

Original Research Article

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Effect of Inorganic and Biofertilizers on Growth of Gynodioecious Papaya

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ABSTRACT

The experiment was carried out to find out the Effect of inorganic and biofertilizers on growth of Gynodioecious papaya. The treatment combinations involving ten levels of T⁻¹ Recommended dose of NPK (RDF) i.e. 250: 250:250 g/plant/year, T⁻² 100% RDF + PSB (50g/plant), T⁻³ 100% RDF + *Azospirillum* (50g/plant), T⁻⁴ 100% RDF + *Azotobactor* (50g/plant), T⁻⁵ 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant), T⁻⁶ 75% RDF + PSB (50g/plant) + *Azotobactor* (50g/plant), T⁻⁷ 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), T⁻⁸ 50% RDF + PSB (50g/plant) + *Azotobactor* (50g/plant), T⁻⁹ 50% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), T⁻¹⁰ Farmer's Practices were given in Red Lady variety. Maximum Plant height (cm), Girth of stem (cm), No of leaves per plant (cm), Petiole length (cm), Petiole girth (cm), Leaf area (m²), Chlorophyll content (mg/100g tissue), East-West Spread (cm), North-South spread (cm), Days taken for 1st flower emergence, Days taken for 1st fruit initiation, First bearing height (cm), Girth at bearing height (cm), Number of leaves at first bearing height (cm). Were observed by the maximum at 180, 270 and 360 DAT were observed under the treatment T₇-75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant) at all the growth stages.

Keywords

Inorganic,
Biofertilizers,
RDF, Papaya

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Introduction

Papaya (*Carica papaya* L) is a fruit found ample in tropical and sub-tropical regions. In India it is commonly known as Papita, pawpawa or True Melon. Papaya's country of origin is South American country Mexico. From there it reached other parts of the world. Now this crop is cultivated in Australia,

Hawaii, Brazil, Malaysia, Burma, Philippines, Sri Lanka, India, South Africa, Thailand, Tropical America and all other tropical and sub-tropical countries. According to the data made available by NHB 2017, due to ideal climatic conditions in Andhra Pradesh the production of Papaya is excellent. However, in India Papaya is produced successfully all over the country round the year. According to the

data available for the agricultural cycle year 2016-17 in India, around 136.1 thousand hectares of area is cultivated with Papaya which is around 2.10% of total fruit area production. On an average nearly 6500 MT per year of Papaya is yielded which is 6.57% of total fruit production in India. In Madhya Pradesh Papaya is cultivated on estimated area of 10.45 hectares. Productivity of Papaya in Madhya Pradesh is around 44.9 MT per hectare. If proper management is done nearly 70 to 80 tonnes per hectare of Papaya can be produced. The fruits of excellent quality are produced under mild subtropical climates where as a dry warm sunny climate tends to add the sweetness to the fruit. Cultivation of Papaya is easy and gives easy returns. The plant of Papaya has adaptability in diverse soil. Fruit of Papaya is attractive, delicious and has multifarious uses. Papaya is a very wholesome fruit. It is one of the best sources of vitamin A. Usually it is assumed that a fruit has yellow pigment due to Carotene in it but Papaya has yellow pigment because of caricaxanthin. Papaya fruit also have β -Cryptoxanthin (8.1 μ g/g) representing 62% of carotenoid content causing yellow/orange fleshed cultivars which are common. Papaya fruit also has red fleshed cultivars which are due to Lycopene. Organic manures and bio-inoculants are substitute of inorganic fertilizers. When these organic manures and bio-inoculants are used in the field where Papaya plant is grown the faster development of plant is clearly visible. The use of organic fertilizers and bio-inoculants increases crop productivity and also improves soil properties. The organic matter in the soil is increased. Water holding property of the soil is improved and nutrients in the soil increases thus increasing the nutritional value of Papaya fruit. The importance of organic manure and bio-fertilizers in Indian agriculture has been known since ancient times as it augments part of N, P, K and also fairly a good amount of micronutrients apart from increasing

availability of applied and native soil nutrients. The practice also improves the soil quality, texture, structure, porosity, infiltration rate, aeration, flora and fauna and better root growth which have beneficial effects on crops by improving their yield, quality and post-harvest traits.

