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Effect of Stem Cutting and Growth Regulators on Rooting and Survival of Fig (*Ficus carica* L.) Cv. Black Ischia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted at Horticultural research farm, Department of Horticulture, B. A. College of Agriculture, AAU, Anand to evaluate effect of stem cutting and growth regulators on rooting and survival of fig (*Ficus carica* L.) cv. Black Ischia. The experiment was laid out in completely randomized design with factorial concept (FCRD) replicated thrice with twelve treatments. Among the all treatments basal cutting with IBA 750 mg/l gave significantly maximum value for shoot : root ratio (7.09), fresh weight of root (2.10 g), dry weight of root (0.403 g), rooting percentage (78.33) and survival percentage (76.66) at 60 days after planting.

Keywords: Fig; IBA; NAA; basal cutting; tip cutting.

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1. INTRODUCTION

The genus *Ficus*, commonly known as figs belongs to the family Moraceae and constitutes an important group of trees. Among them, *Ficus carica* is the most popular and economically important species. It is a deciduous and subtropical tree, originated in east Mediterranean region from where its cultivation expanded to the whole of the Mediterranean region. Turkey is leading fig producing country in the world with the production of 11,35,316 tonne followed by Egypt, Algeria, Iran, Morocco, Syria. In India, it has been in cultivation since pre-historic times. However, the area under common fig has not expanded, in spite of the prevailing favourable soil and climatic conditions. In India, fig is cultivated in an area of about 5714 hectares with the production of 14767 tonne and commercially grown in Pune district of Maharashtra state. Fig is propagated by asexual propagation which is the best way to maintain some species for multiplication of true to type planting material of elite plants. Currently in comparison of other methods of asexual propagation by stem cutting from the mother plant and are placed in a rooting or growing medium, which will eventually produce roots and shoots thus forming a new plant identical to the mother plant. Plant growth regulators usually auxin have an important role in stimulation and initiation of roots to cutting. Auxin induces root formation by breaking root apical dominance induced by cytokinin [1]. There exists lot of contradiction with regards to optimum concentration of growth regulator treatments and type of cutting to be used. Eventually, reports on systematic investigation on the propagation of fig from cuttings and use of growth regulators for better growth are scanty. Therefore, it necessitates undertaking the study on propagation of fig by using different concentrations of IBA and type of cuttings.

2. MATERIALS AND METHODS

2.1 Location

The present investigation was carried out during *kharif* 2019 at horticultural research farm, B. A. college of agriculture, Anand agricultural university, Anand. Anand situated at an elevation of 45.1 meters above the mean sea level (MSL) and is situated on 22° 35' North latitude and 72° 56' East longitude in Gujarat.

2.2 Climate

The climate of Anand region is semi-arid and sub-tropical, winter is fairly cool and dry, while summer is quite hot and dry. An average annual temperature of this region ranges from 12.8 to 37.9 °C and May is the hottest month of this region. An average annual rainfall of this region is about 836 mm. Monsoon of this region is often erratic and uncertain, both in respect of total rainfall and its distribution. The mean weekly meteorological data on maximum and minimum temperature, relative humidity and rainfall recorded by the Department of Meteorology, B. A. college of agriculture, at the Meteorological Observatory of Anand agricultural university, Anand.

2.3 Treatment Details

The experiment was laid out in factorial completely randomized block design with three repetitions. The treatments comprised two levels of stem cutting (C) *viz*., C_1- Tip cutting, C_2- Basal cutting with six levels of plant growth regulators (G) *viz*., G_1- IBA 500 mg/l**,** G_2- IBA 750 mg/l**,** G_3- NAA 500 mg/l**,** G_4- NAA 750 mg/l**,** G_5- IBA 500 +NAA 500 mg/l**,** G_6- Control. Each treatment contains 20 cuttings.

2.4 Preparation of Cutting

Cuttings are prepared from mature shoots of past season growth of fig and the shoot was divided in two parts *i.e.* tip and basal stem cuttings having length of 15 – 20 cm. The basal portion of mature stem was used as basal cutting. Similarly, terminal portion of the stem was used as tip cutting. Slant cut is given on bottom and round cut on the above.

