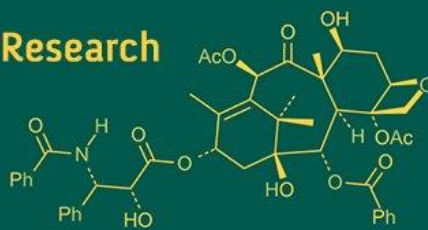


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Effect of rooting media and IBA on rooting and growth of fig cuttings

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Abstract

The present investigation was conducted to study the effect of different rooting media and IBA concentrations on rooting and growth of hardwood stem cuttings of fig (*Ficus carica* L.). The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with two factors comprising four levels of rooting media and four levels of IBA, resulting in 16 treatment combinations, with four replications. Observations were recorded on shoot, and root parameters at different intervals. The results indicated significant differences among the rooting media, IBA concentrations and their interactions for several growth and rooting parameters. The combination of soil+ cocopeat+ sand + vermicompost (1:1:1:1) ratio with IBA 1000 ppm concentration recorded superior performance with respect to first sprouting (10.75 days), number of leaves (12.81), survival (84.43%), number of roots (17.62), root length (16.10 cm). The study revealed that the appropriate combination of rooting medium and IBA concentration can improve rooting and establishment of hardwood stem cuttings in fig.

Keywords: Fig, *Ficus carica*, hardwood cuttings, IBA, rooting media, vegetative propagation, FCRD

Introduction

Fig (*Ficus carica* L.) is subtropical and deciduous small tree belonging to the family of moraceae is one of the most important deciduous trees worldwide, not only as a food source but also for its medicinal properties to treat various illnesses such as leprosy, nose bleeding, antipyretic, emollient, laxative, liver disease, and others. Additionally, it is consumed as a fresh or dried form and serves as a critical resource of trace elements, especially, iron, calcium, and potassium. Also, it is an excellent source of vitamins like thiamine (vitamin B1) and riboflavin (vitamin B2) (Kosoglu *et al.*, 2022) [4].

Fig is salt resistant and drought tolerant crop with a deep and extensive root system. Fig contains principal acids are citric and acetic, whereas small amount of oxalic and malic acids is reported to be present. These trees were demonstrating proficiency in enduring winter dormancy and pruning interventions. This distinct adaptability culminates in making fig trees optimally conducive for integration within the field of agroforestry (Kumar *et al.*, 2023) [5]. The issue of successful plant propagation has garnered considerable attention in recent times. Notably, hardwood cutting serves as the predominant method due to its heightened efficacy and minimal costs. Favored nursery professionals because it simplifies execution while simultaneously technique is facilitating medium-to-large-scale plant production. This approach assures continual availability of cultivars with optimal rooting capacity, effectively reinforcing its widespread preference among practitioners (Santos-Rufo *et al.*, 2024) [11].

Propagation through hardwood cuttings constitutes a method of an asexual plant reproduction, facilitating prolific plant production applicable in horticulture, forestry, agriculture and diverse commercial fields (Stevens *et al.*, 2018) [15].

Regrettably, the restricted capacity to elicit Adventitious Root (AR) initiation and development in most ligneous plants presents a considerable impediment to the successful utilization of asexual reproductive methods.

The important factor influencing the success of cuttings is the formation of adventitious root development. Environmental factors as well as internal and external biological substances have an impact on them, where the phenolic substances accumulation, enzyme content and auxin concentration in cuttings determine their capacity to produce robust seedlings

(Abuazizah *et al.*, 2023) ^[1]. Different propagation media play a crucial role in the success of fig propagation primarily by influencing root development and plant survival. Different media, like well-draining mixes of soil, sand and other additives, provide better drainage, temperature regulation and aeration, leading to increased root growth and survival. Other methods, such as rooting in water or using coco coir, offer specific advantages for particular stages of propagation.

Along with rooting media auxin is instrumental in the successful propagation and cultivation of cuttings from fruit trees extensive literature has affirmatively demonstrated the efficacy of auxins in stimulating root growth of cuttings across a variety of plant species (Yusnita *et al.*, 2024) ^[17]. Good water management also crucial for success.

