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RESEARCH ARTICLE

Influence of Different Nutrient Management Practices on Growth, Yield, Quality and Economics of Brinjal (*Solanum melongena.* L)

Manickam S*, Suganthy M and Ganesh R
Department of Sustainable Organic Agriculture, Directorate of Crop Management, Tamil Nadu Agricultural University, Coimbatore-641003

ABSTRACT

The field experiment was carried out at Tamil Nadu Agricultural University, Coimbatore in 2020 to evaluate the influence of different nutrient management practices on growth, yield and economics of brinjal (*Solanum melongena*. L). There were six treatments consisting of organic, inorganic and combined sources of nutrients evaluated in randomized block design with five replications. Among the treatments, the state recommended management practices (Farm yard manure (FYM) @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + Recommended dose of fertilizers (RDF)) had showed better performances for plant height (139.6 cm), number of branches per plant (29.0), number of leaves per plant (127.6) number of fruits per plant (16.0) and yield per hectare (21.70 tonnes). The highest gross return (Rs. 251676 ha^{-1}) and net return (Rs. 158332 ha^{-1}) were obtained from 100% organic manures applied treatments. The highest benefit: cost ratio (2.84) was obtained from 50% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + seedling treatment with Beejamrit + Ghanajeevamrit @ 250 kg ha^{-1}, Jeevamrit @ 500 litres ha^{-1} $time^{-1}$ twice a month with irrigation water applied treatments. Application of organic sources of nutrients also produced better quality fruits compared to only chemical or integrated nutrient sources. Though, the state recommended management practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF) recorded higher productivity, the organic package consisting of 50% N requirement through organic manures (50 % FYM + 50 % vermicompost) + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg ha^{-1}, Jeevamrit @ 500 litres ha^{-1} $time^{-1}$ twice a month with irrigation water was recommended for economically sustainable organic brinjal production.

Keywords: *Brinjal; Organic; Integrated; Nutrient management; Jeevamrith*

INTRODUCTION

Brinjal (*Solanum melongena* L.) also known as 'egg plant' is an important and indigenous vegetable crop of India. It is the fourth most grown and produced vegetable (2^{nd} Adv. Est. 2019-20) in the country. In Tamil Nadu, it is cultivated over 20,380 ha with an annual production of 2,75,969 tonnes (tnhorticulture.tn.gov.in). Brinjal fruits are an excellent source of starch, proteins, minerals, vitamins, dietary fibers and low-fat content (Zenia and Halina, 2008). It is one of the richest sources of antioxidants mainly ascorbic acid which has been reported to successfully suppress the development and growth of tumors, inhibit inflammation and cardiovascular diseases (Somawathi *et al.,* 2014). The higher ascorbic acid content of the fruits not only helps in better retention of colour and flavor (Kumar and Arumugam, 2013), but also gives tolerance against biotic stresses (Karak *et al.*, 2012). Several researches have been exerted to improve the productivity of this vegetable crop. One of the improvement strategies is to look at the nutritional requirement of the crop that can play a major role in its optimum yield and quality. The application of high input technologies such as chemical fertilizers, pesticides, and herbicides improve production, but there is a growing concern over the adverse effects of the use of chemicals on human health, soil productivity and environmental quality (Sharma *et al.,* 2012).With the popularization of organic farming at the global level, there is a constant haunt for nutritional sources and their applications to sustain the productivity of organic systems. The use of organic amendments to meet the nutrient requirement of crops would be an inevitable practice in the years to come for sustainable agriculture. Developing an appropriate nutrient management package that encompasses traditionally used organic amendments like farm

Corresponding author: paulsebastian.smanickam@tnau.ac.in

yard manure, vermicompost, beejamrith, jeevamrith and ghanajeevamrith becomes crucial in enhancing soil health and quality in the long run. Although the organic amendments contain major nutrients in small quantities compared to the chemical fertilizers, the presence of organic carbon and growth-promoting principles like enzymes and hormones, make them a preferential choice for improving soil fertility and productivity (Bhuma, 2001). Further, few studies have documented the positive relationship of organic amendments with the growth, yield, and quality of fruits (Christo *et al*., 2011; Sarhan *et al*., 2011; Agbo *et al*., 2012).

In light of the above information, a study was carried out to evaluate the effect of different nutrient management practices on plant growth, yield, and fruit quality of brinjal along with the comparative economics of various treatment combinations.

