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INFLUENCE OF ORGANIC SEED TREATMENT AND GROWING MEDIA ON GERMINATION BEHAVIOR AND SEEDLING GROWTH OF PAPAYA (*Carica papaya* L.) CV. RED LADY

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ABSTRACT

The present investigation entitled “Influence of organic seed treatment and growing media on germination behaviour and seedling growth of papaya (*Carica papaya* L.) cv. Red Lady” was carried out at the Fruit Research Station, Imalia, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur during 2024–2025. The experiment was laid out in a Facto- rial Completely Randomized Block Design with 16 treatments and three replications involving two factors, viz., seed treatment and growing media. Seeds were treated with water, coconut water (100%), Beejamrit (100%) and cow dung slurry (50%) for 24 hours. Growing media consisted of soil + sand + vermicompost (1:1:1), soil + sand + vermicompost + *Azotobacter* (50 g/polybag), soil + sand + vermicompost + *Azospirillum* (50 g/polybag) and soil + sand + vermicompost + effective microorganisms (50 ml/polybag). Among different treatment combi- nations, seeds treated with coconut water and grown in media containing soil + sand + vermi- compost + *Azospirillum* recorded minimum days to initial germination (10.00 days) and 50% germination (12.33 days), whereas maximum plant height (8.54 and 11.31 cm), stem girth (1.80 and 3.44 mm) and number of leaves (5.84 and 8.48) were observed at 60 and 90 DAS, respectively.
***Keywords*:** Papaya, seed treatment, germination, seedling growth.

Introduction

Papaya (*Carica papaya* L.) is one of the main fruit crops frequently referred to as” Papita” and” Pawpaw” in India. It was Introduced to India in the 16th century, this dicotyledonous, polyg- amous diploid plant has nine pairs of chromosomes and is a member of the Caricaceae family. Papaya is primarily a tropical fruit, but it can also be cultivated in subtropical regions (Allan, 2002; Galan and Rodriguez, 2007). However, in subtropical conditions, its growth ceases when the temperature drops below 11˚C(Allan, 2002). Mexico, a country in South America, is the origin of papaya, which spread to other regions of the world. In addition to all other tropical and subtropical nations, this crop is currently grown in Hawaii, Malaysia, Australia, Brazil, Burma, Philippines, Thailand, Sri Lanka, India, Tropical America and South Africa. 100 grams of edible portion of papaya contains 2020 IU of carotene (vitamin A), 250 mg of riboflavin (vitamin B2), 40 mg of thiamine (vitamin B1), 0.2 mg of nicotinic acid, 0.5% protein, 0.4% minerals, 0.1% fat, 0.01% phosphorus, 0.01% calcium, and 0.4 mg of iron.

Papaya is commercially propagated through seeds. Germination of papaya seeds is slow, er- ratic and incomplete (Chacko and Singh, 1966). Seed is enclosed with gelatinous sarcotesta, which in turn causes a decrease in seed germination. The sarcotesta prevent oxygen diffusion and water absorption which is necessary for the embryo growth. However, growers often face challenges such as fungal and viral diseases, frost susceptibility and high rate of seedling mor- tality during early stage of growth.

Organic seed treatment focuses on the use of natural compounds like coconut water, beejamrita, and cow dung slurry which contains various phytohormones and active compounds essential for germination and seedling development. Additionally, they also minimize the dependency on chemical inputs, contributing to sustainable and low-cost horticultural approaches. Growing media play a significant role to improve crop growth. The use of bio-inoculants like Azotobacter, Azospirillum and Effective Microorganisms enhance microbial activity in the rhizosphere around root, the root surface and the inner root tissues (Gray and Smith, 2005; Vargas *et al*., 2023). These microorganisms improve nutrient availability and stimulate growth of crop. Moreover, they also increase soil organic matter and enhances soil health. The aim of the study was to improve seed germination and seedling growth of papaya through the different seed treatment and by utilizing growing media inoculated with various bio-inoculants.

