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EXOGENOUS APPLICATION OF IBA AND NAA IMPROVED ROOTING AND SURVIVAL OF HARDWOOD CUTTINGS OF FIG (*FICUS CARICA* L.) CV. DINKAR

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ABSTRACT

Fig (*Ficus carica* L.) stem-cutting propagation method is slow and a lower percentage of the cuttings finally survive due to poor rooting, making it challenging to adopt. This study investigated six distinct concentrations of Indole-3-butyric acid (IBA) and 1-naphthaleneacetic acid (NAA) with control. Treatment T_6 demonstrated the most favourable outcome, displaying a rooting percentage of 69.22%, a maximum root length of 23.18 cm, the highest number of roots of 26 per cutting, roots weights of 2.53 g (fresh) and 0.79 g (dry). Additionally, it exhibited a higher survival rate of 87.35% at 90 days after planting (DAP). Treating fig hardwood cuttings with 2000 ppm of IBA and 2000 ppm NAA and growing them under shade house conditions can be recommended to researchers and the nursery industry to significantly improve rooting success and the overall survival rate of fig cuttings.
***Keywords* :** *Ficus carica* L., IBA, NAA, rooting, hardwood cutting

Introduction

Fig (*Ficus carica* L.) is the oldest domesticated fruit by humans belonging to the Moraceae family. It is native to the Middle East and widely distributed worldwide, including regions such as the Indian subcontinent, Mediterranean countries, South California and the Far East (Lansky & Paavilainen, 2010). Fig tree produces anjeer, a delicious fruit renowned for its exceptional nutritional qualities, consumed both fresh and dried (Kumar *et al.*, 1998). Besides, barks, leaves and fruits of this species play an important role as a medicinal tree to cure diabetes, skin diseases, ulcers, dysentery and diarrhea (Vora *et al.*, 2017). As a traditional tree, this species readily adapts to poor conditions, showing resistance to high calcium, salt, and drought soil levels.

The fig produces non-viable seeds, so these plants are generally multiplicated by air-layering, cutting, grafting and tissue culture (Kumar *et al.*, 1998). Tissue culture has prerequisites, grafting takes a long time and air-layering produces fewer seedlings due to the delicate nature of the mother plant (Koyuncu *et al.*, 2003; Shamsuddin *et al.*, 2021). Cutting propagation, particularly with hardwood cuttings, can produce substantial quantities of true-to-type planting material while preventing deterioration of the mother plant. Apart from that, the stem-cutting propagation method takes a lot of time and only 20–30% of the cuttings survive due to poor rooting, making it challenging to adopt (Darwesh *et al.*, 2014).

Plant multiplication by hardwood cuttings is highly reliant on adventitious root formation (Husen *et* *al.*, 2017). The initiation of adventitious roots is a complicated developmental process influenced by plant growth hormones, water relations of the cuttings and their nutritional level (Hartmann *et al.*, 2017). Plant growth regulatory 'auxins' play a vital role in influencing the rooting and survival of stem cuttings. Previous reports suggested that exogenously applied auxins may enhance adventitious rooting (AR) triggering the action of endogenous auxin (Park *et al.*, 2011). Additionally, it enhances the initiation and development of root primordium through cell division (Fogaca *et al.*, 2005). Indole Butyric Acid (IBA) and Naphthalene Acetic Acid (NAA) are synthetic auxins that are reliable in the promotion of rooting in cuttings (Tsipouridis *et al.*, 2003). Furthermore, IBA is probably the ideal substance for general application since it is non-harmful to plants with a large range of concentrations and highly impactful in accelerating root formation in many plant species (Hartmann *et al.*, 2017). NAA could ensure a greater rooting capacity, cuttings' survival and reduced time required for rooting (Kaewchangwat *et al.*, 2020). These factors have an immense effect on desirable rooting and survival of propagated cuttings. Research on the improvement of propagation techniques for fig trees is of paramount importance for the development of well-being, fruitful and profitable fig orchards (Czaja *et al.*, 2016). This work aimed to determine the best combination of IBA and NAA for achieving desirable rooting with sustainable survival in fig hardwood cuttings.

