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Effect Of Different Integrated Nutrient Management On Growth, Yield And Quality Of Papaya (*Carica Papaya* L.) *Cv*. Red Lady

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ABSTRACT
A field experiment was conducted at College of Agriculture College, Department of Horticulture, Hyderabad the effect of integrated nutrient management on fruit characters and economics of papaya cv. red lady during 2014 and 2015. The experiment laid out RBD design with ten treatments including organic, inorganic and bio fertilizers were comprised with three replications. Results indicated that crop growth and fruit quality were higher in T_9 treatment (75% RDF + 10 kg VC +100g Azotobacter +100g PSB plant^{-1}). There was significant variation in average fruit weight and TSS, titrable acidity as compare to other treatments.
***Key words**: Bio - fertilizers, Fruit length, Fruit weight, INM, Pulp thickness, TSS.*

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INTRODUCTION

Papaya (*Carica papaya L.*) also called papaw or pawpaw, is a quick growing, typically singled stemmed, short lived, perennial herb. It belongs to family Caricaceae is an important fruit crop among fruit crops and attained unprecedented popularity in recent years, due to largely its ease of cultivation, quick returns, and adoptability to diverse soil and climate conditions. It is now distributed throughout tropical and subtropical regions of the world.

It is a highly problematic, complicated and interesting fruit crop from botanical, genetical, cytogenetical and horticultural points of view. Papaya is indigenous to South Mexico and Costa Rica. It was introduced to India from Malacca. It is cultivated throughout the tropics both for fresh fruits and papain. In India it is grown in area of 133 lakh ha with a production of 5699 M.T (NHB, 2015 - 16).

MATERIALS AND METHODS

The experiment was conducted at College of Agriculture, P.J.T.S.A.U, Deportment of horticulture experimental field Rajendranagar, Hyderabad during the period of 2014 - 2015 and 2015 - 2016. The experiment laid out Randomized Block Design with ten treatments and three replications. The treatments comprised likewise, T_1 - RDF (200 N: 200 P_2O_5: 250 K_2O g/plant), T_2 - RDF + 20 kg FYM plant^{-1}, T_3 - RDF + 10 kg vermicompost plant^{-1},T_4 - RDF + 5 kg Neem cake plant^{-1}, T_5 - RDF + 20 kg FYM plant^{-1} + 100g *Azotobacter* + 100g *PSB* plant^{-1}, T_6 - RDF + 10 kg VC + 100g *Azotobacter* +100g *PSB* plant^{-1}, T_7 - RDF + 5 kg NC + 100g *Azotobacter* +100g *PSB* plant^{-1}, T_8 - 75% RDF + 20 kg FYM plant^{-1} + 100g *Azotobacter* + 100g *PSB* plant^{-1}, T_9 - 75% RDF + 10 kg VC +100g *Azotobacter* +100g *PSB* plant^{-1}, T_{10} - 75% RDF+ 5 kg NC +100g *Azotobacter* + 100g *PSB* plant^{-1}. The seedlings of papaya were transplanted in the field adopting a spacing of 2.5 × 2.5 m. **Standard procedures**: Vegetative parameters like higher number of fruits per plant, fruit length, fruit weight, pulp thickness, Fruit yield (kg plant^{-1}) was recorded periodically. Fruit quality attributes such as TSS, total sugars, acidity and ascorbic acid also recorded as per standard procedure. Statistically analysis of data was done based on methods given by Pane and Sukhatme (1985).

RESULTS AND DISCUSSION

Vegetative characters: Vegetative parameters such as plant height, stem girth, petiole length, number of leaves per plant, days to first flowering, day to fruit maturity at 330 days from planting were affected by various application of organic manures, inorganic fertilizers and *biofertlizers* in combination significantly influenced plant growth characters. It is evident from (table 1). Maximum plant height (212.85 cm), stem girth (52.48 cm), petiole length (52.93 cm), number of leaves per plant (46.85) was recorded in T_9 treatment. Significantly lower plant height and stem girth was recorded with T_1 (RDF) treatment. The similar result was reported by Tandel *et al.* (2014), Aneesa Rani and Sathiamoorthy (1997), Shivakumar (2010), Suresh *et al.* (2010) and Singh *et al.* (2010) in papaya and Jeyabaskaran *et al.* (2001). It could be because of continuous supply of available nutrient from organic and inorganic form and effect of bio active substance produced by common application of bio fertilizers. Organic manures along with biofertilizers also improve the aeration in the soil which ultimately might have improved the physiological activities inside the plant like plant height, stem girth and petiole length.

