The Pharma Innovation Journal 2022; 11(12): 2779-2784

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 2779-2784

www.thepharmajournal.com
Received: 11-09-2022
Accepted: 15-10-2022

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Effect of IBA and NAA concentrations and types of media on rooting and survival of cuttings in fig (*Ficus carica* L.)

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Abstract
The field experiment entitled "Effect of IBA and NAA concentrations and types of media on rooting and survival of cuttings in fig (*Ficus carica* L.)" was carried under polyhouse conditions at SKUAST-K, during 2021-2022. The experiment was laid out in a Completely Randomized Design with factorial concept having three repetitions. The treatment consists of three levels of IBA and NAA concentration G_1 (Control), G_2 (IBA 15000 ppm), G_3 (IBA @ 2000 ppm), G_4 (IBA 3000 ppm), G_5 (NAA @ 1000 ppm) G_6 (NAA 1500 ppm), G_7 (NAA @ 2000 ppm) and three level of different media M_1 (soil), M_2 (sand) and M_3 [soil + sand (1:1)]. Among the different IBA concentration, G3 (IBA @ 2000 ppm) recorded significantly the minimum days of sprouting (28), maximum survival percentage (76 per cent), number of primary roots (14.33 cm), number of secondary roots (42), average root length (9 cm), root mass (14.68 cm) and dry weight of roots (1.84 g) after 120 DAP. Cuttings treated with IBA @ 2000 ppm and planted in soil + sand (1:1) media were found better for the propagation of fig through cutting. This is the first study on evaluation of fig (*Ficus carica* L.) in Kashmir region (India).

Keywords: Fig, media, IBA, NAA, hardwood cutting

Introduction

Fig, (*Ficus carica*) is a gynodioecious, deciduous tree that grows up to 7–10 m (23–33 ft) tall, with smooth white bark in tropical and sub-tropical countries. It belongs to family Moraceae. The fig fruit develops as a hollow, fleshy structure called the syconium that is lined internally with numerous unisexual flowers. The tiny flowers bloom inside cup-like structure. The edible mature syconium develops into a fleshy false fruit bearing the numerous one-seeded fruits, which are technically druplets. The whole fig fruit is 3–5 cm (1–2 in) long, with a green skin that sometimes ripens toward purple or brown. Fig fruits are a good source of minerals and bioactive compounds. They are considered healthy fruits because they are a rich source of minerals (Iron, calcium, potassium), amino acids (aspartic acid, glutamine) fiber and carotenoids such as lycopene, cryptoxanthin and carotene (Duenas *et al.* 2008 and Hssaini *et al.* 2019) [2, 5]. In addition, figs are free of fats and cholesterol and are a good source of sugars (fructose, glucose), organic acids and volatile compounds that enhance the flavour of the fruit (Hssaini *et al.* 2019) [5]. In addition, fig fruits are a rich source of phenolic compounds that effectively contribute to colour formation, flavour and aroma (Slatnar *et al.* 2011 and Verberic *et al.* 2008) [10, 12]. Moreover, the colour of the flesh and skin affect the accumulation of phenolic compounds and the antioxidant capacity in fruits (Ercisli *et al.* 2012) [4]. Recently, several studies have shown that fig cultivars and growing locations influence antioxidant potential and other chemical properties such as total soluble solids, sugars, and organic acids (Hssaini *et al* 2019 and Ercisli *et al* 2012) [5, 4]. It has also been reported that fig fruits, roots and leaves are used in various conventional medicines that are effective against certain ailments such as gastrointestinal, respiratory, cardiovascular and anti-inflammatory problems (Duke 2002) [3]. Fig is propagated through both sexual and asexual methods. In sexual method, seed is employed only to produce new varieties by hybridization and for rootstock purposes. In asexual method, it can be successfully propagated by cutting, layering, and grafting. Among all the asexual techniques, the cutting is the easiest and economical method of producing true to type plants, but rooting in hard wood cutting is the fundamental problem in the practical application. For this, use of plant growth regulators is most important.

