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Role of IBA concentrations and rooting media on rooting and survival percentage of lemon (*Citrus limon* Burm) Cv. pant lemon-1 under net house condition

Rohit Kumar and Abhinav Kumar

Abstract
The research work was conducted during the 2019-20 and 2020-21 at Agricultural Farm, Faculty of Agriculture Sciences, Bhagwant University, Ajmer, 305004. The research work experiment was laid in Randomized Block Design (RBD) with three replications. The Treatment-6 (T_6) 800ppm IBA + Garden Soil + Sand + Vermicompost (1:1:1) was gave the highest values in the intervals of parameters *viz*. days taken for sprouting (6.67 and 7.33), maximum percentage of sprouting cuttings (82.32 and 82.52), Number of leaves per cutting (13.00 and 13.05), Longest root (9.56 and 9.59 cm) and Survival percentage (89.20 and 89.90%) as compared to control under the shade house conditions during the both years of experiments.

Keywords: Lemon stem cutting, IBA, vermicompost, sand

Introduction
Citrus belong to Rutaceae family, the genera Citrus (oranges, mandarins, pomelos, grapefruit, lemons, limes and citrons), Fortunella (kumquats) and Poncirus (trifoliate oranges) contain the principal commercial species (Swingle and Reese, 1967) [17]. It is originating in tropical and subtropical Southeast Asia; these plants are among the oldest fruit crops to be domesticated. India ranks sixth in the production of citrus fruit in the world. It is of particular interest because of its high content of vitamin C (Katz and Weaver, 2003) [10].
Citrus fruits are cultivated in more than 100 countries, making them as one of the most important commercial fruit crops of the world. Fruits have the great utility regarding the medicinal properties, social value, religious value and food security in most developing countries. Fruits are rich source of essential nutrients i.e., carbohydrates, vitamins, proteins, fats and minerals etc. for proper growth and development of human body. Lemon trees put on new growth as series of discrete growth cycles or flushes. There is a major flush of new growth in spring season, which produces most of the flowers and some new leaves on shoot tips at mature branches. There is great variation in initiation of growth, flushes and its behaviour depending upon a number of factors such as environmental, type of soil, species, varieties and age of tree etc. Vegetative propagation of plants by stem cuttings is the most commonly used method for producing herbaceous and woody plant in many parts of the world. A cutting is a piece of the part of plants used to propagate which regenerate there missing part is called cutting. Stem cutting can be classified as follows: hardwood cuttings, semi hardwood cuttings, softwood cutting and herbaceous cuttings. In present investigation, three doses of Indole-3-butyric acid (IBA) $C_{12}H_{13}NO_2$ (1H-indole-3-butanoic acid) is a native compound in Arabidopsis that exhibits a number of auxin activities particularly with respect to roots. IBA and IAA are inter-converted by a variety of plants, so IBA and IAA conjugates may play overlapping roles in the plant, with regard to inactivation of IAA or IBA could act as an auxin directly and three combinations of rooting media (garden soil, sand, FYM and vermicompost) were used to prepare ideal rooting media in a definite proportion. The organic nature of FYM and vermicompost favours the friable condition of media for better water holding capacity, resulting flourish development of roots in cuttings. Garden soil is topsoil, enriched with compost and other organic matter so it's nutritious for plants. It has a heavier texture and holds water longer than potting mixes. It's more affordable than potting soil because it doesn't have pricier ingredients like perlite, vermiculite or moss. It's mostly soil, and soil is dirt cheap. (en.wikipedia.org) Sand is a granular material composed of finely divided rock and mineral particles. Sand has various compositions but is defined by its grain size.

Sand grains are smaller than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass. Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent P_2O_5 and .0.5 per cent K_2O.The present method of preparing farmyard manure by the farmers is defective. Urine, which is wasted, contains one per cent nitrogen and 1.35 per cent potassium.

Vermicompost (vermicompost) is the product of the decomposition process using various species of worms, usually red wigglers, white worms, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and vermicast. This process is called vermicomposting, while the rearing of worms for this purpose is called vermiculture. Vermicompost has been shown to be richer in many nutrients than compost produced by other composting methods. It has also outperformed a commercial plant medium with nutrients added, but levels of magnesium required adjustment, as did pH. It is rich in microbial life which converts nutrients already present in the soil into plant-available forms.