Materials and Methods

A field experiment on different inorganic, biofertilizers techniques on growth Papaya (*Carica papaya* L.) was carried out during 2016 and 2017 at Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalyaya, Chitrakoot, District Satna (M.P.). The research work was conducted in the Randomized Block Design with three replications. Each replication was comprised of 10 treatment combinations. In T¹ Recommended dose of NPK (RDF) i.e. 250:250:250 g/plant/year, T² 100% RDF + PSB (50g/plant), T³ 100% RDF + *Azospirillum* (50g/plant), T⁴ 100% RDF + *Azotobactor* (50g/plant), T⁵ 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant), T⁶ 75% RDF + PSB (50g/plant) + *Azotobactor* (50g/plant), T⁷ 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), T⁸ 50% RDF + PSB (50g/plant) + *Azotobactor* (50g/plant), T⁹ 50% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), T¹⁰ Farmer's Practices. The Chitrakoot is situated in semi-arid and subtropical zone of Kymore Plateau & Satpuda Hills of Madhya Pradesh, North of 24° 31' latitude and East of 81° 15' longitude with an altitude of 306 m from mean sea level. The soil of the investigation field was clay loam with good drainage and uniform texture with medium NPK status. Observations were recorded according to standard procedure on Plant height (cm), Girth of stem (cm), No of leaves per plant (cm), Petiole length (cm), Petiole girth (cm), Leaf area (m²), Chlorophyll content (mg/100g tissue), East-West Spread (cm), North-South spread (cm),

Days taken for 1st flower emergence, Days taken for 1st fruit initiation, First bearing height (cm), Girth at bearing height (cm), Number of leaves at first bearing height (cm).

Results and Discussion

Vegetative growth (Table 1-3)

The maximum plant height of plant at 180, 270 and 360 DAT in both the years was found under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant) and minimum value was found under T10- Farmer's Practices, these results conformity with the statements "It is known fact that nitrogen is essential for cell division and cell enlargement as it increases the rotoplasm. Application of RDF + PSB + *Azospirillum* produces better results in plant height with other treatments which may be due to enhanced availability of nitrogen and phosphorus under bio fertilizer treated plots. This view was also confirmed by Suresh and Hassan (1998) and according to them inoculation with *Azospirillum* saved 50 per cent of the nitrogen dose in banana. The results are also in agreement with the findings of Tripathy (2002) who reported that 50 kg P2O5 ha-1 could be saved by the use of PSB in chickpea".

Maximum girth of stem at 180, 270 and 360 DAT in both the years was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the minimum value was found under T10- Farmer's Practices. The increase in trunk girth may be due to improvement of physical properties of soil, higher nutrient uptake and increased activity of microorganisms which were manifested in the form of boosting growth and production of higher carbohydrates (Yadav *et al.*, 2011a). And, it could be due to regularly supply of available nutrient from organic and inorganic

form and effect of bio active substance produced by common use of bio fertilizers. Organic manures along with biofertilizers also enhanced the aeration in the soil which finally might have enhanced the physiological activities inside the plant like plant height.

The similar result was observed by Tandel *et al.*, (2014), Shivakumar (2010), Suresh *et al.*, (2010) and Singh *et al.*, (2010) in papaya. Secondly things the increase in vegetative growth with increasing levels of nitrogen was because nitrogen is an important constituent of chlorophyll and amino acids. Similar observation has been reported by Jayasundara and Huruggamuwa (2005) and Akinyemi and Akande (2008).

