The Pharma Innovation Journal 2022; 11(7): 1495-1498

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 1495-1498

www.thepharmajournal.com
Received: 08-04-2022
Accepted: 18-05-2022

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Effect of integrated nutrient management practices on productivity of papaya (*Carica papaya* L.) in Terai Dooars region

P Chattopadhyay, G Mandal, K Sar and SS Das

Abstract
During the years 2018-19 and 2019-20, a field experiment was undertaken at a farmers' field in Kalchini, Alipurduar, West Bengal to investigate the effects of Integrated Nutrient Management on the yield and economics of papaya farming. The experiment included 4 Treatments (Control, RDF of NPK, 50% RDF, 75% RDF) and 5 Factors (control, biofertilizer+FYM, vermicompost+biofertilizer, boron+FYM, zinc+FYM) that were replicated three times and data was statistically evaluated in randomised complete block design. In terms of yield characteristics, RDF of NPK+ vermicompost+biofertilizer was shown to be superior to other treatments *viz.* total number of fruits (38.725), fruit set percentage (73.29), total yield (59.47 kg ha^{-1}), fruit weight (1.67 kg), minimum days taken to fruit initiation (121.82). For the above stated parameter treatment 75% RDF of NPK+ vermicompost+biofertilizer was statistically at per with each other. In terms of economic analysis maximum highest cost incurred (103114.7), gross return (Rs. 498792.62), net Return (Rs. 395677.96), benefit:cost ratio (4.83) were also recorded under the same treatment combination and was closely followed by 75% RDF of NPK+ vermicompost+biofertilizer in both the year

Keywords: Papaya, Intigrated nutrient management, Yield, Economics.

Introduction
Papaya (*Carica papaya* L.) is a popular fruit crop in recent years due to its delectable flavour, nutritional value, and medicinal properties. With 48 species, papaya belongs to the Caricaceae family's genus Carica. Papaya is a tropical fruit crop that is widely grown in the tropics and subtropics and is thought to have originated in Tropical America (Arvind *et al.* 2013 & Yograj *et al.* 2014) [1]. Despite its great size and output, it is still considered a garden crop. However, in recent years, papaya's relevance as a commercial fruit crop has grown due to its nutritional and medicinal benefits, as well as its quick and constant yielding habit, which provides early income to growers. Papaya commonly known as the "Heavy feeder crop" for that the nutrition of papaya differs from other fruit crops because of its fast growth, continious flowering & fruiting habit and maximum fruit yield. Time relevant and efficient manuring of young and mature plant is very much essential to maintain the health of plant as well as soil and to obtain profitable yield. As papaya demands nutrients continuously in large amounts and use of large quantity of chemically formulated fertilizers alone is not only feasible but also costly to the poor farmers, as majority of them are small and marginal one. Aside from that, the usage of chemical fertilizers has led to an increase in multi-nutrient deficits, nutrient imbalances, and a decline in soil health and production over time (Singh and Varu, 2013) [10]. Integrated nutrition management may be a viable option in this regard. The main goal of integrated plant nutrient management is to use both organic and inorganic nutrients, as well as other micronutrients, in a more rational way to better understand and evaluate the interactions of different nutrients, as well as to lower production costs by using less inorganic fertiliser. Keeping this in view, a field experiment was conducted to study the effect of integrated nutrient management practices on yield and economics papaya and to evaluate the ideal treatment combination for the same.

Materials and Methods
The current field study, titled "Effect of Integrated Nutrient Management Practices on productivity of Papaya (*Carica papaya* L.) in Terai Dooars Region" was carried out during 2018-19 and 2019-20 at farmers field in Kalchini, Alipurduar, West Bengal, which is a part of the Terai-Dooars agro climatic region with an EC of 0.26 ds m^{-1} and a pH of 5.8, the

