**Impact of IBA, NAA and rooting media on morphological parameters of stem cuttings in fig (*Ficus carica* L.)**

**Abstract**

*Ficus carica* L. an economically significant subtropical fruit species, is traditionally propagated through cuttings, necessitating improved rooting techniques for sustainable production. The present investigation reveals the effects of IBA (Indole-3-butyric acid), NAA (Naphthalene acetic acid), and different rooting media on the morphological parameters in fig (*Ficus carica* L.) stem cuttings. The experiment aimed to enhance rooting success and optimize growth conditions for efficient propagation. A series of treatments involving two factors – Factor I (rooting media) with three levels *viz*., S1 – Top soil: vermicompost: perlite (1:2:1), S2 – Top soil: peat: sawdust (1:2:1), S3 – Control and Factor II (plant growth regulators) with five levels viz., G1 – IBA @ 3000 ppm, G2 – IBA @ 5000 ppm, G3 – NAA @ 3000 ppm, G4 – NAA @ 5000 ppm, G5 – Control was applied to fig stem cuttings. The findings indicate that specific combinations of auxins and rooting media significantly influence root initiation and subsequent growth performance. The study provides valuable insights for horticulturists and commercial growers seeking sustainable and cost-effective propagation methods.

***Keywords:*** *Ficus carica. L, stem cuttings, rooting media, auxins, morphological parameters*.

1. **INTRODUCTION**

The family Moraceae includes the genus *Ficus*, often known as figs, which is a significant group of trees. Ficus carica L. is the most well-known and economically significant of them. It is a big, subtropical, deciduous tree or shrub.The fig originated in Asia Minor and made its way to the Mediterranean region early on. It is a very old plant that was reportedly cultivated in the eastern Mediterranean region about 3000-2000 BC. The fig is a peculiar fruit that is sometimes referred to as many fruits or a fake fruit. The male and female flowers of the fig fruit are encased in stem tissue, making it an inverted flower. In botany, this structure is referred to as a "synconium’’ (Dawange *et al*., 2016).

Figs have shallow, spreading roots that can reach a height of 50 feet and are permeable to soil. It is pear-shaped, oblong, and between 2.5 and 10 cm long. Its colour varies from dark purple to yellowish-green (Singh *et al.,* 2015). They are gathered inside the wall and are little in size. Because there are only female flowers on common figs, pollination is not present. The fig's white fleshy wall appears to have thin, delicate skin. The ripe skin might be amber, pale yellow, less pink, rose red, purple, juicy, and tasty. When it's not ripe, it leaks latex and is gummy (Vora *et al.,* 2017).

Figs can be used as an appetizer and laxative in addition to their many therapeutic uses. When fresh or dried figs are eaten with warm water, the health benefits become more pronounced within five to seven days. It is abundant in calcium, manganese, magnesium, potassium, fiber, and vitamins B6, B2, A, and C, according to Kosoglu *et al.,* (2022). According to Mewar and Naithani (2016), fig fruits are crucial for the treatment of a number of illnesses, including gastrointestinal, hypoglycemic, anti-tumor, anti-ulcer, anti-diabetic, lipid-lowering, and antifungal properties. Consuming dried figs was recommended by Ayurveda as a remedy for insomnia.

Globally, 4,15,780 hectares of figs are grown, yielding an estimated 10,47,230 MT of production (Anon, 2019). Egypt leads the world in fig production, followed by Turkey, Algeria, Iran, Morocco, Syria, the United States, and Brazil. India comes in at number twelve, with 3,570 hectares of figs grown, yielding 14,643 MT in Karnataka (Bellary, Chitradurga, and Srirangapatna), Tamil Nadu, and western Maharashtra (Anonymous, 2018).

Both sexual and asexual means are used to spread figs. Seed is exclusively used in sexual procedures for root stock reasons and to create new types through hybridization. It may be effectively reproduced asexually by grafting, layering, and cuttings. Cutting is the simplest and most cost-effective asexual procedure for creating true-to-type plants; nonetheless, the main issue in real-world applications is roots in hard wood cutting. The most crucial tools for this are rooting medium and plant growth regulators. One of the most crucial elements for improved cutting roots and plant longevity is rooting media. The effectiveness of cutting rooting depends on a variety of media, including soil, sand, perlite, vermiculite, FYM, etc. Aghera, DK (2018).