MATERIAL AND METHODS

The field experiment was conducted at Eastern Block Farm, TNAU, Coimbatore, during *Kharif* 2020. The experimental site was located in the western agro-climatic zone of Tamil Nadu at 11°N latitude, 77°E longitude and at an altitude of 426.72m above mean sea level. The soil of the experimental field was clay loam with a pH of 7.7, EC of 0.82 $dSm^{-1,}$ and organic carbon (OC) of 0.8 %. It was low in available nitrogen (195 kg ha^{-1}), medium in available phosphorus (17.5 kg ha^{-1}), and high in available potassium (712 kg ha^{-1}). The experiment was laid out in a randomized block design with six treatments (Table 1) and five replications. Brinjal seedlings of 30 days old (variety CO 2) were transplanted at 60 x 60 cm spacing with a gross plot size of 5x4 m. The nitrogen content of the manures was tested in the laboratory, and the doses of manures were set accordingly so that all the treatments contained the same amount of nitrogen. FYM, vermicompost, jeevamrit, ganajeevamrit and urea, single super phosphate, murate of potash were used as a source of nutrients for organic and inorganic treatments, respectively. Treatments were imposed as per the TNAU Crop Production Guide (CPG) (2020). In the treatments MP_1-I and MP_1-II, pest and disease were managed organically, whereas in the other treatments, pest and disease were managed using chemicals recommended in the TNAU CPG (2020). From each replication, five plants were tagged for recording the growth and yield parameters. Quality parameter like ascorbic acid content was determined by titration method (Miller, 1998) and titrable acidity in the fruits is estimated as per the procedure described by Horwitz (1975). The economics of the system was worked out considering the prevailing cost of inputs and price of output. All the data obtained from the field and laboratory experiments were analyzed statistically for drawing conclusion using analysis of variance (ANOVA) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth characters

Plant height

Plant height is an important phenomenon that is greatly influenced by a set of interacting factors involving genetic makeup, nutrition availability, and field environment. In this study, the plant height at harvest was significantly higher (139.6 cm) in plots treated with state-recommended management practices (MP_2-II). It was followed by plots treated with 100% of nutrient source as organic manures (131.6 cm) and plots treated with 50% of nutrient source as organic manures + 50% as inorganic fertilizers (MP_3-I). The lowest plant height of 120.7 cm was observed in the recommended dose of fertilizers alone applied plots (MP_2-I) (Table 2). Sufficient availability of NPK through inorganic fertilizers (RDF) complemented with growth-enhancing factors from FYM applied at the rate of 25 tonnes per hectare and biofertilizers at 2 kg ha^{-1} might have helped the plants to attain more vigour in MP_2-II. Such complementary effects were also reported by Mishra *et al.* (2017); Sukhlal *et al*. (2019).

Table 1. Treatments details

MP_1-I	:	50% N requirement through FYM + 50 % N requirement through Vermicompost
MP_1-II	:	50% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg/ha, Jeevamrit @ 500 litres/ha/time twice a month with irrigation water
MP_2-I	:	Recommended Dose of Fertilizers (RDF) alone
MP_2-II	:	State recommendation / Farmer's practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF)
MP_3-I	:	50% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + 50% N requirement through inorganic fertilizers
MP_3-II	:	25% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + 25% N requirement through inorganic fertilizers + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg ha^{-1} + Jeevamrit @ 500 litres $ha^{-1}time^{-1}$ twice a month with irrigation water

MP - Management Practice, RDF – 100:50:30 kg of NPK ha^{-1}

Number of branches

The number of primary and secondary branches per plant was maximum (29.0) in state recommended management practices (MP_2-II) applied plots (Table 2). However, it was on par with plots applied with 100% of nutrient source as organic manures (MP_1-I) and plots applied with 50% of nutrient source as organic manures + 50% as inorganic fertilizers (MP_3-1). The least number of branches per plant (20.8) was noted in the recommended dose of fertilizers alone (MP_2-I) applied plots. Anburani and Manivannan (2002) noted that FYM at 25 t ha^{-1} and 100% NPK + biofertilizers recorded the highest values for stem girth and the number of secondary branches (15.58) in brinjal compared to other treatments.

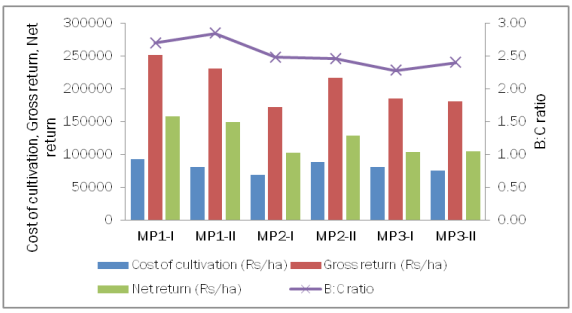

Fig 1. Effect of treatments on economics of brinjal

Number of leaves

A perusal of data in Table 2 revealed that different management practices significantly influenced the number of leaves per plant. Number of leaves per plant was the highest (127.6) in MP_2-II (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF). It was on par with MP_1-I (100% of nutrient source as organic manures) (126.8). The plots treated with recommended dose of fertilizers alone (MP_2-I) have produced lesser number of leaves per plant (92.0).