The maximum no of leaves per plant at 180, 270 and 360 DAT in both the years was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the minimum no of leaves per plant was found under T10- Farmer's Practices. Increased number of leaves per plant might have produced more photosynthates in plants. It is evident that organic sources of nutrients have beneficial effect on growth and development of papaya (Babu *et al.*, 1989). Addition of organic manures to the soil in conjunction with chemical fertilizers and bioinoculants increases the availability of nutrients on long term basis, resulting in favorable effect on plant growth. Amiri *et al.*, 2008 and Amiri *et al.*, 2010 reported about the probiotic effect of microbial inoculants (viz; Trichoderma, Mycoplex and Mycorrhiza roots) in improving the plant growth parameters at the seedling stage in papaya. Increase in the vegetative growth may be either due to better root growth and root spread or improved nutrient availability to plants. Maximum petiole length at 180, 270 and 360 DAT for pooled analysis basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum*

(50g/plant) + *Azotobactor*(50g/plant), while the minimum petiole length was found under T10- Farmer's Practices. Sharma 2004, confirm the findings on petiole length followed a similar trend, This increase might be due to the availability of major as well minor nutrient elements at optimum proportion in the soil and assimilation of food material within the plant. The duration and petiole length was minimum under farmers' practices.

Maximum petiole girth at 180, 270 and 360 DAT in both the years for pooled analysis basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant)+*Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), while the minimum petiole girth was found under T10- Farmer's Practices.

Maximum leaf area at 180, 270 and 360 DAT for pooled analysis basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) +*Azotobactor* (50g/plant), while the minimum leaf area was found under T10- Farmer's Practices. The lowest leaf area was observed under farmers' practices at all the stages of plant growth. The higher leaf area under T7- 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) +*Azotobactor* (50g/plant) might be due to availability of full dose of recommended nitrogen and additional source of nitrogen through biofertilizers. It is well defined that nitrogen increases the chlorophyll synthesis resulting in more area for photosynthesis and net assimilation (Bhukta, 2000).

Maximum chlorophyll content at 180, 270 and 360 DAT for pooled analysis basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobactor* (50g/plant), while the minimum chlorophyll content was found under T10- Farmer's Practices. The papaya plants treated

with combined application of inorganic fertilizer and bio fertilizers treatment. Inorganic fertilizer had significantly boost the physiological parameters and resulted into higher production of photosynthates, translocation of water, nutrient and photosynthates resulting into rapid cell division. The bio fertilizers are play key role in utilization of nutrients in the soil like bio compost, vermi compost, caster cake with inorganic fertilizer are more efficient in maintaining a better photosynthetic efficiency, which is responsible to maintain a better physiological status of the plant. Higher photosynthetic activity is a good indication of physiologically efficient plants in banana.

This primarily depends upon the chlorophyll content of leaf. The chlorophyll content in leaves indicates the efficiency of photosynthesis, where the solar energy is converted into chemical energy. N, P and K were utilized efficiently by the plant, which resulted in producing maximum photosynthates in terms of high biomass and translocating the assimilated materials to the developing sink. The role of nitrogen and potassium in the functioning of chlorophyll is well established.

These results are in accordance with results reported by Kuttamani *et al.*, (2013). In general, treated plants registered more photosynthetic rate and transpiration. Plant photosynthesis appears complex concentration profiles influenced by many factors. According to Sharkey and Ogawa (1987) it has very close relation to photosynthesis, transpiration and respiration. In the present investigation increased rate of photosynthesis is associated with increased transpiration rate with maximum leaf temperature. The similar result was observed by Jeyakumar *et al.*, (2001) in papaya and Ghumare (2009) in sapota.

Table.1 Effect of inorganic and bio-fertilizers on vegetative growth of Papaya

Treatments	Plant height (cm)			Girth of stem (cm)			No of leaves per plant (cm)		
	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT
T ₁	122.92	169.24	175.29	26.84	41.06	45.06	21.88	31.21	40.88
T ₂	125.17	173.81	182.26	29.84	43.72	48.53	25.02	34.32	44.33
T ₃	124.84	172.00	183.09	29.01	42.94	47.87	23.36	32.78	42.80
T ₄	125.65	171.27	183.44	27.71	42.92	46.45	22.11	31.44	41.60
T ₅	120.16	160.25	171.41	23.97	34.49	43.81	21.82	31.83	41.60
T ₆	119.86	161.16	169.29	23.93	37.38	43.19	20.65	30.95	40.96
T ₇	131.46	178.23	185.94	30.45	44.55	50.76	25.19	34.58	44.93
T ₈	112.45	157.94	170.77	22.89	36.05	41.41	19.02	28.44	40.17
T ₉	112.39	157.97	169.57	22.81	35.41	40.75	18.65	28.31	38.73
T ₁₀	106.19	150.10	158.32	20.21	34.07	39.97	18.46	27.44	38.35
S.Em.±	0.1593	0.2021	0.187	0.0711	0.0944	0.0735	0.0502	0.0504	0.0453
CD at 5 %	0.4569	0.5796	0.538	0.2038	0.2709	0.2109	0.1440	0.1446	0.1299

