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Influence of IBA and PHB on regeneration of Kagzi lime (*Citrus aurantifolia* Swingle) through stem cutting

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Abstract
Kagzi lime propagated through hardwood cuttings with low percentage of rooting. Investigations on influence of IBA and PHB on regeneration of cuttings were carried out during the year 2017-18 at Horticulture Garden, College of Horticulture, C.S. Azad University of Agriculture and Technology, Kanpur. Minimum days to sprouting (20.64), maximum number of sprouts per cutting (5.88), maximum percentage of cuttings sprouted (17.68%), maximum length of sprouts (14.88 cm), maximum diameter of sprouts (3.28 cm), maximum number of roots per cutting (42.02), longest root (2.24 cm), diameter of root (6.24 cm), percentage of rooted cuttings (70.12%) and maximum survival percentage (82.66%) were recorded with treatment IBA 2500ppm + PHB 1000ppm (T_9). The treatment with IBA 2000ppm + PHB 1000ppm (T_8) recorded maximum number of leaves (21.02) and maximum leaf length (6.38 cm). The maximum days to sprouting (32.00), minimum number of sprouts per cutting (3.64), minimum sprouting percentage (11.28%), minimum (7.85 cm) length of sprout per cutting, minimum diameter of sprouts (1.98 cm), minimum number of leaves per cutting (14.40), minimum length of leaves (4.10 cm), minimum (3.20 cm) width of leaves, minimum number of roots per cutting (29.80), minimum length of root (1.10 cm), minimum diameter of root (2.57 cm), minimum (48.02%) rooted cuttings and lowest survival percentage (48.26%) were noted under control (T_0).

Keywords: Kagzi Lime, Root Cutting, Hormones, IBA, Survival Percentage

Introduction
The Kagzi lime (*Citrus aurantifolia* Swingle) is the most important and delicious fruit of India as well as world. It belongs to the family Rutaceae. It is a native of the East Indies and has spread all over the world in tropical and sub-tropical regions. The Kagzi lime is an ever green tree small, spiny and irregularly branched. It has small, elliptic to oblong leaves which are pale green. The white Flowers are small and produced in auxiliary clusters. The fruit is small to medium, roundish and thin-skinned having yellow color. The pulp is whitish and has about 6-8 sections. It has high nutritive and medicinal values. The juice is a cheap and very rich source of vitamin C, carbohydrate, protein, fat and contains a fair amount of K, Ca, Fe, Mg, Na, S and P as well for human health. The peel contains volatile oil which is used in the production of perfumes and different kinds of sweet. Lime has medical uses like citric acid which is used as a drug. Kagzi lime also used for preparation of limeade mixed drinks, pickles and ice tea and is squeezed on to seafood to bring out the flavor. It is also used in bottled lime juice like "Limca" and carbonated beverages etc. The juice is acidic with distinctive flavor and used for the preparation of "Shubuta" and "Sugar Sharbat". These qualities make Kagzi lime an important and one of the most popular fruits of India. Kagzi lime is adaptable to a wide range of soil and climatic conditions and is hard enough to withstand considerable neglect as compared to other fruit crops. It is relatively a disease free crop subjected to only a few diseases and insects, and requires less plant protection and irrigation as compared to other important fruit crops. Kagzi lime is found in most parts of the tropics. In India, it is cultivated in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Assam and Chhattisgarh. India is the leading producer of Kagzi lime in the world. In India Kagzi lime is cultivated in an area of 259.3 thousand hectares with production of 2789 thousand MT. The productivity of Kagzi lime in India is 10.8 MT/ha (NHB, 2017) [21].

