND LAYERS OF JOJOBA (*SIMMONDSIA CHINENSIS* (LINK.) C. K. SCHNEIDER)

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ABSTRACT: The effect of auxins and their different concentrations on rooting and root characters of air and ground layers of jojoba was assessed at Maxima Estate Private Limited Farm, Hyderabad, India in 1998. Auxins IBA, NAA and their mixture (IBA + NAA) at concentrations of 1000, 2000, 4000 and 6000 ppm with lanolin paste were evaluated. One year old shoots from three and half years old shrubs were selected and used for this investigation. The experiment was conducted during the rainy season from June to August in a randomised complete block design with three replications. Both air and ground layers of jojoba rooted only when treated with auxins. The maximum percentage of rooting, cumulative primary root length and the longest primary root was recorded with the application of auxins at 6000 ppm. Among auxins, IBA and among concentrations 6000 ppm showed significantly better overall results. Synergism between IBA and NAA was observed only on a number of primary roots developed per rooted layer. As the concentration of auxins increased the percentage of rooting, number of primary roots, cumulative primary roots length and the length of longest primary root were increasing steadily. IBA at 6000 ppm resulted in 68.1% and 72.7% rooting on air and ground layers, respectively. Ground layering technique showed early root initiation, relatively higher percentage of rooting, and a greater number and longer primary roots compared to air layering. Therefore, ground-layering technique can be adapted as a better vegetative propagation method for jojoba.

Key words/phrases: IBA, NAA, vegetative propagation

INTRODUCTION

Jojoba pronounced as ho-ho-ba (*Simmondsia chinensis* (Link.) C.K. Schneider) is the only species in the family Simmondsiaceae and native to a triangle of Sanoran Desert whose corners are roughly Los Angeles (California), Phoenix (Arizona) and the southern tip of Baja California (Mexico) (Singh, 1998). This area encompasses some of the earth's most inhospitable land: in some places, rainfall is as sparse as 80 mm a year, and temperature soar as high as 54°C. Few crops could survive this blistering environment, but among the rocks, gravel, and sand, jojoba endures (Singh and Ghose, 1986). It is also salt and alkali tolerant (Bhatia and Gulati, 1981). Therefore, jojoba has tremendous potential to control desertification and utilize wastelands in the arid and semiarid parts of the world. Moreover, its seed contains 50 to 60 per cent a liquid wax, which is unique in the plant kingdom but similar to the oil of the endangered species sperm whale (Weiss, 1983). The liquid wax and its derivatives seem to have potential for uses in products as diverse as cosmetics, pharmaceuticals, lubricants, foods, electrical insulators, foam-control agents, high-pressure lubricants, heating oils, plasticizers, fire retardants, and transformer oil (Raj, 1998). Thus, jojoba is not only useful to control desertification and utilize wastelands in the arid and semiarid parts of the world but also to preserve the dwindling population of sperm whale.

Jojoba is dioecious and possess a great range of ploidy (chromosome number 36–100) (Rao *et al.*, 1986). Due to its dioecious nature and presence of numerous polyploids, a wide range of diversity exists in seedling population of jojoba. In addition, it is not possible to identify the sex of jojoba shrub morphologically before its flowering age, which usually requires more than two years (Weiss, 1983). Plazkill and Feldman reported that in a seedling population of jojoba about 50 per cent of the plants are usually non-productive males. However, only 10 to 15 per cent male plants in a plantation are sufficient for effective pollination and fertilization (Rao *et al.*, 1986). Therefore, vegetative propagation of jojoba not only ensures genetic uniformity like other crops but also to manage the proportion of male and female plants in a plantation.

Propagation of jojoba vegetatively by stem cutting, air layering, in-arching and tissue culture (Yermanos, 1979; Arce and Jordan, 1988; Plazkill and Feldman, 1993; Benizoni, 1995) have been attempted but not yet by ground layering. Yermanos (1979) reported that rooting of cuttings of jojoba is low (50%), slow and requires considerable green house facilities. Arce and Jordan (1988) also found only 56 and 26 percent rooting with IBA and NAA treatment, respectively. Although plant-lets have been developed by *in vitro* culture, their survival rate on the field was very low (Benzioni, 1995). Therefore, the available information so far indicates that easy, less costly and efficient vegetative propagation method for jojoba is not yet developed and the effect of auxins and their different concentrations seems not exhaustively explored. Thus, this study was carried out to investigate the effect of auxins at different concentrations on rooting and root characters of jojoba air and ground layers.