Auxins are frequently utilized to increase the cuttings' rooting effectiveness. Additionally, it speeds up the production of roots, increases the quantity of roots and other quality parameters of rooted cuttings, and increases the rooting percentage of cuttings in particularly difficult-to-root species. It has been established that auxin plays a fundamental function in root induction and formation. Indole-3-butyric acid (IBA) and 1-napthaleneacetic acid (NAA) are the two synthetic auxins most frequently used for propagation. Both IBA and NAA, either alone or in combination, promote adventitious roots.Hence, optimum concentration of growth hormones should be used to induce rooting in cuttings   
(Reddy *et al.,* 2008).

Cutting treated with IBA @4000 ppm substantially increased shoot length (5.01 cm, 8.36 cm), dry weight of root (0.56 g, 0.73 g), rooting percentage (58.96, 73.24), and the least number of days needed for sprouting (18.07) at 30 and 60 days after planting, as reported by Patel and Patel (2018).

According to Padekar et al. (2018), the treatment G4C1M1 (IBA@70 ppm + tip cutting + Soil + Sand + FYM) had the lowest number of days needed for sprouting and the maximum survival rate in spine gouard.

The effects of cutting kinds and propagation media on the early growth performance of fig (*Ficus carica* L.) roots and shoots were investigated by Shamsuddin et al. in 2021. They employed perlite, peat sawdust, topsoil, and sand as propagation media. When compared to other treatments, they discovered that a 1:1 ratio of peat to perlite produces higher-quality root and shoot development..

1. **MATERIALS AND METHODS**

The present study was Effect of IBA, NAA and rooting media on morphological parameters of stem cuttings in fig (*Ficus carica* L.) at School of Agricultural Science, Karunya Institute of technology and Sciences, Coimbatore, Tamil Nadu during the period 2024 – 2025. The study was laid out in Factorial Complete Randomized Design (FCRD) consists of Factor I (Media) with three levels – (S1 – Top soil: vermicompost: perlite (1:2:1), S2 – Top soil: peat: sawdust (1:2:1), S3 – Control) and Factor – II (Growth regulators) with three levels – (G1 – IBA @ 3000 ppm, G2 – IBA @ 5000 ppm, G3 – NAA @ 3000 ppm, G4 – NAA @ 5000 ppm, G5 – Control) with three replications.

**2.1. Treatment details**

|  |  |
| --- | --- |
| **Treatment** | **Treatment details** |
| **S1G1**  **S1G2**  **S1G3**  **S1G4**  **S1G5**  **S2G1**  **S2G2**  **S2G3**  **S2G4**  **S2G5**  **S3G1**  **S3G2**  **S3G3**  **S3G4**  **S3G5** | Top soil: Vermicompost: Perlite (1:2:1) + IBA @ 3000 ppm  Top soil: Vermicompost: Perlite (1:2:1) + IBA @ 5000 ppm  Top soil: Vermicompost: Perlite (1:2:1) + NAA @ 3000 ppm  Top soil: Vermicompost: Perlite (1:2:1) + NAA @ 5000 ppm  Top soil: Vermicompost: Perlite (1:2:1) + Control  Top soil: Peat: Sawdust (1:2:1) + IBA @ 3000 ppm  Top soil: Peat: Sawdust (1:2:1) + IBA @ 5000 ppm  Top soil: Peat: Sawdust (1:2:1) + NAA @ 3000 ppm  Top soil: Peat: Sawdust (1:2:1) + NAA @ 5000 ppm  Top soil: Peat: Sawdust (1:2:1) + Control  Control+ IBA @ 3000 ppm  Control+ IBA @ 5000 ppm  Control+ NAA @ 3000 ppm  Control+ NAA @ 5000 ppm  Control |

**2.2. Statistical tool:** STAR, OPSTSAT

**2.3. Collection of stem cuttings**

Past season matured shoots were collected from Pomological station, Coonoor. Cuttings from one-year-old shoots with four to five nodes were semi-hardwood. Early in the morning, cuttings were gathered using a secateur. Cuttings should have no leaves on them and be cut to a length of 18 to 22 cm by trimming off the ends that are just above a bud. In order to expose the most surface area possible for optimal roots, the cuttings were slanted.

