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Effect of organic manure and bio-fertilizer on quality and benefit: Cost ratio of papaya (*Carica papaya* L.) Cv. Red Lady

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Abstract
The present investigation was carried out at Krishi Vigyan Kendra, Balod, Indira gandhi Agricultural University, Raipur, Chhattisgarh during the year 2018 -19 and 2019-20, respectively and was laid out in Randomized Block Design (RBD), the experiment comprising ten treatments and three replications. 200:200:200 gm NPK /plant were applied as per recommendation in all ten treatments combinations involving different organic manures and biofertilizers. The results revealed that the fruit yield per plant (38.95 kg) and per ha(116.86), were found significant in papaya plants supplied with RDF +Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant. Regarding quality parameters, lowest titratable acidity (0.015%) and higher content of total soluble solids(8.0^{0}Brix), total sugars (9.73%), were also noted in treatment RDF +Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant and Maximum reducing sugars (8.79%) and minimum non- Reducing sugar (0.94%) found with the treatment RDF+ FYM@ 10 kg /plant +Azospirillum @ 10 gm / plant + PSB @10 gm / plant. The highest net realization of Rs. 711911.00 per hac and greater benefit cost ratio (6.7) was obtained with RDF +Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant. Likewise poor performance was observed in control for all parameters.

Keywords: Papaya, organic manure, biofertilizer, FYM, vermicompost, azospirillum, PSB

Introduction
Papaya (*Carica papaya* L.) is an evergreen herbaceous commercial fruit crop of tropical and subtropical regions and belongs to the family Caricaceae. Papaya is one among the fruits which has attained a great popularity in recent years because of gynodioecious nature, its easy cultivation, quick returns, adoptability to diverse soil and climatic conditions and above all its attractive delicious wholesome fruits having multifarious uses. In India it is cultivated in an area of about 143 thousand ha. with an annual production of 59,80 thousand mt. (Anon, 2019a) [1]. Water and nutrients were the two important crucial basic sources for augmenting crop production. Out of total cost of cultivation of papaya 30% cost account for nutrient management which is one of the key factor and most important cultivation practices to improve the productivity. For sustainable soil productivity, it is very essential to strike a balance in soil biological activity, as any disturbance will affect the nutrient transformation in soil. Application of organic manure and biofertilizer includes the combine use of organics (*i.e.* manure, compost, Cowdung slurry, bio-fertilizers, green manure, crop residues, *etc*) and inorganic fertilizers to increase crop yield and farmers profits, improve crop quality and minimize nutrient losses to environment. Nutrient supply by organic manure and bio-fertilizer in papaya refers to maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity and fruit quality through optimization of benefits from all possible sources in an integrated manner. In this context, the present investigation was undertaken with an objective of finding out the effect of organic manure and biofertilizer in papaya.

Research Methods
The present investigation was carried out during the year 2018-19 & 2019-20 at Krishi Vigyan Kendra, Balod (C.G.) Indira Gandhi Agricultural University, Raipur, and was laid out in Randomized Block Design (RBD), the experiment comprising ten treatments and three replications. 200:200:200 gm NPK /plant were applied as per recommendation in all ten treatments combinations involving different organic manures and biofertilizers viz. T_0– Control (RDF @ 200:200:200 gm NPK /plant/year), T_1- RDF + Cow dung slurry (CDS) @ 4 liter/plant in two split doses), T_2- RDF + FYM @ 10 kg /plant, T_3- RDF + Vermicompost @ 2 kg /plant, T_4- RDF+ Azospirillum@ 10 gm / plant, T_5- RDF + PSB@ 10 gm / plant, T_6-RDF

+Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant, T_7– RDF +CDS+Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant, T_8– RDF+ FYM@ 10 kg /plant +Azospirillum@ 10 gm / plant + PSB @10 gm / plant, T_9- RDF + Vermicompost@ 2 kg /plant + Azospirillum@ 10 gm / plant + PSB @10 gm / plant. The seedlings of papaya were transplanted I the field adopting a spacing of 1.8 m x 1.8 m. Organic fertilizer and biofertilizer was applied in two split (basal and 45 DAP) as per treatments. Inorganic fertilizers were applied at 2nd, 4th, 6th and 8th month after transplanting. The sourse of N,P,K were urea, ssp and mop respectively. The data recorded on growth, yield and yield attributes were analysed statistically (Panse and Sukhatme, 1967) [2].

Research Findings and Discussion

The Effect of Organic manure and Bio-Fertilizer on Yield of Papaya reveals that fruit yield per plant (38.95 kg) and per ha (116.86) were found significant in papaya plants supplied with RDF +Azospirillum@ 10 gm / plant + PSB @ 10 gm / plant. Likewise poor performance was observed in control.