MATERIALS AND METHODS

This investigation was conducted at Maxima Estate Private Limited Farm, Hyderabad, India from June to September 1998. One-year-old 360 and 288 shoots from three and half years-old jojoba shrubs were selected for air and ground layering, respectively. To perform air layering a ring of bark 2 cm width was removed and freshly prepared auxins in lanolin paste were applied at the upper cut end. It was then covered with moist sawdust in white polyethylene bag and tied air tight with twine. To perform ground layering, long-basal branches were selected and an incision was made to open a notch on the under side of the shoot and smeared with the freshly prepared auxins in lanolin paste. Then the shoot pegged into a plastic pot with rooting medium (a mixture of garden soil and farm yard manure in 3:1 ratio). Treatments were: IBA at 1000, 2000, 4000, 6000 ppm, NAA at 1000, 2000, 4000, 6000 ppm, IBA + NAA at 2000, 4000, 6000 ppm and sole lanolin paste (control). The experiment was laid out in a randomised complete block design with three replications. Data of each treatment at each replication was from mean of ten and eight layers in air and ground layers, respectively. Data recorded in percent and counts were transformed to Arcsine and Square root, respectively before subjecting them to statistical analysis. Statistical analysis of data and mean separation was made using MSTAT-C statistical software. Number of rooted layers, number of primary roots per rooted layer, cumulative primary root length and length of the longest primary root were collected after 60 and 85 days of treatment application in ground and air layers, respectively.

RESULTS AND DISCUSSION

Percentage of rooting and root characters of jojoba ground and air layers were significantly influenced with auxin application (Tables 1 and 2). The highest percentage of rooting, 68.06% and 72.7% in air and ground layers respectively were recorded with application of IBA at 6000 ppm. However, layers treated with sole lanolin paste (control) failed to initiate root till 60 and 85 days after treatment application in ground and air layers, respectively. Percentage of rooting obtained with the application of IBA at 6000 ppm was not significantly different from the result obtained with the application of IBA + NAA at 6000 ppm but significantly superior from the result of any other treatments. Application of NAA at 6000 ppm gave significantly lower percentage of rooting compared to IBA and IBA + NAA at the same concentration. However, its percentage of rooting was statistically the same with the result of IBA and IBA + NAA at 4000 ppm both in air and ground layers. Synergism between IBA and NAA was not observed on percentage of rooting of air and ground layers of jojoba. Nevertheless, Singh *et al.* (1962) have noted strong synergistic effect between IBA and NAA on all parameters studied in sapota (*Achras sapota L.*) air layers. This disagreement may be attributed to the difference between the two crops with regard to the nature and concentration of different endogenous plant growth substances they have. Compared to NAA and their mixture, IBA gave relatively higher percentage of rooting both in air and ground layers. Similarly, Arce and Jordan (1988) reported 56% and 26% rooting on stem cuttings of jojoba treated with IBA and NAA, respectively, which indicates the superiority of IBA. Moreover, Syamal and Singh (1993) in air-layers of litchi (*Litchi chinensis* Sonn.), Chatterjiee *et al.* (1989) in air- layers of sapota, Shukla and Bist (1994) in pear (*Pyrus communis L.*) and Sunitha (1991) on cuttings of grapevine (*Vitis vinifera L.*) have reported the superiority of IBA. Sen *et al.* (1965) attributed this difference to their respective differences in initiating hydrolysis of nutritional reserves. Nanda *et al.* (1967) suggested that enhanced hydrolytic activity in the presence of exogenously supplied hormones was responsible for the increased rooting of auxin treated cuttings. The secondary reactions induced by auxins and their interactions with other endogenous substances might account for differential responses of different synthetic auxins in root formation. Hence, it may be possible to suggest that either IBA was more efficient in hydrolysis of nutritional reserves than NAA or the secondary reactions induced due to application of IBA were more helpful for root initiation on jojoba layers.

Table 1. Types and different concentrations of auxins treatment on percentage of rooting and root characters of jojoba air layers.

Treatment	Percentage of rooting	Number of primary roots per rooted layer	Cumulative primary roots length per rooted layer (cm)	Length of the longest primary root (cm)
IBA 1000ppm	31.67 (34.15)	4.6 (2.26)	16.3	4.63
IBA 2000ppm	44.43 (39.82)	6.9 (2.71)	19.6	4.83
IBA 4000ppm	51.87 (46.07)	8.77 (3.04)	26.87	6.1
IBA 6000ppm	68.06 (55.67)	10.04 (3.3)	33.03	6.7
NAA 1000ppm	26.10 (30.6)	4.47 (2.22)	14.13	4.17
NAA 2000ppm	31.93 (34.33)	6.3 (2.59)	18.97	4.7
NAA 4000ppm	47.7 (43.66)	7.57 (2.83)	24.5	4.87
NAA 6000ppm	56.33 (48.77)	9.13 (3.1)	28.3	6.26
IBA+NAA 2000ppm	33.6 (35.4)	7.47 (2.81)	19.33	4.77
IBA+NAA 4000ppm	49.5 (44.71)	8.7 (3.03)	24.77	5.3
IBA+NAA 6000ppm	59.37 (50.41)	11.6 (3.46)	30.8	6.4
Control (lanolin paste)	0 (0)	0 (0.71)	0	0
CV (%)	8.2	5.9	13.6	8.1
LSD (0.05)	6.55	0.323	6.01	0.82

Figures in parenthesis are transformed values.

