

Studies on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Coorg Honey Dew as influenced by media and chemicals

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ABSTRACT

Papaya is one of the most important fruit crops belongs to family Caricaceae grown in tropical to subtropical areas all over the world. It is normally propagated by seeds which show wide variability in germination and seedling growth. The present experiment was carried out to find out the role of media and bio-regulators on seed germination and seedling growth of papaya. The bio-regulator GA₃, borax and thiourea were applied along with media mixture i.e. soil, compost, cocopeat and river sand. The experiment comprised with three media [M₁- Soil + compost + cocopeat (1:1:1), M₂- Soil + compost + river sand (1:1:1) and M₃ - soil + cocopeat + riversand (1:1:1)], three bio-regulators and chemicals [C₁- GA₃- 150ppm, C₂- Borax - 0.5% and C₃- Thiourea - 2000 ppm] and their combinations with 16 treatments. The experimental treatments were laid down in factorial CRD with three replications. The seeds were sown in poly bags filled with respective media and treated with respective bio-regulators. The results showed that the application of treatment M₁C₁ [Soil + compost + cocopeat (1:1:1) + GA₃- 150ppm] was found superior for early as well as higher germination percentage, better shoot growth, better growth of tap root, secondary root production and chlorophyll content in seedlings of papaya cv. Coorge Honey Dew under drier tracts of sub tropical area of Lucknow.

Keywords: Bio-regulators, borax, growing media, papaya, seed germination, thiourea

Papaya (*Carica papaya* L.) belongs to family Caricaceae is originated from tropical America (Hafmer, 1998) and was introduced in India in 16th century from Malacca (Kumar and Abraham, 1983). Papaya is one of the most important fruit crops of Hawaii, Malaysia, Burma, Sri Lanka, India, Queens Land, South Africa, and other tropical and sub-tropical countries of the world. Papaya occupies 2.0 per cent total fruit crop area and 5.3 per cent of total fruit production in India (5381.73 thousand MT of production from 132.18 thousand hectares with average productivity of 40.71 t ha⁻¹(Anon., 2014)). The important papaya growing states are Andhra Pradesh, Maharashtra, Gujarat, Karnataka, Madhya Pradesh, Bihar, West Bengal, Tamil Nadu, Karla, Uttar Pradesh and Rajasthan have ideal climate conditions for its growth and production. Papaya is normally propagated by seed (Cheema and Dhani, 1930) and it is interested by the researchers due to the presence of gelatinous sarcotesta preventing germination and dormancy (Lange, 1961). Generally, growing medium has been adjudged to be the most critical factor determining seedling quality in the nursery, acting as a reservoir for nutrients and moisture. The effect of media on seed germination and seedling growth has been workout by various workers (Angelin and Ouma, 2008; Srivastava *et al.*, 1998; Annapurna *et al.*, 2007)

under different agro-climatic conditions. The significant role of chemical treatment through KNO₃, sodium thiosulphate, thiourea, gibberellic acid (Kadam, 1992) in relation to breaking dormancy, seed germination, growth and development of plant has been observed. The present investigation has been carried out to see the effect of combined application of growing media and chemicals on seed germination and seedling growth of papaya cv. Coorge Honey Dew under drier tracts of sub tropical area of Lucknow.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.), during the year 2013-2014. The experimental site is under drier subtropical climate situated at 111 m from MSL and located at 26°56' North latitude and 80°52' East longitude having temperature ranging from 22°C to 45°C in summer, minimum temperature ranging from 3.5°C to 15°C in winter, relative humidity 60-80% and annual rainfall 750mm. The experiment was laid out in Factorial Complete Randomized Block Design with growing media as one factor and chemicals as another factor. The levels of both the factors media and bio-regulator were three. The treatment comprised of three medium combination (M₁- soil + compost + cocopeat (1:1:1), M₂- soil + compost + river sand (1:1:1) and

