UNDER PEER REVIEW

Original Research Article

Effects of different Plant Growth Regulators on seed germination, seedling growth and establishment of papaya (*Carica papaya*) Cv. Pusa Nanha

Abstract

The present study aims to investigate the "**Effects of different Plant Growth Regulator on seed germination, seedling growth and establishment of papaya (*Carica papaya*) Cv. Pusa Nanha.",** at The Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, during the period 2023-24. The experiment was laid in completely randomized block design with three replications and ten treatment combinations. viz, T_0 (Control), T_1 (NAA 100ppm), T_2 (NAA 150ppm), T_3 (NAA 200ppm), T_4 (GA_3 100ppm), T_5 (GA_3 150ppm), T_6 (GA_3 200 ppm), T_7 (IAA 100ppm), T_8 (NAA 150ppm), T_9 (NAA 200ppm). The seeds were soaked before sowing in the aqueous solution of plant growth regulator for 12 hours as per the treatments. The seeds were then sown in the pre-filled polybags and various parameters related to Germination Parameters, Growth Parameters, Survival and Establishment were evaluated. On the basis of present experimental findings, it is concluded that treatment**T6(GA3 200ppm)** performed best in term of Germination percentage, Seedling vigour index, Number of leaves, Plant height, Chlorophyll content and stem girth Whereas **T_2 (NAA 150ppm)** performed best in term of Leaf length, Leaf width, Leaf area and Establishment Percentage. The lowest observation was recorded in T_0 (Control).

Keywords: GA3, NAA, IAA, PGRs, seed germination, seedling growth and establishment, Papaya var. Pusa Nanha.

1. INTRODUCTION

The papaya, also known as *Carica papaya* L. in botanical terms, is a member of the Caricaceae family and is both a genus and a species of Carica. Chromosome no. (2n=18). One of the world's top crops is grown in tropical and subtropical areas **(Singh and Sexena, 2008).**

Papaya (Carica papaya) is a tropical fruit having commercial importance because of its high nutritive and medicinal value. Papaya cultivation had its origin in South Mexico and Costa Rica. Total annual world production is estimated at 6 million tonnes of fruits. India leads the world in papaya production with an annual output of about 3 million tonnes. Other leading producers are Brazil, Mexico, Nigeria, Indonesia, China, Peru, Thailand and Philippines. The papaya is believed to be native to southern Mexico and neighboring Central America. It is currently cultivated in Florida, Hawaii, Eastern British Africa, South Africa, Sri-Lanka, India, Canary Islands, Malaysia and Australia. It is now present in every tropical and subtropical country.

Papaya is a rich source of vitamin A and C. It has a high nutritive and medicinal value. Papaya trees can grow up to 30 feet tall, and the fruit typically weighs between 1 and 10 pounds. The fruit has a greenish-

yellow skin when unripe, and turns yellow or orange as it ripens. The flesh of the papaya is orange or pink, and is soft and juicy with small black seeds in the center. Papain prepared from dried latex of its immature fruits is used in meat tenderizing, manufacture of chewing gum, cosmetics, for degumming natural silk and to give shrink resistance to wool.

Papaya fruits can be eaten ripe or unripe and prepared as vegetables. The ripe fresh fruits are used to make jam, syrup, crystallized fruits, ice cream flavoring, and soft beverages. Papain, an enzyme used in meat tenderizing preparations, is made from the dried latex of unripe fruits. It works in a similar manner as pepsin **(Meena and jain, 2012)**

Papaya is primarily propagated by seed, yet low germination and weak seedling vigor occur from early seed degeneration after harvest. In the pursuit of improving these essential attributes, the application of growth regulators and the selection of appropriate propagation media have gathered significant attention among researchers and horticulturists.