**2.4. Preparation of plant growth hormone**

By using the any one of the formulae plant growth hormones were prepared. Sodium hydroxide (1N) added to dissolve the plant growth hormones.

**2.5. Preparation of raised beds and planting of cuttings**

Three beds were raised at the composition of S1 – Top soil: vermicompost: perlite (1:2:1), S2 – Top soil: peat: sawdust (1:2:1), S3 – Control. Five cuttings were planted per replications. By quick dip method, cuttings were dipped in plant growth regulators for 25 seconds and planted in slanting position. Raised beds were irrigated daily and weeds were removed properly.

**2.6. Shoot parameters**

**2.6.1 Days taken for sprouting**

Every day, treated cuttings were checked to find the amount of time taken for sprout initiation.

**2.6.2 Leaf length**

Length of leaves was manually measured by using of scale from the rooted cuttings after 90 days and expressed in cm.

**2.7. Root parameters**

**2.7.1 Number of roots**

Number of adventitious roots that are emerged from the rooted cuttings was observed after 90 days.

**2.7.2 Number of root forks**

It refers to the number of secondary roots that forms from the primary roots in stem cuttings.

**2.7.3 Average length of roots**

Using a measuring scale, the average length of adventitious roots for each treatment was manually measured on the 90th day of planting and expressed in centimetres.

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**2.7.4 Root surface area**

It was calculated manually by measuring the length and diameter and substituted in the formulae mentioned below and expressed in cm2.

**2.7.5 Root volume**

It was calculated manually by measuring the length and diameter and substituted in the formulae mentioned below and expressed in cm3.

**2.7.6 Dry weight of roots**

The roots that were collected from each rooted cuttings were dried at 600 C for 12 hours in hot air oven and expressed in grams.

**2.7.7 Fresh weight of roots**

Every rooted cutting from each treatment was collected and promptly weighed on an electronic balance, and presented in grams.

**2.7.8 Survival percentage (%)**

The total number of rooted cuttings that survived under each treatment in each replication was used to calculate the survival percentage of rooted cuttings.

**3. RESULTS AND DISCUSSION**

**3.1 Impact of rooting media and plant growth regulator on shoot parameters**

**3.1.1 Days taken for sprouting**

The results of the study on effect of IBA and NAA and growing media on days taken for sprouting of fig (*Ficus carica*. L) are presented in Fig. 1.

The cuttings that were planted in the S2 (Top soil: Peat: Sawdust (1:2:1) produces sprouting in lesser time of 17.11 followed by S1 (Top soil: Vermicompost: Perlite) of 18.40 whereas S3 (Control) taken longer time of 18.72. Peat has historically been used either by itself or in combination with inorganic (Mendez *et al.,* 2015) and organic materials (Messiga *et al.,* 2021) materials because of its remarkable combination of properties, which include low pH, cation exchangeability, and enhanced porosity.

The cuttings that were treated with G1 (IBA @3000 ppm) starts sprouting in lesser time of 16.37 followed by G2 (IBA @5000 ppm) of 17.93 whereas the cuttings that were untreated (G5) taken longer time for sprouting of 20.09. This was achieved due to higher concentration of IBA hormone promotes root growth, speeding up root initiation and improving the sprouting process (Khapre *et al.,* 2012). The present study seems to be similar to the results obtained by Pandey *et al.,* (2023) in jamun, Maninderdeep *et al.,* (2021) in grapes.

There was no significant relation between rooting media and pant growth regulator on leaf length.

**3.1.2 Leaf length**

The results of the study on effect of IBA and NAA and growing media on leaf length of fig (*Ficus carica*. L) are presented in Table 1.