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M₃- soil + cocopeat + river sand @ 1:1:1) and three bio-regulators (C₁- GA₃ - 150ppm, C₂- borax - 0.5%, C₃- thiourea -2000ppm) having total 16 treatments replicated thrice. GA₃ 150 ppm was prepared by dissolving 150mg GA₃ in small amount of N/10 NaOH solution and volume make up to 1 liter with distilled water and adjusted to neutral pH. The required amount of chemical *i.e.* borax and thiourea was prepared with distilled water. Seeds were treated with KNO₃ solution for 30 minutes for breaking its dormancy and early germination. Then, the seeds were soaked with water 10 hours and treated with GA₃, borax, thiourea and with water (as control) for 6 hours. Different growing media were used as single or as mixture *i.e.* soil (control), Soil + compost + coco peat, Soil + compost + river sand and Soil + cocopeat + river sand at equal proportion (1:1:1). After soaking of seeds, dried on newspaper for one hour under shade and sown in poly bags (12×10 cm size) which were already filled with growing media of respective treatments. Twenty seeds a sown in a single poly bag and total 300 seeds were sown per treatment. Each treatment was replicated thrice and each replication has five poly bags, so fifteen poly bags were kept for one treatment. After sowing of seeds monitoring daily and irrigation is done regularly. The data observations were recorded on the different aspects such as germination attributes *i.e.* days taken to first germination, days taken to 50 percent germination, germination percentage, shoot parameters like height of seedlings, number of leaves, stem diameter, fresh weight, dry weight, root parameters such as length of tap root, diameter of tap root, number of secondary roots, shoot/root ratio and biochemical analysis like chlorophyll content in leaf was measured as per the method suggested by Sadasivam and Manickam (1996). The data pertaining to various investigations on germination and growth of papaya seedlings were subjected to statistical analysis (Sahu and Das, 2014). The significance of various treatment effects was judged with the help of “F” value (test) at 5% level of significance. The critical difference was calculated to assess the significant differences between treatment means.

RESULTS AND DISCUSSION

It is evident from the data (Table 1) that the minimum 12.20 days was required for first germination when the seeds were treated with GA₃ @ 150ppm and sown on growing medium *i.e.* mixture of soil + compost + cocopeat at 1:1:1 ratio (M₁C₁). In case of 50 per cent germination, it was also observed that seeds under M₁C₁ [soil + compost + cocopeat (1:1:1) +

GA₃ – 150 ppm] took 18.00 days for 50% germination and maximum germination percentage (83.33%) was also recorded under treatment M₁C₁. The treatment M₂C₃ also showed minimum days required for first germination after M₁C₁ but, treatment M₃C₃ required 19.33 days for 50% germination while, M₂C₃ resulted maximum germination percentage after M₁C₁. In all the cases, control plants showed maximum days for first germination (23.80 days), for 50 per cent germination (27.33 days) and minimum germination percentage (56.67%). The treatment C₂ (borax- 0.5%) showed delayed germination and took 21.47 days for first germination and 24.33 days for 50% germination. It was also showed that a poor germination (63%) close to the control treatment was recorded under the treatment C₂ (borax- 0.5%). Optimum germination of papaya seed has also been reported by Angeline and Ouma (2008). Similar effect of plant growth regulators on seed germination, seedling vigour in papaya have also been reported by Chacko and Singh (1967).

Among the different media and bio-regulators treatments used M₁C₁ *i.e.* soil + compost + cocopeat (1:1:1) + GA₃- 150ppm had significantly maximum plant height (14.27cm), number of leaves per seedling (13.73), and stem diameter of seedling (4.20mm) after 45 days of sowing and minimum height of seedling (10.95cm), stem diameter (2.63mm), number of leaves per seedling (9.07) were observed in control treatment C₀M₀. The table-1 showed that the effect of media, Chemicals and their interaction had no significant variation regarding the height of seedling at the 35 and 45 days after sowing (DAS). Similarly, the interaction effect of the medium and chemicals was found non-significant. The result was in conformity with the finding of Sen *et al.* (1990). The increase in height of seedling with pre-sowing treatments may be due to removal of sarcotesta which induce seed dormancy and reduces the nutrient and water uptake so, minimize the overall growth of the plant. A maximum plant height, plant girth and internode length were also recorded by Rajwar *et al.* (2007) in ber and Maji (2010) in guava. The more plant height, stem diameter and number of leaves observed in M₁C₁ (GA₃ @ 150ppm+ rooting media M₁) might have occurred due to cell division and cell elongation, which in turn would have increased the internodal length and overall vegetative growth as suggested by Shanmugavelu (1970). The results are also in accordance with result of Chaudhary and Chakrawar (1980) on Kagzi lime.

Table 1: Effect of media and chemicals on germination and growth of papaya seedlings

