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Effect of different growing media and plant growth regulators on seedling growth and root growth of papaya (*Carica papaya* L.) Cv. Pusa Nanha

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Abstract

The present investigation entitled “Effect of Different Growing Media and Plant Growth Regulators on Seedling Growth and root 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 @ 50 ppm, T₅-Soil + cocopeat (2:1), T₆-Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm, T₇-Soil + Cocopeat (2:1) + seed soaking with NAA @ 50 ppm, T₈-Soil + Vermiculite (2:1), T₉-Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm and T₁₀-Soil + Vermiculite (2:1) + seed soaking with NAA @ 50 ppm was used for the experiment for observed the growth i.e. Initiation of seed germination days, height of seedling (cm), Girth of stem (mm), length of root (cm), number of secondary roots/seedling, number of leaves/seedling. The result revealed that early Initiation of seed germination 8.21 days, maximum height of seedling (18.58 cm), Girth of stem (1.41 mm), length of root (6.76 cm), maximum number of leaves/seedling (8.20) and minimum Initiation of seed germination days (19.36 Days), height of seedling (10.08 cm), Girth of stem (0.22mm), length of root (2.80cm), number of leaves/seedling (2.98) was observed under control.

Keywords: NAA, vermicompost, papaya and GA₃

Introduction

Papaya (*Carica papaya* L.) is an economically important tropical fruit crop belonging to the family Caricaceae and is widely cultivated in tropical and subtropical regions because of its high yield potential, nutritional quality, and medicinal properties. The crop is generally propagated through seeds; however, successful nursery production is often limited by delayed and uneven germination caused by seed dormancy and low seed vigor. Papaya seeds possess a gelatinous seed coat containing germination inhibitors, which restrict rapid and uniform emergence. Furthermore, germination is influenced by several environmental factors, including temperature, moisture, oxygen availability, light intensity, and the physical and chemical properties of the germination medium (Sharma *et al.*, 2021) [8]. Improving seed germination and producing healthy seedlings are therefore essential for enhancing productivity and reducing nursery losses, particularly considering the high cost of hybrid papaya seed (Nguyen *et al.*, 2022) [5].

Application of plant growth regulators has emerged as an effective approach to improve seed germination and seedling establishment. Gibberellic Acid (GA₃) is widely recognized for its ability to break seed dormancy by activating enzymes that hydrolyze stored food materials, thereby promoting rapid embryo growth and uniform germination. It also enhances shoot elongation, seedling vigor, and overall plant development (Voruganti *et al.*, 2022) [11]. Likewise, Naphthalene Acetic Acid (NAA), a synthetic auxin, promotes root initiation, stimulates lateral root formation, and improves nutrient absorption, resulting in stronger and more vigorous seedlings. These physiological effects contribute significantly to improved crop establishment and subsequent growth.

Besides growth regulators, the selection of an appropriate growing medium plays a vital role in seedling production. Vermiculite and cocopeat are widely preferred nursery media because they provide excellent aeration, adequate moisture retention, and favorable conditions for root emergence and uniform germination. Vermicompost serves as a valuable organic amendment by supplying essential nutrients, beneficial microorganisms, and naturally occurring growth-promoting substances that enhance seedling growth, root development, and biomass production. Therefore, integrating suitable plant growth regulators with efficient growing media may provide an effective strategy for improving papaya seed germination and nursery performance. Hence, the present study was undertaken to evaluate the combined effect of different plant growth regulators and 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 @ 50 ppm, T₅-Soil + cocopeat (2:1), T₆-Soil + Cocopeat (2:1) + seed soaking with GA₃ @ 150 ppm, T₇-Soil + Cocopeat (2:1) + seed soaking with NAA @ 50 ppm, T₈-Soil + Vermiculite (2:1), T₉-Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm and T₁₀-Soil + Vermiculite (2:1) + seed soaking with NAA @ 50 ppm was used for the experiment for observed the growth i.e. Initiation of seed germination days, height of seedling (cm), Girth of stem (mm), length of root (cm), and number of leaves/seedling.

Results and Discussion

Initiation of seed germination days

The earliest initiation of seed germination was recorded in treatment T₅ (GA₃ @ 100 ppm), which required 8.21 days for germination initiation. This treatment was followed by T₄ (GA₃ @ 50 ppm) and T₇ (NAA @ 100 ppm), which initiated germination in 9.22 and 9.78 days, respectively. The lowest seedling height was observed in the control treatment (T₁). The superior seedling height in GA₃-treated seeds can be attributed to the well-documented role of Gibberellic Acid in promoting cell elongation and division, especially in the stem and shoot regions. GA₃ enhances endogenous auxin levels and activates enzymes like expansins and cell wall-loosening proteins, which contribute to increased cell wall plasticity and internodal elongation (Taiz *et al.*, 2015; Bewley *et al.*, 2013) ^[10, 11]. Additionally, GA₃ accelerates metabolic activities and increases the mobilization of food reserves, resulting in more vigorous seedling growth. Higher concentration (100 ppm) showed a more pronounced effect compared to 50 ppm, indicating a dose-responsive relationship up to an optimum level. NAA

(T₇), a synthetic auxin, also contributed to enhanced seedling height by promoting cell elongation and tissue differentiation, particularly in meristematic regions. It also improves nutrient uptake and water absorption, indirectly supporting shoot elongation (Singh *et al.*, 2014) ^[9]. The lowest seedling height in the control (T₁) suggests that natural endogenous hormone levels alone were insufficient to maximize vegetative growth under nursery conditions, reaffirming the benefit of exogenous application of growth regulators. The delayed germination observed in the control treatment may be attributed to the absence of growth-promoting substances that facilitate rapid metabolic activity and embryo growth. Overall, the application of gibberellic acid, particularly at 100 ppm, proved most effective in promoting early seed germination in papaya.

