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EFFECT OF PLANT GROWTH REGULATORS ON GERMINATION AND SEEDLING GROWTH OF JACKFRUIT (*ARTOCARPUS HETEROPHYLLUS* LAM.)

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ABSTRACT

The present study entitled “Effect of plant growth regulators on germination and seedling growth of jackfruit (*Artocarpus heterophyllus* Lam.)” was carried out in the Forest Nursery and Research Centre, College of Forestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the years 2023 and 2024. A completely randomized design (CRD) was employed with 12 treatments and 3 replications each. The perforated polythene bags of 8 x 10 cm size were used for sowing. The bags were filled with a mixture of Soil, Vermicompost, and Sand in the ratio of 1:1:1. Before sowing the seeds in the polythene bags, the soil was treated with fungicide, i.e. copper oxychloride @ 2%. Two seeds were sown in each polythene bag. Regular watering with a water-cane was done gently in the morning and evening. The 100, 200, 400 and 600 mg of growth regulators viz., GA₃, IBA, NAA, were weighed on an electric balance and then transferred to a beaker with the help of soft brushes to prepare 1000 ml of stock solution of 100, 200, 400, 600 ppm in distilled water. The pre-sowing dip method was adopted for seed treatment. A sufficient amount of Growth regulators of different concentrations was poured in required quantity into the labelled beakers. The treatments included soaking the seed of jackfruit in GA₃, IBA and NAA (100, 200, 400 and 600ppm) for 24.00 hrs duration along with a control. The seeds were extracted, washed with clean water and dried in the shade for a day. The seeds of (*Artocarpus heterophyllus* Lam.) were sown in 2.5 cm depth in polybags prepared with different potting mixtures in July, 2023 and 2024. The various observations of different aspects were recorded for the seed germination and seedling growth parameters of Jackfruit. Jackfruit seed soaked in T₄ GA₃ @ 600 ppm for 24 hrs. recorded significantly, maximum germinations (%), seedling length (cm), root length (cm), collar diameter (mm), number of leaves per seedling, leaf area (cm²) at 120 DAS, fresh and dry weight of shoot (g), fresh and dry weight of root (g), root: shoot ratio, fresh and dry weight of plant (biomass yield) and seed vigour index (I & II).

Keywords : PGR, germination, seedling growth, jackfruit, *Artocarpus heterophyllus*.

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is a member of the Moraceae family. It holds the title of the largest edible fruit globally. This species is believed to be indigenous to the rainforests of the Western Ghats in India and Malaysia. The primary countries producing jackfruit include Bangladesh, India, Myanmar, Indonesia, Sri Lanka, and Malaysia. The viability of jackfruit seeds diminishes rapidly; even a delay of one or two weeks in sowing can result in poor germination rates. Jackfruit seeds are inherently

recalcitrant in nature (Chaudhari *et al.*, 2022). The germination process for jackfruit is prolonged, with a low percentage of germination, slow seedling growth, and an extended period required to reach a graftable size. Pre-sowing treatments are often reported to enhance synchronization and accelerate seedling emergence, thereby improving germination and seedling growth. Consequently, there is a necessity for seed treatments in jackfruit to enhance both seed germination and seedling development (Harshavardhan and Rajasekhar, 2012).

Acknowledging the significance of cultivating jackfruit seedlings for rapid seed germination and subsequent seedling growth, the current experiment has implemented a pre-soaking treatment of seeds with growth regulators (Chaudhari *et al.*, 2022). Nowadays, plant growth regulators are extensively utilized to boost seed germination rates, promoting vigorous and healthy seedling growth. Gibberellic acid, a naturally occurring plant growth regulator, can induce various effects, including the stimulation of seed germination by alleviating dormancy and facilitating the mobilization of endosperm reserves. NAA (1-Naphthalene Acetic Acid), a synthetic plant hormone belonging to the auxin family, is a component in many commercial rooting products for horticultural crops, which may also stimulate seed germination by overcoming dormancy. IBA is widely employed as it promotes root formation by disrupting the root apical dominance caused by cytokinin (Cline, 2000). Plant growth hormones have also been reported to affect seed germination and dormancy by affecting different parts of the seed Kucera *et al.*, (2005).

