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Influence of different levels of IAA and NAA growth regulators on air layers in fig (*Ficus carica* L.) CV. Dinkar

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Abstract
As fig is gaining greater importance and is preferred in dry land Horticulture, perpetuation of the crop needs immediate attention. Although, it is possible to propagate this crop from stem cuttings and by air layering, commercially it is propagated through stem cutting. Reports on systematic investigation into various aspects of propagation of fig from stem cutting and air layering is scanty and sporadic. The experiment on effect of different levels of growth regulator on air layering in fig (*Ficus carica* L.) cv. Dinkar was carried out at Central Nursery, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season in year 2018-19. This investigation facilitates easier, quicker and successful method of propagation with easy and profuse rooting of cutting and air layering in fig. The objective was to find out suitable concentration of growth regulators for rooting and success of air layering. The experiment was laid out in Randomized Block Design in Nine treatments with three replications. The treatments were T_1 (IBA-2500 ppm), T_2 (IBA-5000 ppm), T_3 (IBA-7500 ppm), T_4 (IBA-10000 ppm), T_5 (NAA-2500 ppm), T_6 (NAA-5000 ppm), T_7 (IBA-2500 + NAA-2500 ppm), T_8 (IBA-5000 + NAA- 5000 ppm) and T_9 (Control). The result indicated that, treatment T_3 (IBA-7500 ppm) was found significantly superior for early and profuse rooting and success per cent over the rest of treatment followed by treatment T_7 (IBA-2500 + NAA-2500 ppm). The air layers made with treatment T_3 (IBA-7500 ppm) significantly influence in regards to root growth parameters as it recorded minimum days taken to root initiation (12.44)**,** highest rooting percentage (91.11%), fresh weight (3.34 g), dry weight (1.11 g), length of root (5.64 cm), number of root (17.77). The treatment T_3 (IBA 7500 ppm) also significantly influenced in regards to shoot growth parameters as it recorded minimum number of days required for first sprouting (10.10), length of shoot (6.67, 13.67 and 18.67 cm), number of leaves (6.22, 7.99 and 9.88), number of sprouts (2.87, 4.77 and 6.66), number of shoots (3.54, 5.44 and 7.33), stem girth (2.13, 3.13 and 4.28 cm), seedling height (14.67, 21.68 and 27.66 cm) at 30, 60 and 90 days after transplanting respectively. The treatment T_3 (IBA 7500 ppm) also recorded the maximum success percentage (96.33%) and benefit cost ratio (1.81) after 90 days of transplanting.

Keywords: Growth parameters, growth regulators, rooting, percentage

Introduction
Fig (*Ficus carica* L.) is a deciduous and subtropical fruit crop. It is said to be originated in the east mediterranean region, from where its cultivation expanded to the whole of the mediterranean region. Fig is belongs to Moraceae family. It contain 2n=56 chromosome. Along with date palm, *vinifera* grape and olive, the fig was one of the important fruit crops of the ancient civilization of the eastern mediterranean region and appeared in many songs and legends of historical and mythological background.

Fresh fruit contain of 84% pulp and 16% skin. The average composition of fig is 269 calories, 4 gm proteins, 200 mg calcium, 4 mg iron, 100 IU vitamin A and thiamine per 100 gm of edible portion. In fresh fig 11.50% total sugar also found. Fig helps to maintain the acid alkali-acid balance of the body effectively neutralizing excess acid. The fruit contain 3.02 per cent (dry weight basis) total acid. The acid content range from 0.1 to 0.2 percent (as citric acid). Fresh figs also contain gum muciliage (0.8%) and pentasons (0.83%). Fig coffee is manufactured in Europe which is used as a substitute for coffee. It is good source of carbohydrates including fibre. Fresh fruit are rich in calorie, protein, calcium, and iron. The fruit contain 3.02 percent (dry weight basis) total acid. Citric acid is the predominant acid in fig.

Greece is now the leading fig producing country followed by Algeria, Morocco, Syria and Italy in the world.

Although wild figs are grown in India for thousands of years, the common fig is not being cultivated commercially, though factors like soil and climate are most suitable for its cultivation country. Though fig cultivated an about 1000 ha area in India, on a commercial scale it is cultivated in Pune district of Maharashtra state. It is also cultivated in small area in Bangalore, Mysore, Chitradurga and Bellary districts of Karnataka as well as Ananthpur district of Andhra Pradesh. The total area under fig cultivation is reported to be 883 ha, with production of 2850 MT. (Anonymus 2017-2018).