Treatments	First germination (Days)	50% germination (Days)	Total germination (%)	Height of seedling (cm)			Stem diameter (mm)			Number of leaves		
				Days after sowing			Days after sowing			Days after sowing		
				25	35	45	25	35	45	25	35	45
M ₀ C ₀	23.80	27.33	56.67	3.29	8.07	10.95	1.27	2.17	2.63	3.87	7.33	9.07
M ₁	15.80	22.00	78.00	4.20	12.07	13.89	1.77	2.75	3.97	5.13	9.33	12.67
M ₂	13.27	24.00	75.33	3.99	11.64	13.78	1.64	2.63	3.59	5.07	9.00	12.13
M ₃	16.53	22.33	79.00	4.05	10.85	13.27	1.58	2.72	3.84	4.33	8.93	11.53
C ₁	15.20	23.67	71.67	4.17	11.03	13.83	1.63	2.38	3.76	4.20	8.87	11.87
C ₂	21.47	24.33	63.00	2.87	10.32	13.03	1.45	2.44	4.00	3.13	8.47	11.13
C ₃	21.20	26.00	65.00	3.13	10.47	12.37	1.40	2.58	3.85	3.27	8.40	11.40
M ₁ C ₁	12.20	18.00	83.33	4.91	12.51	14.27	1.85	2.85	4.20	5.47	9.73	13.73
M ₁ C ₂	15.07	23.33	77.00	3.92	10.77	13.30	1.44	2.68	3.66	4.53	8.33	11.87
M ₁ C ₃	16.00	22.67	67.67	4.09	10.52	12.63	1.60	2.50	3.86	4.07	8.60	11.60
M ₂ C ₁	17.13	21.67	76.67	4.47	10.86	12.50	1.62	2.54	3.70	4.60	8.47	12.00
M ₂ C ₂	16.93	23.00	73.33	3.83	10.73	13.55	1.57	2.36	3.81	4.00	8.73	11.87
M ₂ C ₃	14.00	21.33	79.67	4.42	11.63	13.76	1.68	2.53	3.93	4.53	8.67	12.60
M ₃ C ₁	16.73	24.67	75.67	4.34	10.59	13.58	1.72	2.62	3.63	4.13	8.40	12.00
M ₃ C ₂	15.53	23.67	77.67	3.86	10.68	13.05	1.59	2.59	3.79	4.67	8.53	11.47
M ₃ C ₃	14.60	19.33	78.67	4.59	11.30	13.10	1.61	2.47	3.92	4.93	8.60	12.27
Media (M)												
SEm (±)	0.53	0.70	2.29	0.23	0.34	0.37	0.06	0.09	0.08	0.20	0.24	0.18
LSD (0.05)	1.08	1.44	4.68	0.46	NS	NS	0.11	0.18	NS	0.41	NS	0.37
Chemical (C)												
SEm (±)	0.41	0.54	1.78	0.18	0.27	0.29	0.04	0.07	0.07	0.15	0.18	0.14
LSD (0.05)	0.83	1.11	NS	0.36	NS	NS	0.09	NS	NS	0.32	NS	0.29
M × C												
SEm (±)	0.67	1.22	3.97	0.29	0.60	0.65	0.10	0.15	0.15	0.35	0.41	0.32
LSD (0.05)	1.36	2.49	8.11	NS	NS	NS	NS	NS	0.298	0.71	NS	0.65

Table 2: Effect of media and chemicals on root parameters, fresh and dry weight and chlorophyll content of papaya seedlings

Treatment	Root parameters			Shoot/root ratio	Fresh weight (g)	Dry weight (g)	Chlorophyll (mg/g)
	Length (cm)	Diameter (mm)	Total secondary roots				
M ₀ C ₀	3.77	2.66	12.27	2.50	3.60	0.80	128.00
M ₁	7.48	4.06	24.73	2.09	6.69	1.36	131.30
M ₂	6.49	3.79	19.80	2.10	4.51	0.88	129.03
M ₃	6.73	3.90	20.13	1.87	4.56	0.89	129.00
C ₁	7.23	3.95	20.80	2.10	5.96	0.93	131.10
C ₂	7.93	3.87	21.87	2.22	4.96	0.90	129.88
C ₃	7.68	3.82	21.73	2.18	4.39	1.02	131.83
M ₁ C ₁	9.15	4.27	29.27	2.62	7.06	1.72	133.84
M ₁ C ₂	7.82	3.68	22.80	2.02	5.07	0.91	132.57
M ₁ C ₃	7.71	3.61	20.40	2.00	4.62	0.87	129.32
M ₂ C ₁	7.83	3.54	23.13	2.04	6.18	1.18	130.14
M ₂ C ₂	7.47	3.87	19.93	2.25	4.42	0.95	129.50
M ₂ C ₃	8.09	3.73	23.07	2.24	5.10	0.90	131.23
M ₃ C ₁	7.76	3.63	21.67	2.08	6.09	1.14	132.00
M ₃ C ₂	7.77	3.75	22.40	2.13	4.79	0.96	129.20
M ₃ C ₃	8.08	3.90	20.20	2.14	5.62	1.17	132.25
Media (M)							
SEm (±)	0.17	0.09	0.81	0.05	0.31	0.09	0.52
LSD (0.05)	0.35	NS	1.65	0.10	NS	NS	1.07
Chemical (C)							
SEm (±)	0.13	0.07	0.62	0.04	0.24	0.07	0.41
LSD (0.05)	0.27	NS	1.28	0.07	0.49	0.14	0.83
M × C							
SEm (±)	0.30	0.16	1.40	0.08	0.54	0.15	0.91
LSD (0.05)	0.60	0.33	2.85	0.16	NS	0.31	1.85