Materials and Method

The present study entitled “Effect of plant growth regulators on germination and seedling growth of jackfruit (*Artocarpus heterophyllus* Lam.)” was carried out in the Forest Nursery and Research Centre, College of Forestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during 2023 and 2024.

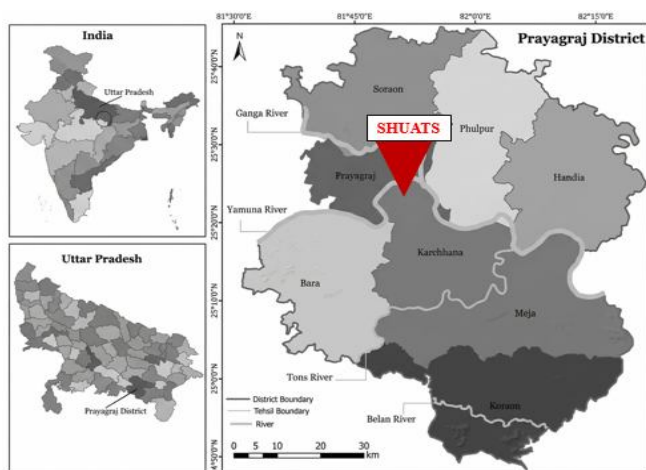


Fig. 1: Study Area at College of Forestry, SHUATS, Prayagraj, Uttar Pradesh

Geographical and agroclimatic conditions of the study site

The experimental site is situated between 25° 42' North latitude and 81° 55' East longitude with an altitude of 98 meters above mean sea level. It lies in the fifth agroclimatic region of India (upper Gangetic

plains), adjacent to the rivers Ganga and Yamuna. The climate of the area is generally tropical, characterized by a hot summer with a maximum temperature of 48°C during May-June and a cold winter with a minimum temperature of 1°C. The average annual rainfall lies between 850 mm and 1000 mm, most of which is concentrated during the monsoon season.

Preparation of growth regulator solution

The 100, 200, 400 and 600 mg of growth regulators viz., GA₃, IBA, and NAA, were weighed on an electronic balance and then transferred to a beaker with the help of soft brushes to prepare 1000 ml of stock solution of 100, 200, 400, and 600 ppm in distilled water. Thirteen different combination viz., T₀: Control (Distilled water), T₁: GA₃ @ 100 ppm, T₂: GA₃ @ 200 ppm, T₃: GA₃ @ 400 ppm, T₄: GA₃ @ 600 ppm, T₅: IBA @ 100 ppm, T₆: IBA @ 200 ppm, T₇: IBA @ 400 ppm, T₈: IBA @ 600 ppm, T₉: NAA @ 100 ppm, T₁₀: NAA @ 200 ppm, T₁₁: NAA @ 400 ppm and T₁₂: NAA @ 600 ppm of growth regulators were tried in complete randomized design with three replications.

Pre-sowing seed treatment

The pre-sowing dip method was adopted for seed treatment. A sufficient amount of Growth regulators of different concentrations was poured in required quantity into the labelled beakers. The treatments included soaking the seed of jackfruit in GA₃, IBA and NAA (100, 200, 400 and 600ppm) for 24.00 hrs duration along with a control.

Preparation of potting media

Before sowing the jackfruit seed in polythene bags, the following preparations were made. The perforated polythene bags, 8 x 10 cm in size, were used for sowing. The bags were filled with a mixture of Soil, Vermicompost, and Sand in the ratio of 1:1:1. Before sowing the seeds in the polythene bags, the soil was treated with fungicide, i.e., copper oxychloride @ 2%. Two seeds were sown in each polythene bag. Regular watering with a water-cane was done gently in the morning and evening.

Seed sowing

The seeds of (*Artocarpus heterophyllus* Lam.) were sown in 2.5 cm depth in polybags prepared with different potting mixtures in July 2023 and 2024.

Observation recorded

For recording data of various observations, fifty plants were selected from each treatment per replication and the mean value was considered for the parameters studied. Germination percentage was

recorded at 30 days after sowing. It was calculated based on below mentioned formula:

$$\text{Germinations Percentage (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}}$$

Shoot length (cm), root length (cm), collar diameter (mm), number of leaves seedling, leaf area (cm²), fresh weight of shoot (g), dry weight of shoot (g), fresh weight of root (g), dry weight of root (g), root shoot: ratio, fresh weight of plant (g) and dry weight of plant (g) were recorded at 120 DAS.