Kagzi lime has a number of distinct varieties (Swingle, 1946) [43] bears seedless variety has a medium fruit size with very acidic juice and it was the favorite commercial variety of California, where it was said to have originated as seedling. Mexican variety represents a group of similar seedlings which has a small fruit size. Rangpur variety has very acidic juice, grouped as a garden plant. Tahiti variety was the favorite variety in southern India (Salaria, 2013) [31]. Propagation of plants by seed become extra tall and come into bearing after a long period. For overcoming this problem, the vegetative multiplication through cutting, grafting, layering and budding are commonly practiced. The vegetative methods of reproduction differs from sexual reproduction in that while the latter involves meiosis, in the former, new cells are formed by mitosis only (Hartmann and Kester, 1976) [9]. These methods have their own merits and demerits. Budding and layering is usually cumbersome and expensive, grafting is also being used to a limited extent. However, stem cutting is an easy method of propagation of this crop. A cutting is a part of plant that will produce roots in soil media and eventually produce a new plant quite true to mother plants. Propagation by cuttings is simple, cheap and rapid method of multiplication but ability of the cutting to regenerate varies with the plant species some regenerate easily others regenerate with difficulty.

The growth, establishment and survival of branches and seedling also depend on the quality of rooting media. There are many commercial rooting media used for cuttings, but many are expensive and locally unavailable. These have to be imported from elsewhere and this makes them expensive so keeping in this view soil was taken as media in this experiment. There is a need to establish appropriate and low cost rooting media. The latest advance in the knowledge of growth regulators in plant propagation has further improved the scope of their use in vegetative propagation of various fruit crops. Vegetative propagation is preferred to reproductive mode of multiplication due to easy maintenance of hereditary characters of the mother plant. The records of propagation by vegetative means appeared during Roman civilization (1000 B.C. - 395 A.D.) and the first scientific paper on raising plants by rooting stem cuttings was published by "Duhamel du Monceau" in the year 1758 (Nanda and Kocher 1985) [19]. Growth regulators have been used to increase the efficiency of propagation by cuttings. Since the discovery of indole-3-butyric acid, it has been freely used to boost vegetative propagation of plants. Cuttings without the growth regulators have shown poor response to rooting (Bhatt and Tomer, 2010) [1]. Among the growth regulators IBA is commonly used. PHB (p- hydroxybenzoic acid) has the potential to improve the product yield and plant fitness in high biomass yielding. Effect of PGRs concentrations on cuttings on Kagzi lime is to be worked out through experimentations which will give the optimum concentration for rooting and survival percentage of cuttings. It is a matter of great interest to find out the best concentration of the growth regulators and its combinations. This can induce better rooting in stem cuttings and can improve the survival of Kagzi lime after detachment.

Methods and Material

The present investigation entitled "Influence of IBA and PHB on regeneration of Kagzi lime (*Citrus aurantifolia* Swingle) through stem cutting" was carried out in the Horticulture Garden, Department of Fruit Science, College of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the rainy season of 2017-18 under agro-climatic and soil conditions of Central Utter Pradesh. The cuttings were taken from healthy and malady free shoots. The cuttings with only un-sprouted buds were selected for the experiment. Healthy and mature shoots having thickness of about 1.0 cm were selected and cuttings were made of about 15-20 cm in length possessing 3-4 buds. Leaves and thorns were completely removed from the cuttings with the help of secateurs. A slanting cut was given at the upper side and a slight slanting cut also was given at the lower end to provide a large surface area to encourage the rooting in cuttings. The cuttings were treated with the respective concentrations of different growth regulators by soaking method (Quick dip). The experiment was laid out in Completely Randomized Design (Poly bag experiment) with ten treatments which replicated thrice. Ten treatments in each replication i.e. control (T_0), IBA 1000 ppm (T_1), IBA 1500 ppm (T_2), IBA 2000 ppm (T_3),IBA 2500 ppm (T_4), PHB 1000 ppm (T_5), IBA 1000 ppm + PHB 1000 ppm (T_6), IBA 1500 ppm + PHB 1000 ppm (T_7), IBA 2000 ppm + PHB 1000 ppm (T_8) and IBA 2500 ppm + PHB 1000 ppm (T_9). A unit of 20 cuttings comprised of one replication, hence total 60 cuttings were used in each treatment including control and 600 cuttings were planted for conducting the present experiment. The treated cuttings were planted in the poly bags prepared for this purpose by incorporating a mixture of sand, soil and farmyard manure and put under the shade of a tree. The medium was prepared well and drenched with chloropyriphos solution to avoid the attack of termites. The cuttings were planted on the same day after treating with growth regulators. There was 1 cutting planted in each poly bag with a 90^0 angle. The holes for planting the cuttings were made in the poly bags with the help of iron rod so as to avoid any damage to cuttings. While planting, about $2/3^{rd}$ portion of the cuttings were buried in the rooting medium, leaving $1/3^{rd}$ portion exposed to the environment. The various observation like Days to sprouting, Number of sprouts per cutting, Percentage of sprouted cuttings, Length of sprouts, Diameter of sprouts, Number of leaves per cutting, Length of leaves, Width of leaves, Number of roots per cutting, Length of longest root, Diameter of thickest root, Percentage of rooted cuttings, Survival percentage of cuttings were recorded with proceeding of experiment. The recorded data were statistically analyzed by using Completely Randomized Design (CRD) as suggested by Panse and Sukhantme (1985).