Material and Methods

The present investigation entitiled "Effect of different levels of growth regulators on layering in fig (*ficus carica* L.) cv. Dinkar" was undertaken at Central nursery, College of Agriculture, Vasantaro Naik Marathawada Krishi Vidyapeeth, Parbhani Maharashtra State during the year 2018-19. Field was situated at $19^0 16'$ North latitude and $76^0 47'$ East longitude and at an altitude of 408.50 m above the mean sea level (MSL) and has subtropical climate.

To conduct the experiment IBA, NAA plant growth regulators were required for early rooting and early root initiation, sphagnum moss as a rooting media and for wrapping of air layers polythene paper pieces of 200 µ gauge and for tying of air layers sutali were used. Poly bags (4" x 5") were used for planting air layers, to study the survival (%) of air layers.

The plants were four years old of uniform size, planted at a distance of (6m x 6m) to serve as a mother plants for preparing layers. Twenty seven uniform plants were randomly selected for the experiment. The number of shoots treated in each treatment in one replication was 30. The total number of shoots treated in each treatment in all replications was 810. Ten extra layers were treated in each treatment from which, data regarding inducement of root rate of periodical increase in formation and to record root and shoot growth parameters. Transparent polythene (200 µ gauge) was used as wrapper. The size of the polythene wrapper was 4x5 cm.

Method of treatment

1 kg sphagnum moss soaked into water for half an hour *i.e.* soaked till wet sphagnum moss was ready to be used.

One year old branches about pencil thickness were selected. Layering operation was done on 30th July, 2018. A ring of bark of 2 cm was removed from just above the upper cut, to expose the fleshy tissues for absorption of applied growth regulator formulations. Girdled portion was moistened with distilled water and a formulation of growth regulator was applied by quick dip method with a soft camel-hair brush to the upper cut surface and also 2 cm portion stem above the cut. The exposed region was immediately covered with a ball of moist, chopped sphagnum moss without disturbing the applied growth regulator. The moss was covered with transparent polythene tubing of 200 µ gauge thickness and both the ends were secured firmly using jute string (sutali). In case of control, however, only sphagnum moss (no growth regulator) was applied. After 60 days of air layering of the shoots, branches were ready for detachment. These were detached by a cut just below the lower end of the giving ringed surface with a sharp secateur. The polythene covers were removed gently and the successful air layers dipped in bavistin solution for a short while were planted in well-prepared polybag as per the plan of layout.

Root characters

Treated layers were detached after 60 days of operation and the following root character were studied

Days to root initiation

The days of appearance of first roots in air layers, which were visible through the transparent polythene sheet, was recorded by periodic observation. The number of days taken for rooting of air layers in each treatment were calculated.

Rooting percentage (%)

The number of rooted air layers was counted after detachment of air layered twings from the mother plants after 60 days of operation. The data was compiled successfully and rooting percent was calculated by following formula

$$\text{Rooting \%} = \frac{\text{No. of rooted air layered plant}}{\text{Total no. of air layers of treatment}} \times 100$$

Average root length (cm)

The observations were recorded at 60 days of layering with the help of scale at time when detachment of air layered twings from the parent plant. The length of primary root was measured in cm from base up to tip.

Fresh weight of roots (g)

Weight of detached roots from their plants were taken with the help of an electrical balance in gram and average fresh weight per layer was calculated.

Dry weight of roots (g)

The fresh weight of roots was previously recorded and then after those roots were kept in oven to dry in appropriate temperature (60 °c) for 12 hrs. For the removal of moisture from the roots. The dry weight of roots was recorded with the help of electric balance after drying of roots and average dry weight in gram per air layer was calculated.

Number of roots

Primary roots were counted at 60 days of layering by taking 3 random samples from each treatment under each replication after detachment of air layers from the mother plant.

Results and Discussion

Days to root initiation

The days to root initiation as influenced by different growth regulators with their suitable combinations are presented in Table 1. It was revealed from the data presented in the Table 1 that IBA, NAA and their suitable combination influenced significantly in case of days to root initiation and causing earliness in rooting of air layers. The mean days required for visible appearance of roots in air layer ranged from 12.44 to 17.66 days.