The growth substance most commonly used for better rooting in cutting of various plant parts are IAA, IBA, NAA etc. Among these auxins, IBA has proved to be the best for proper root growth and are widely used for successful rooting of cuttings. A wide spread use of growth regulators by nurserymen, florists and horticulturist indicates that the growth substance are valuable aid to rooting in cutting. Also rooting media is one of the most important factors for better rooting of cutting and survival of plant. There are different media like soil, sand, perlite, vermiculite, FYM etc. play an important role in success of rooting of cutting. Some media have higher moisture holding capacity with lighter weight, which enhance root formation.
There is a very scarce research done for rooting in cutting and media for better rooting under temperate climatic conditions of Kashmir region. Hence, the present experiment was undertaken as "Effect of IBA and NAA concentrations and types of media on rooting and survival of cuttings in fig (*Ficus carica* L.)

Material and Methods
The present investigation was conducted under poly house in at SKUAST-K, 2020-2021. Hardwood cuttings were taken from one year old shoots which were cut to have 2-3 nodes each. The length of cuttings used for planting was 25-30 cm. The basal end of the cuttings was given a slanting cut to expose maximum absorbing surface for effective rooting. The treatments were IBA @ (3000, 2000, 1500 ppm), NAA @ (2000, 1500, 1000 ppm), distilled water without growth regulator (control). The prepared cuttings were treated with plant growth regulators by quick dip method for 10-15 seconds and were allowed to dry for 15 minutes and then planted in sand. The experiment was laid out in completely randomized block (factorial) design with three repetitions. After 120 days of planting, the cuttings were uprooted carefully from the sand bed without damaging the roots and washed in water. The days taken to sprouting, survival of cutting (%), number of primary root per cutting, number of secondary roots per cutting, average root length and root mass (g) were recorded.

Treatment details
Concentration
G_1: Control
G_2: IBA 1500 ppm
G_3: IBA 2000 ppm
G_4: IBA 3000 ppm
G_5: NAA 1000 ppm
G_6: NAA1500 ppm
G_7: NAA2000 ppm

Types of media
M_1: Soil
M_2: Sand
M_3: Soil + Sand (1:1)

Treatment combination

Treatments	M_1	M_2	M_3
G_1	G_1M_1	G_1M_2	G_1M_3
G_2	G_2M_1	G_2M_2	G_2M_3
G_3	G_3M_1	G_3M_2	G_3M_3
G_4	G_4M_1	G_4M_2	G_4M_3
G_5	G_5M_1	G_5M_2	G_5M_3
G_6	G_6M_1	G_6M_2	G_6M_3
G_7	G_7M_1	G_7M_2	G_7M_3

Statistical analysis
Statistical analysis was carried out by using Microsoft excel 2010 and Opstat software.

Results and Discussions
Days taken to sprouting
Number of days required for initiation of shoot sprout was influenced by different growth regulators and the data is presented in Table 1. From data, it is evident that IBA and NAA significantly influenced the first sprout appearance and initiated early shoot sprouting in planted cuttings. Number of days required for first sprouting of cuttings was found significantly minimum (28 days) in G_3 treatment (2000 ppm @ IBA) whereas maximum number of days required for initiation of sprouting (53 days) was observed in treatment $G_1 M_3$ (Control). Also more days were taken for sprouting in interaction G_2M_1 and G_2M_2 (Fig: 1). The results are supported by the hypothesis that IBA is a root promoting hormone which helped in root induction and increased the sprouting process and hence reduces the time for the sprouting process (Souidan *et al*., 1995; Khapare *et al.*, 2012) [11, 6] in fig.

Table 1: Effect of different IBA, NAA concentration and types of media on days of sprouting of rooted cuttings of fig at 120 DAP

Media (M) IBA (I)	M_1: Soil	M_2: Sand	M_3: Soil + Sand (1:1)	Mean (I)
G_1: Control	67.00	62.67	58.00	62.56
G_2: IBA 1500 ppm	38.00	36.00	33.00	35.67
G_3: IBA 2000 ppm	35.00	31.00	28.00	31.33
G_4: IBA 3000 ppm	46.00	42.00	39.00	42.33
G_5: NAA 1000 ppm	51.00	45.00	44.00	46.67
G_6: NAA 1500 ppm	43.00	42.00	39.00	41.33
G_7: NAA 2000 ppm	49.00	46.00	40.00	45.00
Mean (M)	47.00	43.52	40.14	
(S. Em. ±) Conc. x Rooting Media	1.50			
(C. D. at 5%) Conc. x Rooting Media	3.01			