Therefore, the present study was designed to investigate the impact of growth regulators on the germination, growth, and overall vigour of papaya seedling. Understanding how these variables influence the early stages of papaya growth is pivotal for enhancing the quality and yield of papaya crops, and ultimately contribute to the advancement of sustainable agriculture and the production of nutritious fruits. It has been reported that the germination of seeds of papaya is slow, erratic and incomplete (Chako and Singh 1966) which is mainly due to the accumulation of inhibitors in the sarcotesta, resulting in subsequent decrease in seed germination during storage (Reyes et at., 1980) . Sarcotesta, a gelatinous substance around the seeds that contains germination inhibitors was found to not only impede germination but also the subsequent emergence of seedlings (Malo and Campbell, 2001) . It has been found to stop oxygen from reaching the seed and impeding the germination process

the application of growth regulators and other compounds to seeds, improves their germination and vigour through modifications to the respiratory metabolism and promoter-inhibitor balance. Pre-soaking of papaya seeds in GA_3 and NAA (1-Naphthalene acetic acid) presents a promising approach for nursery and agricultural practices aimed at achieving higher germination rates and healthier seedlings, ultimately contributing to improved papaya crop yields (Mishra et al., 2017) .

Overall, PGRs serves as a valuable tool for papaya growers aiming to cultivate healthier and more productive papaya seedlings (Rana et al., 2020) .

2. MATERIAL REQUIRED

The experiment was arranged in a Randomized Block Design (RBD) with three replications. Each of ten treatments (Table 1)consisted of 180 polybags and each polybag containing one seedling variety of “Pusa Nanha”.papaya seeds (Pusa Nanha) were collected from IARI New Delhi, ensuring its seed quality and varietal purity. The solution of PGRs used i.e. GA3 (100ppm, 150ppm,200ppm) and NAA (100ppm,150ppm,200ppm) and IAA (100ppm,150ppm,200ppm) was prepared by weighing (100mg, 150mg,200mg and 250mg) GA3 and (100mg,200mg 300mg and 400mg) NAA and (100mg, 150mg,200mg) IAA with the help of digital balance. Added10 ml of ethyl alcohol to the container containing the weighed PGR powder. and then finally made up to one liter volume with distilled water. and allowed the seeds to soak in the PGR solution for 12 hours. The treated seeds were shade dried for 15 minutes and sown in the pre-filled polybags of (1 kg capacity) The seeds are sown in each treatment and irrigated immediately. Optimum moisture of media was maintained during the period of seed germination and are labelled with tags. Observations on seed germination percentage and growth characteristics viz., height of the seedling, number of leaves, leaf length,leaf width,leaf area, stem girth, chlorophyll content and seedling vigour index were recorded . establishment % was recorded at 30 days after transplanting. The experimental data were statistically analyzed by following the standard procedures of Panse and Sukhatme.

3. Result and Discussion

The present study on **"Effect of Different Plant Growth Regulators on Seed Germination, Seedling Growth and Establishment of Papaya cv. Pusa Nanha "** was carried out during 2023-2024 at the experimental orchard of Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The observations recorded and results obtained during the period of study have been presented below under the following headings.

3.1 Germination Percentage(%)

Among different PGRs, T6 {GA3 200ppm} recorded maximum germination (%) of 100 % whereas minimum germination (%) of 55.53 % was recorded in T0 (Control). Seeds of papaya when treated with GA3@200ppm for 12hrs resulted in high % of germination and vigour index as GA3 activated cytological enzymes by increasing cell wall plasticity and provided better water absorption, promoted seed germination by producing α-amylase enzyme which converted insoluble starch into soluble sugars and initiated the radical growth by removing some metabolic blocks (Anburani et al., 2008).

3.2 Plant Height (cm)

Among different PGRs, T6 {GA3 200ppm} recorded maximum plant height (cm) of 3.47cm (15DAS), 6.53cm (30 DAS), 8.23cm (45 DAS) and 16.83cm(30DAT) whereas minimum plant height (cm) of 2.63cm (15DAS), 4.77cm (30 DAS), 6.83cm (45 DAS) and 13.37cm (30DAT) was recorded in T0 (Control). Maximum plant height in GA might have occurred due to cell division and cell elongation, which in turn would have increased the internodal length. The observations are in agreement with the findings of Deb et al. (2010) in papaya seeds.