Materials and Methods

The current investigation was conducted at Fruit Research Station, Imalia, Department a Horti- culture, College of Agriculture, JNKVV, Jabalpur (M.P) during October to March 2024-2025. Jabalpur is situated at 23.17° N latitude and 79.93° E longitude, with an elevation of 411.78 m above mean sea level. The average annual rainfall of the region is 900 to 1250 mm. Seeds of papaya cv. Red Lady were purchased from Durg market. The experiment was conducted under factorial completely randomized block design with three replications and 16 treatment combinations. There were two factors considered in the experiment seed treatment and growing media. Seeds were treated with water, coconut water (100%), beejamrit (100%) and cow dung slurry (50%), whereas the growing media used were soil +sand +vermicompost (1:1:1), soil +sand +vermicompost +Azotobacter(50g/polybag), soil +sand +vermicompost +Azospirillum (50g/ polybag), and soil +sand +vermicompost +Effective microorganisum(50ml/polybag). Observations were recorded on germination parameters i.e. initial germination, 50% germination, germination percentage; growth parameters i.e. plant height, stem girth and number of leaves at 60 and 90 DAS. Physiological parameters i.e. leaf area index at 90 and 120 DAS, leaf area duration during 90-120 DAS, chlorophyll content index at 90 and 120 DAS.

$$\text{LAI} = \frac{\text{Total leaf area}}{\text{Ground area}}$$

$$\text{LAD} = \frac{\text{L2} + \text{L1}}{2} \times (t_2 - t_1)$$

Where,

L1 = LAI at the first stage

L2=LAI at the second stage

$(t_2 - t_1)$ = Time interval in days

Statistical analysis

Data were collected and statistically analysed using the analysis of variance method described by Panse and Sukhatma (1985) at 5% level of significance.

Results and Discussion

Effect of Seed treatment

The experimental result revealed that seed treatment with coconut water shows minimum days to initial germination, 50% germination and maximum germination percentage which may be due to biochemical changes such as enzyme activation and phytohormone production from coconut water (Kende and Zeevaart, 1997). Coconut water contains several phytohormones like gibberellins, cytokinin, auxin which improve seed germination (Bey *et al*., 2006). It also provides an additional supply of carbohydrates and nutrient, which serves an extra energy source, thereby accelerating metabolic activities for germination, leading to earlier vigorous germination process. Related results were indicated by Dunsin *et al*. (2016) in cucumber, Chuwang *et al*. (2018) in pepper.

The results obtained from the experiment revealed that seed treated with coconut water reported maximum plant height, stem girth, number of leaves at 60 and 90 DAS this might be due to the presence of naturally balanced plant growth promotors, essential mineral nutrients and vitamins in coconut water. It contains nutrients such as potassium (K) and calcium (Ca). Potassium play important role in plant growth, while calcium involved in cell division and elongation. These cellular activities contribute in height of plant (Pandit *et al*., 2001). Zainudin and Adini (2019) reported that papaya seeds treated with coconut water reported superior result in growth characteristics.

Results of the experiment found that treating seeds with coconut water observed highest value for leaf area index, leaf area duration and chlorophyll content index might be due to the plant growth regulators present in coconut water such as indole-3-acetic acid (IAA), cytokinin and salicylic acid, which play important role in enhancing cell division and cell elongation. Broader leaf formation may be due the presence of cytokinin in coconut water, which influence the growth and development of leaf buds. According to Abdullahil *et al*. (2011) observed that incorporating 50ml/l of coconut water into growing media enhance leaf width, and leaf area in Calanthe hybrid plant.

Effect of Growing media

The result of present investigation observed that seeds sown in growing media containing soil+ sand+ vermicompost+ Azospirillum show minimum days to initial germination, 50% germination and maximum germination percentage which may be due to the ability of Azospirillum species to synthesis key phytohormones like Auxins (IAA), Gibberellins and Cytokinins that play crucial role in germination. These phytohormones are known to activate specific enzymes involved in initial phase of germination, enhancing metabolic activities. Studies by de Souza *et al*. (2016), Granada *et al*. (2014), and Garcia-Lemos *et al*. (2020) on clover (*Trifolium repens* L.) supported the positive influence of bacterial auxin (IAA) on seed germination. The similar findings were also reported by Baliah *et al*. (2015); Baliah and Muthulakshmi (2017) found that Azospirillum inoculation increases the germination rate in okra.

