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Impact of integrated nutrient management on growth parameters of papaya (*Carica papaya* L.) Cv. red lady under net house

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Abstract
The present investigation was conducted during the year 2018-19 at Research Farm of Centre of Excellence on Protected Cultivation and Precision Farming under net house, College of Agriculture (IGKV) Raipur (C.G.). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replication and ten treatments. The treatment consists of ten different combination of organic manure and bio-fertilizers along with recommended dose of fertilizer. Result indicated that treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant) showed highest plant height (255.47), plant spread North-South (232.33) & East-West (246.67), plant girth (50.77), number of leaves (53.75), earliness in flowering (70.41days), lower days to fruiting (104.81days) and flowering to maturity (196.33 days) after transplanting.

Keywords: Papaya, organic manure, RDF, Azatobacter, PSB

Introduction
Papaya *Carica papaya* L. belongs to family Caricaceae having 48 recognized species and among them, *Carica papaya* L. is only species grown for edible fruits (Chadha, 1992) [2]. Papaya is a polygamous plant with fundamental types of gender – pistillate, hermaphrodite and staminate where pistillate is stable in proportion to the rest form. Papaya is a evergreen plant with a hollow, unbranched, softwood stem. The leaves are very lengthy with petiole looks like palms. Papaya's nutritional and medicinal properties are well recognized for good source of vitamin C, along with high in sugar and pectin content. Papaya is originated in Mexico as a cross between two species of the genus Carica. It was brought from Malacca to India. In India it is grown in area 132.41 thousand hectare with production of 5667.06 thousand Metric ton (Anony.2017) [1] Now it is cultivated in tropical and subtropical part of the word. Essential nutrients are necessary to accomplish different physiological functions in crops in suitable quantities. To accomplish nutrient requirement for crop chemical fertilizer is mostly used.
Chemical fertilizer deteriorates the soil's physical, chemical and biological characteristics and, in turn, soil productivity. Since ancient times, the significance of organic manures in Indian agriculture has been recognized because they consist of N, P, K and also have a healthy quantity of micronutrients. This increases the accessibility of nutrients applied and indigenous to the soil. It also increases soil texture, composition, porosity, infiltration rate, aeration, microbial population and better root development with positive impacts on crop yield, quality and post-harvest characteristics. Integrated Nutrient Management relates to maintaining soil fertility and crop nutrient supply at an optimal rate of production by optimizing the advantages of all available organic, inorganic and biological component sources.

Material and Methods
The present experiment was carried out during the year 2018-2019 under the net house of Centre of Excellence on Protected Cultivation and Precision farming, College of Agriculture, IGKV, Raipur (C.G.). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replication and ten treatments. The treatment consist of ten different combination of organic manure and bio-fertilizers along with recommended dose of fertilizer i.e. T_0 : RDF (200 N, 250 P_2O_5, 250 K_2O g/ Plant + Control, T_1: RDF + 20 kg FYM/plant, T_2 : RDF + 10kg Vermi-compost /plant, T_3 : RDF + 5 kg Neem Cake /plant, T_4 : RDF +20 kg FYM/plant+ 100 g *Azotobacter* + 100g PSB /plant, T_5: RDF +10 kg Vermi-compost +100 g *Azotobacter* + 100g PSB /plant, T_6: RDF + 5 kg Neem cake +100 g *Azotobacter* + 100g PSB/Plant, T_7: 75% RDF + 20kg FYM/plant +100g *Azatobacter* +100 g PSB /plant, T_8: 75% RDF +10kg Vermi-compost +100 g *Azatobacter* +100 g PSB/plant, T_9 : 75% RDF + 5 kg

Neem Cake+100 g *Azotobacter* +100 g PSB /Plant. Papaya sapling were planted at spacing of 1.8 x 1.8 metre of spacing. Biofertilizer that is *Azatobacter* and phosphate solubilizing bacteria were applied along with Vermicompost and FYM before transplanting.

Result and discussion

After 180 days of transplanting maximum plant height (255.47 cm) was attained by treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant). The minimum plant height (216.62 cm) was achieved by treatment T_0 (RDF + Control). Increase in plant height under treatment T_9 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant) may be due to enhancement in physical as well as chemical property of soil, higher uptake of nutrient results in form of growth. Organic manure integrated with biofertilizer may have helped better aeration so as to increase plant height. Similar result was also reported by Srinu *et al.* (2017) [8], Tandel *et al*. (2014) [10] and Shivakumar (2010) [7] in papaya.

Studied on North-South direction revealed that maximum plant spread 232.33 cm was performed by T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant). The minimum plant spread 196.67 cm was achieved by T_0 (RDF + Control) after 180 days of transplanting. Investigation on East-West direction revealed that maximum plant spread 246.67 cm was achieved by T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant). The minimum plant spread 195.93 cm was achieved by T_0 (RDF + Control) which was at par with T_1-200.49cm after 180 days of transplanting. It has been reported that biofertilizers that of *Azotobactor* sp. and Pseudomonas sp., which are known to fix atmospheric N_2 improves vegetative growth by benefiting host plants through supply of growth hormones and vitamins (Shaban and Mohsen, 2009) [6].