experimental soil comprised 0.5 percent organic carbon, 184.4 kg ha^{-1} nitrogen, 190 kg ha^{-1} phosphorus, and 191 kg ha^{-1} potassium. A three-replication randomized complete block design was used to set up the experiment. The current study included 20 distinct treatments, each with a different nutritional amount, i.e. T_0F_0 (control), T_0F_1 (control + biofertilizer+FYM), T_0F_2 (control+ vermicompost+biofertilizer)), T_0F_3(control+ boron+FYM), T_0F_4(control+ zinc+FYM), T_1F_0(RDF of NPK+ control), T_1F_1(RDF of NPK+ biofertilizer+FYM), T_1F_2(RDF of NPK+ vermicompost+biofertilizer), T_1F_3 (RDF of NPK+boron+FYM), T_1F_4 (RDF of NPK+ zinc+FYM), T_2F_0 (50% of RDF+control), T_2F_1 (50% of RDF+biofertilizer+FYM), T_2F_2 (50% of RDF+vermicompost+biofertilizer), T_2F_3 (50% of RDF+boron+FYM), T_2F_4 (50% of RDF+ zinc+FYM), T_3F_0 (75% of RDF+control), T_3F_1 (75% of RDF+biofertilizer+FYM), T_3F_2 (75% of RDF+vermicompost+biofertilizer), T_3F_3 (75% of RDF+boron+FYM), T_3F_4 (75% of RDF+ zinc+FYM). Because of its widespread acceptance among farmers, the cultivar C.V. Red Fort was chosen for the experiment and bought from a local market. With medium-sized plants, this is a medium-sized F_1 hybrid. The fruits are oval in shape and the flesh is a dark reddish orange colour. They are sweet and have a lovely flavour. The young saplings were transplanted to the main field at a spacing of 2m×1.8m during the first week of July. Urea, Single Super Phosphate, and Murate of Potash were applied to the plant in the form of Urea, SSP, and MOP. During field preparation, 1/3 of the fertiliser was applied during pit filling. The remaining are divided in half and applied at a 45 days interval. When using Factor F_1 as a bio-fertilizer, azotobactor is well mixed with PSB and 100gm of the mixture is applied to the pit during field preparation. During field preparation, FYM used @20 kg $plant^{-1}$. During the field preparation for Factor F_3, vermicompost was applied at a rate of 5 kg $plant^{-1}$. In the case of micronutrient application, combine the required amounts of Zn and B with water and thoroughly apply to the plants. The micronutrient application procedure was carried out in the evening. The data on yield related atributes was statistically examined.

Result and Discussion

The present field investigation entitled "Effect of Integrated Nutrient Management Practices on productivity of Papaya (*Carica papaya* L.) in Terai Dooars Region" was carried out to understand the perfect combination of organic, inorganic fertilizers, biofertilizers and micronutrients for better growth and quality. Persual data revealed that integrated nutrient management practices had a good impact on the yield of freshly harvested fruits. The combination effect of organic, inorganic, biofertilizers and micronutrients had an positive interaction on total number of blossoms in papaya plants. The data collected during the reproductive stage demonstrated that there was a lot of heterogeneity between the treatments. The RDF of NPK+ vermicompost+biofertilizer had a higher total number of fruits. The plants fed with the aforesaid treatments produced the greatest quantity of fruits. This increase in the number of fruits set in this treatment could be due to the use of biofertilizers in combination with vermicompost and chemical fertilisers, which may have a positive effect on inflorescence development, which may result in higher levels of nutrients in the crop's assimilating area, increasing the rate of dry matter production, which is positively correlated with the number of flowers and fruits set. Cell division and cell elongation were encouraged by adequate food supply and the induction of growth hormones, resulting in an increase in the quantity of flowers and fruits. The above findings are closely in line with Srinu *et al.* (2017) [9] in papaya, Gupta and Tripathi (2012) [2] in strawberry cv. Chandler, Tripathi *et al.* (2015a) [12] in aonla and Katiyar *et al.* (2012) [4] in ber. Fruit set percentage was also well reacted to with relation to integrated nutrient management strategies, in addition to total flower and fruit. According to the results of the aforesaid experiment, maximum fruit set percentage was also recorded under the same treatment combination. It is possible that this type of observation was made because of a bigger number of flowers and fruits produced, which increased the proportion of fruit set. In this regard, bio fertiliser, along with vermicompost and other chemical fertilisers, may have played a contribution. Srinu *et al.* (2017) [9] in papaya and Tripathi (2012) [2] in strawberry cv. Chandler observed similar findings.

The early fruiting is a much more essential criteria which can generate early income to the growers. Various treatments had an impact on the number of days it took for fruit to form during the growing phase. These two characteristics are extremely significant to its growers. Perusal data revealed that, there was a substantial variance in the number of days it took for inisiation of first fruits in relation to integrated nutrition management strategies. The plants treated with RDF of NPK+ vermicompost+biofertilizer took fewer days to reach their initial fruit development. This kind of early fruiting observed might be due to improved net absorption rate and better development may help to produce sufficient endogenous metabolites accounting for early blooming and simultaneous transport of growth components like cytokinin to the auxiliary bud and breaks the apical dominance. In banana, Hazarika and Ansari (2010) [8], Nayyer *et al.* (2014), Srinu *et al.* (2017) [9] in papaya, and Gupta and Tripathi (2012) [2] in strawberry cv. Chandler, Hazarika and Ansari (2010) [8], Nayyer *et al.* (2014)