The cuttings that were planted in S2 (Top soil: Peat: Sawdust (1:2:1) produces longest leaf of 14.19 cm followed by S1 (Top soil: Vermicompost: Perlite (1:2:1)) of 12.35 cm whereas S3 (Control) produces the small leaves of 11.77 cm. This was due to sawdust has good aeration and low bulk density leads to production of healthy shoots (Messiga *et al.,* 2021)

The cuttings that were treated with 3000 ppm of IBA (G1) gave longest leaf of 14.79 cm followed by 5000 ppm of NAA (G4) of 13.26 cm whereas untreated (G5) cuttings produce smallest leaf of 10.72 cm. The lengthening of shoots and leaves may be due to growth regulators facilitating the increased consumption of nitrogen, carbohydrates, and other nutrients caused by higher IBA concentrations. Similar results were found in Kaur, (2017) in peach and Maninderdeep *et al.,* (2021).

There was no significance in leaf length, influence by rooting media and plant growth regulators.

**3.2 Impact of rooting media and plant growth regulator on shoot parameters**

**3.2.1 Number of roots**

The results of the study on effect of IBA and NAA and growing media on number of roots of fig (*Ficus carica*. L) are presented in Table. 1.

The cuttings that were planted in S2 (Top soil: Peat: Sawdust (1:2:1) produces more number of roots of 15.79 followed by S1 (Top soil: Vermicompost: Perlite (1:2:1)) of 13.95 whereas S3 (Control) produces less number of roots of 13.91. Okanlawon *et al.*, (2016) cited that peat soil provides optimum condition for rooted cuttings because of its higher amount of organic matter, porosity and water holding capacity that results in higher root growth and development.

The cuttings that were dipped with IBA @5000 ppm (G2) obtained highest number of roots of 19.29 followed by G4 (NAA @3000 ppm) of 14.51 whereas lowest number of roots were observed in untreated cuttings. The higher number of roots at IBA @5000 ppm due to accumulation of internal substances that moves down for cell division and enhanced better expression of root primordial that resulted in well-developed rooting system. The similar findings were reported by Bhosale *et al.,* (2014) in Pomegranate and Yogesh *et al.,* (2023) in Guava Cv. Lucknow-49.

Interaction effect between plant growth regulators and rooting medium on number of roots was non-significant.

**3.2.2 Average length of roots**

The results of the study on effect of IBA and NAA and growing media on average length of roots of fig (*Ficus carica*. L) are presented in Table. 1.

The cuttings that were planted in S2 media (Top soil: Peat: Sawdust (1:2:1)) produced the longest root length of 19.77 cm followed by S1 (Top soil: Vermicompost: Perlite (1:2:1)) of 18.48 cm whereas shortest roots were produced in S3 (Control) media of 17.19 cm. According to Waseem et al. (2013), an appropriate propagation medium should have the capacity to retain both water and nutrients, since this influences the average lengthening of roots. Shamsuddin *et al.,* (2021) reported when the cuttings were planted in peat soil (propagation medium) results in longest length of roots.

Longest roots were obtained when cuttings were treated with IBA @5000 ppm (G2) of 23.79 cm followed by IBA @3000 ppm (G1) of 18.71 whereas shortest length of roots were produced in untreated cuttings (G5) of 14.64 cm. The hydrolysis of the polysaccharides in these cuttings into physiologically active sugars would have produced the improved root length that the IBA @5000 ppm started. It also provides energy to the root primordia through respiratory activity and facilitates the rapid elongation of meristematic cells to initiate longer roots (Sing *et al.,* 2014). Similar results were reported by Rao *et al.,* (2022) in pomegranate and Yogesh *et al.,* (2023) in guava.

There was no significant effect between plant growth regulators and rooting media on root length.

**3.2.3 Number of root forks**

The results of the study on effect of IBA and NAA and growing media on root surface area of fig (*Ficus carica*. L) are presented in Table. 1.

The cuttings that were planted in S2 media (Top soil: Peat: Sawdust (1:2:1)) produces more number of root forks of 6.59 followed by S1 (Top soil: Vermicompost: Perlite (1:2:1)) of 6.01 whereas less number of root forks was observed in S3 (Control) media of 5.59. According to Gopale and Zunjarrao (2011), a well-aerated medium promotes metabolic processes for root initiation and increases number of root forks. When cultivated on sawdust and top soil as opposed to river sand, young stem cuttings of *Buchholzia coriacea* have similarly shown comparable results (Akinyele, 2010).

