Effects of different plant growth regulators and growth media on the germination and growth of papaya seedlings.

ABSTRACT

The study titled "Effect of Growth Media and Plant Growth Regulators on Germination and Seedling Growth of Papaya (Carica papaya L.)" aims to explore the optimal conditions for the successful germination and growth of papaya seedlings through the application of various growth media and plant growth regulators. Papaya is a tropical fruit with significant economic and nutritional importance, and its successful propagation is crucial for improving crop yields and enhancing profitability for farmers. The research investigates how different plant growth regulators such as auxins, cytokinins, and gibberellins, in combination with various growth media, influence the germination rate, seedling vigor, and post-transplant survival rate of papaya seedlings. By conducting controlled experiments, the study seeks to determine the most effective treatment combinations that result in enhanced seedling growth, improved germination percentages, and higher survival rates after transplanting. Through the statistical analysis of the data, the research provides valuable insights into the physiological responses of papaya seedlings to different growth conditions. The findings from this study not only contribute to the development of more efficient and sustainable papaya cultivation practices but also offer broader implications for the propagation of other economically important crops.

Keywords: Carica papaya L., growth media, plant growth regulators, seedling growth, vermicompost, gibberellic acid, naphthalene acetic acid, seedling vigor, survival percentage.

INTRODUCTION

India's diverse climatic conditions have nurtured a thriving fruit industry, making it a major contributor to the country's economy. Fruits, rich in essential nutrients and vitamins, are vital components of a balanced diet and have gained significant prominence in the global market. According to recent data, India's fruit production has continued to rise. In 2021-2022, the country produced an estimated 320 million tons of fruits, solidifying its position as the world's second-largest fruit grower. This significant increase from previous years is a testament to the industry's growth and the government's efforts to promote fruit cultivation. Papaya remains a key export for India, with the country maintaining a dominant global market share of around 44%. Other fruits, such as mangoes, grapes, bananas, and pomegranates, are also exported to various countries, contributing to India's agricultural exports. The fruit industry has not only provided economic benefits but has also played a crucial role in improving rural livelihoods. It has generated employment opportunities, particularly for small-scale farmers and women, leading to rural development and poverty reduction. While India remains the leading producer, other countries like Brazil, Indonesia, Nigeria, Mexico, and Ethiopia have also made strides in expanding their papaya cultivation. Factors such as climate change, market demand, and technological advancements can influence production levels and market shares. (NHB, India)

The fruit of the papaya plant is 15-50 cm in length and 10- 20 cm in thickness. The fruit which are produced by the female is generally round or ovoid while the one produced by hermaphrodite, develops an elongated and cylindrical fruit. The immature fruit has greenish or white flesh which contains white milky latex. However, when the fruit matures, it changes to reddish-orange and contain small, black, ovoid seeds.

A molecular study looks for, characterizes, and assesses the genetic diversity of a desired genotype. The technique offers several advantages over conventional techniques and has become an essential tool for the study, conservation and improvement of plant species. The study of genetic diversity are done by DNA based markers for identification, development of genotypes.

Applying plant growth regulators (PGRs) and choosing the right growth medium can have a big impact on papaya (Carica papaya L.) seedling growth and germination. Understanding these factors can help optimize conditions for successful papaya cultivation.

MATERIALS AND METHODS

Three replications were included in the Completely Randomized Design (CRD) setup for the investigation. There were 150 polybags in each of the ten treatments (Table 1), and each polybag contained one "Red Lady" seedling variety.

Table 1: Treatment symbols

Treatment	**Symbols**
Vermicompost + Soil (2:1)	T_1
Soil + Vermicompost (2:1) + GA3 @ 150 ppm seed soaking	T_2
Soil + Vermicompost (2:1) + 50 ppm of NAA soaked in the seeds	T_3
Copaceat + Soil (2:1)	T_4
Soil + Cocopeat (2:1) + 150 ppm GA3 soaking of seeds	T_5
Soil + Cocopeat (2:1) + 50 ppm NAA soaking of seeds	T_6
Vermiculite + Soil (2:1)	T_7
Soil + Vermiculite (2:1) + 150 ppm of GA3 soaking for seeds	T_8
Soil + Vermiculite (2:1) + 50 ppm NAA soaking for seeds	T_9
Control (Soil)	T_{10}

- **Seedling height**

From each treatment, ten seedlings were chosen at random and given permanent tags. At 30 and 45 days following planting, the level of the labeled seedlings was estimated utilizing a meter scale, and the mean plant level was determined by averaging the levels of ten randomly picked seedlings.