According to the results of the above experiment, plants treated with T_1F_2 (RDF of NPK+ vermicompost+biofertilizer) produced the highest fruit yield (59.47 kg ha^{-1}), fruit weight (1.67 kg), were recorded with RDF of NPK+ vermicompost+biofertilizer. The above results could be attributed to increased vermicompost, biofertilizers, and chemical fertilisers in optimal amounts, which could result in higher fruit Furthermore, vermicompost's nitrogen-fixing qualities and biofertilizers' phosphorous-solubilizing properties may increase nitrogen and phosphorous availability to plants as well as their translocation from which help to enhance the fruit weight as well as total fruit yield. These findings are closely supported by of Nayyer *et al.* (2014) in banana, Gupta and Tripathi (2012) [2] in strawberry, Katiyar *et al.* (2012) [4] in ber, Kumar *et al.* (2015) [5] in Guava, Ravishankar *et al.* (2010) [8], and Kanwar *et al.* (2020) [6] in papaya.

In terms of economic evaluation RDF of NPK+ Vermicompost+Biofertilizer found best. Highest cost incurred (Rs.103114.7), gross return (Rs. 498792.62Rs), net return (Rs. 395677.96), benefit:cost ratio (4.84) was found in RDF of NPK+vermicompost+biofertilizer which was followed by 75% of RDF+vermicompost+biofertilizer and the lowest result was found in control. The highest Economical

evaluation was recorded under RDF of NPK+ vermicompost+biofertilizer might be due to lower input cost and higher efficiency of combination of chemical fertilizer, vermicompost and biofertilizer increase the yield potential at an optimized level. This may be increase the Gross return, Net Return and Benefit: Cost ratio as well. The findings are closely in line with Sharma (2004) [11] in papaya.

Table 1: Effect of integrated nutrient management practices on yield and yield related attributes of papaya

Treatment	Days taken to First fruit Initiation	Fruit set percentage	Total Fruit	Fruit weight	Total Yield
T_0F_0	176.65^{a}	53.49^{g}	18.77^{h}	1.17^{g}	28.10^{i}
T_0F_1	165.80^{cd}	57.52^{def}	22.26^{gh}	1.24^{efg}	33.38^{fgh}
T_0F_2	168.44^{bc}	56.13^{efg}	23.32^{fgh}	1.23^{fg}	29.20^{hi}
T0F3	157.89^{ef}	56.110^{efg}	25.13^{efg}	1.34^{defg}	35.18^{efg}
T0F4	170.71^{b}	55.10^{fg}	20.89	1.28^{efg}	28.87^{hi}
T1F0	161.75^{de}	58.17^{def}	30.00^{cd}	1.31^{defg}	39.75^{de}
T1F1	140.88^{jk}	63.01^{bc}	30.65^{cd}	1.53^{abcd}	53.52^{b}
T1F2	121.82^{n}	73.29^{a}	38.72^{a}	1.67^{a}	59.47^{a}
T1F3	138.13^{kl}	62.85^{bc}	32.26^{bc}	1.42^{bcdef}	43.13^{d}
T1F4	134.52^{l}	65.69^{b}	27.26^{de}	1.59^{abc}	33.44^{fgh}
T2F0	151.83^{gh}	57.82^{def}	22.62^{gh}	1.26^{efg}	29.91^{hi}
T2F1	158.90^{ef}	57.10^{defg}	23.50^{fgh}	1.38^{cdefg}	37.71^{ef}
T2F2	167.62^{bc}	54.79^{fg}	24.01^{efgh}	1.35^{defg}	31.14^{ghi}
T2F3	155.19^{fg}	57.96^{def}	25.22^{efg}	1.39^{cdefg}	40.31^{de}
T2F4	161.49^{de}	58.09^{def}	24.26^{efgh}	1.33^{defg}	31.91^{ghi}
T3F0	144.02^{ij}	60.11^{cd}	25.09^{efg}	1.39^{cdefg}	39.10^{de}
T3F1	148.13^{hi}	60.00^{cde}	26.61^{ef}	1.45^{bcdef}	48.83^{c}
T3F2	129.24^{m}	72.10^{a}	34.66^{b}	1.64^{ab}	56.66^{ab}
T3F3	149.06^{h}	64.18^{b}	30.21^{cd}	1.48^{abcde}	55.34^{ab}
T3F4	170.73^{b}	58.48^{def}	24.00^{efgh}	1.37^{cdefg}	39.45^{de}
SEM	1.54	1.18	1.118	0.07	1.63
CD(p=0.05)	4.35	3.33	3.148	0.19	4.59
CV(%)	2.46	4.83	10.340	12.25	10.05