Height of seedling (cm)

The maximum seedling height (18.58 cm) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was found to be significantly superior to most of 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 seedling heights of 17.73 cm and 17.31 cm, respectively. Among the treatments receiving NAA, T₇ [Soil + Cocopeat (2:1) + seed soaking with NAA @ 50 ppm] produced a seedling height of 16.88 cm, followed by T₄ [Soil + Vermicompost (2:1) + seed soaking with NAA @ 50 ppm] and T₁₀ [Soil + Vermiculite (2:1) + seed soaking with NAA @ 50 ppm], which recorded heights of 15.71 cm and 15.18 cm.

Girth of stem (mm)

The maximum stem girth (1.41 mm) was recorded under treatment T₉ [Soil + Vermiculite (2:1) + seed soaking with GA₃ @ 150 ppm], which was significantly superior to the remaining treatments. The minimum stem girth (0.22 mm) was observed in the untreated control (T₁). GA₃ significantly enhances stem girth by promoting cell division in the cambial region and facilitating greater radial expansion of tissues. It stimulates the synthesis of enzymes and structural components that lead to increased thickness of vascular tissues (Rai *et al.*, 2011) ^[7]. In seedlings, this results in stronger, more vigorous plants capable of better survival during transplanting. NAA (T₇), as a synthetic auxin, also contributes to stem girth improvement by enhancing vascular differentiation and cell expansion, particularly in xylem and phloem tissues. This auxin-induced growth leads to improved translocation and support structure within the seedling stem (Bose *et al.*, 2012) ^[12]. The minimal girth observed in the untreated control (T₁) is a consequence of the absence of exogenous growth regulators, which limited metabolic activity and structural development during early seedling growth.

Length of root (cm)

Among the various treatments, the maximum root length (6.76 cm) 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 produced root lengths of 6.03 cm and 5.80 cm, respectively. The minimum

root length (2.80 cm) was observed under the control treatment (T₁). The enhanced root elongation in GA₃-treated seedlings is primarily due to its ability to stimulate cell elongation in the root meristematic region. Gibberellic Acid promotes the activity of hydrolytic enzymes, such as α -amylase, which enhances the mobilization of food reserves toward growing root tips, thereby supporting vigorous root development (Kumar *et al.*, 2017) ^[4]. Additionally, GA₃ improves water and nutrient uptake by enhancing root surface area and encouraging deeper rooting. The effect of NAA (T₇) in increasing root length is related to its role as a root-promoting hormone. NAA stimulates root initiation and elongation by increasing auxin concentration at the root tip, enhancing cell division and elongation in the root apical meristem (Chauhan *et al.*, 2011) ^[3]. In contrast, the minimum root length in the control (T₁) suggests that endogenous hormone levels were insufficient to initiate strong root growth, emphasizing the effectiveness of growth regulator application in seedling development.

Number of leaves/seedling

Among the various treatments, the maximum number of leaves per seedling (8.20) 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 7.90 and 6.74 leaves per seedling, respectively. The minimum number of leaves per seedling (2.98) was recorded under the control treatment (T₁).

The superior performance of GA₃-treated seedlings (especially at 100 ppm) is attributed to GA₃'s ability to break dormancy, enhance cell division, and stimulate leaf primordia development in the apical meristem. Gibberellic Acid also enhances photosynthetic efficiency, chlorophyll synthesis, and carbohydrate mobilization, all of which contribute to higher leaf production (Patel *et al.*, 2016) ^[6]. NAA (T₇), as a synthetic auxin, enhances leaf number by promoting cell enlargement and division in leaf meristems and stimulating vascular differentiation, which supports better nutrient transport to growing leaves (Bose *et al.*, 2012) ^[2]. Auxins also help maintain apical dominance, leading to uniform and compact growth. The minimal leaf number in the control (T₁) reflects the absence of any exogenous growth stimulus, resulting in slower metabolic activity and limited vegetative development.

Table 1: Effects of plant growth Regulators on initiation of seed germination days of Papaya cv. Pusa Nanha

Treat.	Initiation of Seed Germination Days	Height of seedling (cm)	Girth of stem (mm)	Length of root (cm)	Number of leaves/seedling
T ₁	19.36	10.08	0.22	2.80	2.98
T ₂	13.70	14.09	0.49	4.57	4.69
T ₃	10.85	17.31	1.12	5.80	6.74
T ₄	11.96	15.71	0.94	4.98	5.98
T ₅	14.84	11.97	0.39	3.94	3.90
T ₆	10.18	17.73	1.24	6.03	7.90
T ₇	11.19	16.88	1.05	5.36	6.41
T ₈	12.61	14.33	0.52	4.78	5.44
T ₉	8.69	18.58	1.41	6.76	8.20
T ₁₀	12.27	15.18	0.79	4.82	5.60
S.Em±	0.504	0.411	0.016	0.129	0.154
CD at 5%	1.497	1.221	0.047	0.381	0.457

Conclusion

The present investigation revealed that different growing media and plant growth regulators significantly influenced seed germination and seedling growth of papaya cv. Pusa Nanha. Among the treatments, T₉ (Soil + Vermiculite 2:1 + seed soaking with GA₃ @ 150 ppm) recorded the earliest seed germination (8.21 days), maximum seedling height (18.58 cm), stem girth (1.41 mm), root length (6.76 cm) and number of leaves per seedling (8.20). In comparison, the control treatment recorded the poorest seedling growth, with delayed germination (19.36 days), minimum seedling height (10.08 cm), stem girth (0.22 mm), root length (2.80 cm) and number of leaves (2.98). Thus, T₉ was found to be the most effective treatment for promoting early germination and superior seedling growth of papaya cv. Pusa Nanha under the conditions of the present study.

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