3.3 Number of leaves

Among different PGRs, T6 {GA3 200ppm} recorded maximum number of leaves per plant of 2.53 (15DAS), 4.40 (30 DAS), 6.60 (45 DAS) and 10.00(30DAT) whereas minimum number of leaves of 2.00 (15DAS), 3.33 (30 DAS), 5.43 (45 DAS) and 8.50 (30DAT) was recorded in T0 (Control). Higher number of leaves per plant produce might be due to invigoration of physiological process of plants and stimulatory effects with GA3 to form new leaves at faster rates and thus increased vegetative growth that could have attributed to higher metabolic activities, enhanced growth and higher carbohydrates production. The results are in conformity of Sen et al. (1990) in papaya seeds and Kalalbandi et al. (2003) in kagzi lime.

3.4 Leaf Length(cm)

Among different PGRs, T2 {GA3 150ppm} recorded maximum leaf length(cm) of 1.90cm (15DAS), 3.30cm (30 DAS), 4.57cm (45 DAS) and 8.83cm (30DAT) whereas minimum leaf length (cm) of 1.50cm (15DAS), 2.63cm (30 DAS), 4.03cm (45 DAS) and 8.07cm (30DAT) was recorded in T0 (Control).

3.5 Leaf Width(cm)

Among different PGRs, T2 {GA3 150ppm} recorded maximum leaf width (cm) of 0.87cm (15DAS), 2.57cm (30 DAS), 3.77cm (45 DAS) and 8.50cm (30DAT) whereas minimum leaf width (cm) of 0.57cm (15DAS), 1.80cm (30 DAS), 2.73cm (45 DAS) and 7.37cm (30DAT) was recorded in T0 (Control). 53

3.6 Seedling Vigour Index

Among different PGRs, T6 {GA3 200ppm} recorded maximum seedling vigour index of 823.33 whereas minimum seedling vigour index of 382.07 was recorded in T0 (Control). The highest seedling vigour in GA3 was attributed to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growth points and higher activity of enzymes. Enzymatic and hormonal mechanism stimulate metabolic process such as sugar mobilization, protein hydrolysis, oxidation, etc (Earlplus and Lambeth, 1974), which leads to increase in root length, shoot length and seedling dry weight, in turn increase in seedling vigour. The present results are in conformity with the results of Gurung et al., (2014)

3.7 Chlorophyll Content (SPAD Value)

Among different PGRs, T6 {GA3 200ppm} recorded maximum chloropyll content (SPAD value) of 41.30 whereas minimum chlorophyll content (SPAD value) of 33.63 was recorded in T0 (Control). This may have been due to growth regulators and agrochemicals causing decreased chlorophyll degradation, and increased chlorophyll synthesis. Growth regulator application delayed leaf senescence which could also be attributed to higher chlorophyll content. Similar results were reported by Shinde and Jadhav (1995) in cowpea and Sai Sankar (2001) in mung bean and the application of gibberellins increased the chlorophyll and protein content in the wax apple fruits (Moneruzzaman et al. 2012)

3.8 Stem Girth (cm)

Among different PGRs, T6 {GA3 200ppm} recorded maximum stem girth(cm) of 0.38 cm (45 DAS) and 0.56cm (30DAT) whereas minimum stem girth (cm) of 0.21cm (45 DAS) and 0.35cm (30DAT) was recorded in T0 (Control). It is revealed that stem diameter of papaya significantly increased under T6 (200ppm GA3). Increase in girth of stem may be possible due to stimulation of cambium and its immediate cell progeny, as observed. Dhankhar and Singh (1996) and Gholap et al. (2000) in Anola (Phyllantus emblica L.) and Deb et al. (2010) in papaya.

3.9 Leaf Area(cm)

Among different PGRs, T6 {GA3 200ppm} recorded maximum leaf area (cm) of 43.83cm (45 DAS) and 59.53cm (30DAT) whereas minimum leaf area (cm) of 19.90cm (45 DAS) and 35.10cm (30DAT) was recorded in T0 (Control). Additional availability of NAA in the seed may have increased the level of amylase in aleurone tissue of the seed for better conversion of the complex starches into simple sugars for providing energy for growth, and, leaf area increased with increase in time to a maximum, coinciding with maximum top growth, and a steady decline at later stages Similar results were also reported by Ram Asrey et al, 2001 in musk melon.