Results and discussion

Days to sprouting

The mean data of sprouting were recorded and analyzed statistically. It is evident that data presented in table-1 revealed that earliest (20.64 days) sprouting of cuttings was observed under (T_9)treatment, which was significantly lesser to all treatments of IBA and PHB and control barring treatments T_6, T_7 and T_8 which showed 23.02, 22.48 and 21.59 days to sprouting respectively. Treatment T_0 (control) recorded maximum days to sprouting which was closely at par with treatment T_1 (31.44 days). All other treatments exhibited significant variation when compared with control in this regard. Treatments T_2, T_3, T_4 and T_5 taking 28.33, 27.12, 25.48 and 27.12 days to sprouting did not vary significantly when compared among them. The present investigations are in line with the reports of Singh *et al.* (2006) [36] and Kumar and Sachan (2015) [15] in sweat lime and Shukla *et al.* (2010) [35] and Kaur (2015) [12] in peach.

Number of sprouts per cutting

The numbers of sprouts per cuttings were noted under each treatment. The data obtained were analyzed statistically. It is clear from table-1 that treatment of IBA 2500 ppm+ PHB 1000 ppm (T_9) produced significantly maximum (5.88) number of sprouts per cutting when compared with control (3.64). T_6, T_7 and T_8 revealing 5.60, 5.80 and 5.84 number of sprouts per cutting did not vary when compared among themselves. Similarly, when again compared with treatment T_9 (5.88) there were no significant variation. Treatments T_1, T_2 and T_5 revealed 4.10, 4.20 and 3.88 number of sprouts which did not show significant fluctuation when compared among themselves. Similarly, treatments T_3 and T_4 revealing 4.80 and 4.85 numbers of sprouts per cutting when compared in between was found none significant in their influences. These findings are in agreement with the reports of Singh *et al.* (1986) [37], Singh *et al.* (2006) [36] and Kumar and Sachan (2015) [15] in sweet lime, Bhatt and Tomer (2010) [1] in Kagzi lime and Singh *et al.* (2014) [38] in Shahtoot.

Percentage of sprouted cuttings

The percentages of sprouted cuttings observations were recorded and the data were analyzed statistically and presented in table-1. The highest percentage of sprouted cuttings (17.68%) was obtained with IBA 2500 ppm+ PHB 1000 ppm (T_9) treatments followed by T_8 (17.00%). The minimum percentage of sprouted cuttings was exhibited under control (T_0) showing 11.28% sprouted cuttings. All the treatments recorded significant variation when compared with control. Treatments T_1, T_2 and T_5 gave 13.42, 14.58and 14.24 percentage of sprouted cuttings, when compared among themselves it showed none significant variation. Similarly, treatments T_6, T_7 and T_8 revealing 16.32, 16.66 and 17.00% of sprouted cuttings respectively when compared among themselves showed none significant variation. In this regard, treatment T_3 and T_4 also presenting 15.28 and 16.26% of sprouted cutting did not bring significant variation. Similar, results have been reported by Singh *et al.* (2006) [36] in sweet lime, Diwaker and Katiyar (2013)[7] in Kagzi lime, Shukla *etal.*(2010)[35]and Kaur (2015)[13]in peach, Singh *et al.*(2014) [38] in shahtoot and Kaur *et al.* (2016) [12] in pomegranate.

