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Effects of different plant growth regulators on seed germination and seedling growth of papaya (*Carica papaya* L) Cv. Pusa Nanha

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Abstract

The present investigation entitled “Effects of Different Plant Growth Regulators on Seed Germination and Seedling Growth of Papaya (*Carica papaya* L) Cv. Pusa Nanha” was conducted at University Research Farm, GHRU, Saikheda in *Kharif* Season of 2025, are presented and described in this chapter. Data pertaining to various criteria used for treatment evaluation were analyzed statistically to test their significance and analysis of variance for these data has been given in appendices at the end. The research trail was carried on papaya crop cv. Pusa Nanha. The application of PGR and vermicompost in different form and combinations, T₁-Control, T₂- Soil + Vermicompost (2:1), T₃-Soil + Vermicompost (2:1) +Seed soaking with GA₃@ 150 ppm, T₄-Soil + Vermicompost (2:1) +seed soaking with NAA @ 50ppm, T₅- Soil + cocopeat (2:1), T₆-Soil+ Cocopeat (2:1) + seed soaking with GA₃@ 150ppm, T₇-Soil+ Cocopeat (2:1) + seed soaking with NAA@50ppm, T₈-Soil + Vermiculite (2:1), T₉- Soil + Vermiculite (2:1) + seed soaking with GA₃@ 150ppm and T₁₀- Soil + Vermiculite (2:1) + seed soaking with NAA @ 50 ppm was used for the experiment for observed the growth and economics i.e. fresh weight of shoot (g), dry weight of shoot (g), fresh weight of root (g), dry weight of roots, Seeding vigor, gross return, net return and benefit: cost ratio. The result revealed that maximum fresh weight of shoot (8.78 g), dry weight of shoot (3.53g), fresh weight of root (1.20 g), dry weight of roots (0.312 g), Germination Percentages (79.19%), Seeding vigor index (1855.50), (₹23,760 per 1000 seedlings), net return (₹18,110), and benefit-cost ratio (4.21) was observed under treatment T₉ and minimum fresh weight of shoot (2.32 g), dry weight of shoot (0.91g), fresh weight of root (0.931g), dry weight of roots (0.082 g), Germination Percentages (31.97%), Seeding vigor index (493.08), (₹9,570 per 1000 seedlings), net return (₹4,570), and benefit-cost ratio (1.91) was observed under control.

Keywords: Papaya, economics, NAA and GA₃

Introduction

Papaya (*Carica papaya* L.), a member of the family Caricaceae, is one of the most important tropical fruit crops cultivated throughout the world for its high nutritional, medicinal, and economic value. It is an excellent source of vitamins A and C, minerals, dietary fiber, and the enzyme papain, making it an important fruit for both fresh consumption and processing. Despite its commercial significance, papaya cultivation is constrained by poor and erratic seed germination. Fresh papaya seeds often exhibit physiological dormancy due to the presence of a mucilaginous sarcotesta and endogenous germination inhibitors, resulting in slow and non-uniform germination (Sharma *et al.*, 2021) ^[9]. Environmental factors such as temperature, moisture availability, oxygen, light, and the type of germination medium also influence seed germination and seedling establishment. Since papaya seeds are relatively expensive, improving germination percentage and producing vigorous seedlings remain major challenges for commercial nurseries (Nguyen *et al.*, 2022) ^[6].

Plant growth regulators play a crucial role in overcoming seed dormancy and promoting seedling growth. Naphthalene Acetic Acid (NAA), a synthetic auxin, stimulates cell division and elongation, promotes root initiation, and enhances lateral root development, thereby improving nutrient and water uptake. It is also known to reduce premature fruit drop and improve fruit growth in several horticultural crops. Gibberellic Acid (GA₃) is another important plant growth regulator that effectively breaks seed dormancy by stimulating the synthesis of hydrolytic enzymes

responsible for mobilizing stored food reserves during germination. In addition, GA₃ promotes stem elongation, seedling vigor, and flowering in many crop species (Voruganti *et al.*, 2022) [11].

The choice of growing medium is equally important for successful seed germination and seedling production. Media such as vermiculite and cocopeat provide excellent physical conditions due to their high porosity, moisture retention capacity, and aeration, ensuring rapid and uniform germination. Vermicompost, although comparatively denser, is rich in plant nutrients, beneficial microorganisms, enzymes, and humic substances that enhance subsequent seedling growth and biomass accumulation. Therefore, the combined use of suitable plant growth regulators and growing media may substantially improve papaya seed germination, seedling vigor, and nursery performance. Keeping these facts in view, the present investigation was undertaken to evaluate the influence of plant growth regulators and different growing media on germination and seedling growth of papaya.

