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Effect of growing media, Pgrs and seasonal variability on rooting ability and survival of lemon (*Citrus Limon* L.) cuttings

Vijay Pratap Singh[1], P.K. Nimbolkar*[2], Saurabh K. Singh[3], N. K. Mishra[4], and Arunima Tripathi[5]

[1] Department of Hort culture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, U. S. Nagar, Ut arakhand, India.
[2,3,4,5]Department of Hort culture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, U. S. Nagar, Ut arakhand, India

Corresponding author: prashantnimbolkar111@gmail.com

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Abstract

The effect of different growing media (soil, soil+FYM, soil+vermicompost, soil+cocopeat, soil+sand+FYM, soil+sand+vermicompost and soil+sand+cocopeat), hormonal treatments (Control, IBA 500 ppm, NAA 500ppm and IBA+NAA 500ppm each) and growing seasons (rainy and spring) on the number of sprout per cut ing, number of primary roots per cut ing, number of secondary roots per cut ing and survival percentage of cut ings of lemon cv. Pant Lemon-1, was evaluated. Among the different growing medium, number of sprouts per cut ing (2.58) with soil+sand+vermicompost, number of primary roots per cut ing (9.03) and number of secondary roots per cut ing (16.67) with soil+sand+cocopeat and survival percentage (82.23) with soil+sand+FYM, recorded maximum. Growth hormones IBA 500 ppm resulted maximum (2.42) number of sprouts per cut ing as well as highest survival percentage (81.68). Hormonal combination of IBA 500 ppm+NAA 500 ppm were resulted maximum number of primary roots (7.74) and secondary roots (16.19) per cut ing. Over all compare between spring and rainy seasons, spring season was found superior regarding number of sprout per cut ing (2.29) and number of primary roots per cut ing (7.30). Whereas, number of secondary roots per cut ing (15.30) and survival percentage (77.37), were more in spring season.

Highlights

- Growing medium of soil + sand and cocopeat, hormonal combination of IBA 500 ppm + NAA 500 ppm in spring season are best treatments for rooting ability of cut ings.
- Growing medium of soil+sand+FYM and hormonal treatment (IBA 500 ppm) are effective as a survival of lemon cut ings in rainy season.

Keywords: seasonal variability, survival percentage, cut ings, media, hormones.

Citrus occupies a very important place in fruit map of the world and is grown commercially in more than 50 countries around the world. In India also, citrus is one of the major fruit crops, and it cultivated in 1042.49 thousand ha area with the production of 10089.73 thousand tons, among which lemon and lime contribute about 255.21 thousand ha in area 2523.51 thousand tons on production basis

(Annonymus, 2013). Lemon (*Citrus limon* L.) is an important plant of *Citrus species.* Lemons are either used as fresh or in preserved form. Tarai region of Ut arakhand is unique in climate and characterized by hot and humid summer and extremely cold winters. Among all the citrus fruit tried in this area, lemon has performed relatively well. Lemon is usually propagated by seeds which are commonly polyembryonic in nature, resulting in both zygotic and nucellar individuals. Lemon propagation by cut ings is considered an alternative technique, providing high quality planting material, especially as plants with limited seed availability, such as low seed producing cultivars, and recalcitrant nature of seed. Plant growth regulators, such as indole-3-butyric acid (IBA), naphthalene acetic acid (NAA) and 6-Benzylaminopurine (BAP), are frequently used to promote shooting and rooting in cut ings (Hartmann *et al*. 2002; Sharma *et al*. 2013; Verma (2013). Different growing media that are well aerated, well drained and with good water retention are used in establishing crop plantlets (Rymbai and Reddy, 2010; Bhosale *et al*. 2014). Cultivar difference and weather condition also affect rooting in various fruit plant cut ings (Mishra and Singh, 1984). Keeping in view, the present investigation was undertaken to evaluate best growing media and rooting hormone in relation to seasonal variation.