Unlike other compost, worm castings also contain worm mucus which helps prevent nutrients from washing away with the first watering and holds moisture better than plain soil. Increases in the total nitrogen content in vermicompost, an increase in available nitrogen and phosphorus, as well as the increased removal of heavy metals from sludge and soil have been reported. The reduction in the bioavailability of heavy metals has been observed in a number of studies. (en.wikipedia.org)

Methods and Material

The research work was conducted during the 2019-20 and 2020-21 at Agricultural Farm, Faculty of Agriculture Sciences, Bhagwant University, Ajmer, 305004. The Ajmer comes under semi-arid zone and is situated at a latitude of 26.4499° N and longitude of 74.6399° E. The altitude of the place is 484 meters from mean sea level. The mean annual precipitation on the basis of last fifteen years is 473 mm, which receives almost from South-West monsoon during June to October. The mean annual minimum and maximum temperatures are 10.80°C and 41.1°C, respectively. The average humidity ranges from 29.75 per cent in summer and 51.23 per cent in rainy season. Thus, Ajmer has hot and dry summer with moderate cold winter. The experiment was conducted in Randomized Block Design (RBD) with three replications. Total ten treatments including control i.e., T_1-400ppm IBA + garden soil + sand (1:1), T_2- 400ppm IBA + garden soil + sand + FYM (1:1:1), T_3- 400ppm IBA +garden soil + sand + vermicompost (1:1:1), T_4-800ppm IBA + garden soil + sand (1:1), T_5- 800ppm IBA + garden soil + sand + FYM (1:1:1), T_6- 800ppm IBA + garden soil + sand + FYM (1:1:1), T_7-1200ppm IBA + garden soil + sand (1:1), T_8-1200ppm IBA + garden soil + sand + FYM (1:1:1), T_9-1200ppm IBA + garden soil + sand + vermicompost (1:1:1) and T_{10}- Control (Garden soil) were used. Cutting is obtain from the 10 months old shoots of Pant Lemon-1 cultivar of lemon. According to treatment combinations, the different rooting media were prepared and filled in black colour poly-bags. The 22 cm long and pencil thickness sized cuttings were made and treated with prepared IBA solution according to different doses of IBA. Thereafter, cuttings were planted in poly-bags and placed in shade net-house during third week of July month. The various observation like Number of shoots per cutting days taken for sprouting (6.67 and 7.33), maximum percentage of sprouting cuttings (82.32 and 82.52), Number of leaves per cutting (13.00 and 13.05), Longest root (9.56 and 9.59 cm) and Survival percentage (89.20 and 89.90%) were recorded with proceeding of experiment. The recorded data were statistically analysed by using randomized block design (RBD) as suggested by Gomez and Gomez (1996) [6].

Result and Discussion

Results from the Table-1 showed that each increment in IBA concentration significantly affected in terms of days taken to sprouting as compared to control and other treatments.

Days taken to sprouting (Days)

The effect of different treatments on rooting of lemon cuttings significantly influenced the days taken to sprouting of cutting of cv. Pant lemon-1, Amongst all the treatments which were applied at time of planting of cutting of lemon, the treatment 800 ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost (1:1:1) was found to be most effective treatment by recording minimum days taken to sprouting (6 days), whereas, maximum days (16 days) taken for sprouting were recorded under control (garden soil). Earliest sprouting of cutting may be due to prevention of down-word translocation of carbohydrate and accumulation of higher level of endogenous auxins in the ringed, lower portion of cutting during the period of root initiation which might have resulted earliest completion of physiological process involved in rooting and sprouting.

In context to growth media, soil + sand + vermicompost produce earliest sprouting, longer and thicker sprouts due to optimum nutrient uptake and enhanced availability of nutrients and growth promoting substances. Due to natural accumulation of auxins and carbohydrates in the wounded area is increased.

Beside this, ethylene production is also increased which promote adventitious root formation in stem cutting resulting in early intake of buds in cuttings. Similar results were also reported by Singh, K.K. *et al.* (2013) [15], Ibrahim, M. E. (2015) [7] and Patel, B. *et al.* (2021) [21].

Per cent of sprouting of cuttings (%)

The application of rooting hormones like IBA and rooting media on per cent of sprouting of cutting was showed a significant effect. The maximum (82%) percent of sprouting was recorded with an application 800ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost (1:1:1). This may also be due to higher net assimilation rate on account of better growth leading to the production of endogenous metabolites earlier in optimum level enabling early bud initiation and thereby better survival. Further, vermicompost in comparison to FYM used for polybag mixture contained higher level of nutrients. Increase in sprouting percentage may be due to better utilization of stored carbohydrate, nitrogen and other factor with the aid of growth regulator. The above findings are close in conformity with the finding Singh, K.K. *et al.* (2013) [15], Ibrahim, M. E. (2015) [7], K. K. Singh (2018) [8] and Dinesh Raj Tanwar *et al.* (2020) [3].

Number of leaves per cutting

The effect of various concentrations of IBA and rooting media significantly affected the number of leaves per cutting as compared to control. The maximum number of leaves per cutting was recorded under the treatment 800 ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost (1:1:1) followed by 800 ppm IBA + garden soil + sand + FYM (1:1:1), While minimum number of leaves per cutting was obtained under control (garden soil). It might be due to activation of auxin content in vegetative part and growth favoured by the nutrients present in vermicompost at root levels, resulting the greater number of leaves per cuttings. These findings are in agreement with earlier workers Bassan *et al*. (2009) [1] and Singh, G. *et al.* (2017) [14].