More number of root forks were reported when cuttings were treated with 5000 ppm of IBA (G2) of 7.30 followed by NAA @5000 ppm (G4) of 6.22 whereas less number of root forks were observed when cuttings were untreated G5 of 4.96. In addition to increasing the number of roots and root forks per cutting, exogenous administration of both natural and synthetic auxins at greater concentrations to stem cuttings frequently encourages the expansion of preexisting root systems, which further facilitates sprouting and growth (Haissing, 1974). Similar results were reported by Saha *et al.,* (2020) in eucalyptus.

Interaction effect between rooting media and plant growth regulator on number of root forks was found to be non-significant.

**3.2.4 Root surface area and Root volume**

The results of the study on effect of IBA and NAA and growing media on root surface area and root volume of fig (*Ficus carica*. L) are presented in Table. 2.

The cuttings that were planted in S2 media (Top soil: Peat: Sawdust (1:2:1)) express higher root surface area (51.48 cm2) and root volume (7.49 cm3) followed by S1 (Top soil: Vermicompost: Perlite (1:2:1)) of 47.86 cm2 and 6.70 cm3 whereas lowest root surface area (43.81 cm2) and root volume (6.03 cm3) was recorded in S3 (Control) media. High porosity is necessary for root growth and surface area attained by propagation medium that increased uptake of nutrients and water (Samar and Saxena, 2016).

The cuttings that were dipped in IBA @5000 ppm (G2) exhibit higher root surface area (65.20 cm2) and root volume (10.22 cm3) followed by NAA @5000 ppm (G4) of 48.42 cm2 and IBA @ 3000 ppm (G1) of 7.13 cm3 whereas lowest root surface area (33.73 cm2) and root volume (3.06 cm3) was obtained in untreated cuttings (G5). The similar findings were found by Loconsole *et al.,* (2022) in glossy abelia cuttings.

Both root volume and root surface area were non-significant among rooting media and plant growth regulators.

**3.2.5 Fresh weight and dry weight of roots**

The results of the study on effect of IBA and NAA and growing media on fresh weight and dry weight of roots of fig (*Ficus carica*. L) are presented in Table. 2.

Higher fresh weight (7.31 g) and dry weight of roots (1.27 g) were observed when cuttings were placed in S2 media (Top soil: Peat: Sawdust (1:2:1)) followed by S1 media ((Top soil: Vermicompost: Perlite (1:2:1)) of fresh weight (6.93 g) and dry weight (0.87 g) whereas lowest fresh weight (6.03 g) and dry weight (0.75 g) was observed in S3 media (Control). Peat soil offers the best conditions for rooted cuttings due to its greater levels of organic matter, water-holding capacity, and porosity, all of which promote root growth and development, according to Okanlawon *et al.,* (2016). Similar reports were gave by Shamsuddin *et al.,* (2021) in fig (*Ficus carica* L.).

Cuttings that were treated with IBA @5000 ppm (G2) results in higher fresh weight (10.22 g) and dry weight (2 g) followed by IBA @3000 ppm (G1) of fresh weight (7.9 g) and dry weight (0.92 g) whereas lowest fresh weight (3.06 g) and dry weight (0.30 g) was observed in untreated cuttings (G5). The external administration of IBA stimulates the flow of natural auxin (IAA) from the leaves and shoot tips, which may be the reason for the maximum fresh and dry root weight. The present findings were similar to Caruso *et al.,* (2021) in fig cuttings, Kim *et al.,* (2021) in *Veronica* stem cuttings, Ali *et al.,* (2022) in Dragon Fruit, Rao *et al.,* (2022) in pomegranate.

Interaction of S2G2 (Top soil: Peat: Sawdust (1:2:1) + IBA @5000 ppm) whereas S3G5 (Control) interaction produces lower dry weight of 0.28 g.

**3.2.6 Survival per centage**

The results of the study on effect of IBA and NAA and growing media on survival per centage of fig (*Ficus carica*. L) are presented in Fig. 2.