Data represented in table is average of three replicates

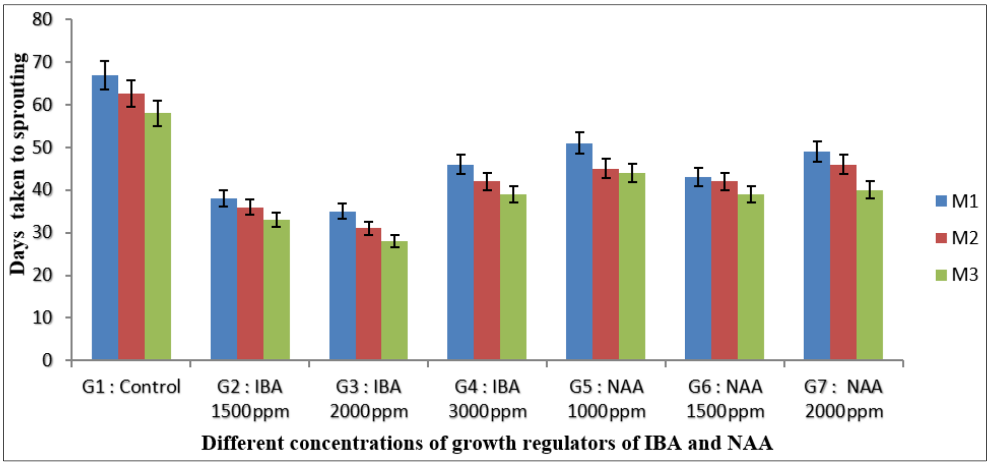

Fig 1: Effect of different IBA, NAA concentration and types of media on days of sprouting of rooted cuttings of fig at 120 DAP

Survival of cuttings

The interaction effect of IBA and media was found significant (Table 2). The maximum survival percentage (76.00%) was recorded in G_3M_3 (IBA @2000ppm with media soil + sand) at 120 DAP. The minimum survival percentage (40.00%) was recorded in interaction G_1M_1 (Control with soil media) at 120 DAP (Fig: 2). This might be due to better aeration, temperature, humidity, drainage and porosity in M_3 media which in turn increase root number and root length coupled with IBA treatment which developed effective root system and increase the uptake of nutrients and water. These findings are in concordance with the findings of (Reddy *et al* 2008) [13] in fig.

Table 2: Effect of different IBA and NAA concentration and types of media on survival of rooted cutting of fig at 120 DAP

Media (M) IBA (I)	M_1: Soil	M_2: Sand	M_3: Soil +Sand (1:1)	Mean (I)
G_1: Control	26.00	32.00	40.00	32.67
G_2: IBA 1500 ppm	62.00	66.00	73.00	67.00
G_3: IBA 2000 ppm	65.00	70.00	76.00	70.33
G_4: IBA 3000 ppm	60.00	65.00	68.00	64.33
G_5: NAA 1000 ppm	58.00	61.00	67.00	62.00
G_6: NAA 1500 ppm	61.00	65.00	70.00	65.33
G_7: NAA 2000 ppm	56.00	58.00	62.00	58.67
Mean (M)	55.43	59.57	65.14	
(S. Em. ±) Conc. x Rooting Media	2.01			
(C. D. at 5%) Conc. x Rooting Media	4.02			

Data represented in table is average of three replicates

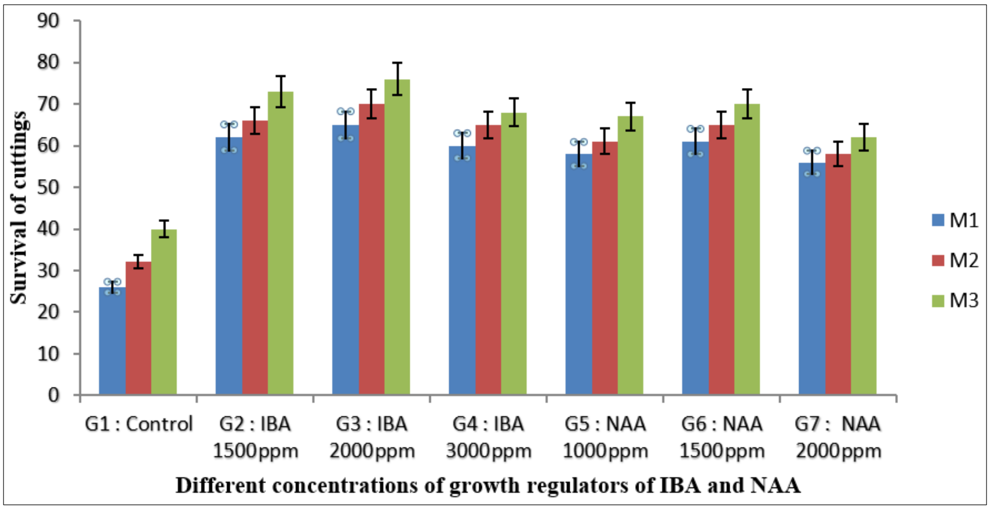

Fig 2: Effect of different IBA and NAA concentration and types of media on survival of rooted cuttings of fig at 120 DAP

