

Short communication

Effect of organic manures and biofertilizers on growth and yield attributes of papaya (*Carica papaya* L.)

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Abstract

An experiment was carried out at College of Agriculture, Vellayani, Kerala Agricultural University to study the effect of organic manures and biofertilizers on growth, yield and quality parameters of papaya with 11 treatments replicated thrice in randomised block design. Different doses of organic manures and bio fertilizers were applied to the plant on nitrogen equivalent basis. The study revealed that application of 100 per cent recommended dose of N in organic form along with AMF and PGPR Mix-1 significantly increased the fruit weight, fruit girth, fruit length, fruit volume, pulp percentage, flesh thickness of the fruit, and total yield of the plant compared to other organic treatments and 100 per cent RDF (240: 240: 480 g NPK plant⁻¹ year⁻¹ + FYM 10kg plant) increased the number of fruits per plant.

Key words: AMF, Papaya, Biofertilizers, PGPR Mix-1.

Papaya is an important tropical fruit crop which is popular for its nutraceutical properties. It is a good source of vitamin A, carotenoids, antioxidants and other minerals like Ca, Fe and Mn. Papain, the proteolytic enzyme obtained from the latex of papaya plant is an ingredient in cosmetic products, pharmaceuticals, etc. Year round production and cheap price of the fruit have made papaya an ideal fruit for the processing industry. Heavy bearing nature and quick growing habit makes papaya a highly nutrient exhaustive fruit crop. As harvests are intermittent from the start of production, the nutrient management for the crop has to be done judiciously as nutrients are frequently required (Mendonea et al., 2006). Dependence on chemical fertilizers to satisfy the nutrient requirements of the crop can have a negative impact on the physical properties of the soil, health and productivity. In this context, the present investigation on the effect of organic manures and biofertilizers on yield of papaya was initiated.

The study was conducted in the Department of Pomology and Floriculture, College of Agriculture, Vellayani during 2016 in randomised block design with 11 treatments replicated thrice. The papaya variety, Surya released from IIHR was used for the study. Combinations of different organic manures [farm yard manure (FYM), vermicompost and poultry manure] and biofertilizers [Arbuscular Vesicular Mycorrhiza (AMF) and Plant Growth Promoting Rhizobacteria (PGPR) Mix-1] were evaluated for the effect on growth and yield of papaya. The treatments included were :100% recommended dose of nitrogen (RDN) as organic source (T₁); 75% RDN as organic source (T₂); 100% RDN as organic source + PGPR Mix-1 (T₃); 75 % of RDN as organic source + PGPR Mix-1 (T₄); 100% of RDN as organic source + AMF(T₅); 75% RDN as organic source +AMF (T₆); 100% RDN as organic source + PGPR Mix-1 + AMF (T₇); 75% RDN as organic source + PGPR Mix-1+AMF(T₈); Full dose of recommended NPK+ Vermicompost

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(T₉); Full dose of recommended NPK as 240:240:480 g per plant per year in the form of urea, muriate of potash and rock phosphate respectively (T₁₀); Absolute control (T₁₁).

The package of practice recommendation of NPK included in the study was 240:240:480 g NPK per plant per year. Basal dose of FYM, 10 kg/plant as per recommendation, was applied uniformly to all treatments except T₉ and T₁₁. In T₉, vermicompost in quantity equivalent to the N content in 10 kg FYM was applied. Organic manures were applied on N equivalent basis in six splits at two months interval. Combination of FYM, poultry manure and vermicompost in the ratio of 2:1:1 was the organic sources used to supply the RDN of 240 g/plant. Additional requirement of P and K was met through application of rock phosphate and potassium sulphate respectively. Arbuscular vesicular mycorrhiza was applied at the rate of 5 g/plant at time of planting and PGPR Mix- I @ 5 g/ plant was applied twice, as basal dose and one month after planting. *Pseudomonas fluorescens* was applied as foliar spray (2%) at bimonthly intervals and *Trichoderma* enriched cowdung (25g) as basal application was given uniformly to all treatments except T₁₀ and T₁₁. Papaya seeds were treated with

Pseudomonas fluorescens (2%) and sown at a spacing of 2m x 2 m in the experimental plots. Growth and yield parameters were recorded at regular intervals and at harvest. The data were statistically analysed statistically in Randomized Block Design and significance was tested using analysis of variance technique