- **Number of roots**

At the hour of relocating, ten randomly chosen seedlings from every treatment had their foundations counted.

- **Root length**

Utilizing a meter scale, the root length of 10 randomly chosen papaya seedlings was estimated 45 days in the wake of sowing, starting from the place where the roots began to the tip, in centimeters. The average length of the roots was then determined.

- **Survival percentage**

By transferring the seedlings into the field, the survival percentage of papaya seedlings was measured. Each treatment was applied to five plants, and the survival rate up to ten days following transplanting was computed using the following formulas:

$$Survival\ \% = \frac{Total\ number\ of\ survival\ seedlings}{Total\ number\ of\ transpanted\ seedlings} \times 100$$

RESULTS AND DISCUSSIONS

- **Height of Seedling (cm)**

The information in Table 2 and Plate A showed that, at 30 and 45 days after papaya seedling sowing, there was a huge impact on seedling height from different growth media and plant growth controllers. Except for treatment T5, which stayed at standard at the two phases, growth media and plant growth controllers recorded essentially higher seedling height at 30 and 45 DAS. At 30 and 45 DAS, separately, the expansion in plant height of papaya seedlings under T2 was recorded as being 80% and 70% higher than that of T10 plants.

Table 2: Impact of growth media and controllers on papaya seedling height.

Treatments		Height of Seedling(cm)	
		30DAS	45 DAS
T_1	Vermicompost + Soil (2:1)	8.8	11.7
T_2	Soil + Vermicompost (2:1) + GA3 @ 150 ppm seed soaking	10.2	13.2
T_3	Soil + Vermicompost (2:1) + 50 ppm of NAA soaked in the seeds	11.1	15.5
T_4	Copaceat + Soil (2:1)	8.5	11.7
T_5	Soil + Cocopeat (2:1) + 150 ppm GA3 soaking of seeds	9.9	14.1
T_6	Soil + Cocopeat (2:1) + 50 ppm NAA soaking of seeds	11.3	10.8
T_7	Vermiculite + Soil (2:1)	7.6	11.0
T_8	Soil + Vermiculite (2:1) + 150 ppm of GA3 soaking for seeds	7.9	13.6
T_9	Soil + Vermiculite (2:1) + 50 ppm NAA soaking for seeds	8.0	9.00
T_{10}	Control (Soil)	6.5	.36
	S. Em±	.28	.36
	CD (P =0.05)	.61	1.15

- **Roots Number**

Table 3's data showed that, compared to the other treatments, treatment T2 had a noticeably greater number of roots per plant than the others, with the exception of treatment T1, which stayed at par. But under treatment T9, or soil, the fewest amount of roots were noted. The treatment T4 showed a 50.90 percent increase in the number of roots per plant.

This might be due to combination of this media provided better condition like aeration and porosity for proper growth and development of seedlings leads to increase number of leaves. These results were in close agreement with Ramteke et al. (2015) in papaya when they used cocopeat as ingredients of growing media.

Length of Root (cm)

The root length data shown in Table 3 and Plate B made it abundantly evident that the papaya seedling treatment T2 at 45 days after sowing had the longest roots. However, treatment T10 recorded the least. With the exception of treatment T5, which was statistically equivalent to treatment T2, treatment T2 turned out to be noticeably better than the other treatments.

It might be due to the cocopeat provides adequate nutrients and enhances both the physical and biological properties and the water holding capacity of soil (Soegiman, 1982). These results were also in conformity with the finding of Kumawat et al. (2014) in papaya when they used cocopeat as ingredients of growing media.

Table 3: Growth media and plant growth controllers influence papaya seedling root amount and length

Treatments	Roots Number	Length of Root (cm)
T_1	15.9	8.8
T_2	16.0	9.0
T_3	18.2	10.0
T_4	15.6	8.1
T_5	16.8	9.7
T_6	18.2	10.9
T_7	13.8	8.1
T_8	14.1	8.0
T_9	16.9	9.1
T_{10}	12.1	6.8
S.Em ±	0.30	0.23
CD	0.86	0.88

- **Survival percentage**

Table 4: Plant growth regulators and growth media affect papaya survival 10 days after transplanting

Treatments	**Survival (%)**
T_1	89
T_2	95
T_3	91
T_4	80
T_5	97
T_6	94
T_7	82
T_8	88
T_9	89
T_{10}	71
S.Em ±	2.9
CD	4.0

The statistics (Table 4) show that the survival percentage of papaya seedlings in the field after ten days was considerably increased by the application of growth media and plant growth regulators. Treatment T3 had the highest survival rate, whereas treatment T10 had the lowest. Although T3 was shown to be statistically comparable to treatments (T2, T4, T5, and T6), it was much better than T10.