Table 1: Effect of different levels of growth regulators on days taken to root initiation and rooting percentage of air layering in fig cv. Dinkar

Sr. No.	Treatments	Days to root initiation	Rooting percentage (%)
1	T1 – IBA 2500 ppm	16.55 (- 6.71)	82.22 (10.11)
2	T2 – IBA 5000 ppm	16.11 (- 9.63)	83.33 (12.00)
3	T3 – IBA 7500 ppm	12.44 (- 41.97)	91.11 (19.52)
4	T4 – IBA 10000 ppm	15.77 (- 11.99)	86.66 (15.39)
5	T5 – NAA 2500 ppm	16.66 (- 6.03)	78.88 (7.04)
6	T6 – NAA 5000 ppm	16.88 (- 4.63)	76.66 (4.35)
7	T7- IBA-2500 ppm + NAA - 2500 ppm	14.32 (- 23.32)	88.88 (17.50)
8	T8 – IBA-5000 ppm + NAA - 5000 ppm	14.99 (- 17.82)	82.11 (10.70)
9	T9- Control	17.66	73.33
	SE±	0.71	3.54
	CD at 5% level	2.15	10.68

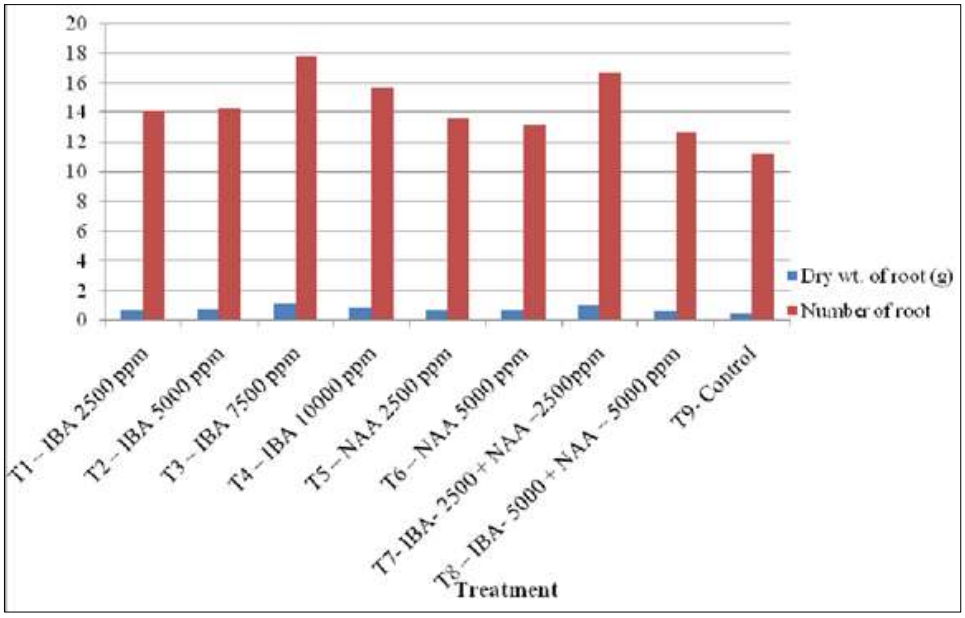

Fig 1: Effect of different levels of growth regulators on air layering in fig on days taken to root initiation and rooting percentage (%)

The significantly minimum number of days (12.44) required for rooting of air layers was recorded in treatment T_3 (IBA 7500 ppm) which was – 41.97 per cent decreased as compared to control however which was found at par with treatment T_7 (IBA 2500 ppm + NAA 2500 ppm) (14.32) which was- 23.32 per cent decreased as compared to control. It was followed by treatments T_8 (IBA 5000 ppm + NAA 5000 ppm) (14.99) and T4 (IBA 10000 ppm) (15.77) respectively. The significantly maximum number of days (17.66) for appearance of root and earliness in rooting of air layers was recorded in treatment T_9 (Control).The results are in conformity with those reported by Singh and Singh (2004) [9] in jack fruit, Bhosale *et al.* (2009) [2] in pomegranate.

Rooting percentage (%)

There was significant effect of IBA, NAA and their combination on rooting percentage of air layers in fig. The rooting percentage was recorded at the time of visible appearance of roots on the mother plant.