Material and Methods

The present investigation was conducted at the Research Farm of Banda University of Agriculture and Technology, Banda located at 25 °31' N latitude, 80 °20' E longitude and an elevation of 146 m above sea level during the period of 2020-2021. The hardwood cuttings were obtained from cv. Dinakar (Fig. 1) as mother trees that were 2 years old, were maintained under optimal horticultural practices. The experimental research was organized using Randomized Block Design (RBD), where seven unique concentrations of IBA and NAA *i.e.,* T_1- IBA 1000 ppm, T_2- IBA 2000 ppm, T_3-NAA 1000 ppm, T_4 -NAA 2000 ppm, T_5 -IBA 1000 ppm + NAA 1000 ppm, T_6- IBA 2000 ppm + NAA 2000 ppm and T_7-control were investigated. Each combination was replicated three times, and each replication consisted of 30 individual cuttings cultivated under a shade house environment (Fig.3) for the duration of the experiment. The various hormonal formulations were prepared (Fig.2.) by dissolving the required quantity of individual hormones in 10 mL of methanol and then making up the volume of 1 liter by adding distilled water. For fig plant cuttings, the basal sections were rapidly immersed in specific solutions utilizing the quick-dip technique. During this procedure, approximately 3 cm of the cut end of each cutting were submersed in the hormonal solution for duration of 1 minute. Subsequently, the cuttings were subjected to a 15-minute period of shade drying and then planted into polybags measuring 6 cm × 9 cm in size. These polybags were filled with a mixture of soil, farmyard manure (FYM), and sand in a volumetric ratio of 1:3 (soil: FYM and sand). The polybags were kept in a shade house and irrigated on a regular basis. The parameters took into account the percentage of rooted cuttings, length of longest root (cm), number of roots (Fig. 4), fresh and dry weight (g) of roots and survival percentage were taken at 90 DAP. Recorded data of the above-mentioned parameters were subjected to statistical analysis by using SAS 2.0 (statistical analysis system software version).

Result and Discussion

Rooting percentage

The rooting percentage of cuttings was studied on the 90th day and it was observed that among the different concentrations of growth hormone, cutting treated with T_6 recorded the maximum rooted cuttings percentage (69.22%), followed by T_5 recorded 67.78% rooted cuttings as represented in Fig. 5. Moreover, the minimum rooting percentage (36.67%) observed with T_7- control. Yusnita *et al.* (2017) observed that 100% of the roots formed when IBA and NAA were combined in semi-hardwood cuttings of Malay apples. Further, In *Cordyline terminalis* and *Azalea alexander* L. higher rooting was recorded when IBA and NAA were applied in combined form rather than alone (Rahdari *et al.*, 2014; Mohana *et al.*, 2014). IBA promotes root development in stem cuttings through processes like conversion to IAA, elevating free-IBA levels, improving tissue responsiveness to IAA, boosting internal IAA synthesis, and potentially collaborating with IAA's function.

Number of roots

The significant influence of growth hormone on the number of roots in fig cuttings on the 90th day of treatment is presented in Table 1. Among various treatments, the maximum root count (26.67) was achieved with T_6, followed by T_5 with 25.13 roots and T_2 of 23.47. Conversely, the lowest root count (17.93) was observed in T_7-control. Khalid and Ahmed (2022) revealed that the rooting number increased significantly, reaching 59.85 with the application of NAA. Additionally, Reddy *et al.* (2008) recorded that the maximum number of roots were obtained when both IBA and NAA were used in combination. In particular, the observed phenomenon might be because the use of auxins stimulates cambial activity, leading to the movement of stored food materials towards the location of root initiations.

Length of the longest root

The length of the longest root examined on 90 DAP is displayed in Table 1. Treatment T_6 recorded the longest root (23.18 cm) followed by T_5 with a measurement of 21.54 cm. Mewar and Naithani (2016) recorded that treatment with 6000 ppm of IBA in wild figs exhibited a markedly longer root length (12.13 cm). Babaie *et al.* (2014), observed the maximum root length in *Ficus binnendijkii* cuttings treated at 6000 ppm IBA. Reddy *et al.* (2008) recorded that fig hardwood cuttings treated with IBA 2500 + NAA 2500 ppm produced the longest root length per cutting (19.05 cm). Particularly, the action of IBA on the translocation of metabolites and carbohydrate metabolism, which may be implicated in the influence of hormones on root length, maybe the cause of this rise in root length. Another possibility is that auxin activity triggered the hydrolysis and transfer of carbohydrates and nitrogenous compounds located close to the base of cuttings, which speed up cell elongation and cell division in a beneficial environment (Mewar & Naithani, 2016).