It might be due to soil and cocopeat is improved soil texture, structure, porosity, water holding capacity, activity of useful soil micro fauna and flora, maintained soil temperature and improved soil health and nutrient status of medium (Hartmann and Kester, 1997). Similar results were also obtained by Bhardwaj (2014) and Ramteke et al. (2015) in papaya.

CONCLUSION

The study on the effect of growth media and plant growth regulators (PGRs) on the germination and seedling growth of papaya (Carica papaya L.) highlights the critical importance of selecting appropriate media and PGR combinations for optimizing in vitro propagation. Soil-based media, while effective, can be complemented or even outperformed by soilless media like coco peat and vermiculite, which offer better control over nutrient and water management. The inclusion of compost further enhances soil structure and fertility, promoting healthier seedling development. Among PGRs, auxins, gibberellins, cytokinins, ethylene, and abscisic acid each play distinct roles in influencing growth parameters, from root initiation and cell division to breaking seed dormancy and improving stress tolerance. The experimental data indicate that specific PGR combinations, particularly those involving higher-response media codes, significantly enhance bud formation, shoot multiplication, and reduce the time required for bud initiation. Optimal sterilization treatments also contribute to higher survival rates of explants. Overall, this study provides valuable insights into the best practices for in vitro propagation of papaya, which can lead to more efficient and higher-yield cultivation methods.

REFERENCES

Abirami, K., Rema, P. A., & Mathew. (2010). Effect of different propagation media on seed germination, seedling growth, and vigor of nutmeg. Journal of Medicinal Plants Research, 4(19), 2054-2058.

Abirami, K., Rema, P. A., & Mathew. (2010). Effect of different propagation media on seed germination, seedling growth, and vigour of nutmeg. Journal of Medicinal Plants Research, 4(19), 2054-2058.

Anjanawe, S. R., Kanpure, R. N., Kachouli, B. K., & Mandloi, D. S. (2013). Effect of plant growth regulators and growth media on seed germination and growth vigor of papaya. Annals of Plant and Soil Research, 15(1), 31-34.

Anonymous. 2017-18. http://nhb.gov.in/statistics

Asmah, R., Rozita, R., Wan, N., Izzah, W. M., Zain, S. E., & Huzaimah, A. S. (2002). Antiproliferative activity of pure lycopene compared to both extracted lycopene and juices from watermelon (Citrullus vulgaris) and papaya (Carica papaya) on human breast and liver cancer cells. Linus Journal of Medicinal Science, 2(2), 55-58.

Bhardwaj, R. L. (2013). Effects of nine different propagation media on seed germination and the initial performance of papaya (Carica papaya L.) seedlings. The Journal of Horticultural Science and Biotechnology, 88(5), 531-536.

Choudhary, R. C., Kanwar, J., & Singh, P. (2022). Effect of gibberellic acid (GA3) and growing media on seedling growth parameters of papaya (Carica papaya L.) cv. Pusa Nanha. The Pharma Innovation Journal, 11(1), 247-251.

Choudhary, R. C., Kanwar, J., Chouhan, G. S., Sing, P., & Tanwar, D. R. (2018). Effect of ga3 and growing media on seedling growth of papaya (Carica papaya L.) cv. pusa Nanha. Inter. J. of Che. Stud, 6(6), 1008-1012.

Dash, B. P., & Singh, D. (2019). Effect of different growing media on seed germination and subsequent seedling growth of papaya (Carica papaya Linn) cv. Pusa Nanha under Prayagraj agro climatic conditions. Journal of Pharmacognosy and Phytochemistry, 8(5), 141-143.

Hossain, F., Islam, N., Ali, S., Kayes, A., & Choudhury, S. (2023). GA3 and growing medium influence papaya seed germination and seedling growth. Trends in Horticulture, 6(2), 3263.

Kumawat, R., Maji, S., Govind, G., & Meena, D. C. (2014). Studies on seed germination and seedling growth of papaya (Carica papaya L.) cv. Coorg Honey Dew as influenced by media and chemicals.

Pandey, A., & Bahadur, V. (2024). Effects of Different Plant Growth Regulators on Seed Germination, Seedling Growth and Establishment of Papaya (Carica papaya) Cv. Pusa Nanha. Journal of Advances in Biology & Biotechnology, 27(6), 717-724.