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Effect of IBA and NAA on the Rooting and Vegetative Growth of Hardwood Cuttings in Common Fig (*Ficus carica* L.)

Rutuja Nale[1], Gaurav Sharma[1], Ranjit Pal[1], R. K. Patel[2] and Shivali Sharma[1]

[1]Dept. of Fruit Science, College of Horticulture and Forestry, Rani Laxmi Bai Central Agricultural University, Jhansi, Uttar Pradesh (284 003), India

[2]Division of Grassland and Silvipasture Management, ICAR-Indian Grassland Research Institute, Jhansi, Uttar Pradesh (284 003), India

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Corresponding gauravhort@gmail.com

0000-0002-4775-2977

ABSTRACT

The present investigation was carried out at Horticultural Nursery of Rani Lakshmi Bai Central Agricultural University (RLBCAU), Jhansi during the year 2021 to study the effect of different levels of IBA and NAA on the rooting and vegetative growth of hard wood cutting in common fig. The experiment was laid out in Completely Randomized Design in eleven treatments with three replications. The treatments comprised of IBA (500, 1000, 1500, 2000, 2500 ppm) and NAA (500, 1000,1500, 2000, 2500 ppm) by quick dip method along with control. The result indicated that IBA (2500 ppm) was found to be best in terms of early sprouting (10.26 days), Sprouted cutting (88.84%), survival % (87.29), number of roots cutting^{-1} (12.35 and 20.86), length of longest root cutting^{-1} (23.01 cm), length of shoot (12.37 cm and 26.19 cm), shoot diameter (1.59 cm), number of shoot cutting^{-1} (1.73 and 2.06) , fresh weight of roots cutting^{-1} (12.72 g), dry weight of roots cutting^{-1} (4.75 g) fresh weight of shoot cutting^{-1} (32.73 g), dry weight of shoot cutting^{-1} (9.19 g), number of leaves (8.77 and 11.40), leaf size i.e. length and width (14.20 cm and 13.56 cm), fresh weight of plant biomass (45.46 g) and dry weight of plant biomass (13.94 g).

KEYWORDS: Fig, hardwood cutting, IBA, NAA

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1. INTRODUCTION

Fig (*Ficuscarica* L.) is one of the traditional Mediterranean fruit species. The common fig belongs to family *Moraceae* and is known as 'Anjeer' in hindi which has over 1400 species classified into 40 genera (Watson and Dallwitz, 2004). In 2018, world production of raw figs was about 1.14 million tons, led by Turkey (with 27% of the world total), Egypt, Morocco, and Algeria as the largest producers collectively accounting for 64% of the total fig production (Anonymous, 2020). The area under fig cultivation in India is about 5600 ha with a production of about 13,802 Mt and an average productivity of 12.32 t ha^{-1} (Anonymous, 2020). In India, fig cultivation is done in Maharashtra, Gujarat, Karnataka, Uttar Pradesh and Tamil Nadu. It is minor fruit crop in Northern India. Fig fruit represents an important constituent of the diet, because of its nutri-medico value. Its fruit is pear shaped and is botanically called as syconium (multiple fruit). The fruits can be consumed either in fresh or dried form. The fruitshave high calorie, protein, calcium, iron and fibre content (Shamsuddin et al., 2021). It has a nutritive index of 11, as against 9 for apple and 8 for raisin. The total sugar content of fresh fig is 16% and that of dried fig is 52% (Ganiet al., 2018). However, majority (about 80%) of the fruit is consumed in the dried form (Masithah, 2018). Figs have smooth white bark and can grow to be big shrubs or trees up to 10 meters tall that are gynodioecious. Figs can withstand drought and salinity one of the best among fruits that may be grown in semi-arid regions. Due to its nutritional and therapeutic qualities, figs are one of the healthiest fruits and are linked to a longer life span. As such, they should be a significant part of any diet. It is common to eat both fresh and dried fruits.

