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Research Article

EFFECT OF ETIOLATION AND PLANT GROWTH REGULATORS ON ROOTING OF AIR LAYERING IN FIG *CV.* BROWN TURKEY

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Abstract: Fig (*Ficus carica* L.) is a nutritious fruit packed in with a rich source of calcium, iron and sugar. For this, there is an increased awareness among farmers to cultivate fig. Hence the present investigation was carried out in the fig block of orchard of Department of Horticulture, Khalsa College, Amritsar during the year 2019-2020 to study the effect of etiolation and growth regulators on the rooting of air layers in fig *cv.* Brown Turkey. The research study was carried out with two levels of etiolation (etiolation and non-etiolation), three levels of NAA(500, 750 and 1000 ppm) and IBA(500.750 and 1000ppm) along with control to find out the influence of etiolation, growth regulators and their treatment combinations. In the experiment the treatments were replicated thrice in a factorial randomized block design. The results of the study revealed that etiolation(E1) proved to be the best in minimising the number of days to initiation and 100 percent rooting. It was also superior in increasing the production of primary and secondary roots, root length and thickness, rooting percentage and survival of rooted air layers. Among growth regulators the air layered shoots treated with 1000 ppm IBA was significant than other auxin treatments in terms of minimizing the time for root initiation , increase in rooting percent, primary and secondary shoot formation, length and thickness of roots, early sprouting with higher number of sprouts per cutting, greater shoot length with more number of leaves. Among interaction effect between etiolation and application of growth regulators the treatment combination E1T5 was numerically effective in reducing the period for first rooting, rooting percentage, increase in number, length and weight and primary and secondary roots, shoot number and shootlength with maximum survival of the air layers.

Keywords: *Fig, NAA, IBA*

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Introduction

Fig (*Ficus carica* L.) is considered as a classical fruit tree of antiquity associated with the beginning of horticulture in Mediterranean basin. It belongs to family Moraceae and is also known as milk berry, radish fruit, honey fruit [1]. It is an important syconus fruit tree originated from Western Asia. The original home of fig is believed to be southern parts of Arabia. The genus ficus is a large one with more over 1400 species classified into up 40 genera out of which 65 species are found in India[2].Fig production is mainly confined to Turkey, Egypt, Iran, USA and Italy, out of which Turkey is leading country contributing 28% to the world production an fresh basis and 56% dried basis. In India fig is grown in different region with its commercially cultivation Maharashtra, Bangalore, Bellary (Karnataka) Saharanpur (UP), Coimbatore (Tamil Naidu), Gujarat and Andhra Pradesh In Punjab it is cultivated as a minor crop mostly grown scattered in gardens or in hometowns. Presently, it is of low commercial importance, but it is gaining popularity in the farming community [3]. Fig is rich source of calcium, iron and sugar. Dried figs contain a large amount of fibre, copper manganese, magnesium, potassium, calcium and vitamin C, B6, B2, B1, A and C which can improve physical strength, nerve capability and treatment of neurological diseases. It has antipyretic diuretic and aphrodisiac properties. Due to the presence of antioxidants fig is used as a laxative. Fruits preserved in vinegar are used against liver disorders. The fruits also are helpful in relieving cough, cold, skin infections and ringworms. They are also claimed to be useful in liver and spleen disorders to cure piles and in the treatment of gout [4]. Fig are consumed as fresh, dried, preserved candied and canned. In the whole world, about 90% of the fig produced are dried. Fresh figs are used as dessert fruits. Fig coffee is used in countries like Europe. It is added in cakes, bread and ice creams.

Fig leaves serve as fodder in India [5]. Air layering in the fig is the oldest technique in vegetative propagation [6]. It does not require any special techniques as in the case of grafting and budding. The roots are developed from the aerial part of a plant after the shoots are girdled and enclosed in a moist rooting medium. This method is also known as Chinese layerage or pot layerage or marcottage or circumposition or gootee. The practice of etiolation is used in propagation criteria in which some portion of shoots are devoid of light during the growing season due to which reduction of photodecomposition of auxins which are utilized in root initiation in that portion [7]. Hence a study was conducted to study etiolation and plant growth regulators during air layering.

