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Effect of IBA and growing media on growth and survival of stem cutting in Kagzi Lime (*Citrus aurantifolia*)

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Abstract

The experiment was conducted at Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. Prayagraj during the session 2023 - 2024. The experiment was laid out in completely randomized design with three replications, and the study consists of nine treatment combinations including control by using different Effect of IBA and growing media on growth and survival of stem cutting in Kagzi Lime. The best treatment was T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) & T₈ (Soil + Sand + Cocopeat + IBA 500 ppm) which shows highest values in all the parameters viz., days to first sprouting (6.62), number of sprouts/cutting (3.86), Length of new shoot per cutting (cm) (21.57 cm), Leaves per shoot (43.46), Survival percentage (80.09%), Percentage of rooting of cutting (%) (24.97%), Length of root (cm) (28.96 cm), Fresh weight of root (g) (4.65 g), Dry weight of root (g) (1.77 g).

Keywords: Kagzi Lime, IBA, Cocopeat, vermicompost, sand, soil

1. Introduction

Citrus fruits botanically known as hesperidia are being successfully cultivated in tropical and subtropical regions of the world. Presently, the citrus fruits are grown all over the world in more than 140 countries; most of the crop grows on either side of a belt around the equator covering tropical and subtropical areas of the world 35°N and 35°S latitudes with cultivation and production concentrated in major regions in the Northern Hemisphere.

Citrus fruits are popular in subtropical regions of North India and tropical regions of South India mainly due to their hardy nature and good nutritional values. India produced 3717 MT of lime/lemon fruits annually from 3.17 lakh hectare areas with an annual productivity of 11.72 tonnes/hectare (NHB database 2019 and 2020) ^[15]. Rajasthan produce about 994.38 MT of fruits production from an area of 61.58 thousand hectare (NHB, 2019-20) ^[15].

Cocopeat is also becoming very popular material as a growing media. It has an excellent pore space (25-30 per cent) and fine structure required for proper growth and development of seedlings. Moreover, it is a rich source of nutrients and can easily be mixed with other growing media. Vermiculite is the micaceous mineral which expands significantly when heated. Chemically it is hydrated magnesium, aluminium, iron, silicate. When expanded it is very light in weight. It is neutral in reaction and has good buffering properties. It is insoluble in water. Vermiculite is available in 4 Grades, out of which the Horticultural Grade No. 2 should be used for rooting and No. 4 for seed germination.

Vermicompost is a peat-like material with high porosity, aeration, drainage, water holding capacity and microbial activity, which make it an excellence soil conditioner (Edwards, 2002) ^[1]. There are many reports available in the literature, which indicates that vermicompost contain plant growth regulating materials, such as humic acid (Muscolo *et al.*, 1999) ^[14] and plant growth regulators like auxin, gibberellins and cytokinins (Tomati *et al.*, 1988) ^[28], which are responsible for increase in plant growth and yield of many crops (Atiyeh *et al.*, 2002) ^[1]. It is used as a media for propagation but should be mixed with soil in proper combination.

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Indole Butyric Acid (IBA) is the synthetic plant hormone. It is active in inhibiting axillary bud break on developing new shoots, and it stimulates the root initiation. It promotes cell elongation which helped to increase in root length. It is a leading plant hormone used to generate new roots in the cloning of plants through cuttings (Polat and Caliskan, 2006) ^[16].

2. Materials and Methods

This experiment was laid out from October 2023 to February 2024 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The horticulture research farm is situated at 25° 39' 42" N latitude, 81° 67' 56" E longitude and at an altitude of 98 m above mean sea level. The treatment consisted of T₁- Soil + Sand, T₂-Soil + Sand + Vermicompost, T₃-Soil + Sand + Cocopeat, T₄-Soil + Sand + IBA 500 ppm, T₅-Soil + Sand + IBA 600 ppm, T₆-Soil + Sand + Vermicompost + IBA 500 ppm, T₇-Soil + Sand + Vermicompost + IBA 600 ppm, T₈- Soil + Sand + Cocopeat + IBA 500 ppm, T₉ - Soil + Sand + Cocopeat + IBA 600 ppm. The experiment was laid out in a Completely Randomized Design (CRD) with nine treatments. Data recorded on different aspects of the fruit crop, viz., growth and establishment were subjected to statistical analysis by the analysis of variance method economic data analysis using mathematical methods.

3. Results and Discussion

3.1 Shoot parameters

3.1.1 Days to first sprouting

The data Days to first sprouting of Kagzi Lime as growth of stem of different media in are summarized in Table 1.