A significant contributing element to the rooting of fig cuttings appears to be the availability and mobilization of carbohydrates at the base of the cuttings (Aslmoshtaghi and Shahsavar, 2011). According to Kumar et al. (2023), figs cannot be propagated in a generative manner. Conventional generative propagation employs tiny seeds devoid of endosperm, or food reserves, which makes it difficult for the seeds to germinate in the wild (Rineksane et al., 2018). The cutting technique is one of the vegetative propagations that may be applied for successful propagation. Cuttings result in new plants with the same characteristics as the parent, a faster propagation period, and a lower amount of plant material is needed to generate further plants. Depending on the kind of plant, growth regulators may be used (Ismaini et al., 2018). Every plant naturally contains phytohormones, or PGRs. Despite its availability, PGR must be added in order to speed up the growth of roots and shoots. Auxin group PGR has a considerable influence on root development on cuttings, whereas cytokinin group has an impact on shoot growth. By starting cell elongation, auxin can affect the process of root cell elongation (Wijaya and Sudrajad, 2019).

The auxin group is mostly present in shallot bulbs because of the imperfect growth of the top of the disc, or main stem, which produces a tuber as a result of swelling from the petals wrapping around one another and accumulating auxin (Wibowo et al., 1998).

Fig is propagated from seed, cutting, layering, grafts and by tissue culture techniques (Dhage et al., 2012). Out of these methods, propagation through hard wood cutting is relatively easy and a cheap method of propagation (Singh and Bahadur, 2015). Through hard wood cutting vigorous plants can be raised in less than a year. Under north Indian conditions cuttings are prepared when plants have shed their leaves in winter season and become dormant. The use different concentration of auxins on the cuttings has made it possible to improve the percentage and rate of success of the cuttings, reduction in time of initiation of cuttings and better rooting in fig. However, the success is also based on various other factors including the climatic conditions of the region. Though fig cultivation in Bundelkhand region is having lot of potential and the demand for plants is increasing, yet no or very little work has been done so far on propagation of fig under Bundelkhand region. The identification of auxins and their concentrations will help in enhancing the survival%even more and thus meeting demand of the fig growing farmers of Bundelkhand region. Keeping these points in view, the present research work was carried out to study the effect of IBA and NAA on the rooting and vegetative growth of hardwood cuttings and to find their optimum concentrations in common fig under Bundelkhand region.

2. MATERIALS AND METHODS

This experiment was conducted in the Horticultural Nursery, Rani Lakshmi Bai Central Agricultural University (RLBCAU) during March–June, 2021. The experiment was carried out by planting the hardwood cutting of fig in black polythene bags of size 25×15 cm^2. Polythene bags were filled with potting mixture prepared by mixing of one part of soil, vermicompost and neem cake each in 1:1:1 proportion. The cuttings of fig cv. Dinkar were selected from 4-year-old healthy, moderately vigorous grown mother plant, grown in the model orchard of Department of fruit science, RLBCAU, Jhansi. Hardwood cuttings were prepared from one-year old shoot having 15–20 cm length and 1.5–2 cm diameter. The basal portion of mature stem was used as hardwood cutting. Each cutting had 4–5 nodes. Cuttings were prepared by giving straight cut at basal (bottom) usually just below a node and slant cut was given on the top 1.3–2.5 cm above the bud. The treatments consisted of different concentrations of IBA (500, 1000, 1500, 2000, 2500 ppm), NAA (500, 1000, 1500, 2000, 2500 ppm) and distilled water without growth regulator as control. The quick dip method (10 s) was used to treat the cutting with auxin solution. In this method, the basal end of the prepared cuttings was kept standing in solution of auxin to a depth of 3–3.5 cm for 10ss and were allowed to dry for 20m and then planted in polybags. 21 cuttings for each treatment were treated with auxin solution and repeated thrice in Completely Randomized Design. After 60 and 90 days of planting, the cuttings were uprooted carefully from the polybag without damaging the roots and washed under tap water.The survival % of cutting was recorded 90 days after planting.