Lower days to first flowering of (139.64 days) and days to fruit maturity (200.82 days) were recorded in T_9 treatment. Significantly higher days to first flowering were recorded with T_1 treatment (170.12 days) and which was on par with T_2 treatment (168.83 days). 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.,* 2011a) in papaya. These results are in conformity with the findings reported by Shivakumar (2010) and Suresh *et al*. (2010) in papaya and Jeyabaskaran *et al.* (2001).

Fruit yield: fruit yield in terms of number of fruits and their weight were found to be significantly different among various treatments (Table 2). The maximum number of fruits per plant (32.22), fruit length (26.34), number of fruits per plant (32.22), pulp thickness (2.34 cm) and fruit yield (31.72 kg $plant^{-1}$) were recorded significantly T_9 treatment. The significance response of *Azotobacter,* organic manure with part supplementation with inorganic fertilizers had positively and significantly influenced the yield attributes. It is well known that efficiency of bioagent can be well exploited with the use of organic manure with inorganic fertilizers (Suther, 2009) which might have improved the yield parameters by better availability and uptake of nutrient by plant roots and enhancing the source - sink relationship by increasing the movement of carbohydrates from the leaves to the fruits. Similar findings have been reported by Yadav (2006), Srivastava (2008) and Sha and Karuppaiah (2010).The results also in close conformity with the findings of Ravishanker *et al.* (2010) and Chaudhri *et al*. (2001) in papaya.

Fruit quality attributes: it is evident from (Table 2) significantly minimum loss of weight was recorded in treatment T_9 treatment (9.71%) and maximum value of weight loss was observed in control treatment T_1 treatment (18.29%). This might be due to high population of microbes, organic manures usually help to degrade and mobilize the nutrients to available form. The presence of vital nutrients and some unidentified metabolites like GA_3 might have acted as ripening retardants leading to reduced respiration, transpiration and weight loss with extended shelf life (Shivakumar, 2010). Minimum firmness was recorded in treatment T_1 (control) and maximum value of firmness was obtained with treatment T_9 treatment. Presence of epicuticular wax on the fruit skin also reduces respiration and transpiration during post harvest period by partially blocking the lenticels, cuticle and consequently retards the moisture loss caused by transpiration. Higher availability of secondary nutrients, metabolite s like GA_3 and reduced gaseous exchange effects delay in ripening, senescence, less tissue break down and softening of tissue which increases firmness and extends storage life. These results are in conformity with the findings reported by Singh *et al*. (2010) in papaya and Bhavidoddi (2003) and Patel (2008) in Banana. Minimum spoilage was recorded in treatment T_9 (45.43%) and maximum value of spoilage was observed in T_1 treatment (64.43%). Significantly minimum TSS was recorded in treatment T_1 (6.95 ^{0}Brix) and maximum value of TSS was obtained with treatment T_9 (10.62 ^{0}Brix) which was followed by T_7 treatment (Table 3). Minimum reducing sugars were recorded in treatment T_1 treatment (7.68 %) and Maximum value of reducing sugars were obtained with treatment T_8 (9.01 %) and which was on par with T_9 treatment (8.97 %). Significantly minimum total sugars were recorded in treatment 8.68 % (control) and maximum value of total sugars were obtained with treatment T_9 (10.91 %). Minimum ascorbic acid was recorded in control (20.52 mg/100g pulp) and maximum value of ascorbic acid was obtained with treatment T_9 (23.51 mg/100 g pulp). The application of different treatments had no significant effect on acidity of papaya. It might be due to the addition of organic manures supplements ample of nutrients, moisture and growth promoting substances which enhances metabolic and hormonal activity of the plant and that promotes production of more photosynthates which was stored in fruits in the form of starch and carbohydrates. It is an established fact that the transformation of mature fruit into ripe form *i.e.*, during the process of ripening in storage the fruit undergoes physical, physiological and biochemical changes. The increase in TSS, Total sugar and ascorbic acid content of papaya fruits could be attributed to the conversion of reserved starch and other insoluble carbohydrates into soluble sugars. The reduction of titratable acidity of papaya fruits through application of different organic manure with inorganic fertilizer might be due to the positive influence of boron and zinc in conversion of acids into sugar and their derivatives by the reaction involving glycolytic path way or be used in respiration both (Singh *et al*., 2010). These results elucidate the findings of Singh *et al.* (2013), Ganeshamurthy *et al*. (2004), Shivakumar (2010), and Yadav *et al.* (2011a) in papaya and El-Naby (2000).