Length of longest root (cm)

The length of longest root was significantly influenced by increasing doses up to 800 ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost, then it was significantly declined with further higher doses of Indole-3-Butyric Acid. The maximum length of longest root was recorded with an application 800 ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost (1:1:1), whereas minimum was recorded under control. The improved root formation and root growth in this rooting medium could be due to better aeration and drainage and water maintenance capacity of the substrate which are critical for the first phase of root initiation. Unlike other growing media, vermicompost contains good amount of 'plant available nutrients' and appears to increase and retain more of them for longer period of time. Therefore, lemon cuttings grown in polybag mixture containing vermicompost had better root growth. The enhanced hydrolytic activity in presence of applied IBA coupled with appropriate rooting medium might be responsible for the increased percentage of rooted cuttings in the present study. Similarly, views were held by Farah *et al*. (2009) [4], Singh, G. *et al.* (2017) [14], Patel B. *et al.* (2018) [13] and Malakar, A. (2019) [11].

Survival percentage

Survival per cent of lemon cuttings was significantly affected by all the treatments during investigation. The applied doses of 800 ppm IBA + garden soil + sand + vermicompost (1:1:1) was found to be most appropriate treatment in terms of survival per cent.

The maximum (88.70%) survival per cent was recorded under the 800 ppm Indole-3-Butyric Acid + garden soil + sand + vermicompost (1:1:1) followed by 800ppm IBA + garden soil + sand + FYM (1:1:1) while, minimum (57.60%) survival per cent was recorded under control. In addition to that when using growth regulator boosting the rooting can be attributed to the favourable conditions like high temperature (30-35^{0}C) and high relative humidity (80-90%) with higher photosynthetic activity which promoted better rooting in cutting and survival percentage. These results are in close conformity with those of the earlier workers Fraternale *et al*., (2010) [5], Chayanika *et al.*, (2011) [2], Tallon *et al*. (2012) [18], Singh, V. P. *et al.* (2015) [16], Patel B. *et al.* (2018) [13] and Dinesh Raj Tanwar *et al.* (2020) [3].

Table 1: Role of IBA Concentrations and Rooting Media on Rooting and Survival Percentage of Lemon (*Citrus limon* Burm) Cv. Pant Lemon-1 Under Net House Condition

Notation	Treatments	Days taken for sprouting		Percentage of sprouting cuttings		Number of leaves per cutting		Longest root (cm)		Survival percentage (%)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	400 ppm IBA + Garden Soil + Sand (1:1)	13.67	14.33	42.62	42.80	4.33	4.56	4.60	4.63	60.43	60.57
T_2	400 ppm IBA + Garden Soil + Sand + FYM (1:1:1)	13.00	13.33	47.11	47.27	5.67	6.06	5.23	5.27	64.47	64.58
T_3	400 ppm IBA + Garden Soil + Sand + Vermicompost (1:1:1)	10.67	11.00	55.30	55.40	7.33	7.33	6.16	6.16	67.22	67.56
T_4	800 ppm IBA + Garden Soil + Sand (1:1)	10.67	11.34	63.20	63.28	8.67	9.05	7.65	7.70	73.88	73.96
T_5	800 ppm IBA + Garden Soil + Sand + FYM (1:1:1)	7.00	7.33	74.13	74.23	11.33	11.94	8.21	8.24	81.25	82.22
T_6	800 ppm IBA +Garden Soil + Sand + Vermicompost (1:1:1)	6.67	7.33	82.32	82.52	13.00	13.05	9.56	9.59	89.20	89.90
T_7	1200 ppm IBA + Garden Soil + Sand (1:1)	7.33	7.67	71.62	72.10	11.00	11.57	7.01	7.05	79.39	79.94
T_8	1200 ppm IBA + Garden Soil + Sand + FYM (1:1:1)	9.00	9.00	61.02	61.61	9.33	9.83	6.63	6.72	71.10	71.95
T_9	1200 ppm IBA + Garden Soil + Sand + Vermicompost (1:1:1)	10.33	10.67	56.65	57.11	9.00	9.39	5.78	5.82	66.61	66.97
T_{10}	Control (Garden Soil)	16.00	16.33	39.77	40.00	4.00	4.61	3.90	3.98	58.39	59.07
S.Em ±		0.45	0.45	0.39	0.40	0.45	0.33	0.06	0.06	0.22	0.30
CD		1.35	1.35	1.16	1.18	1.32	0.98	0.17	0.17	0.65	0.88

Conclusion

In present investigation different IBA concentrations and rooting media were applied for rooting of cuttings of lemon cv. Pant Lemon-1. In this respect a total ten treatments were tried. Out of these, the treatment 800ppm IBA + Garden Soil + Sand + Vermicompost (1:1:1) was found to be the most significant treatment for rooting of stem cuttings and survival percentage of lemon (*Citrus limon* Burm) cv. Pant Lemon-1 as compared to control under net house conditions.

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