Fresh and dry root weights

Ninety days after planting the treatment revealed an impressive impact of growth hormone on both the fresh and dry root weights as indicated by the graphical illustration in Fig. 6. The maximum fresh weight of roots (2.53 g) was observed in T_6, followed by T_5 (2.37 g). In contrast, the minimum fresh weight (1.64 g) was recorded in T_{7-}control which was statistically similar to T_3 (1.62 g). Besides the dry weight with T_6 exhibited the maximum (0.79 g), succeeded by T_5 (0.74 g) and T_2 (0.67 g). Conversely, the lowest dry weight (0.51 g) was observed in the T_{7-} control which is almost similar to T_3 (0.52 g) and it was followed by T_4 (0.55 g) and T_1 (0.64 g). According to several studies, the combination of IBA and NAA produces a maximum fresh and dry mass of roots in hardwood cuttings of Phalsa (Singh & Tomar, 2015; Ghosh *et. al.*, 2017). The rise in root count per cutting possibly impacted root fresh weight, as evidenced in Phalsa (Singh & Tomar, 2015). Additionally, the increased dry root weight could be linked to greater root length, facilitating the accumulation of stored carbohydrates and a higher root count leading to increased root volume per cutting in hardwood.

Survival percentage

As indicated in Fig.7 there was a notable variance in survival percentage among different levels of growth hormone. Treatment T_6 was statistically on par with T_5 and T_2, and had the highest survival rate while T_{7-} control showed the lowest survival percentage, which was statistically comparable to T_3, followed by T_1. Moreover, the survival rate in T_6 increased by 1.15 times higher than the T_{7-}control. Treatment of IBA at 3000 ppm boasts considerably the highest survival rate of rooted cuttings of fig cv. Dinkar (Kuntagol *et al.*, 2018). Patel *et al.* (2017) found that the IBA @4000 ppm measured the highest survival rate (67.2 %). Besides, it could be because the roots were longer and more numerous under this treatment, which allowed for greater absorption of nutrients and moisture from the media and as a result of higher survival rate (Reddy *et al.,* 2008).

Conclusion

Based on the findings of the present study, the treatment of fig hardwood cuttings with IBA at 2000 ppm and NAA at 2000 ppm under shade house conditions is recommended as an effective and practical approach for nursery growers and researchers aiming to enhance the rooting and survival of fig hardwood cuttings. This research contributes to the optimization of propagation techniques in fig cultivation, potentially leading to increased productivity and success in fig nurseries

Fig. 1: Preparation of Hardwood cuttings of fig cv. Dinkar.

Fig. 2: Prepared solution of different concentrations of IBA and NAA.

Fig. 3: Different treatments well managed under shade house.

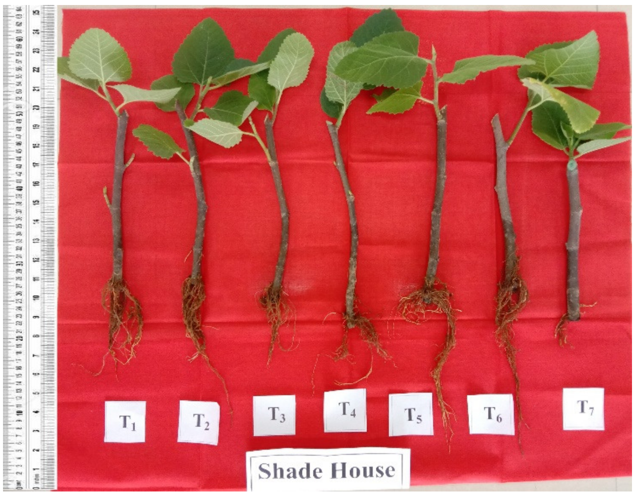

Fig. 4 : Rooting performances of hardwood cuttings of fig cv. Dinkar with different treatments.