Table.2 Effect of inorganic and bio-fertilizers on vegetative growth of Papaya

Treatments	Petiole length (cm)			Petiole girth (cm)			Leaf area (m ²)		
	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT
T ₁	24.06	33.56	40.55	8.65	8.68	8.97	4.74	7.06	9.12
T ₂	25.26	34.36	41.36	9.46	9.86	9.92	5.19	7.84	10.00
T ₃	25.13	34.14	41.13	9.25	9.28	9.33	4.45	7.34	9.62
T ₄	24.83	33.85	40.84	8.72	8.73	8.94	4.73	7.13	9.33
T ₅	23.76	32.78	39.77	8.62	8.64	8.75	4.62	6.95	8.95
T ₆	22.96	32.47	39.47	8.45	8.49	9.17	4.54	6.83	8.87
T ₇	25.96	36.47	43.46	9.64	9.87	10.04	5.22	7.97	10.20
T ₈	23.01	31.71	39.01	8.32	8.34	8.44	4.38	6.11	7.82
T ₉	22.76	31.77	38.77	8.15	8.17	8.21	4.24	5.97	7.36
T ₁₀	22.07	31.08	38.08	7.61	7.90	8.01	3.85	5.19	6.69
S.Em.±	0.0282	0.0331	0.0325	0.0128	0.0138	0.014	0.0089	0.0177	0.0236
CD at 5 %	0.0810	0.0950	0.0932	0.0366	0.0395	0.041	0.0255	0.0507	0.0677

Table.3 Effect of inorganic and bio-fertilizers on vegetative growth of Papaya

Treatments	Chlorophyll content (mg/100g tissue)			East-West Spread (cm)			North-South spread (cm)		
	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT	180 DAT	270 DAT	360 DAT
T ₁	132.89	131.37	130.25	145.54	164.03	173.03	127.79	171.36	177.59
T ₂	139.69	138.17	137.05	163.44	183.74	192.74	157.77	180.17	189.17
T ₃	136.59	135.02	133.89	154.25	174.82	183.82	151.53	178.95	187.95
T ₄	135.99	134.42	133.29	149.38	166.29	177.79	150.28	175.43	183.02
T ₅	131.92	130.40	129.27	142.93	160.77	169.77	141.74	162.72	171.73
T ₆	123.15	121.63	120.50	132.51	147.81	156.81	134.27	160.16	169.16
T ₇	144.09	142.57	141.45	164.44	190.56	199.41	159.97	183.87	192.87
T ₈	122.63	121.27	119.86	131.52	146.64	156.10	135.44	151.03	160.03
T ₉	121.70	120.36	117.20	131.56	146.63	155.21	133.63	146.20	155.20
T ₁₀	114.97	110.95	109.28	129.17	143.73	152.73	129.56	144.60	153.60
S.Em.±	0.1901	0.1994	0.2062	0.2725	0.3394	0.3400	0.2678	0.3018	0.2967
CD at 5 %	0.5452	0.5718	0.5914	0.7816	0.9734	0.9751	0.7680	0.8657	0.8509