Maximum plant height, stem girth and number of leaves were obtained with soil+ sand+ vermicompost+ Azospirillum. Azospirillum play important role in plant growth promotion mechanisms including biological nitrogen fixation, activation of enzyme and synthesis of phyto- hormones. Biological nitrogen fixation increases the availability of nitrogen to plant which stimulate formation of proteins and nucleic acids. These molecules are key component for chloroplast, thereby enhancing photosynthesis and ultimately promoting the vegetative growth of plant. According to de Andrade *et al*., 2019 *Azospirillum brasilense* + *Burkholderia cepacia* + *Enterobacter cloacae* inoculation contributes in improved plant height, number of leaves in strawberry.

The investigated data found that seeds sown in growing media containing soil+ sand + ver- micompost+ Azospirillum observed highest value for leaf area index, leaf area duration and chlorophyll content index which might be due to cytokinin production by Azospirillum enhancing cell division, leaf expansion, and delaying leaf senescence as well as facilitates the conversion of etioplasts into functional chloroplasts and chlorophyll biosynthesis (Angeli *et al*., 2001; Zafar *et al*., 2012; Zwack and Rashotte, 2013). Additionally, it also enhances nutrient uptake, particularly nitrogen also supports assimilation of amino acid that further involve in protein and nucleic acid production which is essential for chloroplast development leads to greater chlorophyll accumulation (Awasthi *et al*., 1996). These findings are in agreement with the results reported by Dayeswari *et al*., (2017) in papaya.Interaction effect of seed treatment and growing media

The data on interaction effect shows that seed treated with coconut water and sown in grow- ing media containing soil+ sand+ vermicompost+ Azospirillum take minimum days to initial germination, 50% germination and maximum germination percentage. The presence of growth promoting substance and enzyme present in coconut water supports germination. Additionally, Azospiriilum inoculation increases the nitrogen and phosphorous availability to germinating seeds by stimulating metabolic activity, thereby improving the germination rate (Jain *et al*., 2007). Similar finding was reported by Singh *et al*. (2018) in citrus.

The data shows that interaction effect of seed treatment with coconut water and growing media consist of soil+ sand+ vermicompost+ Azospirillum observed maximum plant height, stem girth and number of leaves. Coconut water contains different plant growth promoters and nutrients which stimulate nutrient uptake and metabolic activity, all of which led to plant growth. Moreover, Azospirillum inoculation has ability to increase nutrient availability and promote seedling growth (Sekar, 1995; Rajendran *et al*., 2003; Kasthuri Rengamani *et al*., 2006). Similar findings were reported by Mohan and Rajendran (2014) in wood apple.

The analysis of interaction data found that combination of seed treatment with coconut water and Soil, Sand, Vermicompost inoculated with Azospirillum as growing media reported highest value for leaf area index, leaf area duration and chlorophyll content index. Broader leaf formation may be due the presence of cytokinin in coconut water, which influence the growth and development of leaf buds. Azospirillum enhance leaf chlorophyll content and photosynthesis efficiency, promoting overall plant growth and biomass accumulation in plant tissues (Alvarez *et al*., 2019; Galindo *et al*., 2019) which show impact on leaves growth and leaves area growth. Similar findings were reported by Moreira *et al*. (2022) in lettuce.

Table 1: Effect of seed treatment and growing media on germination of papaya cv. Red Lady