3. RESULTS AND DISCUSSION

On the perusal of data Table 1, it is evident that IBA and NAA significantly influenced the growth parameters. First sprout appearance with significantly earliest days for first sprouting of cutting minimum (10.26 days) in treatment 2500 ppm IBA whereas maximum days required for initiation of sprouting (17.80 days) was Control. Significantly highest%of sprouted cutting (88.84) was recordedwith 2500 ppm IBA. Significantly maximum survival % (87.29) was observed in the treatment 2500 ppm IBA followed by 2000 ppm IBA (81.10%) and 1500 ppm IBA (80.90%), all of these treatments however, were at par to each other but superior over rest of the treatments including control which recorded minimum survival % (52.33). Hardwood cutting may have contained more stored carbohydrate which in turn might have increased root number and root length with IBA treatment which in developed effective root system and increased the uptake of nutrients and 3water in cutting (Reddy et al., 2014). This result in are in conformity with those reported by (Mewaret al., 2018) in wild fig, (Tanwaret al., 2020) and Bhosale et al., 2009) in pomegranate. The number of roots cutting^{-1} increased significantly with increase in the concentration of auxin irrespective of the type of auxin. At 60 days after planting of cutting, highest number of roots cuttings^{-1} (12.35) was recorded with 2500 ppm IBA, which was significantly superior over all the other treatment whereas, at 90 days after planting of cutting, highest roots cutting^{-1} (20.86) was also observed in the treatment 2500 ppm IBA, which however, was at par with 2000 ppm IBA (19.80) but superior over all the other treatments. The maximum length of root was observed in 2500 ppm IBA (23.01 cm) which was at par with treatments 2000 ppm IBA, 1500 ppm IBA and 1000 ppm IBA but significantly superior to rest of the treatments. Increase in number of roots cuttings^{-1} might be due to the positive effect of auxin which may have induced an enhanced rate for root initiation and subsequent production of a greater number of roots (Ara et al., 2023). The fresh weight of root recorded at 90 days revealed significant difference in fresh weight of root as influenced by different concentration of IBA and NAA treatment and increased with increasing concentration of auxin. Application of 2500 ppm IBA

Table 1: Effect of IBA and NAA on root parameter of fig cutting cv. Dinkar

Treatment details	No. of days for sprouting	% of sprouted cutting	Survival %	No. of roots cutting^{-1}		Length of longest root cutting^{-1} (cm)	Fresh weight of root cutting^{-1} (g)	Dry weight of root cutting^{-1} (g)
				60 DAP	90 DAP			
T_1: 2500 ppm IBA	10.26	88.84	87.29	12.35	20.86	23.01	12.72	4.75
T_2: 2000 ppm IBA	11.93	83.73	81.10	11.31	19.80	21.97	11.75	4.30
T_3: 1500 ppm IBA	12.80	79.89	77.70	10.91	17.73	21.78	11.34	4.69
T_4: 1000 ppm IBA	14.33	76.22	80.90	9.92	14.13	21.68	11.59	4.26
T_5: 500 ppm IBA	16.26	71.39	69.80	8.75	12.20	18.62	9.10	3.33
T_6: 2500 ppm NAA	12.80	80.19	74.53	9.41	14.13	17.95	8.70	3.66
T_7: 2000 ppm NAA	13.40	74.34	66.63	8.43	11.80	16.15	7.62	2.95
T_8:1500 ppm NAA	14.20	70.02	61.86	8.05	11.93	14.75	6.66	2.45
T_9: 1000 ppm NAA	15.00	64.70	58.60	7.22	11.00	12.49	6.39	1.66
T_{10}: 500 ppm NAA	17.33	61.62	55.40	6.82	11.00	12.07	5.88	1.40
T_{11}: Control	17.80	56.14	52.33	5.90	10.53	10.44	4.90	0.96
SEd	0.44	1.22	2.59	0.26	0.47	0.51	0.23	0.23
CD (p=0.05)	1.30	3.60	7.66	0.77	1.38	1.53	0.69	0.69

resulted in significantly maximum fresh weight of roots (12.72 g). Similarly, the dry weight of root was significantly influenced by different concentration of auxinat 90 days after planting. Maximum dry weight of root (4.75 g) was observed in the treatment 2500 ppm IBA, followed by 2000 ppm IBA (4.30 g), 1500 ppm IBA (4.69) and 1000 ppm IBA (4.26) all of which however, were at par but superior to other treatments. The dry weight depends upon the fresh weight also and therefore, a similar trend was observed for dry weight as in fresh weight. The results are in line with the finding of (Benedetto et al., 2023) in Fig.