The data Days to first sprouting percentage of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Days to first sprouting of Kagzi Lime of (13.98) was recorded with treatments T₁ (Soil + Sand) recorded, while the minimum (6.62) was recorded treatment T₉ (Soil + Sand + Cocopeat + IBA 600 ppm). Further, the interaction effect of growing media significantly influenced the Days to first sprouting.

Different authors across the globe also found that thicker cuttings had higher reserve food materials such as stored carbohydrates and nitrogen. Growing media also play a very crucial role in early bud sprouting as it provides required amount of nutrients, good water holding capacity, porosity and aeration for the growing roots, which all together helps in earliest bud sprouting. Results obtained are in close conformity with those of Harshvardhan (2011) ^[8] in jackfruit, Beer *et al.*, (2013) ^[4] in guava, Singh *et al.*, (2015) ^[25], Ibrahim *et al.*, (2015) ^[9] and Kumar and Kumar (2022) ^[11] in lemon.

3.1.2 Sprouts per cutting

The data Sprouts per cutting of Kagzi Lime as growth of stem of different media in are summarized in Table 1.

The data Sprouts per cutting of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Sprouts per cutting of Kagzi Lime of (3.86) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (1.67) was recorded treatment T₁ Soil + Sand. Further, the interaction effect of growing media significantly influenced the Sprouts per cutting. The maximum number of sprouts per cutting with optimum use

of IBA treatment might be due to better root growth, which augmented absorption and translocation of nutrients from growing media stimulate various plant metabolic processes. The reserve food material in cuttings also contribute toward the production of maximum number of sprouts per cuttings. In polyhouse, relative humidity and optimum temperature conditions are ideal for increasing number of sprouts per cuttings. These results agree with those of Singh (2001) ^[23] in bougainvillea, Singh *et al.*, (2013) ^[24] in citrus and Tanwar *et al.*, (2020) ^[26] in pomegranate.

3.1.3 Length of new shoot per cutting (cm)

The data Length of new shoot per cutting (cm) of Kagzi Lime as growth of stem of different media in are summarized in Table 1. The data Length of new shoot per cutting (cm) of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Length of new shoot per cutting (cm) of Kagzi Lime of (21.57) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (13.09) was recorded treatment T₁ Soil + Sand. Further, the interaction effect of growing media significantly influenced the length of new shoot per cutting (cm).

Our findings are in harmony with those of Kaur *et al.*, (2018b) ^[10], Tanwar *et al.*, (2020) ^[26] and Kumar *et al.*, (2022) ^[11] in pomegranate. They opined that plant growth regulators helps in better utilization of carbohydrates and nitrogen stored in mature and thick cuttings. IBA enhances capability of cells to divide and form new cells which causes majority of necrotic layers to disappear and results in maximum length of new shoot per cutting. The higher length of sprouting might be due to the fact that growing media provide good amount of mineral nutrition, increases microbial activity, retain moisture and gaseous exchange.

3.1.4 Leaves per shoot

The data Leaves per shoot of Kagzi Lime as growth of stem of different media in are summarized in Table 1.

The data Leaves per shoot percentage of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Leaves per shoot of Kagzi Lime of (43.96) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (22.14) was recorded treatment T₁ (Soil + Sand). Further, the interaction effect of growing media significantly influenced the Leaves per shoot.

These observations agreed with Rathwa *et al.*, (2017) ^[21] in pomegranate in guava in pomegranate. The possible reason might be the physiological condition of the cutting, which helped to maintain higher growth using reserve food material and maintain adequate supply of photosynthates which enhances vegetative growth of the cuttings. The increase in number of leaves may also be attributed due to increased cell division and elongation at higher IBA concentration. Growing media also played a major role in leaves development as growing media provides useful soil micro fauna and flora, maintained soil temperature, nutrients and minerals to the plants, which all together enhances development of leaves.

3.1.5 Survival percentage

The data Survival percentage of Kagzi Lime as growth of stem of different media in are summarized in Table 1.

The data Survival percentage of kagzi Lime increased significantly by the application of different IBA and growing

media essence under experiment over the control. The maximum Survival percentage of Kagzi Lime of (80.09) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (26.79) was recorded treatment T₁ (Soil + Sand). Further, the interaction effect of growing media significantly influenced the Survival percentage. These result findings are similar Tanwar *et al.*, (2020) ^[26], Rajkumar *et al.*, (2017) ^[20] and Kumari *et al.*, (2013) ^[13] in pomegranate. It might be due to high nutrient content, water holding capacity, good drainage and high porosity which helps in better development of root system resulting in maximum survival percentage of rooted cuttings. The survival percentage of cuttings was mostly depended on root of shoot characters.