Treatment	Details	Days to initial germination	Days to 50% germination	Germination (%)
Seed treatment				
S_1	Water	13.08	16.58	77.50
S_2	Coconut water	11.25	14.33	87.50
S_3	Beejamrit	12.50	15.33	84.17
S_4	Cow dung slurry	12.08	15.67	81.67
SEm ±		0.16	0.16	1.18
CD (5%)		0.45	0.45	3.39
Growing media				
M_1	Soil + Sand + VC	14.33	18.50	78.33
M_2	Soil + Sand + VC + Azotobacter	11.42	14.67	85.00
M_3	Soil + Sand + VC + Azospirillum	10.42	13.08	86.67
M_4	Soil + Sand + VC + EM	12.75	15.67	80.83
SEm ±		0.16	0.31	1.18
CD (5%)		0.45	0.90	3.39
Interaction (S × M)				
S_1M_1	Water + Soil + Sand + VC	15.67	19.33	73.33
S_1M_2	Water + Soil + Sand + VC + Azotobacter	12.33	16.33	80.00
S_1M_3	Water + Soil + Sand + VC + Azospirillum	11.00	13.67	90.00
S_1M_4	Water + Soil + Sand + VC + EM	13.33	17.00	76.67
S_2M_1	Coconut water + Soil + Sand + VC	12.67	17.67	83.33
S_2M_2	Coconut water + Soil + Sand + VC + Azotobacter	10.67	12.67	90.00
S_2M_3	Coconut water + Soil + Sand + VC + Azospirillum	10.00	12.33	90.00
S_2M_4	Coconut water + Soil + Sand + VC + EM	11.67	14.67	86.67
S_3M_1	Beejamrit + Soil + Sand + VC	11.67	14.67	80.00
S_3M_2	Beejamrit + Soil + Sand + VC + Azotobacter	11.33	14.33	86.67
S_3M_3	Beejamrit + Soil + Sand + VC + Azospirillum	10.33	13.00	90.00
S_3M_4	Beejamrit + Soil + Sand + VC + EM	13.67	15.67	80.00
S_4M_1	Cow dung slurry + Soil + Sand + VC	14.33	18.67	76.67
S_4M_2	Cow dung slurry + Soil + Sand + VC + Azotobacter	11.33	15.33	83.33
S_4M_3	Cow dung slurry + Soil + Sand + VC + Azospirillum	10.33	13.33	86.67
S_4M_4	Cow dung slurry + Soil + Sand + VC + EM	12.33	15.33	80.00
SEm ±		0.31	0.31	2.36
CD (5%)		0.90	0.90	NS

Table 2: Effect of seed treatment and growing media on plant growth of papaya cv. Red Lady

Treatment	Details	Plant height (cm)		Plant girth (mm)		No. of leaves	
Seed treatment		60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS
S_1	Water	6.75	8.31	1.37	2.60	4.38	6.68
S_2	Coconut water	7.62	9.59	1.56	3.01	5.02	7.48
S_3	Beejamrit	7.38	9.04	1.41	2.72	4.58	6.95
S_4	Cow dung slurry	6.84	8.52	1.47	2.79	4.85	7.24
SEm ±		0.04	0.05	0.02	0.04	0.05	0.06
CD (5%)		0.11	0.15	0.05	0.10	0.14	0.16
Growing media							
M_1	Soil + Sand + VC	6.47	7.70	1.29	2.38	3.83	5.91
M_2	Soil + Sand + VC + Azotobacter	7.49	9.31	1.50	2.93	5.12	7.67
M_3	Soil + Sand + VC + Azospirillum	7.87	10.40	1.63	3.13	5.64	8.19
M_4	Soil + Sand + VC + EM	6.78	8.06	1.39	2.67	4.24	6.57
SEm ±		0.04	0.05	0.02	0.04	0.05	0.06
CD (5%)		0.11	0.15	0.05	0.10	0.14	0.16
Interaction (S × M)							
S_1M_1	Water + Soil + Sand + VC	6.29	7.30	1.24	2.32	3.60	5.62

S_1M_2	Water + Soil + Sand + VC + Azotobacter	7.07	8.59	1.43	2.65	4.59	7.13
S_1M_3	Water + Soil + Sand + VC + Azospirillum	7.24	9.67	1.47	2.83	5.39	7.88
S_1M_4	Water + Soil + Sand + VC + EM	6.42	7.69	1.34	2.60	3.95	6.07
S_2M_1	Coconut water + Soil + Sand + VC	6.72	8.13	1.36	2.49	3.97	6.14
S_2M_2	Coconut water + Soil + Sand + VC + Azotobacter	8.05	10.46	1.64	3.28	5.77	8.36
S_2M_3	Coconut water + Soil + Sand + VC + Azospirillum	8.54	11.31	1.80	3.44	5.84	8.48
S_2M_4	Coconut water + Soil + Sand + VC + EM	7.15	8.48	1.45	2.81	4.49	6.92
S_3M_1	Beejamrit + Soil + Sand + VC	6.56	7.96	1.26	2.35	3.82	5.89
S_3M_2	Beejamrit + Soil + Sand + VC + Azotobacter	7.75	9.37	1.45	2.82	4.80	7.36
S_3M_3	Beejamrit + Soil + Sand + VC + Azospirillum	8.13	10.67	1.54	3.07	5.59	8.10
S_3M_4	Beejamrit + Soil + Sand + VC + EM	7.10	8.16	1.38	2.62	4.12	6.43
S_4M_1	Cow dung slurry + Soil + Sand + VC	6.30	7.41	1.29	2.38	3.92	5.97
S_4M_2	Cow dung slurry + Soil + Sand + VC + Azotobacter	7.08	8.81	1.49	2.98	5.32	7.82
S_4M_3	Cow dung slurry + Soil + Sand + VC + Azospirillum	7.55	9.96	1.69	3.18	5.74	8.32
S_4M_4	Cow dung slurry + Soil + Sand + VC + EM	6.45	7.91	1.40	2.64	4.42	6.85
SEm ±		0.07	0.11	0.03	0.07	0.10	0.11
CD (5%)		0.22	0.31	0.09	0.20	0.29	0.32