Number of Primary and secondary roots

The data presented in Table 3 and Table 4 clearly indicate that maximum number of primary and secondary roots i.e. 13.67 and 42 per cutting respectively was observed in G_3M_3 treatment Among the different IBA and NAA levels, IBA @ 2000 ppm recorded the maximum number of roots, due to the positive response of IBA for root initiation and consequent production of more number of roots. This may be because of the reason that auxin helps in rooting behaviour only up to certain limit. This could be because of the adequate quantity of auxin for cambial activity is necessary for initiation of root primordial, therefore the highest performance was seen at balanced concentration of IBA @ 2000 ppm) (Fig 3, 4). The enhanced expression of root primordial and profuse development of root system as observed in the present investigation could be due to synergistic mode of action between IBA and other constituents in plant tissues control organ formation. The results in terms of number of roots are similar to the study of Rahman *et al.*, (1991) [9].

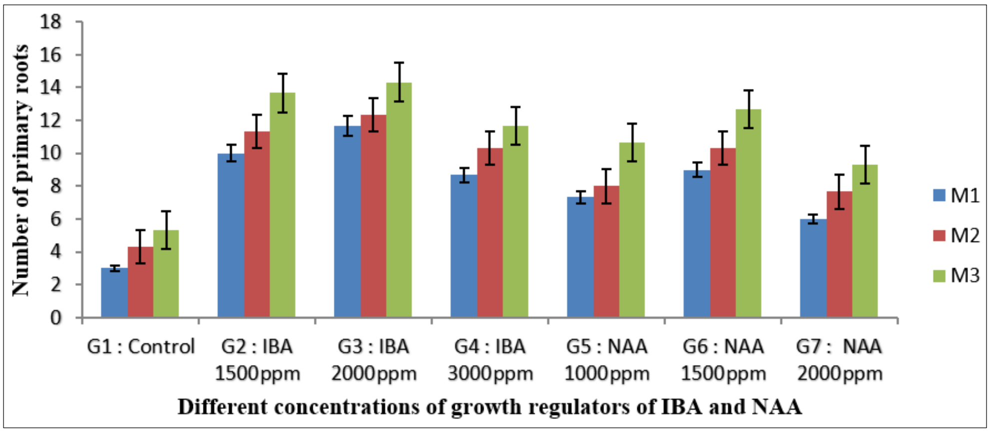

Fig 3: Effect of different IBA and NAA concentration and types of media on number of primary roots of fig at 120 DAP

Average root length

Also the data revealed that treatment G_3M_3 in Table 5 gave maximum length of root per cuttings (9 cm), which was at par with treatment G_6M_3 (8.33 cm), while, lowest length (1 cm) of root per cutting observed in treatment G_1M_1. This may be due to combination of media which is favourable for better growth of a root and IBA at higher concentration improve root growth (Fig 5). Mishra *et al.* (1977) [7] in peach and Pandey *et al*., (1983) [8] in cherry also noted similar results.

Root mass

It is evident from (Table-6) that different concentrations of IBA had significant effect on root mass than control and application of NAA. The maximum root mass (14.68 g) was noted with 2000 ppm @ IBA in medium M_3 followed by (13.86 g) with 1500 ppm in same medium and lowest in control (3.81g) (Fig 6). The increase in mass of root is due to more number and length of roots (Alam *et al*., 2007) [1].