Length of sprouts

The length of longest sprouts was measured with the help of a measuring scale in cm. The data noted were analyzed statistically the mean value presented in table-1 showed that significantly longest sprouts occurred when the cuttings were treated with IBA 2500 ppm + PHB 1000 ppm (14.88cm). Significant variation was exhibited when all treatments were compared intermittently with treatment T_9 except T_8 showing 14.55 cm long sprout when remained statistically equally effective as compared with (T_9).The cuttings under control (T_0) showing the minimum 7.85 cm long sprout were found significantly less effective when compared with all other treatments except T_5 (8.50 cm). Treatments T_1 and T_2 exhibited 9.00 cm and9.15 cm length of sprouts respectively which were significantly at par. Treatments T_3 (10.64 cm) and T_4 (11.36 cm) also proved to be non significant when compared with one another. Similarly, treatments T_6 and T_7 showing 12.24 cm and 13.28 cm length of sprouts respectively demonstrated non significant influences in length of sprouts when compared between themselves. These findings are similar with the reports of Nath (2000) [20] in lemon, Shukla *et al.*(2010) [35] and Kaur (2015) [13] in peach, Singh (2015) [15]in shahtoot, Singh and Singh (2016) [41] in sweet orange and Kamboj *et al.* (2017) [11] in pomegranate.

Diameter of sprouts

The recorded data were analyzed statistically the mean values are presented in table-1. Thickest sprout (3.28 cm) was observed under IBA 2500 ppm+ PHB 1000 ppm (T_9)being significantly greater than all the other treatments closely followed by T_8 (3.12 cm). The maximum thinner diameter was noted under control (1.98 cm) followed by PHB 1000 ppm (T_5) and IBA 1000 ppm (T_1) showing 2.10 cm and 2.16 cm diameter of sprouts respectively, However, (T_1) and (T_5) showed statistically equal length when compared with one another. These findings are in agreement with the reports of Ram *et al.* (2005) [26] and Kamboj *et al.* (2017) [11] in pomegranate, Shukla (2015) [44] and Kaur (2015) [13] in peach, Singh and Singh (2016) [41] in sweet orange, Pandey *et al.* (2003) [23] in citrus and Seran and Thiresh (2016) [34] in dragon fruits.

Number of leaves per cutting

The numbers of leaves produced on the planted cuttings were recorded. The obtained data were analyzed statistically. It is evident from table-1that the total number of leaves per cutting was significantly influenced with the application of different concentrations of IBA and PHB when compared with control (T_0). The maximum (21.02) numbers of leaves per cutting were recorded under treatment T8 followed by the treatment T_7 and T_6 showing 20.98 and 20.48 number of leaves per cutting while the minimum (14.40) number of leaves per cutting were noted with control (T_0). The data when observed closely it was found that treatments T_6, T_7, T_8 and T_9 were significantly at par showing 20.48, 20.98, 21.02 and 20.08 numbers of leaves per cutting respectively. As regard, treatments T_3 and T_4 recording 18.70 and 19.68 numbers of leaves per cutting, did not vary significantly in this respect. Similarly, T_1 (17.90) and T_2 (18.16) were found to be non-significant when compared in between. These findings are in line with the reports of Singh *et al*. (2006) [36] and Kumar and Sachan (2015)[15]in sweet lime, Prati *et al*. (1999) [25] in Tahiti lime, Kaur (2015) [12] in peach and Kamboj *et al*. (2017) [11] in pomegranate.

Length of leaves

The perusal of data presented in table-1 was recorded during experiment and analyzed statistically. The maximum (6.38 cm) leaf length was observed under (T_8) which was significantly superior to all other treatments barring T_7 and T_9 expressing 6.30 and 6.65 cm leaf length respectively. The control (T_0) exhibited minimum leaf length which was significantly lesser among all treatments. The effect of different IBA concentrations was found beneficial to increase the leaf length of Kagzi lime cuttings. The maximum concentration of IBA 2500 ppm recorded 5.90 cm leaf length which was significantly higher than T_1 and T_2 demonstrating 4.60 and 5.50 cm leaf length but significantly at par with T_3 (5.80 cm) treatment. Treatment T_5 (PHB 1000 ppm) produced 4.24 cm leaf length which was significantly lesser among all treatments except only control (T_0). These findings are in close agreement with the reports of Shukla *et al.* (2010) [35] in peach, Devi *et al.* (2016) [6] in Phalsa and Kaur *et al.* (2016) [12] in pomegranate.