The significance of exogenous auxin in adventitious root (AR) formation has been well-recognized previously (Quan *et al.*, 2017) ^[9]. Among auxin compounds, the indole-3-butyric acid (IBA), is particularly known to stimulate adventitious root initiation in plant cuttings Li *et al.* 2016 ^[18].

Although IBA has been widely investigated for improving adventitious rooting in several fruit crops, limited information is available on the combined effect of IBA concentration and rooting media on rooting and subsequent growth of hardwood cuttings of fig cv. Poona Fig under protected nursery conditions.

Therefore, the present study was undertaken to evaluate the individual and interactive effects of rooting media and IBA concentrations on rooting, sprouting, survival and subsequent growth of hardwood cuttings of fig cv. Poona Fig.

Materials and Methods

The experiment was conducted at "Fruit Nursery, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2025-26.

All the treatments were randomized separately in each replication. The experiment comprised of sixteen treatments consisting of four levels of growing media i.e. soil + sand + FYM (1:1:1) M₁, vermicompost + sand (1:1) M₂, soil + cocopeat + sand + vermicompost (1:1:1:1) M₃ and soil + vermicompost (1:1) M₄ and four IBA levels i.e. 500 (I₁), 750 (I₂), 1000 ppm (I₃) and water dipping (I₄) as a control were used for rooting and survival of hardwood cutting of fig (*Ficus carica L.*) cv. Poona Fig were collected from healthy, six-year-old mother plants. Mature, approximately one-year-old shoots of uniform size were selected as planting material. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with sixteen treatment combinations and four replications, number of plants per treatment was 10. The basal portion of the cuttings was treated with the specified IBA concentrations and planted in the respective rooting media under protected conditions. The data obtained were statistically analyzed using OPstat and statistical software for FCRD, and treatment means were compared using the Critical Difference (CD) at the 5% level of significance.

Results and Discussion

1. Days required for first sprouting

The data regarding days required for first sprouting presented in table 1. Among the different growing media, treatment M₃ soil+ cocopeat + sand + vermicompost

(1:1:1:1) was found significantly superior, requiring the minimum number of days (11.95) to start sprouting followed by treatment M₁ soil + sand + FYM (1:1:1). Whereas, the maximum days (14.01) were recorded in treatment M₄ soil + vermicompost (1:1). (Yahya *et al.* 2009) Amongst the IBA levels, the concentration of IBA @ 1000 ppm gave the minimum days (12.03) taken to start sprouting followed by IBA level 750 ppm (12.65). The maximum days to start sprouting (14.12) were recorded under the control (I₄) group. The findings of the present study are in general agreement with Nale *et al.*, (2024) ^[8]

The minimum days required for first sprouting was recorded in treatment combination of M₃I₃ (10.75) which was significantly superior followed by M₁I₃ (10.87). The maximum days taken for treatment combination of M₄I₄ (14.68). It is might be attributed to prevention of downward translocation of carbohydrate and accumulation of higher level of endogenous and exogenous auxins. Hardwood cuttings had more dry matter and more accumulates which might have resulted earliest completion of the physiological processes involved in sprouting. Malakar *et al.* (2019) ^[6].

Table 1: Days required for first sprouting

Days required for first sprouting					
Treatment	M ₁	M ₂	M ₃	M ₄	Mean
I ₁	13.56	13.62	11.50	13.87	13.14
I ₂	12.50	13.43	11.12	13.56	12.65
I ₃	10.87	12.56	10.75	13.93	12.03
I ₄	13.56	13.81	14.43	14.68	14.12
Mean	12.62	13.35	11.95	14.01	-
	M	I	M×I	-	-
"F" test	Sig	Sig	Sig	-	-
SE(m)±	0.27	0.27	0.54	-	-
CD at 5%	0.77	0.77	1.54	-	-