Materials and Methods

The present investigation entitled “Effects of Different Plant Growth Regulators on Seed Germination and Seedling Growth of Papaya (*Carica papaya* L) Cv. Pusa Nanha” was conducted at University Research Farm, GHRU, Saikheda in Kharif Season of 2025, are presented and described in this chapter. Data pertaining to various criteria used for treatment evaluation were analyzed statistically to test their significance and analysis of variance for these data has been given in appendices at the end. The research trail was carried on papaya crop cv. Pusa Nanha. The application of PGR and vermicompost in different form and combinations, T₁-Control, T₂- Soil + Vermicompost (2:1), T₃-Soil + Vermicompost (2:1) +Seed soaking with GA₃@ 150 ppm, T₄-Soil + Vermicompost (2:1) +seed soaking with NAA @ 50ppm, T₅- Soil + cocopeat (2:1), T₆-Soil+ Cocopeat (2:1) + seed soaking with GA₃@ 150ppm, T₇-Soil+ Cocopeat (2:1) + seed soaking with NAA@50ppm, T₈-Soil + Vermiculite (2:1), T₉- Soil + Vermiculite (2:1) + seed soaking with GA₃@ 150ppm and T₁₀-Soil + Vermiculite (2:1) + seed soaking with NAA @ 50 ppm was used for the experiment for observed the growth and economics *i.e.* fresh weight of shoot (g), dry weight of shoot (g), fresh weight of root (g), dry weight of roots, Seeding vigor, gross return, net return and benefit: cost ratio.

Results and Discussion

Fresh weight of shoot (g)

Among the various treatments, the maximum fresh weight of shoot (8.78 g) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to all other treatments. This was followed by T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] and T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm], which recorded fresh shoot weights of 8.23 g and 7.81 g, respectively. The minimum fresh weight of shoot (2.32 g) was observed in the untreated control (T₁).

The increase in fresh shoot weight under GA₃ treatments is attributed to its well-established role in promoting cell division, cell elongation, and enhanced metabolic activity, which leads to vigorous shoot growth and increased tissue hydration (Rai *et al.*, 2011) [7]. GA₃ also facilitates better translocation of assimilates and water uptake, resulting in greater shoot turgidity and biomass accumulation. Similarly, NAA (T₇), being an auxin analog, improves shoot weight by stimulating apical meristem activity, vascular differentiation, and chlorophyll content, which increases photosynthetic efficiency and results in higher shoot biomass

(Singh *et al.*, 2014) [10]. Auxins are also known to enhance nutrient uptake and water retention, which further contributes to the increase in fresh weight. The lowest shoot fresh weight in the control (T₁) reflects the lack of hormonal stimulation, leading to poor cell expansion and reduced shoot growth, underscoring the importance of exogenous PGR application during seedling development.

Dry weight of shoot (g)

Among the various treatments, the maximum dry weight of shoot (3.53 g) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to the other treatments. This was followed by T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] and T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm], which recorded dry shoot weights of 3.14 g and 3.07 g, respectively. The minimum dry weight of shoot (0.91 g) was observed under the control treatment (T₁).

The increase in dry shoot weight with GA₃ treatments is attributed to its role in promoting cell division, elongation, and enhanced biosynthesis of structural carbohydrates like cellulose and hemicellulose, which contribute to dry matter accumulation (Randhawa & Singh, 1992) [8]. Moreover, GA₃ improves photosynthetic activity and nutrient assimilation, leading to more robust shoot growth and greater biomass accumulation. Similarly, NAA (T₇) improves vascular differentiation and translocation efficiency, thereby enhancing nutrient use and dry matter partitioning to the shoots. Auxins also support chloroplast development and enzyme activity, indirectly boosting biomass production (Katoch *et al.*, 2003) [4]. In contrast, the lowest shoot dry weight in the control (T₁) reflects slower metabolic activity, reduced structural growth, and poor carbohydrate synthesis in the absence of growth-promoting substances.

Fresh weight of roots (g)

Among the various treatments, the maximum fresh weight of roots (1.20 g) was recorded under treatment T₅ (GA₃ @ 100 ppm), indicating its superiority in promoting root growth and biomass accumulation. This treatment was followed by T₄ (GA₃ @ 50 ppm) and T₇ (NAA @ 100 ppm), which recorded fresh root weights of 1.15 g and 1.14 g, respectively. In contrast, the minimum fresh weight of roots (0.98 g) was observed under the control treatment (T₁), which remained significantly inferior to all growth regulator treatments. The lower root biomass in the untreated seedlings may be due to the absence of growth-promoting substances that enhance root initiation and development.