Width of leaves

The recorded data were present in table-2 clearly showed that the maximum (4.68 cm) width of leaves was found under IBA 2500 ppm + PHB 1000 ppm treatment (T_9) which was significantly superior to all IBA treatments as well as treatment of PHB 1000 ppm (T_5) and control also. The minimum (3.20 cm) width of leaf was recorded under control (T_0). When data was thoroughly examined it was found that treatments T_7 (4.50 cm), T_8 (4.58 cm) and T_9 (5.68 cm) were significantly equal. Similarly treatment T_6 (4.10 cm), T_7 (4.50 cm) and T_8 (4.58 cm) were also significantly at par when compared among themselves. Treatments T_1 (3.75 cm), T_2 (3.80 cm), T_3 (3.90 cm), T_4 (3.92 cm) and T_5 when compared with one another there were none significant variations in this regard. These findings are in close agreement with the reports of Shukla *et al.* (2010) [35] in peach, Devi *et al*. (2016) [6] in Phalsa and Kaur *et al*. (2016) [12] in pomegranate.

Number of roots per cutting

The recorded data under each treatment were analyzed statistically depicted in table -2 clearly showed that maximum number of roots (42.02) per cutting were significantly maximum recorded under T_9 (IBA 2500 ppm + PHB 1000 ppm) treatment and the minimum number (29.80) of roots per cutting were exhibited with control (T_0). Treatment T_9 proved significantly superior over control and other treatments. It was found that treatments T_7 (41.75) and T_8 (41.79) were at par in this regard. Among, treatments T_1 (32.65), T_2 (33.90) and T_3 (35.65), it was found that T_1 and T_2 did not exhibit significant variation. Similarly, same trend was observed when compared between treatments T_2 and T_3. Though, treatments T_3 and T_4 recorded 35.65 and 36.50 number of roots per cutting respectively but did not show significant differentiation when compared in between. Treatment T_5 exhibited 30.00 roots per cutting did not differ significantly when compared with control (29.80). Thus, above investigation are similar with reports of Sandhu *et al.* (1991) [33], Hore and Sen (1993) [10] and Kaur *et al.* (2016) [12] in pomegranate, Nath (2000) [20] in lemon, Diwaker and Katiyar (2013) [7] in Kagzi lime and Reddy *et al.* (2008) [29] in fig.

Length of root

The data presented in table-2 recorded during the experiment were analyzed statistically clearly showed that the longest (2.24 cm) root was found under T_9 (IBA 2500 ppm + PHB 1000 ppm) being significantly superior over control (1.10cm). Among treatments when data were examined it was found that treatments T_1 (1.20 cm), T_2 (1.32cm), T_3 (1.64 cm) and T_5 (1.26 cm) did not show significant variation when compared with control (1.10 cm), similarly treatment T_1 (1.20 cm) and T_5 (1.26 cm) showed statistically equal when compared between themselves. Treatments T_3, T_4, T_6, T_7 and T_8 revealing 1.64 cm, 1.74 cm, 1.70 cm, 1.92 cm and 22.08 cm length of root respectively when compared among them showed none significant variations. These findings are in agreement with the reports of Sandhu and Singh (1986) [37], Pandey *et al*. (2003) [23] and Singh *et al*. (2006) [36] in sweet lime, Upadhyay and Badyal (2007) [45], Panda and Das (1990) [22], Ram *et al*. (2005) [26] and Kaur (2015) [12] in peach, Bose *et al*. (1985) [2] in litchi, Singh (2017) [11] in Phalsa and Prati *et al*. (1990) [22] in Tahiti lime.