The data on the plant height recorded at 2, 6 and 12 months after planting (MAP) revealed the significant variations with the nutrient sources used (Table 1). Application of 75 per cent RDN in organic form + AMF (T₆) and 100 per cent RDN in organic form + PGPR Mix-1 and AMF (T₇) showed significantly greater plant heights (299.33 cm and 267 cm) and were on par. The increase in plant height may be attributed to the fixation of N by the microorganisms and regulation of N supply to the plants (Babu, 2003). Ravishankar and Karunakaran (2010) reported an increase in plant height of papaya with the organic treatment of rock phosphate 300 g/plant along with sun hemp 40 kg/plant. The girth of the plant at 12 MAP was found to be greatest (55.03 cm) in the combination of 100 per cent RDN (organic) + PGPR Mix-1 and AMF. The AMF inoculation increased the plant growth of papaya by increased mycelial biomass which explored large

Table 1. Effect of organic manures on plant height and girth of papaya of papaya

Treatments	Plant height (cm)						Plant girth (cm)					
	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
T ₁	61.00	88.66	124.66	179.66	206.33	244.66	9.23	12.06	21.40	28.33	37.33	42.70
T ₂	54.33	106.66	119.66	188.33	218.33	223.33	10.90	14.66	21.73	29.03	37.40	43.33
T ₃	72.73	77.33	154.33	198.00	216.33	264.66	12.36	17.50	21.70	31.06	38.70	50.03
T ₄	56.33	93.00	129.33	172.66	205.00	254.33	13.16	18.40	24.33	31.06	39.20	44.73
T ₅	70.33	91.73	133.33	174.66	214.33	245.33	13.60	20.70	27.36	34.06	41.66	50.00
T ₆	85.16	125.66	164.50	199.33	241.00	291.33	13.73	22.16	31.20	39.36	41.03	54.70
T ₇	75.33	100.00	157.66	181.33	227.00	267.00	17.10	22.36	33.03	40.00	48.83	55.03
T ₈	67.00	86.33	137.00	176.00	217.33	245.33	10.63	16.03	25.70	32.03	40.43	44.00
T ₉	74.06	104.00	138.66	186.00	226.33	254.33	12.70	18.06	26.36	32.70	40.03	46.00
T ₁₀	77.83	115.66	169.00	209.33	243.66	263.00	13.30	20.03	27.03	33.00	40.73	50.00
T ₁₁	50.00	68.66	100.00	170.33	192.33	217.33	8.46	12.03	20.03	27.03	34.00	38.00
SEm±	9.19	6.46	13.07	13.33	15.40	13.38	1.27	2.24	1.39	1.63	1.72	1.72
CD (0.05)	19.172	NS	27.273	NS	NS	27.919	3.667	3.682	2.919	3.409	3.592	3.603

T₁-100% of recommended dose of N as organic, T₂-75% of recommended dose of N as organic, T₃-100% of recommended dose of N as organic + PGPR Mix-1, T₄-75 % of recommended dose of N as organic + PGPR Mix-1, T₅-100% of recommended dose of N as organic + AMF, T₆-75% of recommended dose of N as organic + AMF, T₇-100% of recommended dose of N as organic + PGPR Mix-1+ AMF, T₈-75% of recommended dose of N as organic + PGPR Mix-1+ AM F, T₉-Full NPK of KAU POP + Vermicompost (N equivalent to FYM of KAU POP), T₁₀- 100% RDF (240:240:480 g NPK plant/year, FYM-10 kg/plant/year), T₁₁- Absolute control

Table 2. Effect of organic manures on height at first flowering, days to flowering, number of flowers per cluster, fruit set per cent and days to first harvest in papaya

Treatments	Height at first flowering (cm)	Days to flowering	Number of flowers per cluster	Fruit set %	Days to first harvest
T ₁	90.33	178.0	2.00	70.00	254.3
T ₂	96.00	179.3	1.67	71.33	249.6
T ₃	86.00	172.6	1.33	73.00	247.3
T ₄	77.00	173.0	2.33	78.00	250.3
T ₅	78.67	163.3	1.33	79.00	232.6
T ₆	75.67	156.6	1.67	74.66	219.3
T ₇	71.67	153.3	2.67	83.66	220.6
T ₈	87.00	166.6	1.67	73.00	238.6
T ₉	86.67	166.6	2.33	73.33	242.3
T ₁₀	90.00	166.0	1.67	75.33	233.6
T ₁₁	93.67	183.6	1.33	62.66	254.6
SEm±	3.53	2.97	0.52	2.90	3.11
CD (0.05)	7.382	6.212	NS	6.062	6.503

soil volume, thus resulting in higher nutrient uptake rates (Gharge et al., 2014).

Application of 100 per cent RDN (organic) + PGPR Mix-1 reduced the number of days taken for first flowering and height at first flowering (Table 2). The influence of the organic manure combinations on the number of flowers per cluster was not significant. The results were in agreement with the reports of Shijini (2010), who noted that application of vermicompost and *Trichoderma* along with RDF in papaya reduced the height at first flowering and number of days for flowering. Results corroborate the earlier reports of Lima and Hawa (2007).