2.5 Preparation of Growth Regulators Solution

The required quantity of IBA and NAA was taken and dissolved in a small quantity of 95 percent of absolute alcohol. Finally, 1000 ml volume of stock solution for 500, 750 ml/l of growth regulators were prepared by adding distilled water. The required quantity of stock solution was taken and diluted with distilled water to make required strength.

2.6 Treatment Application and Planting of Cutting

Base of the cuttings are dipped in IBA and NAA solutions through quick dip (2-3 minutes) method. The treated cuttings are shade dried for 5 minutes and are planted in poly bags filled with potting mixture in slanting position. Potting mixture was prepared by mixing of cocopeat, vermicompost and vermiculite (2:1:1 proportion). Regular watering and plant protection operations are done manually as prescribed.

3. RESULTS AND DISCUSSION

3.1 Shoot: Root Ratio

3.1.1 Effect of stem cutting

The result in Table 1 showed that the stem cutting had significantly effect on shoot : root ratio. The highest shoot : root ratio (6.17) was observed in basal cutting at 60 DAP. While, significantly minimum shoot : root ratio (5.60) was recorded in tip cutting. This is might be due to basal cutting have more maturity, thickness, accumulation of dry matter which increase the dry weight of shoot and root resulted it increase the shoot : root ratio.

3.1.2 Effect of plant growth regulators

The cutting treated with plant growth regulators was significantly affected on shoot : root ratio. The highest shoot : root ratio (6.96) was observed in G_2 (IBA 750 mg/l) at 60 DAP. It was statistically at par with plant growth regulator G_1 (IBA 500 mg/l). While, the minimum shoot : root ratio (4.07) was found in G_6 (control). This is might be due to auxins which are known to induce stimulus for regeneration of roots by promotion of hydrolysis, mobilization and utilization of nutritional reserves in the region of root and shoot formation.

3.1.3 Interaction effect

From the data Table 3 showed that interaction between stem cutting and plant growth regulators were found significant. Treatment T_8 (C_2G_2-basal cutting with IBA 750 mg/l) recorded significantly maximum shoot : root ratio (7.09) at 60 DAP. It was statistically at par with treatment T_1 (C_1G_1), T_2 (C_1G_2) and T_7 (C_2G_1). While, significantly minimum shoot : root ratio (4.03) was observed in treatment T_6 (C_1G_6).

3.2 Fresh Weight of Root (g)

3.2.1 Effect of stem cutting

Significantly maximum fresh weight of root (1.47 g) was observed in basal cutting at 60 DAP. While, significantly minimum fresh weigh of root (0.75 g) was recorded in tip cutting. This is might be due to sufficient stored carbohydrates and internal factors including carbohydrate metabolism leading to cell enlargement and hence, triggering the growth of meristematic tissue and also initial stored material of basal cuttings resulting in early initiation of roots may have contributed towards increased root fresh weight. The result is in conformity with finding of Bhuva [2] and Sivaji et al. [3] in fig.

3.2.2 Effect of plant growth regulators

Among the different plant growth regulators G_2 (IBA 750 mg/l) showed significantly maximum fresh weight of root (1.54 g) at 60 DAP. It was statistically at par with plant growth regulator G_1 (IBA 500 mg/l). While, significantly minimum fresh weight of root (0.54 g) was recorded in G_6 (control). The maximum fresh weight of roots was attributed to the fact that auxins exogenously applied are helpful for initiation and growth of roots and also auxin increased the permeability of cell for moisture, nutrients and resulted in the enlargement of cell causing more growth of the root. An increase fresh weight of root is in accordance with the findings of Sivaji et al. [3] in fig, Ghosh et al. [4] in phalsa, Hakim et al. (2018) in pomegranate.

3.2.3 Interaction effect

It is observed from Table 3 interaction between stem cutting and plant growth regulators were found significant. Treatment T_8 (C_2G_2-basal cutting with IBA 750 mg/l) observed significantly maximum fresh weight of root (2.10 g) at 60 DAP. It was statistically at par with treatment T_7 (C_2G_1). While, significantly minimum fresh weight of root (0.46 g) was observed in treatment T_6 (C_1G_6). The present findings are in accordance with the results reported by Bhuva [2], Shinde [5] and Sivaji et al. [3] in fig.

