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Effect of growing medias and PGRs on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. red baby

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Abstract

Papaya (*Carica papaya* L.) is a popular fruit of the tropics and subtropics of the world. There are well-known challenges in the cultivation of this crop in the present day, including incomplete germination and frost sensitivity, as well as fungal and viral diseases. Papaya nursery is normally raised through seeds. Various growing media and PGRs were used in the experiment, including soil, soil + FYM, soil + vermicompost, soil + rice husk, soil + cocopeat and soil + FYM + rice husk + vermicompost + cocopeat in a 1:1 ratio each, on the other hand, PGRs such as GA3 (100 ppm, 150 ppm), NAA (100 ppm, 150 ppm) and their combination (GA3 + NAA @ 100:100 ppm) were taken for the treatment. The result indicated that the different growing media i.e., soil + FYM + vermicompost + rice husk + cocopeat is found to be the most effective for better root growth parameters (time taken to germinate the first seed, number of roots, fresh and dry weight of roots) and shoot growth parameters (number of leaves, fresh and dry weight of shoot) was maximum. Among PGRs GA3 @ 150 ppm recorded higher values for root growth parameters and shoot growth parameters of papaya seedlings. The treatment combination of soil + FYM + vermicompost + rice husk + cocopeat and PGRs GA3 150 ppm showed better root growth parameters and shoot growth parameters. Therefore, it is concluded that the combination of soil + FYM + vermicompost + rice husk + cocopeat and GA3 @ 150 ppm were found most suitable for better growth of papaya seedlings.

Keywords: Seedlings, growing media, NAA, GA3, FYM, cocopeat

Introduction

Papaya is botanically known as *Carica papaya* L. and belongs to the family Caricaceae, is originated in tropical America (Anburani and Shakila, 2010) [2]. The papaya fruit crop is characterized by a year-round fruiting season, low maintenance and high nutritional content (Ming *et al.*, 2015) [8]. Papaya cultivation has been restricted in certain parts of the country due to several limitations. In India, its cultivation poses several problems, including propagation problems, different-sex forms, waterlogging, waterborne diseases, and temperature sensitivity due to the current climate. As a result, papaya is generally propagated by seed (Chavez-Pesquera and Nunez-Farfan, 2016) [6]. A plant's survival depends on the growing media. It provides adequate nutrients and water. In addition to providing water and nutrients, a root substrate also permits gaseous exchange between roots and the environment (Abad *et al.*, 2002) [1]. The soil is usually used as a basic medium because it is cheapest and easy to procure (Bhardwaj, 2013) [3]. Rice husk promotes seed germination by maintaining the right temperature, providing soft media for germination and sprouting and protecting seeds from fungal damage in moist soil (Radha *et al.*, 2018) [10]. Cocopeat has a large pore space that allows enhanced aeration and holds up to eight times its weight in water, so it can function as a sponge (Abad *et al.*, 2002) [1]. Vermicompost provides root systems with the necessary oxygen levels and it also stores water and nutrients for plants (Sinha *et al.*, 2009) [12]. Germination times were reduced when seeds were soaked in GA3 and NAA for 12 hours (Anburani and Shakila, 2010) [2]. Gibberellins act in the mobilization of seed reserves during the germination process. Therefore, GA3 is considered an important germination promoter that increased the seed germination of papaya (Zanotti and Barros, 2014) [15]. Different sizes and types of portrays have recently been developed to grow fruit seedlings. Therefore, growing media and growth regulators have been used within Punjab agroclimatic conditions to determine papaya seedling germination and growth parameters.