The higher value of total soluble solids (TSS) (8.0^{0}Brix), was recorded with treatment T_6 (RDF + Azospirillum @ 10 gm / plant + PSB @ 10 gm / plant) in papaya fruit cv. Red Lady during both the year and pooled analysis which is at par with T_6 and T_9. The other quality parameters of papaya cv. Red Lady in terms of higher total sugar (9.73%),, and minimum titratable acidity (0.015%) were reported when the plants were treated with RDF + Azospirillum @ 10 gm / plant + PSB @ 10 gm / plant (T_6) during both the years and pooled study in papaya cv. Red Lady which is at par with T_7,T_8 and T_9. Maximum reducing sugar (8.79%) and minimum non-reducing sugar (0.94%) were obtained with treatment RDF+ FYM@ 10 kg /plant +Azospirillum@ 10 gm / plant + PSB @10 gm / plant(T_8). Poor performance was observed in control. The quality in general was superior in the plants treated with integration of organic manure and bio-fertilizer. It might be due to the addition of organic manure and bio-fertilizer 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, TS 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 and bio-fertilizer 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) [6]. These results elucidate the findings of Ganeshamurthy *et al*. (2004), Kumar *et al*. (2010), Shivakumar (2010), and Yadav *et al.* (2011a) [3, 4, 5, 7] in papaya.

The highest BCR (6.7) was obtained with treatment of RDF + Azospirillum @ 10 gm / plant + PSB @ 10 gm / plant (T_6) having net return of Rs. 711911.00 per ha. Higher net return and BCR in treatment T_6 might be due to higher yield and gross return. However lowest net return (Rs. 454191) recorded with control T_0 and benefit cost ratio (3.6) were recorded with the treatment receiving only RDF + FYM @10 kg /plant (T_2). The cost of FYM is high therefore BCR is lower. These results are in conformity with results reported by Shivakumar (2010) [5], and Yadav *et al.* (2011b) [8] in papaya.

Table 1: Effect of Organic manure and Bio-Fertilizer on fruit yield and qualitative parameters of papaya

Treatments	Fruit per plant(Kg)	Fruit yield per hac.(t)	Total soluble solids (^{0}Brix)	Reducing sugar (%)	Non-reducing sugar (%)	Total Sugar (%)	Titrable acidity (%)
	(Pooled mean)						
T_0- Control (RDF @ 200:200:200 gm NPK /plant/year)	26.43	79.30	7.17	7.31	2.05	9.35	0.022667
T_1 - RDF + Cow dung slurry (CDS) @ 4 liter/plant in two split doses	27.39	82.18	7.32	8.18	1.18	9.36	0.020333
T_2 - RDF + FYM@ 10 kg / plant	27.87	83.62	7.31	8.23	1.19	9.42	0.021167
T_3 - RDF + Vermicompost @ 2 kg /plant	29.26	87.78	7.26	8.29	1.08	9.37	0.019667
T_4 -RDF+ Azospirillum @ 10 gm / plant	30.08	90.25	7.27	8.38	1.09	9.47	0.019333
T_5 - RDF + PSB @ 10 gm / plant	30.67	92.02	7.32	8.48	1.04	9.52	0.018833
T_6 -RDF + Azospirillum @ 10 gm / plant + PSB @ 10 gm / plant	38.95	116.86	8.00	8.77	0.96	9.73	0.015667
T_7 –RDF + CDS + Azospirillum @ 10 gm / plant + PSB @ 10 gm / plant	36.85	110.56	7.86	8.76	0.96	9.72	0.017333
T_8 – RDF+ FYM@ 10 kg /plant +Azospirillum@ 10 gm / plant + PSB @10 gm / plant	38.64	115.92	7.96	8.79	0.94	9.72	0.015667
T_9 - RDF + Vermicompost@ 2 kg /plant + Azospirillum@ 10 gm / plant + PSB @10 gm / plant	36.18	108.55	8.00	8.69	1.01	9.70	0.016333
S.Em.±	0.551	1.653	0.0142	0.027	0.038	0.0185	0.00041
C.D.at 5%	1.637	4.912	0.0422	0.081	0.113	0.0551	0.0012

Table 2: Economics of treatments

Treatment	Fruit Yield	Cost of treatment Rs/ha	Other expenditure Rs/ha	Total expenditure Rs/ha	Total return Rs/ha	Net return Rs/ha	BCR
T_0	79.3	24089	76820	100909	555100	454191	4.5
T_1	82.18	27339	76820	104159	575260	471101	4.5

T_2	83.62	50089	76820	126909	585340	458431	3.6
T_3	87.78	31889	76820	108709	614460	505751	4.6
T_4	90.25	26689	76820	103509	631750	528241	5.1
T_5	92.02	26689	76820	103509	644140	540631	5.2
T_6	116.86	29289	76820	106109	818020	711911	6.7
T_7	110.56	32539	76820	109359	773920	664561	6.0
T_8	115.92	58539	76820	135359	811440	676081	4.9
T_9	108.55	37089	76820	113909	759850	645941	5.6

Cost of CDS: Rs. 2.5/application
Cost of vermi compost: 6 Rs/kg
Cost of FYM: 2 Rs /kg
Cost of Azospirillum: 100 Rs /kg
Cost of PSB: 100 Rs /kg
Selling price of papaya fruits: 7 Rs /kg
Cost of Urea: 6.68 Rs /kg
Cost of single super phosphate: 7.74 Rs /kg
Cost of murate of potash: 16.80 Rs /kg

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