The increase in root fresh weight with GA₃ treatments is attributed to its ability to stimulate root elongation and cell expansion, along with enhancing the mobilization of food reserves, which supports root tissue hydration and biomass accumulation. Gibberellic Acid improves root vigor and nutrient absorption efficiency, leading to better water uptake and higher fresh root mass (Kumar *et al.*, 2012) [5]. NAA, being a root-inducing auxin, promotes adventitious root formation and elongation, especially in early seedling stages. It enhances auxin-induced gene expression responsible for cell division in root meristems, leading to increased root biomass and overall vigor (Bisht *et al.*, 2010) [1]. The lowest root fresh weight in the untreated control (T₁) highlights the limiting effect of absent hormonal support, resulting in reduced root development and water-holding capacity, which directly affects seedling health and transplant success.

Dry weight of roots (g)

Among the various treatments, the maximum dry weight of roots (0.312 g) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to all other treatments. This was followed by T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] and T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm], which recorded root dry weights of 0.274 g and 0.236 g, respectively. The minimum dry weight of roots (0.082 g) was observed under the untreated control (T₁).

The observed increase in root dry weight with GA₃ application is due to its influence on cell division, elongation, and vascular tissue differentiation, leading to the development of structurally stronger and denser root systems. GA₃ also promotes enhanced translocation of photosynthates and nutrients to root tissues, thus supporting higher dry matter deposition. NAA (T₇), being an auxin analog, further contributes by stimulating root primordia formation and lateral root development, which enhances root surface area and biomass. Auxins improve carbohydrate metabolism and the formation of secondary xylem, contributing to dry weight gain in root tissues (Katoch *et al.*, 2003) [4]. The lowest dry weight in the control (T₁) shows that without hormonal intervention, limited root growth and low structural tissue accumulation occurs, affecting the seedling's ability to anchor and absorb nutrients effectively.

Germination Percentages

Among the various treatments, the highest germination percentage (79.19%) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to all other treatments. This was followed by T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] and T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm], which recorded germination percentages of 74.53% and 66.86%, respectively. The lowest germination percentage (38.19%) was observed under the untreated control (T₁).

Seedling vigor

The maximum seedling vigour index (1855.50) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to all other treatments. This was followed by T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] and T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm], which recorded vigour indices of 1544.74 and 1419.68, respectively. The minimum seedling vigour index (493.08) was observed under the control treatment (T₁).

The seedling vigor index (SVI) is a function of both germination percentage and seedling growth (length of shoot + root). The significantly higher SVI under GA₃ treatments can be attributed to its role in breaking dormancy, enhancing enzymatic activity (such as α -amylase for starch hydrolysis), and promoting rapid mobilization of stored food reserves-all of which result in faster and more robust seedling development (Deshmukh *et al.*, 2020) [2]. The role of NAA (T₇) in increasing seedling vigor is due to its auxin activity, which promotes cell elongation and division, particularly in root and shoot tips, enhancing total seedling length and thereby improving vigor index (Gupta *et al.*, 2016) [3]. Both hormones stimulate metabolic processes and improve seedling physiological performance, making the seedlings more viable for transplanting and establishment. The lowest SVI in T₁ (control) reflects the lack of such physiological enhancements, resulting in slower growth and reduced seedling quality.

Economics

The economics of papaya seedling production was significantly affected by the different growing media and plant growth regulator treatments. Among all the treatments, T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm] recorded the highest gross return (₹23,760 per 1000 seedlings), net return (₹18,110), and benefit-cost ratio (4.21). The superior economic performance of this treatment may be attributed to its higher germination percentage, enhanced seedling vigour, and greater production of healthy and marketable seedlings. The favourable moisture retention and aeration properties of vermiculite, coupled with the stimulatory effect of GA₃ on seed germination and seedling growth, contributed to better nursery performance.

Treatment T₆ [Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm] recorded the second-highest gross return (₹22,350), net return (₹16,800), and benefit-cost ratio (4.03). Similarly, T₃ [Soil + Vermicompost (2:1) + seed soaking with GA₃ @ 150 ppm] produced a gross return of ₹20,070, net return of ₹14,670, and a benefit-cost ratio of 3.72. The improved profitability under these treatments may be due to enhanced germination, seedling establishment, and production of a higher number of saleable seedlings.

In contrast, the lowest gross return (₹11,460), net return (₹6,460), and benefit-cost ratio (2.29) were recorded under the control treatment (T₁), mainly due to poor germination and reduced seedling growth. Overall, the results indicate that the use of suitable growing media in combination with GA₃ @ 150 ppm seed soaking can substantially improve the profitability of papaya seedling production. Therefore, T₉ may be recommended for commercial nursery production of papaya cv. Pusa Nanha. (Ramteke *et al.*, 2017) [12].