The highest percentage of fruit set was observed in the treatment 100% RDN (organic) + PGPR Mix-1 and AMF which differed significantly from all other treatments. Earliness in harvest of fruits was recorded in plants receiving 75 per cent RDN (organic) + AMF (T₆) and 100 per cent RDN (organic) + PGPR Mix-1 and AMF (T₄). Similar results were reported by Dutta et al. (2010) wherein early harvest of papaya fruits was recorded in plants treated with *Azotobacter* + *Azospirillum* + VAM + FYM.

Perusal of the data in Tables 3 and 4 reveal the significantly higher values for fruit characters in T₇ [100 % RDN (organic) + PGPR Mix-1 and AMF].

Table 3. Effect of organic manures on fruit weight, length and girth of papaya

Treatments	Fruit weight (g)	Fruit length(cm)	Fruit girth (cm)
T ₁	507.24	16.50	30.67
T ₂	483.33	16.16	29.00
T ₃	587.46	17.83	37.06
T ₄	518.31	16.93	31.33
T ₅	666.63	20.23	37.06
T ₆	596.59	18.56	32.50
T ₇	804.86	20.63	40.33
T ₈	621.89	17.83	32.90
T ₉	640.70	18.53	32.50
T ₁₀	624.44	18.67	37.11
T ₁₁	311.19	15.03	26.13
SEm±	1.28	0.65	1.17
CD (0.05)	2.682	1.33	2.441

Fruit weight (804.86g), fruit length (20.63cm), fruit girth (40.33cm), fruit volume (705.71g/cm), pulp per cent (82.43%), flesh thickness (3.36cm) were maximum in this treatment. Results of the study were in agreement with the findings of the trial conducted by Dutta et al. (2010), in which the incorporation of *Azotobacter*, *Azospirillum* and VAM along with 2 kg FYM per plant improved the fruit characters in papaya. The soil aeration, improved by the application of organic manures and increased physiological activities of soil, increased the yield attributes in banana (Hazarika and Ansari, 2010). Ravishakar and Karunakaran (2010) also documented maximum fruit weight in papaya with organic nutrition by application of FYM 20 kg/plant

Table 4. Effect of organic manures on fruit volume, pulp, flesh thickness, number of fruits and yield per plant

Treatments	Fruit volume (cc)	Pulp %	Flesh thickness(cm)	Number of fruits/ plant	Total yield/plant(kg)
T ₁	445.98	67.00	2.33	48.33	24.61
T ₂	422.32	68.67	2.20	40.10	21.28
T ₃	514.77	69.67	2.33	49.26	32.49
T ₄	448.88	76.83	2.46	40.56	20.28
T ₅	582.58	79.83	3.16	48.27	32.63
T ₆	521.44	73.00	2.53	38.85	23.41
T ₇	705.71	82.43	3.36	49.78	39.91
T ₈	545.57	77.00	3.00	47.20	29.54
T ₉	560.14	72.00	2.90	50.48	34.12
T ₁₀	547.65	80.23	3.10	50.82	33.66
T ₁₁	271.32	60.00	1.86	38.72	15.26
SEm±	3.93	2.87	0.14	0.81	1.04
CD (0.05)	8.211	6.002	0.333	1.686	2.034

along with neem cake at 4 kg and wood ash at 2.5 kg per plant.

However, the number of fruits per plant was the highest (50.82) in T₁₀ which involved application of 100 per cent NPK dose (240:240:480 g NPK/plant/year), and was on par with T₉ (50.48), T₇ (49.78) and T₃ (49.26) through the uptake of nutrients which were readily available in absorbable form. The highest yield/plant (Table 4) was recorded for T₇ (39.91 kg) which was significantly different from other treatments. The results were in conformity with the findings of Shivakumar et al. (2012), who noticed that application of farm yard manure along with 100% recommended dose of nitrogen resulted in high fruit yield in papaya variety Surya.

The higher values for flesh thickness and pulp percentage of fruits in the present investigation recorded in T₇ and T₁₀ was according to the report of Kirad et al. (2010) that application of 75 per cent recommended dose of fertilizers along with 25 per cent of vermicompost and rhizosphere bacterial culture improved the flesh thickness and pulp percentage along with other yield parameters. Singh et al. (2010) reported that continuous supply of higher rate of organic manure improved the productiveness of papaya.

From the overall assessment of the growth and fruit yield characters of papaya as influenced by different nutrient sources, 100 per cent recommended dose of nitrogen in organic form (FYM, vermicompost and poultry manure) along with PGPR Mix-1 and AMF was the best treatment in increasing the growth and yield of papaya

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