Among the different rooting media, the S2 media (Top soil: peat: sawdust (1:2:1)) had the highest survival percentage (62.67 %) where the cuttings planted inS1 media (Top soil: vermicompost: perlite (1:2:1)) had the next survival percentage of 56 %. Whereas lowest survival percentage (41.33 %) recorded when the cuttings were planted in S3 media (Control). At this treatment, longer and more numerous roots enable better uptake of moisture and nutrients from the media, ultimately increasing the survival rate.

G2 (5000 ppm IBA) treatment significantly improved the survival percentage of rooted cuttings (82.22 %) next to G1 (3000 ppm IBA) had the value of 60 %. Whereas lowest survival percentage (28.89 %) was observed in G5 (Control). Singh *et al.,* (2003) reported that IBA increases rooting and root length in Piper longum, suggesting that auxin activity may have facilitated the hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings, thereby accelerating cell elongation and cell division in the proper environment. The current study agrees with the results that IBA @5000 ppm expressed highest survival percentage shown in fig by Reddy *et al.,* (2008 a) and by Thakur *et al.,* (2014) in Olive cuttings.

It was determined that there was no significant interaction between the concentration of NAA, IBA, and different rooting media and survival percentage.

**Table :1 Impact of plat growth regulators and rooting medium on leaf length (cm), no. of roots per cuttings, no. of root forks, average length of roots (cm)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Leaf length (cm)** | **No. of roots per cutting** | **No. of root forks** | **Average length of roots (cm)** |
| **S1** | 12.34 | 14.77 | 6.01 | 18.48 |
| **S2** | 14.64 | 15.79 | 6.59 | 19.77 |
| **S3** | 11.85 | 13.08 | 5.59 | 17.19 |
| **CD @ 5%** | 0.914 | 1.242 | 0.369 | 0.981 |
| **SE (D)** | 0.445 | 0.605 | 0.18 | 0.478 |
| **G1** | 13.03 | 14.31 | 5.79 | 18.71 |
| **G2** | 15.64 | 19.29 | 7.30 | 23.79 |
| **G3** | 11.94 | 13.98 | 6.04 | 17.13 |
| **G4** | 13.37 | 14.51 | 6.22 | 18.13 |
| **G5** | 10.72 | 10.66 | 4.96 | 14.64 |
| **CD @ 5%** | 1.18 | 1.603 | 0.46 | 1.266 |
| **SE (D)** | 0.575 | 0.781 | 0.232 | 0.617 |
| **S1G1** | 12.43 | 15.03 | 5.77 | 18.93 |
| **S1G2** | 15.70 | 18.77 | 7.23 | 23.57 |
| **S1G3** | 11.00 | 14.17 | 5.90 | 17.20 |
| **S1G4** | 12.17 | 14.93 | 6.27 | 18.47 |
| **S1G5** | 10.40 | 10.97 | 4.87 | 14.23 |
| **S2G1** | 14.03 | 15.27 | 6.33 | 20.07 |
| **S2G2** | 16.60 | 21.53 | 7.87 | 25.47 |
| **S2G3** | 14.17 | 15.50 | 6.67 | 18.43 |
| **S2G4** | 15.80 | 15.38 | 6.60 | 19.23 |
| **S2G5** | 12.60 | 11.33 | 5.50 | 15.67 |
| **S3G1** | 12.63 | 12.63 | 5.27 | 17.13 |
| **S3G2** | 14.63 | 17.57 | 6.80 | 22.33 |
| **S3G3** | 10.67 | 12.27 | 5.57 | 15.77 |
| **S3G4** | 12.13 | 13.27 | 5.80 | 16.70 |
| **S3G5** | 9.17 | 9.67 | 4.50 | 14.03 |
| **CD @ 5%** | NS | NS | NS | NS |
| **SE (D)** | NS | NS | NS | NS |