Material and Methods

The experiments were conducted during the year 2013 and 2014 under open condition in the Horticulture Research Center of G.B. Pant University of Agriculture and technology, Pantnagar, Udham Singh Nagar, Ut arakhand, India. Pantnagar is situated at 29° N latitude, 79.3° E longitude and at an altitude of 243.8 m above the mean sea level in the tarai region of Shivalik range of Himalaya. The experimental material consisted of 20 cm long stem cut ings collected from the middle portion of one year old shoots of cv. Pant lemon-1. The cut ings were planted during two different seasons (rainy and spring season) and maintained under uniform cultural practices. The treatment combination in this experiment consisted of seven different type of media mixtures consisting, Soil (M_1), Soil + FYM (M_2), Soil+Vermicompost (M_3), Soil+Cocopeat (M_4), Soil+Sand+FYM (M_5), Soil+Sand+Vermicompost (M_6) and Soil +Sand + Cocopeat (M_7). Concentration of Growth Regulators *viz*. Control 0 ppm (G_0), IBA 500 ppm (G_1), NAA 500 ppm (G_2) and IBA+NAA 500 ppm each (G_3) applied at the basal portion of the cut ing as a quick dip method with two different seasons rainy and spring. The experiment was laid out in factorial Randomized Block Design. Each treatment combination was applied to 10 cut ings and replicated thrice. Two third portion of each cut ing was inserted in the media. All cut ings maintained under uniform cultural schedule during the whole period of investigation. Data recorded during course of investigation were subjected to statistical analysis under two factor RBD design by Cochrn and cox (1992).

Results and Discussion

Number of sprouts per cut ing

Results obtained on sprouts per cut ings are presented in table 1. During rainy season, average number of sprouts per cut ing were found to be higher (2.74) in soil+sand+vermicompost medium while minimum (1.78) average number of sprouts per cut ing were found in soil medium. The combination treatment of IBA and NAA, at 500 ppm each gave maximum (2.28) average number of sprouts per cut ings while minimum (1.93) average number of sprouts per cut ing was found in distilled water (control). Similar findings have also been reported by Ranjusha and Gangaprasad (2014) with IBA and NAA. However, in spring season, maximum (3.06) average number of sprouts per cut ing was found in soil+sand+cocopeat medium while minimum (1.68) average number of sprouts per cut ing was observed in soil+vermicompost medium. Moisture holding capacity of cocopeat might have improved the sprouting of shoots despite low rainfall and humidity during spring season. Application of IBA at 500 ppm resulted in maximum (2.67) average number of sprouts per cut ing. While minimum

(1.91) average numbers of sprouts per cut ing were observed in distilled water (control). Similar effect of IBA has also been investigated by Omer and Salih. (2004) on rooting of kiwifruit cut ings.

Table 1: Effect of growing media, growth regulator and growing season on number of shoots per cutting.

Treatments	Number of sprout per cutting		
	S_1 (Rainy season)	S_2 (Spring season)	Pooled mean
M_1 (soil)	1.78	2.05	1.91
M_2 (soil + FYM)	1.86	2.50	2.18
M_3 (soil + vermicompost)	2.36	1.68	2.02
M_4 (soil + cocopeat)	2.10	2.26	2.18
M_5 (soil + sand + FYM)	1.97	2.10	2.04
M_6 (soil + sand + vermicompost)	2.74	2.42	2.58
M_7 (soil + sand + cocopeat)	2.08	3.06	2.57
G_0 (Control)	1.93	1.91	1.92
G_1 (IBA 500 ppm)	2.17	2.67	2.42
G_2 (NAA 500ppm)	2.13	2.13	2.13
G_3 (IBA+NAA 500+500 ppm)	2.28	2.47	2.38
Overall mean (season)	2.13	2.29	
	F-test	S.Em (±)	C.D. (P=0.05)
Growing media (M)	S*	0.09	0.25
Growth hormones (G)	S*	0.07	0.19
Season (S)	S*	0.05	0.13

S*– Significant, S – Season , S_1 – Rainy season, S_2 – Spring season, M – Growing media, G – Growth hormones, S.Em (±) – Standard error means, C.D. – Critical difference.