Table 2. Types and different concentrations of auxins treatment on percentage of rooting and root characters of jojoba ground layers.

Treatment	Percentage of rooting	Number of primary roots per rooted layer	Cumulative primary roots length per rooted layer (cm)	Length of the longest primary root (cm)
IBA 1000ppm	32.77 (34.82)	5.6 (2.47)	55.87	12.5
IBA 2000ppm	42.5 (40.66)	8.0 (2.9)	64.70	14.0
IBA 4000ppm	57.5 (49.34)	9.63 (3.18)	71.50	17.8
IBA 6000ppm	72.7 (58.5)	11.53 (3.47)	78.97	22.5
NAA 1000ppm	27.77 (31.75)	5.3 (2.41)	50.43	12.0
NAA 2000ppm	33.33 (35.66)	6.8 (2.7)	58.07	13.7
NAA 4000ppm	49.03 (44.43)	8.53 (3.0)	67.57	16.4
NAA 6000ppm	59.7 (50.67)	10.67 (3.34)	76.53	18.7
IBA + NAA 2000ppm	36.93 (37.41)	8.2 (2.94)	60.0	10.83
IBA + NAA 4000ppm	55.7 (48.28)	10.4 (3.3)	69.8	15.0
IBA + NAA 6000ppm	65.83 (54.34)	12.2 (3.56)	77.2	19.7
Control (lanolin paste)	0 (0)	0 (0.71)	0	0
CV (%)	8.2	4.7	3.6	11.6
LSD (0.05)	6.91	0.274	4.38	3.47

Figures in parenthesis are transformed values.

The result of this investigation indicated that percentage of rooting was increased steadily as the concentration of auxins increased. The maximum percentage of rooting was recorded from layers treated with the maximum auxin concentration, 6000 ppm. Hence, further evaluation of higher concentrations of auxins will have paramount importance to identify the optimum concentration for maximum percentage of rooting of jojoba layers. Among the two layering techniques evaluated, ground layering showed relatively higher percentage of rooting and early root initiation.

The maximum number of primary roots developed per rooted layer, 11.6 and 12.2 on air and ground layers, respectively, were recorded with the application of IBA + NAA at 6000 ppm. Nevertheless, the result obtained with the application of IBA at 6000 ppm in air layers and IBA at 6000 ppm, NAA at 6000 ppm and IBA + NAA at 4000 ppm in ground layers was not statistically significant. This result indicated that IBA and NAA had synergistic effect on the number of primary roots developed per rooted layer. Similarly, Singh *et al.* (1962) reported the presence of synergism between IBA and NAA on rooting and root-characters of sapota air layers. Effect of auxin concentrations on number of primary roots developed per rooted layer indicated that, the number of primary roots developed per rooted layer increases as the concentration of applied auxin concentration increases. However, the effect of IBA + NAA at 6000 ppm and 4000 ppm was not significantly different. Ground layers had relatively more number of primary roots per rooted layer than air layers for all treatment combinations.

Jojoba has delicate or fragile roots; hence, layers with more number of primary roots could have better establishment capacity on the field. Therefore, treatments that induce prolific primary roots development are useful for vegetative propagation of jojoba.

The highest cumulative primary root length and the longest primary root per rooted layer were recorded on both air and ground layers treated with IBA at 6000 ppm (Tables 1 and 2). However, it was not significantly longer than the cumulative length of primary roots developed with the application of NAA and IBA + NAA at 6000 ppm. Therefore, the effect of different auxins on cumulative primary roots length was not significantly different. Like percentage of rooting and number of primary roots developed per rooted layer, the cumulative primary roots length increased steadily with increasing the concentration of auxins. Cumulative primary roots length had a positive relation with the number of primary roots developed per rooted layer. Therefore, auxins affect the cumulative primary roots length either through increasing the number of primary roots developed per rooted layer or by increasing cell division and enlargement at each primary root. Syamal and Singh (1993) reported similar result in air layers of litchi. Compared to air layers, ground layers had longer primary roots. This could be attributed to the difference in time of root initiation and the rooting media and environment among the two layering techniques. Jojoba plants have an exceptionally deep root system as a mechanism for drought resistance. Matured shrubs have roots penetrating as far as 15 to 20 m into the soil and young plants have roots ten times longer than the height of the plant above ground (Weiss, 1983). Therefore, a treatment, which induces development of longer primary roots, may have paramount importance for its establishment and survival on the field.

CONCLUSIONS

In general among auxins, IBA and among concentrations 6000 ppm showed better overall result. The result of this study also revealed that, of the two vegetative propagation techniques, ground layering gave early root initiation, relatively higher percentage of rooting and better root characters than air layering. In addition, ground layering is technically simple and less costly and jojoba is suitable for ground layering since it is bushy by its nature. Therefore, ground layering seems better for vegetative propagation of jojoba compared to air layering. However, the success seems low, mainly because the type of shoot, rooting media, ideal season and time required for rooting is not standardized. Thus, the authors suggest that standardization of the above conditions should be future research agenda.

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