Materials and Methods

The research study was conducted at the fig block of orchard of Department of Horticulture, Khalsa College Amritsar during the year of 2019-2020. Amritsar represents the climatic conditions prevailing in the sub-tropical humid zone of Punjab state. It receives an annual rainfall of 735 mm, the major portion of which falls from July-September. During winter, frost is of common occurrence while in summer, the atmospheric temperature occasionally reaches up to 48ºC.For the purpose of air layering, five-year-old trees of fig were selected for the study. The shoots of uniform age (one year old) of 45- 55 cm in length and with girth (0.7-1.0 cm) diameter were randomly selected for air layering. On the selected plants, one-year old shoots of 0.7- 1.0 cm were tagged. The leaves were removed from the base of the selected shoots. The treatments such as girdling and etiolation were given to the shoots during the month of June (15 days before air layering). Girdling was done on selected healthy shoots by removing a bark shoot about 2.5-3.0 cm long carefully by giving two circular cuts with a sharp knife at about 50-60 cm from the tip of the shoots. The girdled portion was scraped. The girdled portion was covered with black insulation tape to bring etiolation. In the present experiment growth regulators was prepared in lanolin paste base.

Air layering operation was carried out thirty days after preconditioning treatments. Black polythene strips used for etiolation were removed from the shoots. To facilitate easy penetration of the chemical pin puncturing of the shoots above the girdled portion was done. With the help of a fine camlin brush the growth regulators in lanolin paste was smeared to the upper part of the girdled portion of the shoot. Sphagnum moss pre-soaked in water, was used to cover the girdled portion immediately after application of growth regulators. In case of control, no growth regulator was smeared. The rooted layers were separated from the parent plant in three stages to reduce the shock of sudden separation. The first V-shaped cut (30 days after layering) was given in half way through the stem about 2.5 cm below the point of root emergence. The second cut was given to deepen than the first one after a week. A few days later the final cut was given, separating the layers from the mother plant. All the layers were kept immersed in water and studies were made for the root and shoot characteristics after 60 days of layering. The percentage of rooted air layers of fig was computed 60 days after layering in relation to total air layers tied. The number of primary and secondary roots were observed after washed samples for each treatment and replication separately and average was noted after taking fresh weight of roots, it was oven dried at 60°C for 48 hours then dry weight was obtained per layer. The establishment and survival percentage of air layers in nursery were recorded after 120 days of detachment.

Experimental Results

Rooting percentage

It is evident from the results that the etiolated shoots (E1) reported more production of roots (81.37%) followed by lesser (72.32%) in case of non-etiolated shoots (E2). The treatment of IBA 1000 ppm (I6) was the most effective in producing higher percentage of rooting (91.89%). The lowest percentage of rooting (64.31%) were recorded in the untreated shoots(I7). Significant interaction effect of etiolated and level of growth regulators was found in rooting percentage. The treatment combination of etiolated and 100 ppm IBA treated layers (E1I6) gave maximum (98.55) percentage of rooting and the treatment combination of non-etiolated and untreated control (E2I7) reported the minimum rooting of 58.33 percent respectively.

Table-1 *Influence of etiolation and level of growth regulators on percentage of rooting in air layered shoots of fig cv.Brown Turkey*

	Levels of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean(I)
E_1	78.76	80.33	83.74	64.51	93.43	98.55	70.30	81.37
E_2	66.68	57.41	85.08	75.11	78.42	85.24	58.33	72.32
Mean(E)	72.72	68.87	84.41	69.81	85.92	91.89	64.31	

Effects	CD (5%)
Etiolation (E)	0.12
Growth regulators (I)	0.22
Interaction (E * I)	0.32

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Table-2 Influence of etiolation and growth regulators on number of primary roots per layer at 60 DAL of fig *cv.* Brown Turkey

	Level of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean(I)
E_1	76.28	77.47	79.42	79.76	80.23	81.25	62.55	76.71
E_2	68.37	69.50	72.21	73.32	74.14	75.18	56.13	69.84
Mean(E)	72.33	73.48	75.81	76.54	77.19	78.21	59.37	