Table 1. Effect of different integrated nutrient management on vegetative growth parameters

Treatments	Plant height (cm)	Trunk girth (cm)	Petiole length (cm)	No. of leaves/ Plant	Days taken to first flowering (Days)	Days taken to fruit maturity (Days)
RDF (200 N: 200 P_2O_5: 250 K_2O g/plant)	178.18	41.08	45.03	44.90	170.12	214.58
RDF + 20 kg FYM plant^{-1}	190.25	46.38	45.00	40.47	168.83	210.88
RDF + 10kg Vermicompost plant^{-1}	187.37	45.75	42.21	42.52	169.84	211.97
RDF + 5 kg Neem cake plant^{-1}	188.68	47.55	39.75	40.34	165.04	218.61
RDF + 20 kg FYM plant-1 + 100g *Azotobacter* + 100g *PSB* plant-1	187.24	47.03	43.06	41.50	164.03	212.45
RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	192.46	48.51	44.34	41.84	164.86	215.67
RDF + 5kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	182.06	48.15	46.41	40.93	162.65	215.31
75% RDF + 20 kg FYM plant-1 + 100g *Azotobacter* + 100g *PSB* plant^{-1}	199.97	50.75	50.34	44.34	166.21	209.84
75% RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	212.85	52.48	52.93	46.85	139.64	200.82
75% RDF + 5 kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	190.39	49.05	44.43	42.66	165.95	210.96
S.Em. ±	2.81	0.65	1.34	0.53	0.96	1.86
C.D at 5%	8.23	1.91	3.94	1.55	2.81	5.44

Table 2. Effect of different integrated nutrient management on fruiting parameters

Treatments	Fruit weight (g)	Pulp thickness (cm)	Fruit length (cm)	Number of fruits per plant	Fruit yield (kg plant^{-1})
RDF (200 N: 200 P_2O_5: 250 K_2O g/plant)	1682.34	1.67	23.83	22.06	20.66
RDF + 20 kg FYM plant^{-1}	1743.00	1.91	19.47	23.11	22.45
RDF + 10kg Vermicompost plant^{-1}	1632.08	1.86	22.66	24.09	23.68
RDF + 5 kg Neem cake plant^{-1}	1473.85	1.70	19.20	27.08	24.67
RDF + 20 kg FYM plant^{-1} + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1577.45	1.63	24.45	26.76	25.77
RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1731.94	1.54	21.86	28.48	26.74
RDF + 5kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1795.00	1.38	21.07	28.69	27.76
75% RDF + 20 kg FYM plant^{-1} + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1861.85	2.22	23.25	28.02	29.81
75% RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1929.12	2.34	26.34	32.22	31.72
75% RDF + 5 kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	1750.16	1.68	21.24	28.81	29.79
S.Em. ±	37.09	0.07	0.23	0.29	0.10
C.D at 5%	108.78	0.21	0.69	0.84	0.28

Table 3. Effect of different integrated nutrient management on quality parameters

Treatments	PLW (%)	Firmness (kg cm^{-2})	Spoilage (%)	TSS (^{0}Brix)	Reducing sugars (%)	Ascorbic acid (mg/100g of pulp)	Titrable acidity (%)	Total sugars (%)
RDF (200 N: 200 P_2O_5: 250 K_2O g/plant)	18.29	5.88	64.43	6.95	7.68	20.49	0.19	8.68
RDF + 20 kg FYM plant^{-1}	15.15	7.23	47.58	7.44	8.19	20.68	0.18	9.53
RDF + 10kg Vermicompost plant^{-1}	15.89	6.99	52.89	7.42	8.83	22.01	0.18	9.89
RDF + 5 kg Neem cake plant^{-1}	15.79	7.39	49.18	7.89	8.24	22.51	0.16	10.20
RDF + 20 kg FYM plant-1 + 100g *Azotobacter* + 100g *PSB* plant^{-1}	15.66	7.68	49.32	8.11	8.41	21.50	0.20	9.63

RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	15.06	7.09	52.90	7.99	8.46	22.22	0.18	10.36
RDF + 5kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	15.17	7.52	46.00	8.46	8.54	22.70	0.18	10.37
75% RDF + 20 kg FYM plant-1 + 100g *Azotobacter* + 100g *PSB* plant^{-1}	11.00	7.31	48.40	8.45	9.01	23.03	0.14	10.66
75% RDF + 10 kg VC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	9.71	8.36	45.43	10.62	8.97	23.63	0.13	10.91
75% RDF + 5 kg NC + 100g *Azotobacter* + 100g *PSB* plant^{-1}	13.73	6.35	51.37	7.65	8.23	20.69	0.17	10.50
S.Em. ±	0.54	0.04	1.70	0.12	0.04	0.21	0.01	0.08
C.D at 5%	1.59	0.13	4.97	0.36	0.13	0.63	NS	0.24

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