Maximum plant girth (50.77 cm) obtained under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant) at 180 DAT. Minimum plant girth (38.82 cm) was achieved by T_0 (RDF + Control) after 180 days of transplanting. The application of organic sources and bioinoculants produced variety of growth substances and antifungal substances, which ultimately helpful in promoting vegetative vigour of the plants. Similar finding was observed by Meena *et al.* (2014) [3] in guava.

Maximum number of leaves (53.75) obtained under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant) at 180 days after transplanting. Minimum plant leaves (44.74) was achieved by T_3 (RDF + 5kg Neem Cake/ plant) which was at par with T_0 (RDF + Control) with 45.47 leaves. Similarly, after 180 days of transplanting, maximum petiole length of (92.02cm) obtained under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant). Minimum petiole length (77.83 cm) was noted in T_3 (RDF + 5kg Neem Cake/ plant). Probably, the application of organic sources and bioinoculants produced variety of growth substances and antifungal substances, which ultimately helpful in promoting vegetative vigour of the plants. The result in higher biomass production has showed by production of petiole length.

Among the all treatment minimum days to flowering (70.41) were observed under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant) and that was followed by T_7 which have taken 75.83 days to flowering. Maximum days taken to flowering is by T0 (RDF + Control) that is 101.85 days. Among the all treatment minimum days to fruiting (104.81) were observed under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant), which is followed by T_7 & T_9 which have taken 114.53 & 118.66 days to fruiting. Maximum days taken to fruiting is by T_0 (RDF + Control) that is 132.82 days. Among the all treatment minimum days to flowering to maturity (196.33) were observed under treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant), which is followed by T_9 which have taken 196.33 days. Maximum days (218) taken from flowering to maturity is by T_0 (RDF + Control) which was at par with T_1, T_2 & T_3 which have matured at 213.67, 214.33 & 216 respectively. This is due to improved nutritional accessibility and nutrient uptake through plant roots and improved source sink relationship by increasing carbohydrate flow from leaves to fruit.

Table 1: Effect of Integrated Nutrient Management on growth parameters of papaya cv. Red Lady under net house.

	Treatments	Plant height (cm) 180 DAT	Plant spread (cm)		Plant girth(cm)
			N-S	E-W	180 DAT
T_0	RDF + Control	216.62	196.67	195.93	38.82
T_1	RDF + 20 kg FYM/plant	232.17	208.67	200.49	43.98
T_2	RDF + 10 kg Vermicompost /plant	240.95	208.67	209.62	43.60
T_3	RDF + 5 kg Neem Cake /plant	232.60	215.00	213.44	44.20
T_4	RDF + 20 kg FYM/plant + 100 g *Azotobacter*+ 100g PSB /plant	242.64	214.33	216.81	43.79
T_5	RDF + 10 kg Vermicompost +100g *Azotobacter* + 100g PSB /plant	248.50	210.00	212.58	44.92
T_6	RDF + 5 kg Neem cake + 100 g *Azotobacter* + 100 g PSB/Plant	245.47	215.33	220.45	46.39
T_7	75% RDF + 20 kg FYM /plant + 100 g *Azatobacter* +100 g PSB /plant	251.77	214.33	227.59	47.44
T_8	75% RDF + 10 kg Vermicompost + 100 g *Azatobacter* +100 g PSB/plant	255.44	232.33	246.67	50.77
T_9	75% RDF + 5 kg Neem Cake +100 g *Azotobacter* +100 g PSB /Plant	251.05	215.00	233.82	46.53
	SE(m)±	1.25	3.43	3.02	0.72
	CD at 5%	3.72	10.26	8.99	2.15

Table 2: Effect of Integrated Nutrient Management on growth parameters of papaya cv. Red Lady under net house.

Treatment	Number of leaves	Petiole length(cm)	Days taken to first flowering	Days taken to first fruiting	Days taken to flowering to maturity
T_0	45.47	78.52	**101.85**	**132.82**	**218.00**
T_1	45.26	84.97	95.67	128.97	213.67
T_2	46.70	82.85	93.00	129.80	214.33
T_3	44.74	77.83	88.00	128.33	216.00
T_4	47.38	81.46	89.00	126.50	209.67
T_5	48.90	86.64	88.00	125.83	212.33
T_6	49.35	86.74	79.67	126.27	210.00
T_7	50.30	90.04	75.83	114.53	200.00
T_8	53.75	92.02	70.41	104.81	196.33
T_9	49.81	88.90	79.00	118.66	204.33
SE(m)±	0.99	0.65	1.01	1.01	1.72
CD at 5 %	2.95	2.00	3.01	3.01	5.12

Conclusions

From the present finding it can be concluded that the growth attributing parameters like plant height, plant spread, number of leaves, petiole length were high and days to first flowering, fruiting and maturity were minimum in treatment T_8 (75% RDF + 10 kg Vermi-compost + 100 g *Azotobacter* +100 g PSB/Plant).

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