Table 1: Effects of plant growth regulators on growth and economics of Papaya seedlings cv. Pusa Nanha

Treat.	Fresh weight of shoot (g)	Dry Weight of shoots	Fresh weight of root (g)	Dry weight of roots	Germination Percentages	Seedling Vigour%	Total Cost (₹)	Germination (%)	Gross Return (₹)	Net Return (₹)	B:C Ratio
T ₁	2.32	0.91	0.931	0.082	34.30	493.08	5000	31.97	9,570	4,570	1.91
T ₂	4.51	1.77	1.024	0.120	44.86	713.98	5300	44.86	13,470	8,170	2.54
T ₃	7.81	3.07	1.129	0.236	66.86	1419.68	5400	66.86	20,070	14,670	3.72
T ₄	6.34	2.49	1.062	0.178	59.19	1117.10	5340	59.19	17,760	12,420	3.33
T ₅	3.78	1.48	0.995	0.092	41.53	605.34	5450	41.53	12,450	7,000	2.28
T ₆	8.23	3.14	1.126	0.274	74.53	1544.74	5550	74.53	22,350	16,800	4.03
T ₇	7.11	2.78	1.101	0.197	63.86	1224.85	5490	63.86	19,170	13,680	3.49
T ₈	5.11	2.00	1.033	0.168	49.52	924.51	5550	49.53	14,850	9,300	2.68
T ₉	8.78	3.53	1.144	0.312	79.19	1855.50	5650	79.19	23,760	18,110	4.21
T ₁₀	5.71	2.24	1.043	0.178	55.86	1004.10	5590	55.86	16,770	11,180	3.00
S.Em±	0.115	0.053	0.010	0.002	1.006	25.01					
CD at 5%	0.342	0.157	0.030	0.005	2.988	74.30					

Common Cost (₹) 5000

Conclusion

The present investigation concluded that the application of different growing media and plant growth regulators significantly influenced seed germination, seedling growth, vigour and economics of papaya cv. Pusa Nanha. Among the treatments, T₉ (Soil + Vermiculite 2:1 + seed soaking with GA₃ @ 150 ppm) recorded the best overall performance, with maximum shoot and root fresh and dry weights, germination percentage (79.19%), seedling vigour index (1855.50), gross return (₹23,760 per 1000 seedlings), net return (₹18,110) and benefit-cost ratio (4.21). The control treatment (T₁) recorded the lowest performance. Thus, T₉ can be recommended as the most effective treatment for producing healthy, vigorous and economically profitable papaya seedlings of cv. Pusa Nanha under the conditions of the present study.

References

1. Bisht P, Rawat GS, Dobhal R. Influence of plant growth regulators on root traits of ber seedlings. *Indian Journal of Horticulture*. 2010;67(4):553-555.
2. Deshmukh RG, Pagar SV, Patil HP. Influence of GA₃ on seed germination and seedling vigor in papaya (*Carica papaya* L.). *International Journal of Chemical Studies*. 2020;8(2):2385-2389.
3. Gupta MC, Sharma P, Beniwal BS. Effect of seed priming with growth regulators on seedling vigor in ber (*Ziziphus mauritiana*). *Indian Journal of Horticulture*. 2016;73(3):392-396.
4. Katoch D, Rathi DS, Singh G. Effect of plant growth regulators on dry matter partitioning and growth of papaya seedlings. *Himachal Journal of Agricultural Research*. 2003;29(1-2):28-32.
5. Kumar R, Singh VB, Dwivedi S. Effect of plant growth regulators on root development in custard apple. *Journal of Horticultural Sciences*. 2012;7(1):34-38.
6. Nguyen VH, Nguyen MT, Nguyen TT, Tran DH. Rooting media and growth regulators affect propagation from stem cuttings of *Carica papaya* L. cv. Tainung No. 2 and Red Lady. *International Journal of Research in Agricultural Sciences*. 2022;9:24-35.
7. Rai RK, Sinha SK, Kumari S. Effect of plant growth regulators on seed germination and seedling growth of papaya (*Carica papaya* L.). *Asian Journal of Horticulture*. 2011;6(2):332-335.
8. Randhawa GS, Singh T. *Plant growth and development*. Kalyani Publishers; 1992.
9. Sharma P, Yadav RK, Jain MC, Bhateshwar MC. Growing media and cow urine influence the seed germination and seedling growth of papaya (*Carica papaya* L.). *Journal of Crop and Weed*. 2021;17(3):253-259. doi:10.22271/09746315.2021.v17.i3.1520.
10. Singh G, Singh OP, Kumar P. Influence of plant growth regulators on germination and seedling development in papaya. *The Bioscan*. 2014;9(2):647-650.
11. Voruganti SR, Singh J, Jayarajan S. Effect of growth regulator and growing media on seed germination of papaya: A review. *The Pharma Innovation Journal*. 2022;11(4):1121-1124.
12. Ramteke V, Paithankar DH, Kurrey VK, Pandey AK. Effect of seed treatments on germination, growth and survival of papaya (*Carica papaya* L.) seedlings. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(11):2896-2901.