3.2 Roots parameters

3.2.1 Percentage of rooting of cutting (%)

The Percentage of rooting of cutting (%) of Kagzi Lime as growth of stem of different media in are summarized in Table 2. The data Percentage of rooting of cutting (%) of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Percentage of rooting of cutting (%) of Kagzi Lime of (24.97) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (16.23) was recorded treatment T₁ (Soil + Sand). Further, the interaction effect of growing media significantly influenced the Percentage of rooting of cutting (%).

The reason maximum rooting success is that growing media provides nutrients, retain moisture and variety of micro-organisms which further support root growth and contribute to maximum percentage of rooting percentage. Further, auxins increase cell division by increasing the level of endogenous cytokinin which induces more number of root primordia. These results are in accordance with Copes and Mandel (2000) ^[7] in fig, Bose *et al.*, (2002) ^[5] in chrysanthemum, Prince *et al.*, (2017) ^[18] and Kumar *et al.*, (2019) ^[12] in carnation.

3.2.2 Length of root (cm)

The data Length of root (cm) of Kagzi Lime as growth of stem of different media in are summarized in Table 2.

The data Length of root (cm) of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Length of root (cm) of Kagzi Lime of (28.96 cm) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (12.45 cm) was recorded treatment T₁ (Soil + Sand). Further, the interaction effect of growing media significantly influenced the Length of root (cm).

The probable reason for higher root length at the time of growth was availability of ample sunlight and controlled temperature in polyhouse which enhances the process of photosynthesis resulted in abundance food material and increases sprout length. There is also reserve food material in mature and thick cuttings which enhances increase in root length. The use of auxins also has direct effect on increasing root length as auxins leads to root formation and root growth. These roots then absorb nutrients and water from the growing media resulting in direct effect on increasing root length of the cuttings. Similar results on maximum sprout length were given by Purohit *et al.*, (1985) ^[19] in pomegranate, Sarada *et al.*, (1991) ^[22] in cashew and Chopde *et al.*, (1999) ^[6] in custard apple, Rathwa *et al.*, (2017) ^[21] in pomegranate and Kumar and Kumar (2022) ^[11] in lemon.

3.2.3 Fresh weight of root (g)

The data Fresh weight of root (g) of Kagzi Lime as growth of stem of different media in are summarized in Table 2.

The data Fresh weight of root (g) of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Fresh weight of root (g) of Kagzi Lime of (4.65 g) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (1.26 g) was recorded treatment T₁ (Soil + Sand). Further, the interaction effect of growing media significantly influenced the Fresh weight of root (g).

Similar results were shown by Tanwar *et al.*, (2020) ^[26] and Batista *et al.*, (2011) ^[3] in pomegranate, Parvez *et al.*, (2007) ^[17] in peach and Banker and Prasad (1992) ^[2] in pomegranate. They conveyed that it might be due to the maximum weight of root of cutting which enhanced the nutrient uptake and resulted in more photosynthate production. Food in the form of photosynthates provides required energy for cell division and cell elongation.

3.2.4 Dry weight of root (g)

The data Dry weight of root (g) of Kagzi Lime as growth of stem of different media in are summarized in Table 2.

The data Dry weight of root (g) of kagzi Lime increased significantly by the application of different IBA and growing media essence under experiment over the control. The maximum Dry weight of root (g) of Kagzi Lime of (1.77 g) was recorded with treatments T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) recorded, while the minimum (0.83 g) was recorded treatment T₁ Soil + Sand. Further, the interaction effect of growing media significantly influenced the Dry weight of root (g).

The maximum dry weight of root, of lime might be due to the fact that growing media had good water holding capacity, porosity and provide vital oxygen to the roots. The growing media under favourable environmental conditions leads to the maximum roots growth which directly effects other elements present in roots. Also, IBA is very effective root promoter, resistant to oxidation and retain near the site of application and therefore, one of the best rooting stimulators. These results are in confirmatory with Weaver (1972) ^[29] in carnation, Thomas *et al.*, (2003) ^[7] in dianthus and Kumar *et al.*, (2019) ^[12] in carnation

3.3 Economics

The data Economic of Kagzi Lime as growth of stem of different media in are summarized in Table 3.

3.3.1 Cost of Cultivation (INR/ha)

The lowest cost of cultivation was found in the control plot (INR 1125/pot) and the highest cost of cultivation (INR 1305/pot) was observed treatment 9 Soil + Sand + Cocopeat + IBA 600 ppm because of higher doses of Cocopeat and IBA 600 ppm.

3.3.2 Gross return

Gross return (INR 5211/pot) was found to be highest in treatment 9 Soil + Sand + Cocopeat + IBA 600 ppm as compared to other treatment.