Table 3: Effect of different IBA and NAA concentration and types of media on number of primary roots of fig at 120 DAP

Media (M) IBA (I)	M_1: Soil	M_2: Sand	M_3: Soil +Sand (1:1)	Mean (I)
G_1: Control	3.00	4.33	5.33	4.22
G_2: IBA 1500 ppm	10.00	11.33	13.67	11.67
G_3: IBA 2000 ppm	11.67	12.33	14.33	12.78
G_4: IBA 3000 ppm	8.67	10.33	11.67	10.22
G_5: NAA 1000 ppm	7.33	8.00	10.67	8.67
G_6: NAA 1500 ppm	9.00	10.33	12.67	10.67
G_7: NAA 2000 ppm	6.00	7.67	9.33	7.67
Mean (M)	7.95	9.19	11.09	
(S.Em. ±) Conc. x Rooting Media	0.94			
(C. D. at 5%) Conc. x Rooting Media	1.89			

Data represented in table is average of three replicates

Table 4: Effect of different IBA and NAA concentration and types of media on number of secondary roots of fig at 120 DAP

Media (M) IBA (I)	M_1: Soil	M_2: Sand	M_3: Soil +Sand (1:1)	Mean (I)
G_1: Control	14.00	16.00	18.00	16.00
G_2: IBA 1500ppm	34.00	37.00	40.00	37.00
G_3: IBA 2000ppm	39.00	41.00	42.67	40.89
G_4: IBA 3000ppm	30.00	33.00	36.67	33.33
G_5: NAA 1000ppm	31.00	33.00	37.00	33.67
G_6: NAA 1500ppm	35.00	37.00	41.00	37.67
G_7: NAA 2000ppm	28.00	30.00	35.00	31.00
Mean (M)	30.14	32.48	35.76	
(S.Em. ±) Conc. x Rooting Media	2.38			
(C. D. at 5%) Conc. x Rooting Media	4.76			

Data represented in table is average of three replicates

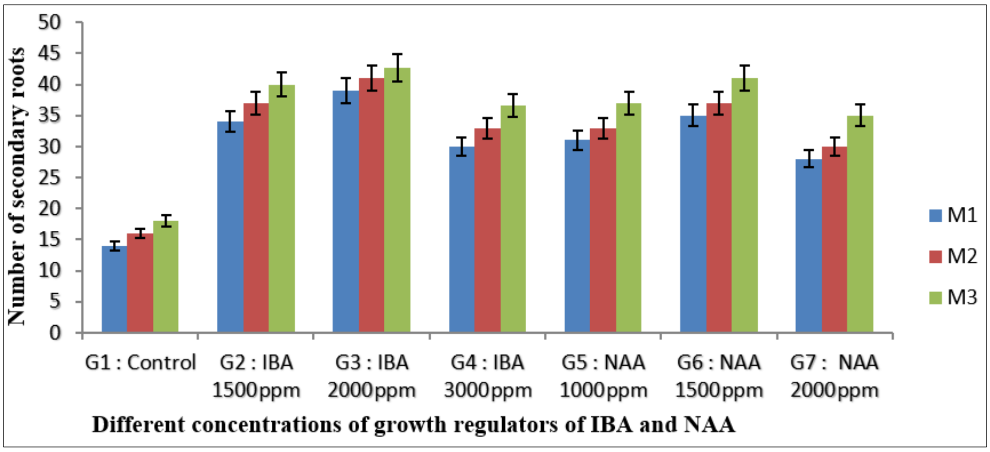

Fig 4: Effect of different IBA and NAA concentration and types of media on number of secondary roots of fig at 120 DAP

Table 5: Effect of different IBA and NAA concentration and types of media on average root length (cm) of fig at 120 DAP

Media (M) IBA (I)	M_1: Soil	M_2: Sand	M_3: Soil +Sand (1:1)	Mean (I)
G_1: Control	1.04	2.59	3.47	2.37
G_2: IBA 1500ppm	4.17	6.00	7.77	5.98
G_3: IBA 2000ppm	5.00	7.00	9.00	7.00
G_4: IBA 3000ppm	2.82	5.00	7.00	4.93
G_5: NAA 1000ppm	4.67	5.67	6.67	5.67
G_6: NAA 1500ppm	6.00	7.00	8.33	7.11
G_7: NAA 2000ppm	4.00	5.33	6.00	5.11
Mean (M)	3.96	5.51	6.89	
(S.Em. ±) Conc. x Rooting Media	0.75			
(C. D. at 5%) Conc. x Rooting Media	1.51			