The data related to the length of shoot of cutting at 30, 60 and 90 days after planting is presented in Table 2. The length of shoot increased with increase in level of auxin. At 30 days after planting, significantly maximum shoot length (6.06 cm) was observed with 2500 ppm IBA which however, was at par with 2000 ppm IBA (5.27 cm). Similar trend was observed at 60 and 90 days after planting. At 60 days after planting, significantly maximum length of shoot (12.37 cm) was recorded with 2500 ppm IBA, which was statistically similar to application of 2000 ppm IBA but superior to all the other treatments. Whereas, at 90 days after planting maximum length of shoot (26.19 cm) was found to be significantly superior with 2500 ppm IBA at par with 2000 ppm IBA (24.43 cm). Maximum shoot diameter (1.59 mm) was observed in the treatment 2500 ppm IBA, which however, was at par with treatment 2000 ppm IBA followed by 1500 ppm IBA. Increment in shoot diameter might be due to maximum number of leaves in T_1 and vigorous root system which might have resulted in more carbohydrate assimilation and also enhanced the absorption of minerals and water from the soil. Whereas, significantly maximum number of shoots (1.73) was observed in the treatment 2500 ppm IBA, which was superior to all the other treatments including control which recorded minimum number of shoots (0.667) at 60 days after planting of cutting. Similarly, at 90 days after planting of cutting, significantly, maximum number of shoots (2.06) was observed in the treatment T_1 2500 ppm IBA). Maximum number of shoot formation with higher treatment of auxins might be due to the fact that auxins help in formation of vigorous root system which may have increased the nutrient uptake under the influence of IBA (Tanwar et al., 2020). Variation in number of shoot due to different concentrations of IBA and can be caused by variation in mobilization of auxin within cuttings, their effect on hydrolysis of reserve food material into reducing and non-reducing sugars, phenolic compounds and metabolites (Wakale et al., 2021). Highest fresh weight of shoots (32.73 g) was found in the treatment 2500 ppm IBA which statistically similar with treatments 2000 ppm IBA (31.95 g) followed by 1500 ppm IBA (30.81 g). However, lowest fresh weight of shoot (14.78 g) was observed in control. On the perusal of data collected in respect of dry weight of shoot at 90 days after planting presented in Table 2, it is observed that, the dry weight of shoot was significantly influenced by different concentration of auxin and it consistently increased with increase in concentration of auxin. The maximum dry weight of shoot (9.19 g) was found to be significantly superior in the treatment 2500 ppm

Table 2: Effect of IBA and NAA on shoot parameter of fig cutting cv. Dinkar

Treatment details	Shoot length (cm)			Shoot diameter (cm)	No. of shoot cutting^{-1}		Fresh weight of shoot cutting^{-1} (g)	Dry weight of shoot cutting^{-1} (g)
	30 DAP	60 DAP	90 DAP		60 DAP	90 DAP		
T_1: 2500 ppm IBA	6.06	12.37	26.19	1.59	1.73	2.06	32.73	9.19
T_2: 2000 ppm IBA	5.27	11.88	24.43	1.50	1.40	1.86	31.95	8.39
T_3: 1500 ppm IBA	5.09	9.74	22.74	1.48	1.33	1.60	30.81	7.63
T_4: 1000 ppm IBA	4.85	8.74	21.31	1.22	1.13	1.46	28.36	7.38
T_5: 500 ppm IBA	3.78	7.95	21.20	1.10	1.06	1.20	25.31	7.04
T_6: 2500 ppm NAA	4.31	11.19	20.31	1.49	1.46	1.80	29.11	6.82
T_7: 2000 ppm NAA	3.61	10.82	18.34	1.13	1.13	1.53	22.27	6.70
T_8:1500 ppm NAA	3.54	8.92	17.41	0.91	1.20	1.46	25.74	6.76
T_9: 1000 ppm NAA	3.22	8.03	16.36	0.83	1.06	1.40	21.02	6.61
T_{10}: 500 ppm NAA	3.09	7.30	16.22	0.76	0.80	1.40	21.08	6.34
T_{11}: Control	3.10	6.21	14.30	0.62	0.66	1.13	14.78	5.65
SEd	0.27	0.36	0.78	0.81	0.08	0.08	1.07	0.21
CD (p=0.05)	0.81	1.08	2.30	0.10	0.24	0.25	3.17	0.63

Table 2: Continue...