Overall during both the seasons, mean average number of sprouts per cut ing were highest (2.58) in soil+sand+vermicompost medium while minimum (1.91) mean average number of sprouts per cut ing were found in soil medium. The observed results might be due to bet er aeration, nutrient availability, enzymatic activity and moisture retention capacity of substrate. The results obtained are in agreement with those reported by Shree *et al.* 2007 in mulberry cut ings. Spring season was found to be best for the production of higher (2.29) number of shoot per cut ing followed by rainy season (2.13) probably because of higher endogenous auxin activity in the cut ings.

Table 2. Effect of growing media, growth regulator and growing season on average number of primary roots per cuttings.

Treatments	Number of primary roots per cutting		
	S_1 (Rainy season)	S_2 (Spring season)	Pooled mean
M1 (soil)	6.22	4.91	5.56
M2 (soil+FYM)	5.5	6.91	6.25
M 3 (soil+vermicompost)	6.03	7.15	6.59
M4 (soil+cocopeat)	6.57	7.51	7.04
M 5 (soil+sand+FYM)	6.73	7.19	6.96
M6 (soil + sand + vermicompost)	7.76	7.06	7.41
M7 (soil + sand + cocopeat)	7.72	10.34	9.03
G0 (Control)	5.55	5.56	5.55
G1 (IBA 500 ppm)	6.74	7.01	6.87
G2 (NAA 500ppm)	7.34	8.09	7.72
G3 (IBA + NAA 500 + 500 ppm)	6.95	8.54	7.74
Overall mean (season)	6.64	7.30	
	F-test	S.Em (±)	C.D. (P=0.05)
Growing media (M)	S	0.196	0.55
Growth hormones (G)	S	0.148	0.416
Season (S)	S	0.105	0.294

S*– Significant, S – Season, S_1 – Rainy season, S_2 – Spring season, M – Growing media, G – Growth hormones, S.Em (±) – Standard error means, C.D. – Critical difference.

Number of primary roots

Number of primary roots per cut ing (Table 2) showed that growing media, growth regulator concentration and growing seasons had significant effect on number of primary roots per cut ing. In rainy season, maximum (7.76) number of primary

roots cut ing was found in soil+sand+vermicompost medium while minimum (5.50) number of primary roots per cut ing was observed in soil+FYM. The results are in the conformity with previous reports on positive effect of vermicompost based medium on the length of primary roots (Shirol *et al*. 2001). NAA, 500 ppm gave maximum (7.34) number of primary roots per cut ings while minimum (5.55) number of primary roots per cut ings was observed in distilled water taken as control. The induction of maximum number of roots in the treated cut ings might be due to the fact that cambial activity involved in root-initiation is stimulated by growth regulators in many species as reported by Digby and Wanerman, 1965. In spring season, maximum (10.34) number of primary roots per cut ing was found in soil+sand+cocopeat medium while minimum (4.91) number of primary roots per cut ing was observed in soil medium. Higher root formation in Cocopeat might be due to its ability to store and release nutrients to plants for extended periods of time. It also has great oxygenation properties which is important for healthy root development. These results are in conformity with the results of Rahimi *et al* 2011. The combination of IBA and NAA at 500 ppm each gave maximum (8.54) number of primary roots per cut ing while minimum (5.56) number of primary roots per cut ing was observed in distilled water. During both the season, mean of number of primary roots per cut ing was found highest (9.03) in soil+sand+cocopeat medium while lowest (5.57) number of primary roots per cut ing was observed in soil medium. The observed results could be due to the bet er aeration and high water holding capacity of substrate. Among the growth regulators higher (7.74) numbers of roots per cut ings were observed with cut ings treated with the combination of IBA and NAA at 500 ppm each followed by (7.72) in cut ings treated with NAA, 500 ppm while minimum (5.55) number of primary roots per cut ing was observed in distilled water. Rymbai and Reddy also reported higher rooting with IBA treatment. Seasonal effect is clearly visible in the present study as there was maximum rooting (7.38) in cut ings planted in spring season followed by monsoon (6.65) planting. The reduction in root formation in rainy season might be due to higher rainfall, which restricted the aeration of root zone and reduced initiation of roots.