Effects	CD (5%)
Etiolation (E)	0.10
Growth regulators (I)	0.20
Interaction E * I	0.28

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Number of primary roots

From the data it is clear that the etiolated layers (E1) produced significantly more mean roots (76.71) while minimum roots (69.84) were recorded in the non-etiolated layers (E2).Among the growth regulators maximum number of roots(78.21) were recorded in case of I6 while minimum number of roots(59.37) were recorded in untreated layers (I7). The interaction effect between etiolation and growth regulators concentrations showed significantly maximum primary root numbers (81.25) observed in the etiolated layers treated with IBA 1000 ppm (E1I6) and minimum (56.13) primary roots were observed in non-etiolated and untreated layers (E2I7).

Number of secondary shoots

It is apparent from the data that the greater number of secondary roots (123.24) was observed in the treatment of etiolated layer (E1), than without etiolated layers (E2) with production of (113.03) secondary roots per layer. According to the data the highest number of secondary roots (126.41) was observed in the treatment I6 (IBA at 1000 ppm) and the lowest number of secondary roots (99.41) was observed with the untreated treatment (I7). The data of interaction revealed that treatment combination (E1I6) gave significantly a greater number of secondary roots per layer (132.40) whereas the lowest number of secondary roots (96.36) was observed in treatment (E2I7) at 60 DAL.

Table-3 *Influence of etiolation and growth regulators on number of secondary roots per layer at 60 DAL of fig cv.Brown Turkey*

	Level of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean(I)
E_1	1232.18	124.43	126.48	125.22	128.55	132.40	102.47	123.24
E_2	110.55	111.36	117.33	116.52	118.68	120.42	96.36	113.03
Mean(E)	116.86	117.90	121.90	120.87	123.61	126.41	99.41	

Effects	CD(5%)
Etiolation (E)	0.08
Growth regulator (I)	0.13
Interaction E*I	0.19

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Fresh weight of roots(g)

It is evident from the data that the fresh weight of roots was maximum (1.66g) in etiolated shoots (E1) which was superior over (1.37 g) innon etiolated shoots (E2). As compared to the growth regulator treatments maximum fresh weight of roots were recorded in treatment of IBA 1000 ppm (I6) weighing 1.78 g. Minimum fresh weight (1.33 g) was recorded under the treatment I7. An interaction effect of etiolation and growth regulators were found significant. Maximum fresh weight of roots was recorded in the treatment combination E1I6 (2.04 g) and the minimum (1.23 g) fresh weight of roots were recorded in untreated non etiolated treatment combination E1I7.

Table-4 *Influence of etiolation and growth regulators on fresh weight (g) of roots in air layered shoots of fig cv.Brown Turkey*

	Level of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean (I)
E_1	1.48	1.57	1.71	1.80	1.77	2.04	1.23	1.66
E_2	1.17	1.26	1.29	1.40	1.50	1.52	1.43	1.37
Mean(E)	1.32	1.42	1.50	1.60	1.63	1.78	1.33	

Effects	CD (5%)
Etiolation (E)	0.06
Growth regulators (I)	0.10
Interaction (E*I)	0.14

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Dry weight of roots(g)

The data presented in table indicated that the dry weight of roots was significantly maximum (0.62 g) in the treatment (E1) whereas minimum (0.54 g) was obtained with non-etiolation treatment (E2). From the results it is clear that. IBA at 100 ppm (I6) was the most effective for indicating maximum (0.71 g) dry weight of roots. The minimum (0.45 g) dry weight of roots was observed under control (I7).

Interaction effect between etiolation and growth regulators was found to be significant. The combination of E1I6 produced maximum (0.82 g) dry weight whereas minimum (0.43 g) dry weight was reported n in the treatment combination of E2I7.