Diameter of root

The effect of different treatment of IBA and PHB on diameter of root is presented in table-2. The significantly maximum (6.24 mm) diameter of roots revealed with treatment T_9 over control. The minimum (2.57 mm) diameter of roots was exhibited under control. From scenario of data it was found that treatments T_1, T_2, T_3, T_4, T_5 and T_6 were found significantly similar recording 3.48 mm, 3.68 mm, 4.05 mm, 4.70 mm, 3.08 mm and 4.92 mm diameter of roots which were significantly equal among themselves but when compared with control, there were significant variation. The treatments T_3, T_4 and T_6 were also found at par when compared one another. When comparison of treatments T_1, T_2 and T_5 were made with control (T_0) it was found at par in this regard. Treatments T_6, T_7 and T_8 exhibiting 4.92 mm, 5.20 mm and 5.64 mm diameter of roots respectively were found significantly at par when compared with T_9 treatment, whereas, in this respect treatments T_3 (4.05 mm) and T_4 (4.70 mm) were found significantly lesser influence over treatment T_9 (6.24 mm) but they remained at par in between. These findings are in agreement with the reports of Sandhu and Singh (1986) [37], Pandey *et al*. (2003) [23] and Singh *et al*. (2006) [36] in sweet lime, Upadhyay and Badyal (2007) [45], Panda and Das (1990) [22], Ram *et al*. (2005) [26] and Kaur (2015) [12] in peach, Bose *et al*. (1985) [2] in litchi, Singh (2017) [11] in Phalsa and Prati *et al*. (1990) [22] in Tahiti lime.

Percentage of rooted cuttings

The data presented in table-2 were recorded during experiment and analyzed statistically. The percentage of rooted cuttings was significantly maximum (70.12%) under T_9 treatment over control and poorest percentage of rooted cutting was observed under control (48.02%). Treatment T9 exhibited significantly superior among T_1 (51.12%), T_2 (56.00%), T_3 (59.44%), T_4 (62.42%), T_5 (62.24%), T_6 (66.00%) and T_7 (68.08%) barring treatment T_8 (69.02%) which did not show significant improvement in percentage of rooted cuttings. After further perusal of data, treatment T_1 (IBA 1000 ppm) and T_5 (PHB 1000 ppm) presented 51.12% and 50.24% rooted cuttings respectively which did not give significant variation when compared with one another. Similarly, treatment T_7 (68.08%) and T_8 (69.02%) were also found significantly at par when compared in between. These findings are in line with the reports of Kim *et al*. (1990) [14], Sabhah *et al*. (1991) [30], Kumar *et al*. (1995) [16], Rawas *et al*. (1998) [27], Nath (2000) [20] and Datta *et al*. (2000) in citrus species, Bose *et al.* (1985) [2] in litchi and Panda and Das (1990) [22] in pomegranate.

Survival percentage of rooted cuttings

The survival percentage of rooted cutting under each treatment was recorded and the data obtained were analyzed statistically and the mean values are presented in table-2. Treatment T_9 (IBA 2500 ppm +PHB 1000 ppm) increased significantly maximum percentage of rooted cuttings (82.66%) and the poorest survival percentage of rooted cutting was observed under control (48.26%). All other treatments i.e. IBA 1000 ppm (T_1), IBA 1500 ppm (T_2), IBA 2000 ppm (T_3), IBA 2500 ppm (T_4), PHB 1000 ppm (T_5) IBA 1000 ppm +PHB 1000 ppm (T_6) and IBA 1500 ppm + PHB 1000 ppm (T_7) recording 56.28, 65.42, 69.63, 70.08, 54.22, 75.82 and 76.78 showed significantly lesser survival percentage of rooted cutting when compared with treatment T_9 except T_8 which did not show significant variation in this regard. Treatments T_6 and T_7 when compared in between it was found to cause non significant variation. Similarly,

treatment T_3 and T_4 were also found none significant when compared with each other. The improved establishment of cuttings with aid of synthetic growth substances has been reported by early scientists in different crops i.e. Debnath (1986) [5], Rawas *et al*. (1998) [27], Pandey *et al*. (2003) [23] in different citrus species, Moazzam (2001) [18] and Tripathi and Shukla (2004) [44] in pomegranate, Mishra *et al.* (1986) [17] in plum, Ceonel *et al.* (1994) [4] in litchi, Reddy *et al.* (2008) [29] in fig and Kaur *et al.* (2016) [13] in pomegranate.