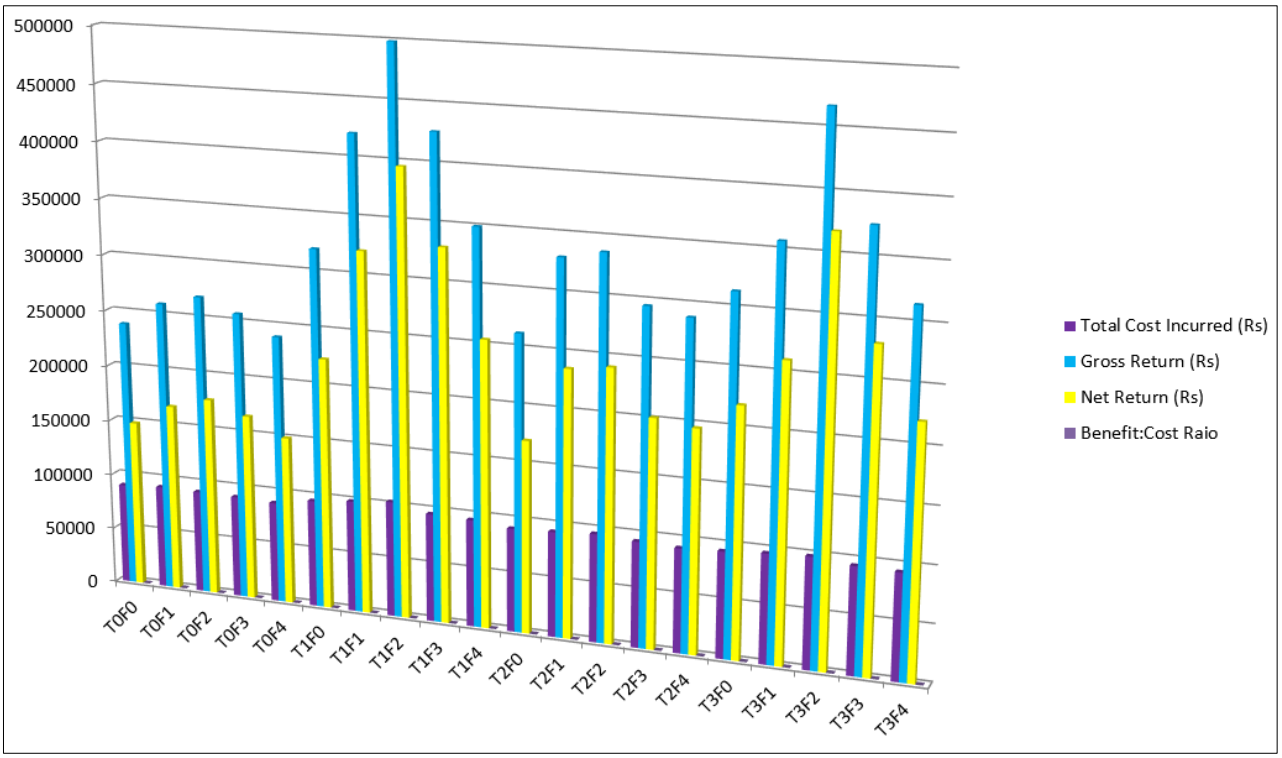

Fig 1: Effect of Integrated Nutrient Management Practices on Economics of Papaya

Conclusion

It can be concluded from the above mentioned field study that the combination of recommended dose of fertilizer *viz* 200:200:250 g plant^{-1} year^{-1}, vermicompost @ 5kg plant^{-1} and 100 g well mixed PSB and azotobactor was shown to be superior in practically for every yield related attribute in the above field trial, according to the experimental data. 75% RDF+ vermicompost @ 5kg plant^{-1} and 100 g well mixed PSB amd azotobactor was also shown to be comparable to the above stated treatments. However, the lowest result was observed under control plot. In terms of papaya economics, a similar pattern was observed. Recommended dose of fertilizer

viz. 200:200:250 g plant^{-1} year^{-1}, vermicompost @ 5kg plant^{-1} and 100 g well mixed PSB and azotobactor was determined to be best in terms of highest cost, gross return, net return, and benefit:cost ratio.

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