3.3.3 Net return (INR/ha)

Net return (INR 3906/pot) was found to be highest in treatment 9 Soil + Sand + Cocopeat + IBA 600 ppm as compared to other treatment.

3.3.4 B:C ratio(B:C)

Benefit cost ratio (2.99) was found to be highest in treatment 9
Soil + Sand + Cocopeat + IBA 600 ppm and minimum benefit

cost ratio (1.00) was found to be in treatment 1 (Control) as compared to other treatments.

Table 1: Effect of IBA and growing media on shoot parameters of stem cutting in Kagzi Lime

Treatment Symbol	Treatment combinations	Days to first sprouting	Sprouts per cutting	Length of new shoot per cutting (cm)	Leaves per shoot	Survival percentage (%)
T ₁	Soil + Sand	13.98	1.67	13.09	22.14	26.79
T ₂	Soil + Sand + Vermicompost	13.24	1.89	14.47	24.47	29.23
T ₃	Soil + Sand + Cocopeat	12.56	2.13	15.25	27.25	36.34
T ₄	Soil + Sand + IBA 500 ppm	11.79	2.34	16.58	29.58	45.45
T ₅	Soil + Sand + IBA 600 ppm	10.63	2.85	17.80	33.36	49.56
T ₆	Soil + Sand + Vermicompost + IBA 500 ppm	9.34	2.96	18.36	35.69	58.67
T ₇	Soil + Sand + Vermicompost + IBA 600 ppm	8.35	3.45	19.96	37.74	67.89
T ₈	Soil + Sand + Cocopeat + IBA 500 ppm	7.34	3.73	20.85	39.85	73.78
T ₉	Soil + Sand + Cocopeat + IBA 600 ppm	6.62	3.86	21.57	43.96	80.09
	F-test	S	S	S	S	S
	SEm(±)	0.36	0.12	0.50	1.11	1.51
	CD (p=0.05)	1.08	0.35	1.51	3.34	4.53

Table 2: Effect of IBA and growing media on root parameters of stem cutting in Kagzi Lime

Treatment Symbol	Treatment combinations	Percentage of rooting of cutting (%)	Length of root (cm)	Fresh weight of root (g)	Dry weight of root (g)
T ₁	Soil + Sand	16.23	12.45	1.26	0.83
T ₂	Soil + Sand + Vermicompost	17.56	14.45	1.56	0.89
T ₃	Soil + Sand + Cocopeat	18.89	16.78	2.23	0.95
T ₄	Soil + Sand + IBA 500 ppm	19.13	17.23	2.56	1.03
T ₅	Soil + Sand + IBA 600 ppm	20.46	18.56	3.89	1.09
T ₆	Soil + Sand + Vermicompost + IBA 500 ppm	21.79	19.89	3.96	1.25
T ₇	Soil + Sand + Vermicompost + IBA 600 ppm	22.31	22.08	4.12	1.37
T ₈	Soil + Sand + Cocopeat + IBA 500 ppm	23.64	25.86	4.45	1.59
T ₉	Soil + Sand + Cocopeat + IBA 600 ppm	24.97	28.96	4.65	1.77
	F-test	S	S	S	S
	SEm(±)	0.34	0.59	0.12	0.04
	CD (p=0.05)	1.02	1.76	0.36	0.11

Table 3: Effect of IBA and growing media on economic of stem cutting in Kagzi Lime

Treatment Symbol	Treatment combinations	Cost of cultivation	Gross return	Net return	B:C
T ₁	Soil + Sand	1125	2254.5	1129.5	1.00
T ₂	Soil + Sand + Vermicompost	1195	2551.5	1356.5	1.13
T ₃	Soil + Sand + Cocopeat	1215	2875.5	1660.5	1.36
T ₄	Soil + Sand + IBA 500 ppm	1205	3159	1954	1.62
T ₅	Soil + Sand + IBA 600 ppm	1225	3847.5	2622.5	2.14
T ₆	Soil + Sand + Vermicompost + IBA 500 ppm	1275	3996	2721	2.13
T ₇	Soil + Sand + Vermicompost + IBA 600 ppm	1285	4657.5	3372.5	2.62
T ₈	Soil + Sand + Cocopeat + IBA 500 ppm	1295	5035.5	3740.5	2.88
T ₉	Soil + Sand + Cocopeat + IBA 600 ppm	1305	5211	3906	2.99

4. Conclusion

Based on the results of the present study, it is concluded that, overall treatment T₉ (Soil + Sand + Cocopeat + IBA 600 ppm) performed best in growth and survival % of kagzi lime.

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