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Material and Methods

The present investigation was carried out at a hi-tech polyhouse, Department of Fruit Science, Lovely Professional University, Kapurthala, Punjab during the year 2021-2022. The experiment was laid out in Factorial Completely Randomized Design. The experiment comprised a combination of GA3 and growing media. The treatments included six levels of growing media i.e., Soil (T1), Soil + FYM (T2), Soil + Vermicompost (T3), Soil + Rice Husk (T4), Soil + Cocopeat (T5) and Soil + FYM + Rice Husk + Vermicompost + Cocopeat (T6) as well as five levels of Plant growth regulators GA3 @ 100 ppm (C1), GA3 @ 150 ppm (C2), NAA @ 100 ppm (C3), NAA @ 150 ppm (C4), GA3 @ 100 ppm + NAA @ 100 ppm (C5) and Control (C0). A combination of the above growing media was filled in the portrayals according to the treatment. Thereafter, the seeds were soaked in GA3 (100 ppm and 150 ppm) and NAA (100 ppm and 150 ppm) for 12 hours. An analysis of variance was conducted on the data collected during the study period. Seeds were irrigated by light irrigation every day after sowing until they germinated. The data generated by this investigation were computed, tabulated, and analyzed using the statistical software OPSTAT (Panse and Sukhatme, 1985) [9].

Results and discussion

Data reveals that the growing medias and level of PGRs significantly influence the time is taken to germinate the first seed, number of the roots, number of leaves, fresh weight of the shoot, fresh weight of the root, dry weight of the shoot and dry weight of the root of Red Baby papaya seedling.

Effect of PGRs

According to table 1, the various root growth parameters such as the number of roots, length of the roots, fresh and dry weight of roots were found significant among different treatments. At 60 days after sowing (DAS) the seeds pre-treated with GA3 + NAA were observed that the minimum time taken to germinate the first seed (21.78 days), the maximum number of roots (13.44), highest fresh weight of roots (0.39 g) and highest dry weight of roots (0.029 g) were observed with treatment GA3 + NAA @ 100:100 ppm. This might be because vigorous root growth due to GA3 might have resulted in more production of the photosynthetic product and their translocation through the phloem to the root zone, which might be responsible for improving the root growth. The findings are supported by Shanmugavellu, 2007 [13].

The various shoot growth parameters such as the number of leaves per plant, fresh weight of shoot and dry weight of shoot of seedling were found to be significantly enhanced by GA3 + NAA applications. The maximum number of leaves per plant (6.22), maximum fresh weight of the shoot (3.24 g) and maximum dry weight of the shoot (0.31 g) were found in treatment GA3 + NAA @ 100:100 ppm, while the lowest fresh weight of the shoot (2.04 g) and dry weight of the shoot (0.20 g) were recorded in C0 (control). This seems to be the effect of mobilization of water and nutrients transported at a higher rate which might have promoted more production of the photosynthetic product and translocated them to various plant parts which might have resulted in better growth of the seedlings and hence more fresh and dry weight. These findings are in agreement with the results obtained by Lay *et al.*, 2015 [7] in papaya.

Table 1: Effect of PGRs success on the growth of germinated seeds of Papaya:

PGRs (C)	Time is taken to germinate the first seed	Number of roots	Number of leaves	Fresh weight of the shoot	Fresh weight of the roots	Dry weight of the shoot	Dry weight of the root
(C1)	25.06	10.56	5.78	2.16	0.23	0.21	0.016
(C2)	22.61	12.50	5.61	2.82	0.31	0.27	0.020
(C3)	25.17	11.11	5.61	2.32	0.26	0.22	0.016
(C4)	24.11	10.22	5.67	2.63	0.26	0.26	0.016
(C5)	21.78	13.44	6.22	3.24	0.39	0.31	0.029
(C0)	26.33	9.28	4.83	2.04	0.18	0.20	0.013
CD 5%	0.63	0.57	0.37	0.12	0.023	0.012	0.002
Sem (±)	0.22	0.20	0.13	0.044	0.008	0.004	0.001

Where, C1- GA3 @ 100, C2- GA3 @ 150, C3- NAA @ 100 ppm, C4- NAA @ 150 ppm, C5-GA3 @ 100 ppm + NAA @ 100 ppm, C0- Control

Effect of growing media

According to table 2, the minimum time is taken to germinate the first seed (21.33 days), the maximum number of roots (13.61), highest fresh weight of roots (0.43 g) and highest dry weight of roots (0.032 g) was observed in treatment T6 (soil + FYM + rice husk + vermicompost + cocopeat). This may be due to the synergetic effect of different media compositions. The role of FYM in improving the physical characteristics of the soil, increasing soil ventilation by increasing the porosity and this animal fertilizer being an organic matter in soil is considered a big source of nutrient elements, especially nitrogen and phosphorus. Vermicompost represented hormone-like activity and increased the number of roots, thereby, enhancing nutrient uptake as well as plant growth and development. The findings are supported by Vishwakarma, 2013 [14].