Treatment details	No. of leaves cutting^{-1}			Leaf size (length and width in cm)		Fresh plant biomass (g)	Dry plant biomass (g)
	30 DAP	60 DAP	90 DAP	Length (cm)	Width (cm)		
T_1: 2500 ppm IBA	5.40	8.77	11.40	14.20	13.56	45.46	13.94
T_2: 2000 ppm IBA	5.26	7.98	9.53	13.90	13.32	43.70	12.70
T_3: 1500 ppm IBA	4.50	7.46	9.23	13.24	12.92	42.16	12.38
T_4: 1000 ppm IBA	3.87	6.73	8.99	13.24	12.66	39.95	11.64
T_5: 500 ppm IBA	3.36	5.96	8.46	12.34	11.93	34.41	10.37
T_6: 2500 ppm NAA	4.11	5.73	9.06	13.56	13.02	37.82	10.49
T_7: 2000 ppm NAA	3.86	5.00	8.80	13.03	12.60	29.90	9.66
T_8:1500 ppm NAA	3.52	3.93	8.46	12.74	12.53	32.40	9.21
T_9: 1000 ppm NAA	2.94	2.96	7.86	12.04	11.74	27.42	8.27
T_{10}: 500 ppm NAA	2.74	2.90	8.73	12.06	11.84	26.96	7.74
T_{11}: Control	2.57	2.98	6.93	11.32	10.91	19.68	6.61
SEd	0.24	0.21	0.40	0.31	0.35	0.70	0.33
CD (p=0.05)	0.73	0.64	1.19	0.93	1.03	3.17	0.98

IBA. However, the meandry weight of shoot ranged from 9.19 to 5.65 g. Similar observation had been made earlier by (Chandar and Kumar, 2023) in Fig.

At 30 days after planting, the maximum number of leaves cutting^{-1} (5.40) was noted best on application of 2500 IBA ppm having at par effect with 2000 IBA (5.26). Similar trend was observed at 60 days after planting wherein, the maximum number of leaves cutting^{-1} (8.77) was observed in the treatment 2500 IBA ppm, however, at par with treatment 2000 ppm IBA (7.46). Similarly, at 90 days after planting, maximum number of leaves cutting^{-1} (11.40) was observed in the treatment 2500 IBA ppm, which was also at par with treatment 2000 IBA (9.53). The data revealed that significant difference was observed for length and width of leaves at 90 days after planting of cutting due to the effect of different concentration of IBA and NAA. Maximum length (14.20 cm) and width of leaves (13.56 cm) was found in the treatment T_1 (2500 ppm IBA) at 90 days after planting which was found at par with treatment T_2 and T_3 for length of leaves while for width it was found at par with majority of the treatments but significantly superior over control. Increase in leaf number and size might be due to the vigorous rooting induced by the growth regulators which help cutting to absorb more water and nutrients and thereby producing more leaves. The result in are in conformity with those reported by (Singh et al., 2014) in pomegranate and (Reddy et al., 2008) in Fig.

Plant biomass was significantly influenced due to the various treatment of different concentration of auxin like IBA and NAA. The highest fresh weight of plant biomass (45.46 g) was found in the treatment 2500 ppm IBA followed by 2000 ppm IBA (43.70 g) which were at par with each other. The plant biomass (dry weight) at 90 days after planting presented in Table 2, shows significantly maximum dry weight of plant biomass (13.94 g) on application of 2500 ppm IBA whereas, the mean of fresh weight plant biomass varied from 13.94–6.61 g at 90 days after planting of cutting. Cuttings treated with IBA had also resulted in increased the number of shoots and roots which ultimately help in increase in fresh weight of shoots and roots (Bhosale et al., 2014). The results are in close conformity with those reported by and in (Reddy et al., 2014) in Fig.

4. CONCLUSION

The application of 2500 ppm IBA proved most effective in promoting rapid root and shoot development. This was evidenced by increased percentages of sprouted cuttings and survival rates, as well as enhancements in the number of shoots, shoot diameter, and number of leaves per cutting. Furthermore, notable improvements were observed in both the fresh and dry weights of both shoot and root systems of the cuttings in Fig under Bundelkhand conditions.

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