**Table 2. Impact of plat growth regulators and rooting medium on root surface area (cm2), root volume (cm3), fresh weight of roots (g), dry weight of roots (g)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Root surface area (cm2)** | **Root volume (cm3)** | **Fresh weight of roots (g)** | **Dry weight of roots (g)** |
| **S1** | 47.86 | 6.70 | 6.93 | 0.87 |
| **S2** | 51.48 | 7.49 | 7.31 | 1.27 |
| **S3** | 43.81 | 6.03 | 6.03 | 0.75 |
| **CD @ 5%** | 2.879 | 0.59 | 0.617 | 0.248 |
| **SE (D)** | 1.403 | 0.287 | 0.301 | 0.121 |
| **G1** | 46.25 | 7.13 | 7.19 | 0.92 |
| **G2** | 65.20 | 10.22 | 10.22 | 2.00 |
| **G3** | 44.97 | 6.67 | 6.67 | 0.89 |
| **G4** | 48.42 | 6.64 | 6.64 | 0.69 |
| **G5** | 33.73 | 3.06 | 3.06 | 0.30 |
| **CD @ 5%** | 3.716 | 0.761 | 0.796 | 0.321 |
| **SE (D)** | 1.81 | 0.371 | 0.388 | 0.156 |
| **S1G1** | 47.65 | 6.97 | 7.88 | 0.64 |
| **S1G2** | 65.12 | 9.94 | 9.94 | 2.02 |
| **S1G3** | 44.27 | 6.62 | 6.84 | 0.85 |
| **S1G4** | 48.98 | 6.83 | 6.83 | 0.55 |
| **S1G5** | 33.28 | 3.17 | 3.17 | 0.29 |
| **S2G1** | 49.32 | 8.07 | 7.36 | 1.30 |
| **S2G2** | 71.76 | 11.39 | 11.39 | 2.90 |
| **S2G3** | 46.66 | 7.11 | 6.89 | 0.97 |
| **S2G4** | 52.92 | 7.16 | 7.16 | 0.82 |
| **S2G5** | 36.72 | 3.73 | 3.73 | 0.34 |
| **S3G1** | 41.79 | 6.35 | 6.35 | 0.84 |
| **S3G2** | 58.72 | 9.32 | 9.32 | 1.09 |
| **S3G3** | 43.98 | 6.27 | 6.27 | 0.34 |
| **S3G4** | 43.37 | 5.94 | 5.94 | 0.69 |
| **S3G5** | 31.19 | 2.27 | 2.27 | 0.28 |
| **CD @ 5%** | NS | NS | NS | 0.555 |
| **SE (D)** | NS | NS | NS | 0.271 |

*S1G1 - Top soil: Vermicompost : Perlite (1:2:1) + IBA @ 3000 ppm, S1G2 - Top soil: Vermicompost : Perlite (1:2:1) + IBA @ 5000 ppm, S1G3 - Top soil: Vermicompost : Perlite (1:2:1) + NAA @ 3000 ppm, S1G4 - Top soil: Vermicompost : Perlite (1:2:1) + NAA @ 5000 ppm, S1G5 - Top soil: Vermicompost : Perlite (1:2:1) + Control, S2G1 - Top soil: Peat: Sawdust (1:2:1) + IBA @ 3000 ppm, S2G2 - Top soil: Peat: Sawdust (1:2:1) + IBA @ 5000 ppm, S2G3 - Top soil: Peat: Sawdust (1:2:1) + NAA @ 3000 ppm, S2G4 - Top soil: Peat: Sawdust (1:2:1) + NAA @ 5000 ppm, S2G5 - Top soil: Peat: Sawdust (1:2:1) + Control, S3G1 - Control+ IBA @ 3000 ppm, S3G2 - Control+ IBA @ 5000 ppm, S3G3 - Control+ NAA @ 3000 ppm, S3G4 - Control+ NAA @ 5000 ppm, S3G5 - Control*

**Fig. 1** Impact of plat growth regulators and rooting medium on days taken for sprouting

**Fig. 2** Impact of plat growth regulators and rooting medium on survival (%)

**4. CONCLUSION**

Based on this experimental finding it was indicated that S2 media (Top soil: peat: sawdust (1:2:1)) gave best results in terms of shoot and root parameters. Among different concentration of IBA and NAA, IBA @ 3000 ppm reported maximum values for shoot parameters and IBA @5000 ppm results best value for root parameters.

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