The mean rooting per cent ranged from 73.33 to 91.11. The significantly maximum rooting per cent (91.11%) was observed in treatment T_3 (IBA 7500 ppm) which was 19.52 per cent increased as compared to control however which were found at par with treatments T_7 (IBA 2500 ppm + NAA 2500 ppm) (88.88%) which was 17.50 per cent increased as compared to control, T4 (IBA 10000 ppm) (86.66%), T2 (IBA 5000 ppm) (83.33%), T1 (IBA 2500 ppm) (82.22%) and T8 (IBA 5000 ppm + NAA 5000) (82.11%) ppm followed by treatments T5 (NAA 2500 ppm) (78.88%) and T6 (NAA 5000 ppm) (76.66%) respectively. The significantly minimum root per cent (73.33%) was recorded in treatment T_9 (Control).

The superiority of IBA in producing highest percentage of rooting compared with NAA might be due to its greater chemical stability and low mobility in plant. The results are in conformity with those reported by Ganpati *et al.* (1997) [5] in tamarind, Chandra and K. Dinesh Babu (2009) [3] in pomegranate, Ryambai *et al.* (2010) [8] in guava.

Average length of root (cm)

Root length per at 60 days was significantly influenced by different treatments. The significantly maximum length of root (5.64 cm) was observed in treatment T_3 (IBA 7500 ppm) which was 26.65 per cent increased as compared to control however which were found at par with treatments T_7 (IBA 2500 ppm + NAA 2500 ppm) (5.32 cm) which was 21.81 per cent increased as compared to control, T1 (IBA 2500 ppm) (5.20 cm), T2 (IBA 5000 ppm) (5.06 cm) and T4 (IBA 10000 ppm) (5.05 cm) followed by treatments T6 (NAA 5000 ppm) (4.80 cm) and T5 (NAA 2500 ppm) (4.79 cm) respectively. The significantly minimum root length (4.16 cm) was observed in treatment T_9 (Control)

Table 2: Effect of different levels of growth regulators on average length of root and Fresh wt. of root (g) at 60 days after air layering fig cv. Dinkar

Sr. No.	Treatments	Average root length (cm)	Fresh wt. of root (g)
1	T1 – IBA 2500 ppm	5.20 (20)	2.06 (30.09)
2	T2 – IBA 5000 ppm	5.06 (17.79)	2.18 (33.95)
3	T3 – IBA 7500 ppm	5.64 (26.65)	3.34 (56.88)
4	T4 – IBA 10000 ppm	5.05 (17.62)	2.58 (44.19)
5	T5 – NAA 2500 ppm	4.79 (13.16)	2.04 (29.42)
6	T6 – NAA 5000 ppm	4.80 (13.33)	1.97 (26.91)
7	T7- IBA-2500 ppm + NAA - 2500 ppm	5.32 (21.81)	3.11 (53.70)
8	T8 – IBA-5000 ppm + NAA - 5000 ppm	4.63 (10.16)	1.80 (20)
9	T9- Control	4.16	1.44
	SE±	0.21	0.07
	CD at 5% level	0.63	0.22

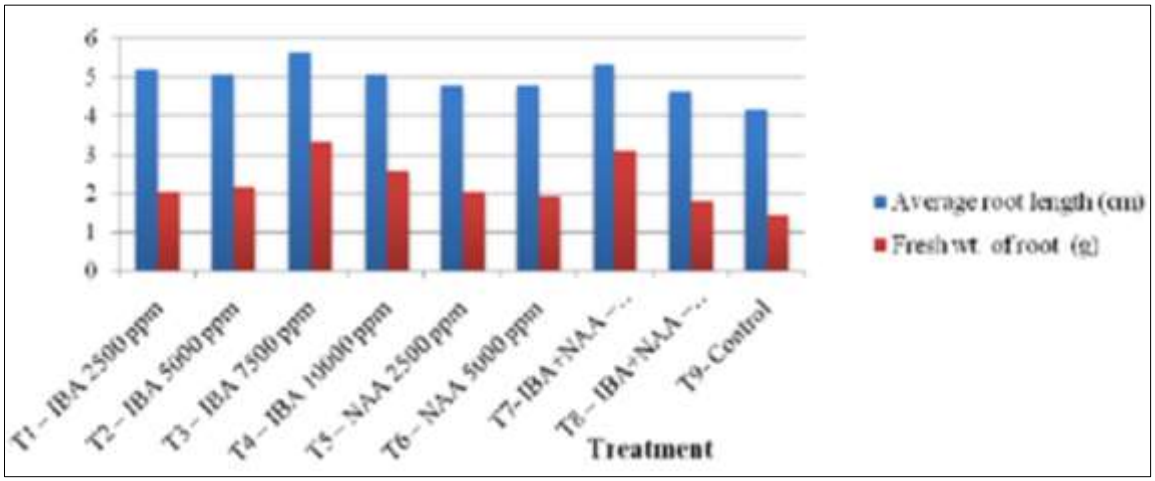

Fig 2: Effect of different levels of growth regulators on air layering in fig on average root length (cm) and fresh weight of root (g)