The length of tap root, diameter of tap root and number of secondary roots increased significantly at 45 days after sowing (Table 2 and Fig. 1) and the longest tap root (9.15cm), maximum diameter of tap root (4.27 mm) and highest number of secondary roots (29.27) were found under treatment M_1C_1 (soil + compost + cocopeat (1:1:1) + GA_3 - 150ppm).

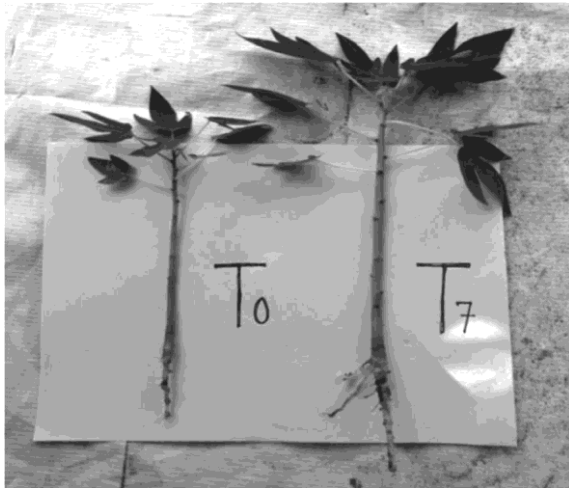


Fig.1: Growth of seedling under control (T_0) and T_7 (best performance)

The minimum length of tap root (3.77cm), diameter of tap root (2.66mm) and number of secondary roots (12.27) were recorded in treatment C_0M_0 (Control). The beneficial effect on root growth parameters due to media soil + compost + cocopeat (1:1:1) might be due to 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). Further the compost also provides close contact between seed and media increases steady moisture supply facilitates root respiration and encourages overall root growth (Chatterjee and Choudhari, 2007). It was observed from the data presented in the Table-2 that shoot/root ratio increased significantly at 45 day of sowing the shoot/root ratio (2.62) was found maximum at treatment M_1C_1 (soil + compost + cocopeat (1:1:1) + GA_3 - 150ppm). Whereas, the minimum shoot/root ratio (2.00) were recorded in treatment M_1C_3 (soil + compost + cocopeat (1:1:1) + thiourea-2000ppm). In present investigation fresh and dry weight of papaya seedling found better in treatment M_1C_1 (soil + compost + cocopeat (1:1:1) + GA_3 - 150ppm). The maximum fresh weight (7.06g) and dry weight (1.72g) of papaya seedlings were

recorded under treatment M_1C_1 (soil + compost + cocopeat (1:1:1) + GA_3 - 150ppm). Minimum fresh weight (3.60g) and dry weight (0.80g) was observed in the control treatment. It was cleared that the media had no significant effect on fresh and dry weight of seedlings, however, the reason behind this fact is not clear. Among the chemicals GA_3 was found better for more fresh and dry weight due to the effect of mobilization of water and nutrients transport at higher rate which might have presented more production of photosynthetic product and translocated then to various plant part which might have resulted in better growth of the seedlings and hence increased fresh and dry weight as suggested by Shanmugavelu (1985).

The maximum total chlorophyll content of papaya seedlings (133.84 mg 100^{-1} g tissue) was recorded under the treatment M_1C_1 (Soil + compost + cocopeat (1:1:1) + GA_3 - 150 ppm), followed by M_5C_3 . The minimum chlorophyll content of papaya seedlings (128.00mg/100g tissue) was recorded in the treatment M_0C_0 (control). The increase in nitrogen content in leaves of seedling with application of media and bio-regulators combination along with compost and GA_3 may be due to stimulated nutrient uptake specially nitrogen and synthesis of chlorophyll which have role in the assimilation of numerous amino acids that are subsequently incorporated in proteins and nucleic acid, which provides framework for chloroplast results into better Chlorophyll content in leaves of treated plant (Awasthi *et al.*, 1996).

It can be concluded that among the growing media and chemicals studied M_1C_1 {Soil + compost + cocopeat (1:1:1) + GA_3 -150 ppm} was found superior for early and higher germination percentage, better shoot growth, better growth of tap root, secondary root production and chlorophyll content of seedlings of papaya cv. Coorge Honey Dew in Lucknow condition.

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