According to table 2, the various shoot parameters have significant results. The treatment T6 (soil + FYM + rice husk + vermicompost + cocopeat) gained the maximum number of leaves per plant (13.61), highest fresh weight of shoot (4.36 g) and highest dry weight of shoot (0.42 g) of papaya seedling. The maximum fresh weight and dry weight of shoot in treatment T6 might be because organic manure initially forms a conducive environment to physical parameters of soil which promote better shoot growth and other vegetative growth in the presence of beneficial microorganisms or biologically active plant growth influencing substances such as phytohormone are released by beneficial microorganisms present in the vermicompost rich soil that increase the average leaf area, fresh weight and dry weight of shoot. These findings are in agreement with the results obtained by Rahangdale, 2015 [11].

Table 2: Effect of growing media on the growth of germinated seeds of Papaya:

Growing media (T)	Time is taken to germinate the first seed	Number of roots	Number of leaves	Fresh weight of the shoot	Fresh weight of the root	Dry weight of the shoot	Dry weight of the root
(T1)	25.78	9.78	5.00	1.82	0.26	0.18	0.013
(T2)	25.94	10.50	5.33	1.93	0.22	0.19	0.014
(T3)	24.94	10.33	5.89	2.00	0.24	0.19	0.016
(T4)	24.33	10.22	5.56	1.98	0.20	0.20	0.017
(T5)	22.72	12.67	5.78	3.12	0.28	0.30	0.018
(T6)	21.33	13.61	6.17	4.36	0.43	0.42	0.032
CD 5%	0.63	0.57	0.37	0.12	0.023	0.012	0.002
Sem (\pm)	0.22	0.20	0.13	0.044	0.008	0.004	0.001

Where, T1- soil, T2- soil + FYM, T3- soil + vermicompost, T4- soil + rice husk, T5- soil + cocopeat, T6- soil + FYM + vermicompost + rice husk + cocopeat

Interaction effect

According to table 3, the various root growth parameters have significant results. The minimum time taken to germinate the first seed (18.67 days), the maximum number of roots (16.33), highest fresh weight of roots (0.70 g) and highest dry weight of roots (0.057 g) was recorded with the treatment T6C5 (soil + FYM + rice husk + vermicompost + cocopeat and GA3 + NAA @ 100:100 ppm). In root growth parameters the overall growth may be improved due to the synergistic effect of media and GA3, media helps to provide better water holding capacity, porosity, soil aeration and supplies a substantial amount of nutrients, especially nitrogen and micro-nutrients for the proper growth of root and GA3 might have increased the physiological activities of seedlings, essential for cell division or cell enlargement or both, because the growth of the plant occurs by two processes i.e. cell division by mitosis which adds new cells and elongation of already existing cells by enlargement of the vacuoles. These findings are in

agreement with Borah *et al.*, 2007 [4].

The various shoot parameters have the maximum number of leaves (7.67), fresh weight of shoot (5.93 g) and dry weight of shoot (0.55 g) was given by media combination T6C5 (soil + FYM + rice husk + vermicompost + cocopeat and GA3 + NAA @ 100:100 ppm). Because GA3 stimulates the cambium and its immediate cell progeny by the process of enhancing the rate of cell multiplication. The rate increase in the dimension of the cell both in the pith and cortex region is faster than the number of cells per unit area resulting in better shoot growth and an appropriate media mixture provides a better root environment to the plant leading to better nutrient availability to the photosynthetically functional leaves that ultimately utilized for shoot growth promotion and media containing FYM and vermicompost as most of the constituents provided a start for the establishment of seedlings which further got supplemented by PGPRs. Similar results are obtained by Chawla and Mehta, 2015 [5].