Table 1. Influence of IBA and PHB on regeneration of Kagzi lime through stem cutting.

Treatments	Days to sprouting	Number of sprouts per cutting	Percentage of sprouted cuttings	Length of sprouts (cm)	Diameter of sprouts (cm)	Number of leaves per cuttings	length of leaves (cm)
T_0 Control	32.00	3.64	11.28	07.85	1.98	14.40	4.10
T_1 IBA 1000 ppm	31.44	4.10	13.42	09.00	2.16	17.90	4.60
T_2 IBA 1500 ppm	28.33	4.20	14.58	09.15	2.40	18.16	5.50
T_3 IBA 2000 ppm	27.12	4.80	15.28	10.64	2.58	18.70	5.80
T_4 IBA 2500 ppm	25.48	4.85	16.26	11.36	2.88	19.68	5.90
T_5 PHB 1000 ppm	27.12	3.88	14.24	08.50	2.10	16.80	4.24
T_6 IBA 1000 ppm+ PHB 1000 ppm	23.02	5.60	16.32	12.24	2.92	20.48	5.82
T_7 IBA 1500 ppm+ PHB 1000 ppm	22.48	5.80	16.66	13.28	2.98	20.98	6.30
T_8 IBA 2000 ppm+ PHB 1000 ppm	21.59	5.84	17.00	14.55	3.12	21.02	6.38
T_9 IBA 2500 ppm+ PHB 1000 ppm	20.64	5.88	17.68	14.88	3.28	20.08	6.35
S.E. Difference	1.577	0.385	0.636	0.517	0.336	0.496	0.153
C.D. @ 5%	3.312	0.808	1.336	1.086	0.706	1.042	0.322

Table 2. Influence of IBA and PHB on regeneration of Kagzi lime through stem cutting.

Treatments	width of leaves (cm)	Number of roots per cutting	Length of root (cm)	Diameter of root (mm)	Percentage of rooted cuttings	Survival percentage of cuttings
T_0 Control	3.20	29.80	1.10	2.57	48.02	48.26
T_1 IBA 1000 ppm	3.75	32.65	1.20	3.48	51.12	56.28
T_2 IBA 1500 ppm	3.80	33.90	1.32	3.68	56.00	65.42
T_3 IBA 2000 ppm	3.90	35.65	1.64	4.05	59.44	69.63
T_4 IBA 2500 ppm	3.92	36.50	1.74	4.70	62.42	70.08
T_5 PHB 1000 ppm	3.70	30.00	1.26	3.08	50.24	54.22
T_6 IBA 1000 ppm+ PHB 1000 ppm	4.10	36.90	1.70	4.92	66.00	75.82
T_7 IBA 1500 ppm+ PHB 1000 ppm	4.50	41.75	1.92	5.20	68.08	76.78
T_8 IBA 2000 ppm+ PHB 1000 ppm	4.58	41.79	2.08	5.64	69.02	81.00
T_9 IBA 2500 ppm+ PHB 1000 ppm	4.68	42.02	2.24	6.24	70.12	82.66
S.E. Difference	0.254	0.894	0.263	0.702	0.649	1.642
C.D. @ 5%	0.533	1.878	0.553	1.476	1.363	3.449

Conclusion

On the perusal of results obtained with present investigation it may be concluded that treatment T_9 (IBA 2500 ppm + PHB 1000 ppm) significantly brought about early sprouting, increased in number of sprouts, percentage of sprouted cuttings, length of sprout, diameter of sprout, width of leaves, number of roots per cutting, length of root, diameter of root, percentage of rooted cuttings and survival percentage of rooted cuttings. Only number of leaves per cutting and length of leaves were significantly enhanced with treatment T_8 (IBA 2000 ppm + PHB 1000 ppm). Hence, on behalf of above results of present investigation it may advice to orchardists and fruit growers of central Utter Pradesh to use solution of IBA 2500 ppm + PHB 1000 ppm for obtaining maximum unique newly plant for plantation of Kagzi lime through cuttings.

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