Table-5 *Influence of etiolation and growth regulators on dry weight(g) of roots in air layered shoots of fig cv. Brown Turkey*

	Level of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean(I)
E_1	0.54	0.57	0.58	0.63	0.78	0.82	0.46	0.62
E_2	0.42	0.52	0.56	0.58	0.64	0.61	0.43	0.54
Mean (E)	0.48	0.54	0.57	0.60	0.71	0.71	0.45	

Effects	CD (5%)
Etiolation (E)	0.01
Growth regulators (I)	0.02
Interaction (E*I)	0.03

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Survival percentage

The survival of 68.70 percent was observed in the treatment E1which was superior to treatment E2 with survival of 52.67 percent. Among growth regulator treatments the highest survival (74.30%) was recorded with IBA 1000 ppm(I6) concentration which was significantly superior over NAA. Minimum survival (37.65%) was reported in control (I7). The interaction between etiolation and growth regulations (ExI) was found to be significant. The highest survival (85.25 %) was recorded from the treatment combination of IBA 1000 ppm and etiolation (E1I6). The lowest survival percentage of 35.06% was observed with the combination of non-etiolation and without use of growth regulators (E2I7).

Table-6 *Influence of etiolation and growth regulators on survival percentage of air layered shoots of fig cv.Brown Turkey*

	Level of growth regulators							
Etiolation	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Mean(I)
E_1	66.66	68.37	76.78	73.36	70.21	85.25	40.24	68.70
E_2	41.71	65.10	58.42	51.71	53.35	63.34	35.06	52.67
Mean(E)	54.18	66.73	67.60	62.53	61.78	74.30	37.65	

Effects	CD (5%)
Etiolation (E)	0.09
Growth regulators (I)	0.15
Interaction (E*I)	0.21

E1 = Etiolation; E2 = Non etiolation; I1 = NAA 500 ppm; I2 = NAA 750 ppm; I3 = NAA 1000 ppm; I4 = IBA 500 ppm; I5 = IBA 750 ppm; I6 = IBA 1000 ppm; I7 = Control

Discussion

The number of days for rooting were significantly influenced by etiolation and the application of growth regulators. Minimum days for commencement and complete rooting was reported in etiolated layers as compared to non-etiolation. This might be due to the availability of reserved food materials in the cells which led to the formation of roots earlier. The results of the present study are also in conformity with the results reported by Hore and Sen, (1997) [8] in pomegranate, Athani *et al*.,(2001) [9] in guava, Hore and Sen, (2004) [10] in jackfruit, Yadav *et al*.,(2014)[11] in guava, Dharshan *et al*.,(2008)[12] in fig, Kumari *et al*.,(2017) [13] in guava. Throughout the whole study it was clear that the application of IBA at various concentrations affected significantly in inducing earlier roots than NAA under study. Out of all the concentrations IBA 1000 ppm proved to be superior in earlier commencement of roots as compared to other concentrations which might be attributed to the presence of sugars and nitrogen substances which might have increased the metabolic activities and mobilization of sugars and nitrogen substances present in stem might have led to the formation of root primordial earlier.