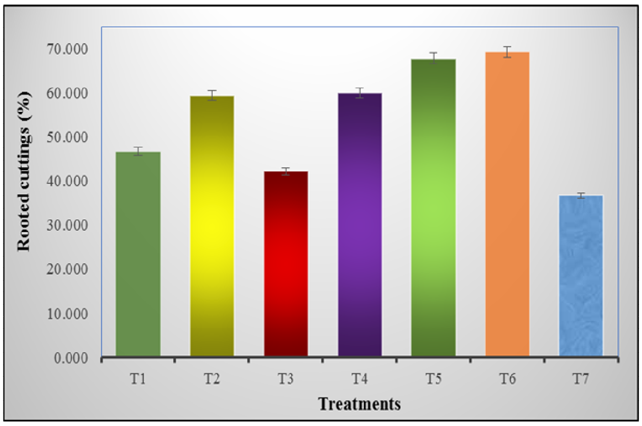

Fig. 5: Percentage of rooted cuttings in hardwood cuttings of fig (*Ficus carica* L.) cv. Dinkar at different treatments.

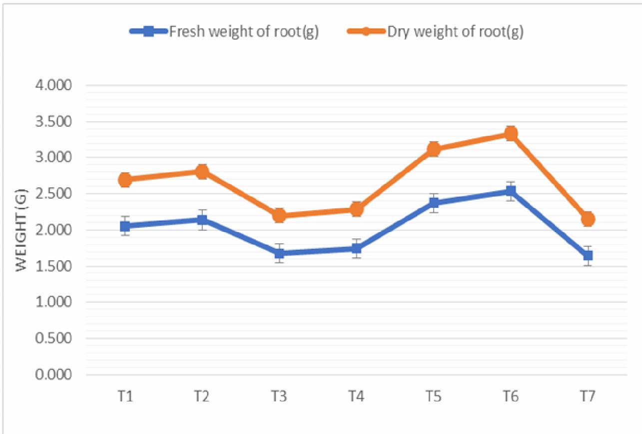

Fig. 6: Changes of the fresh and dry weight of roots of hardwood cuttings of fig (*Ficus carica* L.) cv. Dinkar at different treatments.

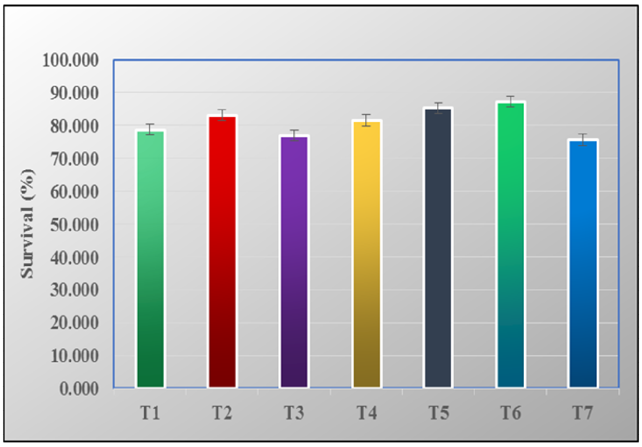

Fig. 7 : Survival trends in hardwood cuttings of fig (*Ficus carica* L.) cv. Dinkar at different treatments.

Table 1: Effect of different treatments (T_1 -T_7) on the percentage of rooted cuttings, number of roots and length of longest root in hardwood cuttings of fig

Treatments	Number of roots/ cutting	Length of longest root (cm)
T_1 (IBA @ 1000 ppm)	22.667^{Cc}	18.003^{Bbcd}
T_2 (IBA @ 2000 ppm)	23.467^{Cc}	18.603^{Bbc}
T_3 (NAA @ 1000 ppm)	18.933^{Dd}	13.940^{Cd}
T_4 (NAA @ 2000 ppm)	19.533^{Dd}	14.730^{Ccd}
T_5 (IBA @ 1000 ppm + NAA @ 1000 ppm)	25.133^{Bb}	21.537^{Aab}
T_6 (IBA @ 2000 ppm + NAA @ 2000 ppm)	26.667^{Aa}	23.183^{Aa}
T_7-(Control)	17.933^{Ee}	14.357^{Ccd}
SEm±	0.283	1.486
C.D. (P=0.05)	0.872	4.579

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