3.10 Establishment Percentage(%)

Among different PGRs, T6 {NAA 150ppm} recorded maximum Establishment (%) of 82.20 % whereas minimum Establishment (%) of 61.07 % was recorded in T0 (Control) In the present study it is noted that the treatment with NAA at 150 ppm concentration gave the maximum survival percentage (82.20%) among all other treatments. This might be due to increased length, maximum number of primary roots and early sprouting resulted in more thickness of the roots, perhaps the ability of regenerating further new fibrous roots from main roots, which probably absorb more nutrients and water from the soil under low transpirational losses. Similar results were also reported by Singh and Bahadur (2015) and Singh et al. (2015) in phalsa.

Table 1. Effects of different Plant growth regulators on Plant height, number of leaves, leaf length, leaf breadth.

Treatment Notion	Treatment details	Germination %.	Plant Height (cm)	Number of leaves	Leaf Length (cm)	Leaf Width (cm)
			30 DAT	30 DAT	30DAT	30 DAT
T_0	Control	55.53	13.37	8.50	8.07	7.37
T_1	NAA@100ppm	77.73	15.03	8.57	8.70	8.27
T_2	NAA@150ppm	94.43	16.03	9.00	8.83	8.50
T_3	NAA@200ppm	88.87	16.17	9.07	8.67	8.23
T_4	GA3@100ppm	88.87	13.40	9.33	7.23	5.93
T_5	GA3@150ppm	100.00	15.47	9.60	8.40	7.93
T_6	GA3@200ppm	100.00	16.83	10.00	8.37	7.83
T_7	IAA@100ppm	83.30	15.03	9.07	7.77	7.73
T_8	IAA@150ppm	72.17	14.67	9.30	8.07	7.40
T_9	IAA@200ppm	94.43	14.73	9.40	8.30	7.47
F-Test		**S**	**NS**	**NS**	**NS**	**S**
S.Ed (±)		**10.56**	**1.29**	**0.41**	**0.70**	**0.58**
C.D. at 5%		**22.19**	**2.71**	**0.86**	**1.47**	**1.22**
C.V		**15.12**	**10.49**	**5.47**	**10.41**	**9.28**

Table 2. Effects of different Plant growth regulators on Seed Vigour Index, Leaf Area (cm^2), Chlorophyll Content (SPAD Value), Stem Girth (cm), Establishment %.

Notion	Treatments	SPAD value.	Seedling vigour index	Leaf Area (cm^2).	Stem Girth (cm).	Establishment %.
T_0	**Control**	33.63	382.07	35.10	0.35	61.07
T_1	**NAA@100ppm**	38.63	601.87	56.97	0.46	80.53
T_2	**NAA@150ppm**	35.87	673.17	59.53	0.45	82.20
T_3	**NAA@200ppm**	39.87	683.17	54.47	0.50	80.53
T_4	**GA3@100ppm**	39.90	680.93	44.17	0.48	80.53
T_5	**GA3@150ppm**	34.13	760.00	47.50	0.51	72.17
T_6	**GA3@200ppm**	41.30	823.33	55.00	0.56	77.73
T_7	**IAA@100ppm**	38.87	603.00	46.47	0.47	67.20
T_8	**IAA@150ppm**	35.67	665.37	45.97	0.41	76.67
T_9	**IAA@200ppm**	36.50	703.23	52.73	0.43	76.63
F-Test		**NS**	**S**	**S**	**S**	**NS**
S.Ed (±)		**2.66**	**90.30**	**4.39**	**0.03**	**7.84**
C.D. at 5%		**5.59**	**189.71**	**9.23**	**0.06**	**16.47**
C.V		**8.71**	**16.82**	**10.81**	**7.92**	**12.71**

4 CONCLUSION

On the basis of present experimental findings, it is concluded that treatment **T6 (GA3 200ppm)** performed best in term of Germination percentage, Seedling vigour index, Number of leaves, Plant height, Chlorophyll content and stem girth Whereas **T2 (NAA 150ppm)** performed best in term of Leaf length, Leaf width, Leaf area and Establishment Percentage.

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