This might be due to the fact that auxin had stimulated elongation of root of many species. The increase in length of root at higher concentration of IBA might be due to hormonal effect and accumulation of other internal substances and their basipetal (downward) movement. The results are in conformity with those reported by Ganpati *et al.* (1997) [5] in tamarind, Paul *et al*. (2009) [7] in water apple, Singh *et al.* (2009) [10] in litchi.

Fresh weight of root (g)

The mean fresh weight of root ranged from 1.44 to 3.34 g. The significantly maximum fresh weight of roots (3.34 g) was observed in treatment T_3 (IBA 7500 ppm) which was 56.88 per cent increased as compared to control however which was found at par with treatment T_7 (IBA 2500 ppm + NAA 2500 ppm) (3.11 g) which was 53.70 per cent increased as compared to control. It was followed by treatments T4 (IBA 10000 ppm) (2.58 g) and T2 (IBA 5000 ppm) (2.18 g) respectively. The significantly minimum fresh weight of roots (1.44 g) was recorded in treatment T_9 (Control).

The highest fresh weight of root biomass might be due to more number of primary and secondary root. This may be attributed to the fact that exogenous application of auxin generally stimulate the movement of natural auxin and other materials in downward direction from leaves to shoot tips, which accumulate at the incision made on the shoot resulting in the formation of root with higher fresh weight. These result are in conformity by Rymbai *et al.* (2010) [8] in guava, Chawla *et al*. (2012) [4] in litchi.

Dry weight of root (g)

The mean dry weight of root ranged from 0.47 to 1.11g. The significantly maximum dry weight of roots (1.11 g) was observed in treatment T_3 (IBA 7500 ppm) which was 57.66 per cent increased as compared to control however which was found at par with treatment T_7 (IBA 2500 ppm + NAA 2500 ppm) (1.06 g) which was 55.67 per cent increased as compared to control. It was followed by treatments T4 (IBA 10000 ppm) (0.85 g) and T2 (IBA 5000 ppm) (0.73 g) respectively. The significantly minimum dry weight of roots (0.47g) was recorded in treatment T_9 (Control). These results are in accordance with the finding reported by Rymbai *et al.* (2010) [8] in guava.

Number of root

The mean root number ranged from 11.21 to 17.77. The significantly maximum number of roots (17.77) was observed in treatment T_3 (IBA 7500 ppm) which was 36.92 per cent increased as compared to control however which was found at par with treatment T_7 (IBA 2500 ppm + NAA 2500 ppm) (16.66) which was 32.72 per cent increased as compared to control.

Table 3: Effect of different levels of growth regulators on dry weight of roots at 60 days after layering and number of roots of air layering in fig cv. Dinkar

Sr. No.	Treatments	Dry wt. of root (g)	Number of root
1	T1 – IBA 2500 ppm	0.69 (31.89)	14.10 (20.50)
2	T2 – IBA 5000 ppm	0.73 (35.62)	14.33 (21.77)
3	T3 – IBA 7500 ppm	1.11 (57.66)	17.77 (36.92)
4	T4 – IBA 10000 ppm	0.85 (44.71)	15.66 (28.42)
5	T5 – NAA 2500 ppm	0.67 (29.86)	13.55 (17.27)
6	T6 – NAA 5000 ppm	0.65 (27.70)	13.21 (15.15)
7	T7- IBA-2500 ppm + NAA - 2500 ppm	1.06 (55.67)	16.66 (32.72)
8	T8 – IBA-5000 ppm + NAA - 5000 ppm	0.62 (24.20)	12.66 (11.46)
9	T9- Control	0.47	11.21
	SE±	0.03	0.69
	CD at 5% level	0.09	2.09