Table 3: Interaction effect of different growing media and PGRs on the growth of germinated seeds of Papaya

Treatment combinations	Time is taken to germinate the first seed	Number of roots	Number of leaves	Fresh weight of the shoot	Fresh weight of the root	Dry weight of the shoot	Dry weight of the root
T1C1	26	9	4.67	1.47	0.23	0.15	0.013
T1C2	24.33	10	4.67	2.17	0.27	0.22	0.017
T1C3	27	10.67	5.33	1.8	0.23	0.18	0.013
T1C4	26.67	9.33	5.33	1.93	0.3	0.19	0.02
T1C5	22	12	5.67	2.3	0.37	0.23	0.027
T1C0	28.67	7.67	4.33	1.27	0.13	0.13	0.01
T2C1	26	9	5	1.57	0.2	0.16	0.013
T2C2	24.33	11.67	5.67	2.27	0.23	0.23	0.013
T2C3	28	11	6.33	1.9	0.23	0.19	0.013
T2C4	26	10.33	5.33	2.03	0.2	0.2	0.013
T2C5	22.67	12.33	5.67	2.4	0.3	0.24	0.02
T2C0	28.67	8.67	4	1.4	0.13	0.14	0.01
T3C1	26	10.33	6.33	1.6	0.23	0.15	0.013
T3C2	22.33	12.67	5.33	2.27	0.27	0.22	0.017
T3C3	26	8.67	5.33	2	0.3	0.19	0.013
T3C4	23.67	9.33	6	2.17	0.23	0.22	0.013
T3C5	23.67	12	6.67	2.43	0.3	0.24	0.023
T3C0	28	9	5.67	1.53	0.13	0.15	0.013
T4C1	25.67	8	5.67	1.43	0.13	0.14	0.013
T4C2	23	11.67	6.33	2.2	0.23	0.22	0.013
T4C3	26	10.33	4.67	2	0.17	0.2	0.01
T4C4	23.33	10.67	5.67	2.33	0.23	0.23	0.013
T4C5	22	13	6.33	2.23	0.3	0.22	0.02
T4C0	26	7.67	4.67	1.7	0.13	0.17	0.01
T5C1	24	13	6.67	2.87	0.23	0.27	0.013
T5C2	21	13.67	6.33	3.5	0.37	0.33	0.027
T5C3	23	13	6.33	2.63	0.23	0.25	0.013
T5C4	22.33	11	5.33	3.13	0.23	0.31	0.013
T5C5	21.67	15	5.33	4.13	0.37	0.38	0.027

T5C0	24.33	10.33	4.67	2.47	0.23	0.26	0.013
T6C1	22.67	14	6.33	4.03	0.37	0.41	0.027
T6C2	20.67	15.33	5.33	4.53	0.47	0.43	0.033
T6C3	21	13	5.67	3.57	0.4	0.34	0.03
T6C4	22.67	10.67	6.33	4.2	0.33	0.42	0.023
T6C5	18.67	16.33	7.67	5.93	0.70	0.55	0.057
T6C0	22.33	12.33	5.67	3.9	0.33	0.35	0.023
CD 5%	1.55	1.41	0.90	0.30	0.055	0.029	0.005
Sem (\pm)	0.55	0.50	0.32	0.107	0.020	0.010	0.002

Conclusion

It may be concluded from the findings of the present study that papaya seeds after treating among the different GA3 + NAA treatments, GA3 + NAA (100:100 ppm), recorded better root growth parameters and shoot growth parameters. In different media combinations, growing media T6 (soil + FYM + rice husk + vermicompost + cocopeat) recorded better root growth parameters and shoot growth parameters. Among the interaction, the application of T6C5 (soil + FYM + rice husk + vermicompost + cocopeat and GA3 + NAA @ 100:100 ppm) recorded better root growth parameters and shoot growth parameters as compared to other treatments of PGRs and other media combinations.

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