3.3 Dry Weight of Root

3.3.1 Effect of stem cutting

Maximum dry weight of root (0.303 g) was obtained in basal cutting at 60 DAP. While,

significantly minimum dry weight of root (0.165 g) was recorded in tip cutting. This is might be due to basal cutting have more starch accumulation and carbohydrate storage which in turn brings favorable condition for root initiation and its dry weight. Similar types of results were also obtained by Bhuva [2], Sivaji et al. [3], Patel and Patel [6] in fig.

3.3.2 Effect of plant growth regulators

The result in Table 2 showed that the plant growth regulators have significantly effect on dry weight of root. The highest dry weight of root (0.309 g) was observed in G_2 (IBA 750 mg/l) at 60 DAP. It was statistically at par with plant growth regulator G_1 (IBA 500 mg/l). While, significantly minimum dry weight of root (0.121 g) was recorded in G_6 (control). This is might be due to auxin helps in increasing growth of roots by cell division and elongation and increase accumulation of internal substance such as carbohydrate and proteins which helps increase dry weight of root. These observations are in agreement with the findings of Bhuva [2] in fig, Ghosh et al. [4] in phalsa, Hakim et al. [7] in pomegranate.

3.3.3 Interaction effect

From the data Table 3 revealed that interaction between stem cutting and plant growth regulators were found significant. Treatment T_8 (C_2G_2-basal cutting with IBA 750 mg/l) recorded significantly maximum dry weight of root (0.403 g) at 60 DAP. It was statistically at par with treatment T_7 (C_2G_1). While, significantly minimum dry weight of root (0.100 g) was recorded in treatment T_6 (C_1G_6). The similar results reported by Bhuva [2], Sivaji et al. [3], Shinde [5], Patel and Patel [6] in fig.

3.4 Rooting (%)

3.4.1 Effect of stem cutting

Significantly maximum rooting percentage (68.61) was observed in basal cutting at 60 DAP. While, minimum rooting percentage (47.22) was recorded in tip cutting. An increase rooting percentage might be due to fact that basal cuttings contain more starch which in turn brings about favorable conditions for rooting. Similar results were also obtained by Dharshan [8] and Sivaji et al. [3] in fig, Elsheikh [9] in lime, Malakar et al. [10] in acid lime.

3.4.2 Effect of plant growth regulators

Among the different concentration of plant growth regulators G_2 (IBA 750mg/l) recorded significantly maximum rooting percentage (70.00) at 60 DAP. It was statistically at par with plant growth regulator G_1 (IBA 500 mg/l). While, minimum rooting percentage (47.50) was recorded in G_6 (control). This is might be due to application of auxins has been found to stimulate cambial activity thereby resulting in mobilization of reserve food material to the site of root initiation. Auxins when applied exogenously to the stem cutting generally increase the development of pre-existing root primordial and increase more number of root and rooting percentage. The same results reported by Dharshan [8] in fig, Ghosh [4] in phalsa.

3.4.3 Interaction effect

Results from the data Table 3 indicated that interaction between stem cutting and plant growth regulators were found significant. Significantly maximum rooting percentage (78.33) was recorded in treatment T_8 (C_2G_2-basal cutting with IBA 750 mg/l). It was statistically at par with treatment T_7 (C_2G_1). While, minimum rooting percentage (33.33) was observed in treatment T_6 (C_1G_6). Similar trends were also observed by Sivaji et al. [3] and Patel and Patel [6] in fig, Rana and Jindal [11], Kumar [12] in kiwifruit, Malakar et al. [10] in acid lime.

3.5 Survival (%)

3.5.1 Effect of stem cutting

Basal cutting was recorded significantly maximum survival percentage (65.55) at 60 DAP. While, significantly minimum survival percentage (24.72) was recorded in tip cutting. The highest survival percentage of basal cuttings might be due to presence of high C/N ratio, higher content of carbohydrate reserves per cutting, higher amount of sugars. The same factors brought about maximum number of shoots and roots per cutting and root length which in turn contributed to high survival percentage. The results of present findings are in conformation with the earlier workers Bhuva [2] and Sivaji et al. [3] in fig, Elsheikh [9] in lime, Kumar [12] in kiwifruit.