The results of the research findings of Chovatia and Singh, (2006) [14] in jamun, Dharshan *et al*., (2008) [12] in fig and Kumari *et al*., (2017) [13] in guava are in agreement with the present findings. Dave (1993) [15] also reported the same in Kagzi lime. The percentage of success in rooting was significantly high in etiolated layers as compared to non-etiolated layers. Studies have indicated that the higher amount of carbohydrates, C:N ratio and rooting co- factors than the non-etiolated layers might be responsible for more rooting in etiolated layers. The results of the present study are in agreement with the results reported by Hore and Sen (1997) in pomegranate, Athani *et al*.,(2001)[9] in guava, Hore and Sen, (2004)[10], in jackfruit, Yadav *et al*.,(2014)[11] in guava, Kumari *et al*.,(2017)[13] in guava. Dharshan *et al*., (2008) [12] also reported the same in fig. Similarly, the layers treated with IBA 1000 ppm recorded maximum percentage of roots. The treatment combination of etiolation and treatment with IBA 1000 ppm showed a maximum percentage of success in terms of rooting of air layered shoots. The role of auxins particularly IBA as rooting hormone is well documented. The above points of discussion hold good for the increased success in rooting of layers observed in the present study. This might be due to the formation of more root primordia in the shoots due to availability of more metabolites in the root zone which resulted in more rooting. The research findings of Singh *et al*., (2009)[16] in litchi, Hore and Sen, (1997)[8] in pomegranate, Athani *et al*.,(2001)[9] in guava, Hore and Sen, (2004) [10], in jackfruit, Yadav *et al*.,(2014) [11] in guava are in support with the present results. The research study is also in line with the findings of Dharshan *et al*., (2008) [12] and Patel (2009) [17] in fig and Kumari *et al*., (2017) [13] in guava. The data pertaining to increased number of primary roots and secondary roots was found in etiolated layers. The length of the roots had a direct relation with earlier rooting. This might be due to the enhanced root primordia in the girdled zone of the shoots. Similar findings have been noted in Sengupta and Thakur., (2001) [18] in jackfruit, Chovatia and Singh, (2006) [14] in jamun, Thakur *et al*., (2017) [19]; Kunal and Syamal, (2005)[20] and Kumari *et al*., (2017) [13] in guava which are in agreement with the present results. Dharshan *et al*., (2008) [12] in fig and Dave (1993) [15] in Kagzi lime also reported the same. The increase in primary and secondary roots, and their weight with the application of 1000 ppm of IBA , could be attributed to the benefits of IBA. The enhanced rooting parameters with the application of growth regulators might be due to the reason that the high metabolic activities and mobilization of sugars and nitrogen substances present in stem and leaves might have helped in the initiation of root primordia in layers. Better root promoting activity of IBA could be attributed to its property of slow movement and its relatively slow destruction by auxin degrading enzyme system. Similar findings have been noted in Sengupta and Thakur., (2001) [18] in jackfruit, Ray *et al*., (2001) [21] and Rahman *et al*., (2002) [22] in litchi, Yadav *et al*., (2014) [11], Kunal and Syamal, (2005) [20] in guava, Kumari *et al*., (2017) [13] in guava. Sonpethekar *et al*., (2004) [23] and Dharshan *et al*.,(2008) [12] in fig and Dave(1993)[15]. It might be due to the accumulation of stored food material. In shorter period and resulted in greater rooting in the girdled portion.

Similar results were reported by Kunal and Syamal, (2005) [20], Yadav., (2008) [12] also reported the same in fig and Dave (1993) [15] in kagzi lime. The concentrations of IBA also resulted in vigorous shoot parameters. Activeness in rooting and higher success was achieved with increasing IBA concentrations. The increase with IBA 1000 ppm might be due to the development of root primordia in the girdled area leading to more root induction with production of more primary and secondary roots which in turn resulted in increase in success percent. The above results are in conformity with Kunal and Syamal, (2005) [20], Yadav *et al*., (2014) [11] in guava, Chaudhari *et al*., (2018) [24], Kumari *et al*., (2017) [13] in guava. Significant interaction effect of etiolation and IBA resulted in more survival might be due to the presence of high C/N ratio and higher content of sugars. The research findings of Dave (1993) [15] in kagzi lime, Kunal and Syamal, (2005) [20], Yadav *et al*., (2014) [11], Chaudhari *et al*., (2018) [24] and Kumari *et al*., (2017) [13] in guava are in line with the present results. Dharsan *et al*., (2008) [12] also reported the same in fig.

Fig-1 (a) Formation of roots in air layering treated with IBA 1000 ppm and etiolation (b) Detached air layers (c) Air layers transplanted in polybags

Fig-2 (a) Formation of roots in air layering treated with IBA 750 ppm and etiolation (b) Detached air layers (c) Air layers transplanted in polybags

Fig-3 (a) Formation of roots in air layering under control (b) Detached air layers (c) Air layers transplanted in polybags

Conclusion

From the results of the present study it can be concluded that in order to boost up the fig cultivation the planting material of fig can be produced by propagation of fig through air layering. For this, the highest success in rooting of air layered shoots could be achieved from etiolation of the shoots and with the treatment of girdled area with 1000 ppm of IBA.

Application of research: It will help to boost the cultivation of fig in sub-tropical conditions of Punjab

Research Category: Air layering in fig

Abbreviations: E- Etiolation, IBA-Indole Butyric acid; NAA- Naphthalene acetic acid; T- Treatment; g- Gram

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Study area / Sample Collection: Department of Horticulture (Agriculture), Khalsa College, Amritsar, 143001, India

Cultivar / Variety / Breed name: Brown Turkey

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