The root: shoot ratio for each treatment was calculated by using the following formula,

$$\text{Root: Shoot Ratio} = \frac{\text{Root dry weight (g)}}{\text{Shoot dry weight (g)}}$$

Vigour Index– I & II were calculated as per the formula suggested by ISTA (Anon., 1985)

Vigour index– I = Germination (%) x Length of seedling (cm)

Vigour index– II = Germination (%) x Seedling dry weight (g)/100

Statistical analysis

The experiment was laid out in a Completely Randomized Design with a factorial concept. The recorded data for all the observations were analyzed statistically by using techniques described by Panse and Sukhatme (1985). The treatment means were compared with C.D. at 5 percent level.

Results and Discussion

The effect of pre-sowing seed treatment with different growth regulators on germinations (%), seedling length (cm), root length (cm), collar diameter (mm), number of leaves per seedling and leaf area (cm²) at 120 DAS of jackfruit seedling under greenhouse conditions in Prayagraj agro-climatic region during the years 2023 and 2024, as well as the pooled data is presented in Table 1. Among the treatments, GA₃ significantly enhanced seed germination compared to IBA, NAA, and the control. The highest seed germination (97.40, 98.44 and 97.92) was observed with treatment T₄ GA₃ @ 600ppm, which was at par with treatment T₃ GA₃ @ 400 ppm. Whereas the minimum seed germination percentage (34.38, 33.33 and 33.85%) was found in treatment T₀ Control (Distilled water) during the first and second years of the experiment with pooled data, respectively. It is possible that GA₃ treatment improved seed germination by facilitating the movement of endogenous auxin and gibberellin-like compounds. The studies by Singh *et al.* (2002) and Prajapati *et al.* (2014) on jackfruit, Panda *et al.* (2018) and Hakimi *et*

al. (2020) on Kagzi lime, and Babu *et al.* (2010) on papaya all support these conclusions.

The data pertaining to seedling height (cm) of jackfruit at 120 days was significantly affected by different plant growth regulators, viz., GA₃, IBA and NAA at (100, 200, 400 and 600) seed sowing for 24hrs. At 120 DAS, the maximum seedling height (50.00, 51.24, and 50.62cm) was noted under treatment T₄ GA₃ @ 600 ppm. The minimum seedling height (21.21, 22.07, and 22.43 cm) was recorded under treatment T₀ (Distilled water soaking) during the years 2023 and 2024, as well as the pooled data. The seedling height may have increased due to improved cell division and elongation facilitated by GA₃ treatment of the seeds. Nimbalkar *et al.* (2012) in their study on Karonda, along with Prajapati *et al.* (2014), Mithlesh *et al.* (2025), and Hakimi *et al.* (2020) in their research on Jackfruit, reported comparable findings.

The data pertaining to root length (cm) of jackfruit at 120 days was significantly affected by GA₃ @ 600-ppm seed sowing for 24hrs. at 120 DAS, significantly maximum root length (cm) (22.21, 22.97 and 22.59) were noted under treatment T₄ GA₃ @ 600 ppm. The minimum root length (cm) (12.72, 12.73, and 12.73) was recorded under treatment T₀ (Distilled water soaking) during the years 2023 and 2024 as well as the pooled data. The enhanced root development could be attributed to a rise in photosynthetic production and its subsequent movement to the root zone via phloem. These results align with the research conducted by Panda *et al.* (2018) on Kagzi lime, as well as the studies by Prajapati *et al.* (2014), Mithlesh *et al.* (2025), and Hakimi *et al.* (2020) regarding jackfruit.