Table.4 Effect of inorganic and bio-fertilizers on reproductive growth of Papaya

Treatments	Days taken for 1 st flower emergence	Days taken for 1 st fruit initiation	First bearing height (cm)	Girth at bearing height (cm)	Number of leaves at first bearing height (cm)
T ₁	107.62	138.76	69.10	5.67	23.19
T ₂	103.46	131.82	59.97	5.98	27.64
T ₃	105.14	133.99	64.87	5.87	25.55
T ₄	106.51	135.18	64.89	5.77	24.10
T ₅	111.14	139.89	67.93	5.55	22.58
T ₆	110.16	139.99	69.98	5.40	21.71
T ₇	102.17	128.40	59.46	6.91	29.12
T ₈	111.52	141.81	74.35	4.96	21.54
T ₉	111.89	141.81	71.54	4.87	20.56
T ₁₀	114.89	145.28	73.69	4.50	17.71
S.Em.±	0.0849	0.1072	0.1140	0.0138	0.0698
CD at 5 %	0.2436	0.3074	0.3270	0.0396	0.2001

Maximum East-West spread and North-South Spread at 180, 270 and 360 DAT in two years was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the minimum East-West spread and North-South Spread was found under T10- Farmer's Practices. It was observed that application of 75% RDF produced significantly higher plant spread and it was noted to be the highest at maturity. The highest plant spread under this treatment was mainly due to longer petiole length and maximum leaf area at this stage. In papaya, petiole length contributes maximum part of spread and it was positively influenced by this treatment. The minimum plant spread was recorded with the farmer's practices, in both directions during both the years and on pooled basis. This might be due to use of fertilizers without any other bio fertilizers dose of as well as other nutrients resulting in restricted growth and ultimately minimum plant spread (Sharma, 2004).

Reproductive growth (Table 4)

Minimum days taken for 1st flower emergence by pooled basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the maximum days taken for 1st flower emergence was found under T10- Farmer's Practices. This results conformity with Srinu *et al.*, 2017, the earliness in flowering might be due to the higher net assimilation rate on account of better growth leading to the production of endogenous metabolites earlier in optimum level enabling early flower reported by (Singh and Varu 2013) and (Yadav *et al.*, 2011) in papaya, and lower days taken to maturity, which might have improved the yield parameters by better presence and uptake of nutrient by plant roots and boosting the source - sink relationship by increasing the transportation of carbohydrates from the

leaves to the fruits. Similar findings have been observed by Yadav 2006, Srivastava 2008 in papaya. Early flowering could be attributed to higher availability and uptake of nitrogen, phosphorus and potassium in proper ratio (Rao and Rao, 1978 in CO 1 papaya; Purohit *et al.*, 1979 in Coorg Honey Dew papaya; Reddy and Kohli, 1989). Shivaputra *et al.*, (2004) also reported early reproductive phase in papaya with vermicompost + inorganic fertilizers. This was contradictory to the findings of Rajbhar *et al.*, (2010), who suggested that lesser nutrient level enhances early flowering in papaya at a lower node.

Minimum days taken for 1st fruit initiation by pooled basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the maximum days taken for 1st fruit initiation was found under T10- Farmer's Practices.

Minimum first bearing height by pooled basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the maximum first bearing height was found under T10- Farmer's Practices. These results are in close corroborated with the findings of Patil *et al.*, (1995) and Mahajan *et al.*, (1998) who reported 10-12 days earlier bearing/maturity in various vegetable crops with the use of fermented fresh cattle dung solutions.

Flowering and bearing height were significantly influenced due to fertigation levels and blending of nutrients. The application of 75% RDF with biofertilizers recorded significantly maximum flowering and it was minimum under only farmers practices. The application of inorganic fertilizers + PSB + *Azospirillum* was found to be statistically best in producing bearing height under both the years as well as on

pooled basis. Similar findings in respect of flowering and bearing height have been reported by Patil *et al.*, (1995) and Patil *et al.*, (1997).

Maximum girth at bearing height by pooled basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the minimum girth at bearing height was found under T10- Farmer's Practices.

Maximum number of leaves at first bearing height by pooled basis was observed under the treatment T7 - 75% RDF + PSB (50g/plant) + *Azospirillum* (50g/plant) + *Azotobacter* (50g/plant), while the minimum number of leaves at first bearing height was found under Farmer's Practices.

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