Number of secondary roots

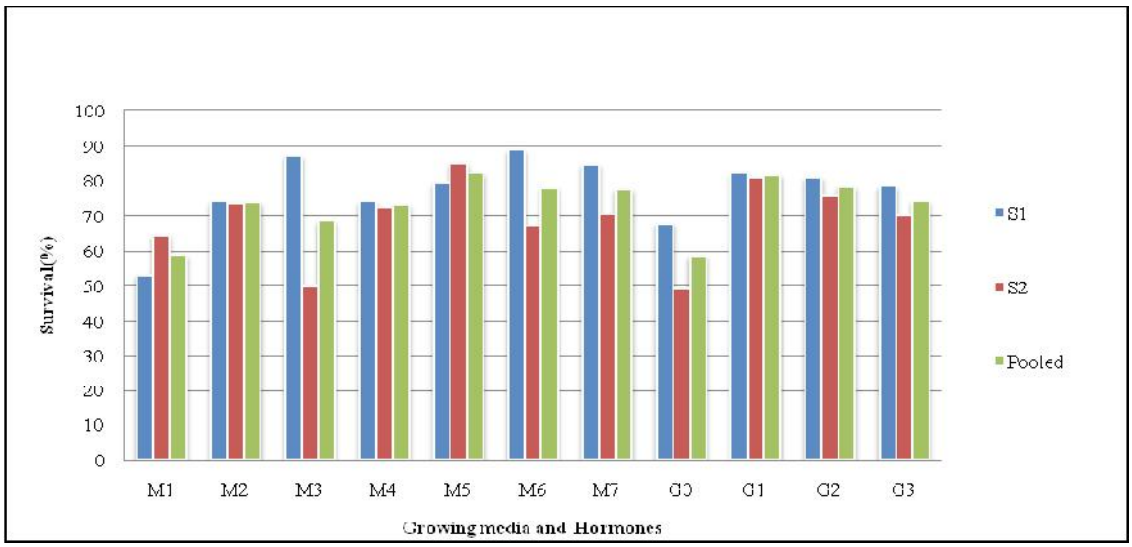
The data pertaining to number of secondary roots per cut ing (Table 3) showed that the treatments had significant effect on number of secondary roots per cut ing.

Table 3: Effect of growing media, growth regulator and growing season on average number of secondary roots per cutting.

Treatments	Number of secondary roots per cutting		
	S_1 (Rainy season)	S_2 (Spring season)	Pooled mean
M1 (soil)	14.31	10.42	13.02
M2 (soil+FYM)	11.92	12.14	12.10
M3 (soil+vermicompost)	13.57	13.00	13.44
M4 (soil+cocopeat)	14.83	13.13	13.58
M5 (soil+sand+FYM)	15.50	13.60	14.41
M6 (soil + sand + vermicompost)	17.50	14.93	15.08
M7 (soil + sand + cocopeat)	19.47	16.38	16.67
G0 (Control)	13.53	10.68	13.56
G1 (IBA 500 ppm)	15.96	14.14	16.09
G2 (NAA 500ppm)	15.77	14.31	15.92
G3 (IBA+NAA 500+500 ppm)	15.94	14.36	16.19
Overall mean (season)	15.30	13.37	
	F-test	S.Em (±)	C.D. (P=0.05)
Growing media (M)	S*	0.35	0.69
Growth hormones (G)	S*	0.26	0.52
Season (S)	S*	0.18	0.37

S*– Significant, S – Season, S_1 – Rainy season, S_2 – Spring season, M – Growing media, G – Growth hormones, S.Em (±) – Standard error means, C.D. – Critical difference.

In rainy season, maximum (19.47) number of secondary roots per cut ing were produced in soil + sand + cocopeat while minimum (11.92) number of secondary roots per cut ing



S_1 – Rainy season, S_2 – Spring season, M1- (soil), M2 (soil+FYM), M3 (soil+vermicompost), M4- (soil+cocopeat), M5- (soil+sand+FYM), M6 - (soil+sand+vermicompost), M7 -(soil+sand+cocopeat), G0 (Control), G1 -(IBA 500 ppm), G2 -(NAA 500ppm), G3 -(IBA+NAA 500+500 ppm).