The data pertaining to collar diameter (mm) of jackfruit at 120 days was significantly affected by GA₃ @ 600ppm seed sowing for 24 hours. At 120 DAS, significantly maximum collar diameter (mm) (11.81, 11.84 and 11.83) were noted under treatment T₄ GA₃ @ 600 ppm. The minimum collar diameter (mm) (5.45, 5.16 and 5.31) was recorded under treatment T₀ (Distilled water soaking) during the years 2023 and 2024 as well as the pooled data. The early germination process may have contributed to an increase in the vegetative growth of the seedling, subsequently resulting in a greater girth of the seedling. It is plausible that the application of GA₃ as a seed treatment facilitated the seedling's growth by promoting cell enlargement and multiplication. These findings align with the research conducted by Prajapati *et al.* (2014) on Jackfruit, Nimbalkar *et al.* (2012) on Karonda, Kumar *et al.* (2008), Mithlesh *et al.* (2025), and Hakimi *et al.* (2020) on mango.

The data pertaining to number of leaves per seedling of jackfruit at 120 days was significantly affected by GA₃ @ 600 ppm seed sowing for 24hrs. at 120 DAS, significantly maximum number of leaves per plant (17.41, 17.665 and 17.53) were noted under treatment T₄ GA₃ @ 600 ppm. The minimum number of leaves per plant (9.91, 10.06 and 9.98) was recorded under treatment T₀ (Distilled water soaking) during the years 2023 and 2024 as well as the pooled data. It is conceivable that GA₃ promoted growth by enhancing cell expansion and proliferation, resulting in robust plant development and ultimately a greater number of leaves per seedling. Nimbalkar *et al.* (2012), Mithlesh *et al.* (2025) in Karonda, Hakimi *et al.* (2020), and Prajapati *et al.* (2014) in jackfruit all documented comparable results.

The data pertaining to leaf area (cm²) of jackfruit at 120 days was significantly affected by GA₃ @ 600 ppm seed sowing for 24hrs. at 120 DAS, significantly maximum leaf area (cm²) (63.56, 63.78 and 63.67) were noted under treatment T₄ GA₃ @ 600 ppm. The minimum leaf area (cm²) (41.54, 41.87 and 41.71) was recorded under treatment T₀ (Distilled water soaking) during the years 2023 and 2024 as well as the pooled data. The dimensions of the leaves, specifically their length and width, may have increased due to the rapid cell division and elongation induced by GA₃ treatment of the seeds. Prajapati *et al.* (2014), Hakimi *et al.* (2020), and Mithlesh *et al.* (2025) observed comparable results in Jackfruit, respectively.

The effect of pre-sowing seed treatment with different growth regulators on fresh and dry weight of shoot (g), fresh and dry weight of root (g) and root shoot: ratio of jackfruit seedling under greenhouse conditions in Prayagraj agro-climatic region during the years 2023 and 2024, as well as the pooled data is presented in table 2. Seed treatment with GA₃ significantly increased fresh and dry of shoot weight, with T₄ (GA₃ @ 600 ppm) maximum 13.51 & 5.55 g in 2023 and 13.41 & 5.52 g in 2024 (pooled 13.46 and 5.54 g). The control (T₀, distilled water) recorded the lowest fresh dry weight of shoot of 8.36 & 2.86 g in 2023 and 8.24 & 2.53 g in 2024, with a pooled mean of 8.30 & 2.70 g. Essentially; the increased weight of seedlings was linked to improved germination, earlier seedling emergence, and enhanced seedling growth. GA₃, functioning as a plant growth regulator, plays a role in promoting cell division, cell elongation, auxin metabolism, cell wall plasticity, and the permeability of the cell membrane, which may have contributed to the improved growth and accumulation of dry matter in various parts of the seedling. These findings are corroborated by the research conducted by Jaiswal *et*

al. (2018) on Kagzi lime, Hakimi *et al.* (2020), Shukla *et al.* (2012) on Kagzi lime, and Chiranjeevi *et al.* (2017) on Aonla.