2. Number of leaves per cutting (30,60,90 days)

The data regarding number of leaves per fig cuttings (30,60,90 days) influenced by rooting media and IBA is presented in Table 2(a), and 2(b). Among the growing media, treatment M₃ was found to be significantly superior achieving the max number of leaves (5.50, 8.32 and 12.01). This was followed by treatment M₁ (soil + sand + FYM 1:1:1), which yielded 5.34, 8.09 and 11.17 leaves per sprouts, conversely, the minimum number of leaves (4.04, 7.03 and 9.40) was recorded in treatment M₄ (soil + vermicompost 1:1). Singh, *et al.* (2015) ^[12, 14] in lemon. Among the various IBA concentration, IBA @ 1000 ppm (I₃) produced a significantly higher number of leaves per cutting, with average of (5.90, 8.32 and 12.06) at 30, 60, and 90 days, respectively. Followed by IBA @ 750 ppm treatment (5.18, 8.00 and 11.40). Conversely, the less number of leaves (3.85, 7.12 and 9.01) was observed in the control (water dipping). These results align with findings by Singh *et al.* (2014) ^[13] regarding *Morus alba*, and Malakar *et al.* (2019) ^[6]. The highest leaf count was recorded in the M₃I₃ treatment combination (7.00, 9.00, and 12.81 at 30, 60, and 90 DAP, respectively), which proved significantly superior to all other treatments. Followed by M₁I₃ (6.75, 8.43, and 12.62), while the minimum number of leaves was consistently observed in the combination of M₄I₄ (2.75, 6.12, and 7.92). During initial stages, the emergence of early sprouts and leaf primordia depends heavily on the internal carbohydrate reserves stored within the mature cutting tissue rather than external treatments. However, as the cuttings advanced to 90 DAP, these internal reserves were depleted,

shifting the plant's dependency to root absorption capabilities. This explains why the synergy between the IBA and growing media became prominent at later stages, as confirmed by similar trends in Singh, *et al.* (2015)^[12, 14] in lemon.

Table 2 (a): Effects of rooting media and IBA concentration on number of leaves at (30,60,90 days)

Treatment	Number of leaves per cutting		
	At 30 days	At 60 days	At 90 days
Rooting media (M)			
M ₁	5.34	8.09	11.17
M ₂	4.26	7.75	10.68
M ₃	5.50	8.32	12.01
M ₄	4.40	7.03	9.40
"F" test	Sig	Sig	Sig
SE(m)±	0.28	0.27	0.14
CD at 5%	0.81	0.78	0.40
IBA (I)			
I ₁	4.56	7.75	10.79
I ₂	5.18	8.00	11.40
I ₃	5.90	8.32	12.06
I ₄	3.85	7.12	9.01
"F" test	Sig	Sig	Sig
SE(m) ±	0.28	0.27	0.14
CD at 5%	0.81	0.78	0.40

Table 2(b): Interaction effects of rooting media and IBA concentration on number of leaves at (30,60,90 days)

Treatment combinations	Number of leaves per cuttings		
	At 30 days	At 60 days	At 90 days
M ₁ I ₁	4.93	8.06	11.12
M ₁ I ₂	5.31	8.25	12.12
M ₁ I ₃	6.75	8.43	12.62
M ₁ I ₄	4.37	7.62	8.81
M ₂ I ₁	3.93	7.68	10.93
M ₂ I ₂	4.00	7.93	11.06
M ₂ I ₃	4.50	8.18	11.81
M ₂ I ₄	4.62	7.18	8.93
M ₃ I ₁	5.00	8.25	12.31
M ₃ I ₂	6.35	8.50	12.56
M ₃ I ₃	7.00	9.00	12.81
M ₃ I ₄	3.68	7.56	10.37
M ₄ I ₁	4.37	7.00	8.81
M ₄ I ₂	5.12	7.31	9.87
M ₄ I ₃	5.37	7.68	11.00
M ₄ I ₄	2.75	6.12	7.93
"F" test	NS	NS	Sig
SE(m) ±	0.57	0.55	0.28
CD at 5%	-	-	0.81