Fig. 1. Effect of growing media, growth regulator and growing season on survival percentage of lemon cutting.

was observed in soil + FYM) medium. The bet er effect of cocopeat probably due to the good aeration and higher pore space in cocopeat which helped in bet er proliferation of roots and ultimately increasing the branching in those roots. Rymbai *et al.* 2012 also reported higher number of secondary branching roots in guava air layering in cocopeat based medium. Effect of 500 ppm IBA found satisfactory and gave maximum (15.96) number of secondary roots per cut ings while minimum (13.53) number of secondary roots per cut ings was observed in distilled water (control). In spring season, maximum (16.38) number of secondary roots per cut ing was found in soil+sand+cocopeat while minimum (10.42) number of primary roots per cut ing was observed in soil medium. Cut ings treated with the mixture of IBA and NAA at 500 ppm each gave higher (14.36) number of secondary roots per cut ing while number of secondary roots per cut ing was lower in cut ings treated with distilled water. Overall during both the season, mean number of secondary roots per cut ing was found maximum (16.67) in soil+sand+cocopeat medium while minimum (12.10) mean number of secondary roots per cut ing was observed in soil+FYM. Hormonal combination of IBA 500 ppm+NAA 500 ppm resulted maximum mean number of secondary roots (16.19) per cut ing while lower number of secondary roots per cut ing (13.56) was recoreded with distilled water. Maximum mean number of secondary roots (15.30) was found in rainy season, followed by spring season (13.37). The beneficial effect of mixtures of root promoting substances was visible in the production of secondary roots. Shoot RNA was found to be an index of bud activity and subsequent seasonal rooting differences. Highest shoot RNA levels and increased vascular cambium activity occurred during peak rooting period in both the easy-to-root and difficulty to root forms (Davis, 1984).

Survival percentage of cut ings

It is evident from the Figure 1 that growing media, growth regulators and growing seasons had significant effect on survival percentage of cut ings. In rainy season, highest (88.81 %) survival percentage of cut ings was found in the cut ings planted in soil+sand+vermicompost medium, while minimum (53.11 %) survival percentage of cut ings

was observed in soil medium. This could be due to the availability of good amount of nutrients in vermicompost and due to the effect of seasonal factors which are associated with it. The findings of Gopale and Zunjorroo (2011) in Jatropha are in accordance with the present results. In the present investigation among the growth regulators IBA at 500 ppm resulted in maximum (82.37 %) survival percentage of cut ings while minimum survival percentage of cut ings (67.86 %) was found in cut ings treated with distilled water which was taken as control .Significant effect of growth regulators on survival percentage was due to root induction capacity of auxin which help in production of adventitious roots and thereby increase in the survival of plants. During spring season, maximum (85.00 %) survival percentage of cut ings was observed in soil+sand+FYM medium while lowest survival percentage of cut ings (50.00%) was found in soil+vermicompost medium. The positive effect of high organic mat er and moisture retention capacity of FYM might have led to effective rooting of cut ings. The findings of Bashir *et al*. (2007) support the results of present investigation. Among different growth regulators IBA at 500 ppm was found to be most effective and gave maximum (80.99 %) survival percentage of cut ings while minimum (49.29 %) survival percentage of cut ings was observed in distilled water (control). Auxin may have induced favourable environment for root and shoot development and enhanced survival (Constanzi *et al.* 1988). The mean percentage of survived cut ings was maximum (82.23 %) in M_5 medium while minimum (58.80 %) mean survival percentage of cut ings was observed in M_1 medium. The effect of IBA at 500 ppm gave maximum (81.68 %) mean survival percentage of cut ings while minimum (58.57 %) mean survival percentage of cut ings was observed with cut ings treated with distilled water (control). Higher success rate of cut ings were observed in rainy season. These finding are in line with the finding of Patil *et al.* (2003), Pandey *et al.* (2011) and Kaur (2015).

Conclusion

From going through above findings, it can be concluded that media soil+sand+cocopeat was best medium. For general shoot and root characters, mixture of IBA and NAA at 500 ppm each, was found best. Rainy season was significantly bet er over spring regarding final survival of cut ings.

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