Data represented in table is average of three replicates

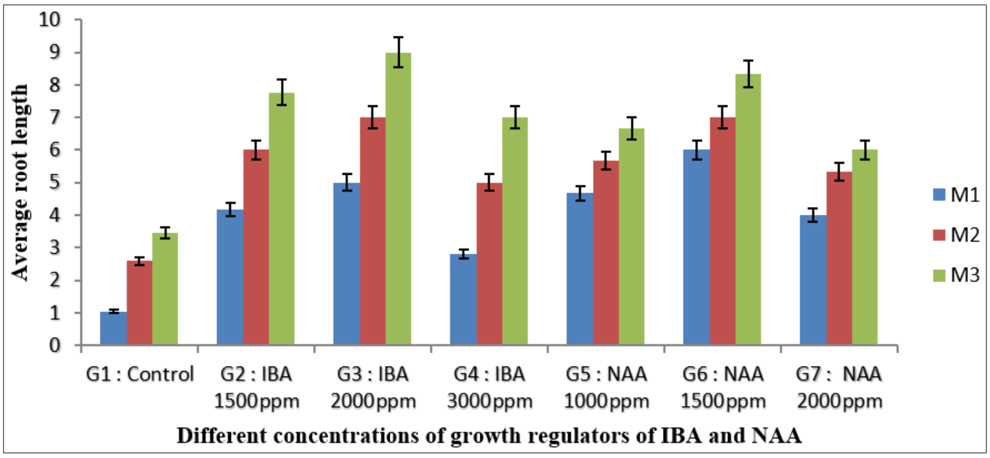

Fig 5: Effect of different IBA and NAA concentration and types of media on average root length (cm) of fig at 120 DAP

Table 6: Effect of different IBA and NAA concentration and types of media on root mass (g) at 120 DAP

Media (M) IBA (I)	M_1:Soil	M_2: Sand	M_3: Soil +Sand (1:1)	Mean (I)
G_1: Control	1.74	2.96	3.81	2.83
G_2: IBA 1500ppm	10.96	11.94	13.75	12.21
G_3: IBA 2000ppm	11.91	12.84	14.68	13.14
G_4: IBA 3000ppm	8.48	10.46	10.75	9.89
G_5: NAA 1000ppm	9.86	10.71	12.85	11.14
G_6: NAA 1500ppm	10.78	12.93	13.86	12.52
G_7: NAA 2000ppm	6.70	8.88	9.52	8.37
Mean (M)	8.63	10.10	11.31	
(S.Em. ±) Conc. x Rooting Media	0.96			
(C. D. at 5%) Conc. x Rooting Media	1.92			

Data represented in table is average of three replicates

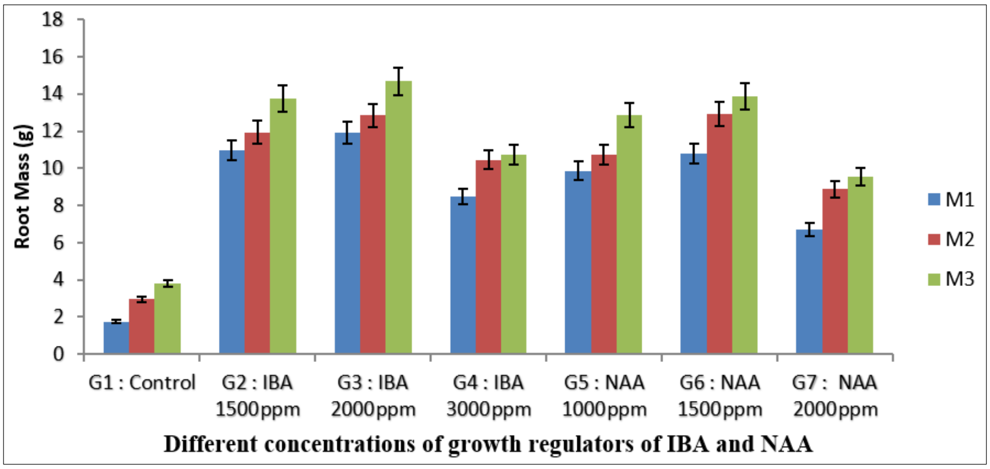

Fig 6: Effect of different IBA and NAA concentration and types of media on root mass (g) at 120 DAP

Conclusion

It was concluded that plant growth regulator IBA applied in different concentrations in various types of media significantly influenced the rooting parameters of the fig cuttings under polyhouse conditions. The better morphological growth parameters of rooted cuttings was observed in the treatment G_3M_3 i.e IBA @ 2000 ppm and planted in media (soil + sand) in the ratio of 1: 1. This is the first study on evaluation of fig (*Ficus carica* L.) in Kashmir region (India).

Acknowledgement

The author is thankful to the Division of Fruit Science SKUAST-K Shalimar, Srinagar for providing the lab and polyhouse facilities to conducting this experiment.

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