3. Survival percentage of cuttings (at 30,60,90 days)

The experimental data regarding survival percentage of cuttings at 30,60, and 90 days influenced by rooting media and IBA concentrations, is presented in Table 3(a) and 3(b). The evaluation of different growing media revealed that treatment M₃ (soil+ cocopeat + sand + vermicompost 1:1:1:1) was significantly superior, and achieving highest survival percentage of 79.15, 79.09 and 78.95 across the observation period, followed by treatment M₁ (soil + sand + FYM 1:1:1) with survival rates of 77.54, 77.64 and 77.59. Conversely, the minimum survival percentage (68.68, 71.46 and 71.40) was recorded in treatment M₄ (soil+ vermicompost 1:1). These findings are consistent with observations by Bhagat and Saraswati (1988). A comparative analysis of the IBA treatments revealed a significant influence on survival percentage. Among the

tested levels, IBA 1000 ppm (I₃) yielded the maximum survival percentage of cuttings (79.42, 80.01 and 79.92) at 30, 60, and 90 days respectively, followed by IBA level 750 ppm showed survival rates of 77.35, 78.84 and 78.56. Conversely, the minimum survival percentage of cuttings 65.17, 66.04 and 65.98 was observed under control treatment (I₄: water dipping). These findings align with the results reported by Singh, *et al.* (2015)^[12, 14] in phalsa. Although at 30 days M₃I₃ recorded the numerically highest survival percentage (84.81%), but the interaction effect was non-significant. The interaction was significant, with M₃I₃ recording the highest survival percentages were recorded in treatment combination M₃I₃ (84.68%, and 84.43%) at 60, and 90days respectively, which may be due to better root development and efficient water and nutrient uptake. The favorable moisture retention and aeration of M₃ may have further supported establishment and sustained growth of the cuttings., followed by M₁I₃ combination (83.56%, 83.18% and 83.18%). The minimum survival percentage observed in M₄I₄ combination (62.81%, 64.12% and 64.06%) for 30,60,90 days respectively, might be attributed to comparatively poor rooting and the absence of IBA stimulation.

Table 3(a): Effect of rooting media and IBA concentration on survival percentage of cutting at (30,60,90 days)

Treatment	Survival percentage of cutting (%)		
	At 30 days	At 60 days	At 90 days
Rooting media (M)			
M ₁	77.54	77.64	77.59
M ₂	71.82	74.21	73.96
M ₃	79.15	79.09	78.95
M ₄	68.68	71.46	71.40
"F" test	Sig	Sig	Sig
SE(m)±	0.95	0.50	0.51
CD at 5%	2.70	1.44	1.47
IBA (I)			
I ₁	75.26	77.51	77.45
I ₂	77.35	78.84	78.56
I ₃	79.42	80.01	79.92
I ₄	65.17	66.04	65.98
"F" test	Sig	Sig	Sig
SE(m) ±	0.95	0.50	0.51
CD at 5%	2.70	1.44	1.47

Table 3(b): Interaction effect of rooting media and IBA on survival percentage of cutting at (30,60,90 days)

Treatment combinations	Survival percentage of cutting (%)		
	At 30 days	At 60 days	90 days
M ₁ I ₁	79.50	79.50	79.43
M ₁ I ₂	81.50	81.50	81.43
M ₁ I ₃	83.56	83.18	83.18
M ₁ I ₄	65.6	66.37	66.31
M ₂ I ₁	71.56	76.06	76.00
M ₂ I ₂	73.62	77.06	76.25
M ₂ I ₃	77.31	77.56	77.50
M ₂ I ₄	64.81	66.18	66.12
M ₃ I ₁	81.00	81.00	80.93
M ₃ I ₂	83.37	83.18	83.00
M ₃ I ₃	84.81	84.68	84.43
M ₃ I ₄	67.43	67.50	67.43
M ₄ I ₁	69.00	73.50	73.43
M ₄ I ₂	70.93	73.62	73.56
M ₄ I ₃	72.00	74.62	74.56
M ₄ I ₄	62.81	64.12	64.06
"F" test	NS	Sig	Sig
SE(m) ±	1.90	1.01	1.03
CD at 5%	-	2.88	2.94

4. Number of roots per cutting

The experimental data regarding number of roots per cutting influenced by rooting media and IBA is presented in Table 4.

The evaluation of different growing media revealed that treatment M₃ soil+ cocopeat + sand + vermicompost (1:1:1:1) was found to be significantly superior and yielded maximum number of roots (14.26), followed by treatment M₁ (soil + sand + FYM 1:1:1) with (13.21). Whereas the minimum number of roots per cutting (11.60) recorded in treatment M₄ (soil + vermicompost 1:1). (Meena *et al.* 2017) [7].