3.5.2 Effect of plant growth regulators

Among the different plant growth regulators G_2 (IBA 750 mg/l) showed significantly maximum survival percentage (54.16) at 60 DAP. While, significantly minimum survival percentage

(35.83) was recorded in G_6 (control). This is might be due to synergistic effect of auxin and phenolic compound on early root initiation, more number of root, more length and diameter of root, which might results in translocation of food material to different parts of shoot. Hence it may results superior growth of different shoot parameters and ultimately final survival of cutting. Similar trends were also observed by Bhuva [2] in fig.

3.5.3 Interaction effect

It is evident from the data Table 3 that interaction between stem cutting and plant growth regulators were found significant. Treatment T_8 (C_2G_2-basal cutting with IBA 750 mg/l) was recorded significantly maximum survival percentage (76.66) at 60 DAP. It was statistically at par with treatments T_7 (C_2G_1). The results reported by Dharshan [8] and Bhuva [2] in fig.

Table 1. Effect of stem cutting on rooting and survival of fig cv. Black Ischia

Stem cutting	Shoot : Root ratio	Fresh weight of root (g)	Dry weight of root (g)	Rooting (%)	Survival (%)
C_1: Tip cutting	5.60	0.75	0.165	47.22	24.72
C_2: Basal cutting	6.17	1.47	0.303	68.61	65.55
S.Em ±	0.08	0.02	0.002	0.90	0.79
C.D. at 5%	0.24	0.05	0.006	2.63	2.30

Table 2. Effect of Plant growth regulators on rooting and survival of fig cv. Black Ischia

Plant growth regulators	Shoot : Root ratio	Fresh weight of root (g)	Dry weight of root (g)	Rooting (%)	Survival (%)
G_1: IBA 500 mg/l	6.94	1.46	0.300	65.83	48.33
G_2: IBA 750 mg/l	6.96	1.54	0.309	70.00	54.16
G_3: NAA 500 mg/l	5.54	0.87	0.193	50.83	41.66
G_4: NAA 750 mg/l	5.65	1.03	0.220	55.00	43.33
G_5: IBA 500 + NAA 500 mg/l	6.15	1.21	0.261	58.33	47.50
G_6: Control	4.07	0.54	0.121	47.50	35.83
S.Em ±	0.14	0.03	0.004	1.56	1.36
C.D. at 5%	0.42	0.08	0.010	4.55	3.97

Table 3. Interaction effect of stem cutting and plant growth regulators on rooting and survival of fig cv. Black Ischia

Treatments	Shoot : Root ratio	Fresh weight of root (g)	Dry weight of root (g)	Rooting (%)	Survival (%)
T_1: Tip cutting with IBA 500 mg/l	7.08	0.92	0.201	58.33	25.00
T_2: Tip cutting with IBA 750 mg/l	6.83	0.98	0.216	61.66	31.66
T_3: Tip cutting with NAA 500 mg/l	4.68	0.63	0.151	38.33	21.66
T_4: Tip cutting with NAA 750 mg/l	5.03	0.69	0.156	43.33	23.33
T_5: Tip cutting with IBA 500 + NAA 500 mg/l	5.97	0.79	0.166	48.33	26.66
T_6: Tip cutting	4.03	0.46	0.100	33.33	20.00
T_7: Basal cutting with IBA 500 mg/l	6.80	2.00	0.398	73.33	71.66
T_8: Basal cutting with IBA 750 mg/l	7.09	2.10	0.403	78.33	76.66
T_9: Basal cutting with NAA 500 mg/l	6.39	1.11	0.234	63.33	61.66
T_{10}: Basal cutting with NAA 750 mg/l	6.27	1.36	0.284	66.66	63.33
T_{11}: Basal cutting IBA 500 + NAA 500 mg/l	6.32	1.63	0.356	68.33	68.33
T_{12}: Basal cutting	4.12	0.62	0.144	61.66	51.66
S.Em ±	0.20	0.04	0.005	2.21	1.93
C. D. at 5%	0.59	0.12	0.015	6.44	5.62
C.V. %	5.98	6.34	3.70	6.59	7.38

4. CONCLUSION

The results obtained from research experiment, it can be concluded that basal cutting of fig treated with IBA 750 mg/l through quick dip method (2-3 minutes) recorded significantly maximum shoot: root ratio, fresh weight of root, dry weight of root, rooting (%) and survival (%).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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