The data pertaining to fresh and dry weight of root (g) of jackfruit was significantly affected by GA₃ @ 600 ppm seed sowing for 24 hours. Seed treatment with GA₃ significantly increased fresh and dry weight of root (g), with T₄ (GA₃ @ 600 ppm) maximum 3.53 & 1.75 g in 2023 and 3.68 & 1.85 g in 2024 (pooled 3.60 & 1.80 g). The control (T₀, distilled water) recorded the lowest fresh and dry weight of root (g) of 1.95 & 0.55 g in 2023 and 2.07 & 0.49 g in 2024, with a pooled mean of 2.01 & 0.52 g. The beneficial impact of GA₃ on the fresh weight of roots may be attributed to the enhanced translocation and assimilation of auxins. The assimilation and redistribution of materials within plants lead to improved growth and vegetative characteristics, thereby augmenting growth attributes. Furthermore, GA₃ may have elevated the auxin concentration in the roots, which promotes the length of the tap root and the quantity of secondary and fibrous roots by stimulating increased root initiation, enhanced nutrient absorption, and root cell elongation, ultimately resulting in greater fresh and dry weight. Additionally, the observed increase in growth can be linked to a rise in dry matter accumulation. These findings align with the research conducted by Patil *et al.* (2012) on Rangpur lime, Khatana *et al.* (2015) on acid lime cv. Kagzi lime, as well as Hakimi *et al.* (2020) and Abbas *et al.* (2015) on white succary mango.

The data pertaining to root shoot ratio of jackfruit was significantly affected by GA₃ @ 600 ppm seed sowing for 24hrs. The control treatment (T₀, distilled water) exhibited the lowest root-to-shoot ratio of 0.20 in 2023 and 0.19 in 2024, resulting in a pooled mean of 0.19. Treatments involving GA₃ demonstrated the most significant enhancement, with T₄ (GA₃ @ 600 ppm) recording 0.31 in 2023 and 0.32 in 2024 (pooled 0.32), while T₃ (GA₃ @ 400 ppm) achieved slightly higher values of 0.32 in 2023 and 0.33 in 2024 (pooled 0.33). IBA @ 600 ppm (T₈) also improved the root-to-shoot ratio in comparison to the control, yielding 0.29 in 2023 and 0.31 in 2024 (pooled 0.30). NAA @ 100 ppm (T₉) demonstrated moderate enhancement with values of 0.25 in 2023 and 0.26 in 2024 (pooled 0.25). This may be attributed to seeds treated with GA₃, which recorded a higher dry weight of both root and shoot, ultimately leading to an increased root: shoot ratio. These findings align with the results reported by Harshavardhan and Rajasekhar (2012) as well as Hakimi *et al.* (2020). The data pertaining to Fresh and dry weight of plant (g) of jackfruit was significantly

affected by GA₃ @ 600 ppm seed sowing for 24hrs. Seed treatment with GA₃ significantly increased fresh and dry weight of plant (g) (biomass yield), with T₄ (GA₃ @ 600 ppm) maximum 59.94 & 18.07 g in 2023 and 61.20 & 17.84 g in 2024 (pooled 60.57 & 17.95g). The control (T₀, distilled water) recorded the lowest fresh and dry weight of plant (g) (biomass yield) of 31.34 & 4.86 g in 2023 and 30.27 & 5.54 g in 2024, with a pooled mean of 30.81 & 5.20g. The data pertaining to seed vigour index I & II of jackfruit was significantly affected by GA₃ @ 600 ppm seed sowing for 24 hours. Seed treatment with GA₃ significantly increased seed vigour index (I & II), with T₄ (GA₃ @ 600 ppm) maximum 4702.20 & 16.86 in 2023 and 4858.86 & 16.95 in 2024 (pooled 4780.53 & 16.90). The control (T₀, distilled water) recorded the lowest seed vigour index I and II of 751.81 & 1.61 in 2023 and 710.71 & 1.78 g in 2024, with a pooled mean of 731.26 & 1.70. The underlying cause may stem from the heightened accumulation of dry matter in the targeted treatments. Furthermore, the primary factor contributing to the rise in vigour index I and II could be attributed to the direct impact on improved seedling growth, which has consequently facilitated the mobilization of stored nutrients towards the root and shoot tips of the plant. These findings are consistent with the studies conducted by Rajamanickam *et al.* (2004) and Hakimi *et al.* (2020).

Conclusion

In conclusion, from the present investigation, it is concluded that GA₃ 600 ppm (T₄) enhanced the germination percentage, seedling length, root length, collar diameter, number of leaves per seedling, leaf area, fresh weight of shoot, dry weight of shoot, fresh weight of root, dry weight of root and increased the seedling vigour index of jackfruit seedling. Hence, farmers and nurserymen for the commercial production of quality seedling material of Jackfruit can adopt the growth regulator GA₃ at 600 ppm.

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