Table 3: Effect of organic seed treatment and growing media on leaf area index (LAI), leaf area duration (cm^2 day) and chlorophyll content index of papaya cv. Red Lady

Treatment Details		Leaf area index		Leaf area duration Cm^2 day	Chlorophyll content index	
Seed treatment		90 DAS	120 DAS	90–120 DAS	90 DAS	120 DAS
S_1	Water	1.52	2.32	503	45.72	47.56
S_2	Coconut water	1.83	3.01	635	53.24	56.00
S_3	Beejamrit	1.62	2.60	584	50.33	53.32
S_4	Cow dung slurry	1.74	2.76	589	51.90	53.86
SEm ±		0.03	0.03	2.70	0.32	0.48
CD (5%)		0.08	0.08	7.78	0.93	1.37
Growing media						
M_1	Soil + Sand + VC	1.36	2.08	486	46.49	47.72
M_2	Soil + Sand + VC + Azotobacter	1.80	2.96	596	52.06	54.44
M_3	Soil + Sand + VC + Azospirillum	1.99	3.25	675	54.13	57.55
M_4	Soil + Sand + VC + EM	1.55	2.40	554	48.50	51.03
SEm ±		0.03	0.03	2.70	0.32	0.48
CD (5%)		0.08	0.08	7.78	0.93	1.37
Interaction (S × M)						
S_1M_1	Water + Soil + Sand + VC	1.22	1.93	458	41.79	42.26
S_1M_2	Water + Soil + Sand + VC + Azotobacter	1.65	2.38	507	45.80	47.80
S_1M_3	Water + Soil + Sand + VC + Azospirillum	1.67	2.77	556	50.24	55.53
S_1M_4	Water + Soil + Sand + VC + EM	1.52	2.20	492	45.03	44.64
S_2M_1	Coconut water + Soil + Sand + VC	1.47	2.20	520	48.80	51.91
S_2M_2	Coconut water + Soil + Sand + VC + Azotobacter	1.89	3.35	655	56.10	57.58
S_2M_3	Coconut water + Soil + Sand + VC + Azospirillum	2.36	3.88	778	56.77	59.88
S_2M_4	Coconut water + Soil + Sand + VC + EM	1.59	2.61	589	51.27	54.64
S_3M_1	Beejamrit + Soil + Sand + VC	1.34	2.08	483	47.61	47.91
S_3M_2	Beejamrit + Soil + Sand + VC + Azotobacter	1.79	3.02	610	52.88	55.99
S_3M_3	Beejamrit + Soil + Sand + VC + Azospirillum	1.83	3.03	683	53.65	56.99
S_3M_4	Beejamrit + Soil + Sand + VC + EM	1.52	2.27	563	47.19	52.40
S_4M_1	Cow dung slurry + Soil + Sand + VC	1.40	2.11	486	47.76	48.80
S_4M_2	Cow dung slurry + Soil + Sand + VC + Azotobacter	1.86	3.09	613	53.47	56.41
S_4M_3	Cow dung slurry + Soil + Sand + VC + Azospirillum	2.11	3.32	684	55.87	57.78
S_4M_4	Cow dung slurry + Soil + Sand + VC + EM	1.58	2.52	573	50.49	52.45
SEm ±		0.05	0.06	5.40	0.64	0.95
CD (5%)		0.15	0.17	15.56	1.85	2.74

Conclusion

Seed treatment with coconut water and inoculation of Azospirillum in growing media comprises of soil +sand +VC significantly improved germination parameters i.e. initial germination, 50% germination; growth parameters i.e. plant height, stem girth and number of leaves and physiological parameters i.e. leaf area index, leaf area duration and chlorophyll content index.

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