A comparative analysis of the IBA treatments revealed a significant influence on biomass accumulation. Among the tested levels, the IBA at 1000 ppm significantly enhanced root development, yielding the maximum number of roots I₃ (15.39) followed by IBA @ 750 ppm (13.43). Conversely, the minimum number of roots (10.92) were recorded under I₄ treatment. These results are in conformity with Karakurt *et al.* (2009) [3].

The maximum number of roots per cutting obtained in treatment combination of M₃I₃ (17.62), which was significantly superior followed by M₁I₃ (16.81) it is due might be the ideal enzyme activation, primordia proliferation, and optimal aeration & moisture conditions. Conversely the minimum number of roots observed in treatment combination of M₄I₄ (10.25) it is due to the poor aeration and moisture in rooting media as well as low auxin concentration leads to minimum number of roots per cutting.

Table 4: Effect of rooting media and IBA on number of roots per cutting

Number of roots per cutting					
Treatment	M ₁	M ₂	M ₃	M ₄	Mean
I ₁	11.75	11.12	11.87	10.87	11.40
I ₂	13.37	12.18	15.56	12.62	13.43
I ₃	16.81	14.43	17.62	12.68	15.39
I ₄	10.93	10.50	12.00	10.25	10.92
Mean	13.21	12.06	14.26	11.60	-
	M	I	M×I	-	-
“F” test	Sig	Sig	Sig	-	-
SE(m) ±	0.30	0.30	0.61	-	-
CD at 5%	0.87	0.87	1.75	-	-

5. Root length (cm)

The experimental data regarding root length influenced by rooting media and IBA is presented in Table 5.

The evaluation of different growing media revealed that treatment M₃ (soil+ cocopeat + sand + vermicompost 1:1:1:1) was found to be significantly superior and resulted maximum root length (14.48), followed by treatment M₁ (soil + sand + FYM 1:1:1) with (12.76), conversely the minimum root length (11.39) was recorded in treatment M₄ (soil + vermicompost 1:1). Similar results was obtained by Rahad *et al.* (2016) [10].

A comparative analysis of the IBA treatments revealed a significant influence on biomass accumulation. Among the tested levels, the concentration of IBA @ 1000 ppm yielded maximum root length I₃ (14.69), followed by IBA @ 750 ppm I₂ (12.85). Conversely, the minimum root length (11.22), was recorded under I₄ treatment. Similar results obtained by Singh, *et al.* (2015) [12, 14].

The maximum root length per cutting recorded in treatment combination of M₃I₃ (16.10), which was significantly

superior followed by M₁I₃ (15.92). Conversely, the minimum root length was observed in treatment combination of M₄I₄ (10.40).

The higher root length in M₃I₃ may be due to the combined effect of optimum IBA (1000 ppm) and a well-aerated, moisture-retentive medium (soil + cocopeat + sand + vermicompost), which supported better root initiation and elongation. M₁I₃ also showed good response due to effective IBA concentration, but was slightly lower than M₃I₃ due to less balanced medium conditions. The lowest root length in M₄I₄ may be due to absence of IBA and less favourable rooting environment. Overall, results indicate that both suitable IBA concentration and appropriate rooting medium are necessary for better root development.

Table 5: Effect of rooting media and IBA on root length (cm)

Root length (cm)					
Treatment	M ₁	M ₂	M ₃	M ₄	Mean
I ₁	11.27	11.08	14.06	10.85	11.82
I ₂	12.61	11.41	15.50	11.86	12.85
I ₃	15.92	14.32	16.10	12.43	14.69
I ₄	11.22	10.98	12.28	10.40	11.22
Mean	12.76	11.95	14.48	11.39	-
	M	I	M×I	-	-
“F” test	Sig	Sig	Sig	-	-
SE(m) ±	0.27	0.27	0.54	-	-
CD at 5%	0.78	0.78	1.56	-	-

Conclusion

The present study revealed that, the rooting medium consisting of soil + cocopeat + sand + vermicompost (1:1:1:1) combined with IBA at 1000 ppm was found to be the most promising treatment for improving sprouting, survival and rooting performance of hardwood cuttings of fig cv. Poona Fig.

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