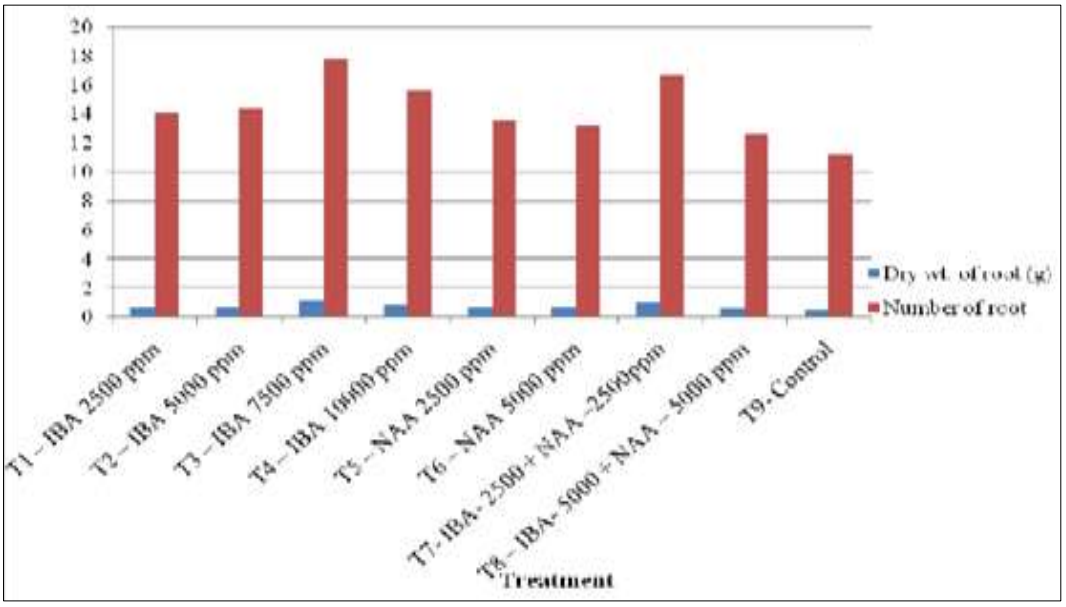

Fig 3: Effect of different growth regulators on air layering in fig on dry weight of root (g) and number of root

It was followed by treatments T4 (IBA 10000 ppm) (15.66) and T2 (IBA 5000 ppm) (14.33) respectively. The significantly minimum number of roots (11.21) was observed in treatment T_9 (Control). The result are supported by the finding reported by Ganpati *et al.* (1997) [5] in tamarind, Chawla *et al*. (2012) [4] in litchi, Khapare *et al.* (2012) [6] in fig.

Conclusion

The overall assessment of the results of present investigation on the "Effect of different levels of growth regulators on air layering in (*Ficus carica* L.) cv. Dinkar" concluded that, IBA 7500 ppm treatment (T3) for air layering in fig significantly influenced the root parameters like days to root initiation (12.44), root length (5.64 cm), number of roots (17.77), fresh weight of root (3.34 g) dry weight of root (1.11 g) and rooting percentage (91.11%) and shoot parameters like days required for first sprout (10.10), number of sprouts (2.87, 4.77 and 6.66), shoot length (6.67, 13.67 and 18.67 cm) and it also shows best performance in regards to no. of leaves (6.22, 7.99 and 9.88), no of shoots (3.54, 5.44 and 7.33), stem girth (2.13, 3.13 and 4.28 cm), seedling height (14.67, 21.68 and 27.66 cm) at 30, 60 and 90 days after transplanting respectively. The treatment T_3 (IBA 7500 ppm) also recorded the maximum success percentage (96.33%) and benefit cost ratio (1.81) after 90 days of transplanting. It is evident that use of IBA 7500 ppm treatment (T3) is a best treatment among all treatments which was at par with treatment T_7 (IBA 2500 ppm + NAA 2500 ppm fallowed by treatments T1 (IBA 2500 ppm), T5 (NAA 2500 ppm) and treatment T_9 (control) recorded significantly minimum value in air layering in fig cv. Dinkar. The significantly maximum rooting as well as success of air layers and more number of healthy air layers was obtained with use of treatment T3 (IBA 7500 ppm). Based on present investigation the application of the treatment T3 (IBA 7500 ppm) may be recommended on adhoc basis for early and faster rooting in air layering of fig under marathwada condition but it needs further confirmation before final recommendation.

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