Yield attributing characters

Number of fruits per plant

The number of fruits per plant is a pivotal character determining yield under different management practices. In the present study, the number of fruits per plant varied significantly among the management practices (Table 3). The plants grown under state-recommended management practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF) produced more number of fruits per plant (16.0) than other nutrient management practices. It was followed by 100% of nutrient source as organic manures (13.9) and 50% of nutrient source as organic manures + 50% as inorganic fertilizers (13.1) applied plots. Mishra *et al.* (2017) reported that the application of *Azospirillum* and RDF produced 17.5 fruits per plant weighing 2.12 kg, which resulted in a higher yield of 28.5 tonnes ha^{-1}.

Fruit weight

Fruit weight was recorded to be statistically non-significant among the treatments(Table 3). However, the average fruit weight per plant grown understate-recommended management practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF) had surpassed all other treatments.It was followed by the MP_1-I, MP_3-I, MP_3-II, MP_1-II, MP_2-I with average fruit weights of 57.2, 55.7, 53.7, 53.4, and 52.8 g, respectively.

Fruit girth

Statistical analysis of data showed that the fruit girth was not significantly influenced by different management practices (Table 3). However, the average fruit girth ranged from 48.2 to 43.6 mm in state recommended management practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF), obtaining higher fruit girth than other treatments. It was followed by 100% of nutrient source as organic manures (MP_1-I) and 50% of nutrient source as organic manures + 50% as inorganic fertilizers applied plots (MP_3-I). Fruit girth was minimum (46.3 mm) in the recommended dose of fertilizers alone applied plots. Sharma *et al*. (2012) observed that the diameter of broccoli was not affected by different nutrient management practices. The results were in contrary with AdilRehman *et al.* (2015) who reported that the growing regimes significantly influenced the fruit diameter of brinjal cultivars.

Quality characters

Titrable acidity

Nutrient management practices have exhibited a significant influence on the titrable acidity of brinjal (Table 3). The highest titrable acidity of 0.36% was recorded in fruits received from 50% of N as organic manures + 50% of N as ghanajeevamrith and jeevamrith (MP_1-II) applied plots. It was on par with fruits (0.32 %) received from 100% organic manures applied plots (MP_1-I). The state recommended management practices applied plots registered slightly lower titrable acidity of 0.22 %. Prabakaran and Pichai (2003) reported that application of organic manures had resulted in higher titrable acidity in tomato; Rekha Eda *et al*. (2018) observed that application of RDF through FYM and vermicompost had resulted in higher titrable acidity in papaya compared to inorganic fertilizer application.

Ascorbic acid

Ascorbic acid also called vitamin C, is an essential antioxidant molecule in plant and animal metabolism. Besides its nutritional relevance, it was shown that increased ascorbate is associated with improved post-harvest quality of fruits. In the present study, biochemical analysis was carried

out to find the influence of different management practices on ascorbic acid and it exhibited a significant difference (Table 3). Among the nutrient management practices, fruits received from MP_1-II and MP_1-I (organically grown plants) have recorded significantly higher ascorbic acid content of 15.39 and 14.84 mg per 100 grams of fruits, respectively. The least ascorbic acid content of 13.56 mg per 100 grams of fruits was noted in fruits received from plants grown under inorganic nutrient management. Sreenivasa *et al.* (2010) observed that seedling root dip with beejamruth, soil application of jeevamruth (500 l ha^{-1}) and foliar application of panchagavya @ 3% recorded higher ascorbic acid content and capsaicin content in chilli fruits. Anju Mohan *et al.* (2020) reported that the brinjal variety CO 2 grown under organic acid-coated phosphatic fertilizer applied plots have shown slightly higher ascorbic acid content (16.68 mg 100 g^{-1}) compared to uncoated fertilizers applied treatments (16.34 mg 100 g^{-1}).

Yield and Economics

Yield

The plots applied with FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF showed superiority over all other treatments by recording a higher fruit yield of 21,703 kg ha^{-1} (Table 3). It was followed by plots treated with 100% nutrient source as organic manures (20,134 kg ha^{-1}) and 50% organic manures + 50% as inorganic fertilizers applied plots (18,565 kg ha^{-1}). Increase in fruit yield might be due to increase in the number of leaves which worked as an efficient photosynthetic structure and produced a high amount of assimilates in the plant system. Kiran *et al.*(2010) reported that more number of branches which borne more number of flowers results in higher number of fruits per plant and fruit yield and their attributes. The superiority of MP_1-II could also be ascribed to readily available macro-nutrients from RDF, micro-nutrients and growth-promoting substances from FYM, efficient microbial activity by *Azospirillum* and Phosphobacteria. Besides, the role of biofertilizers in enhancing the growth characters is well known and they have a positive relationship with FYM as indicated in the present study. Devi *et al.* (2002) observed that treatment with 50 %N +25 % poultry manure + biofertilizer resulted in the highest yield (27.57 t ha^{-1}) of brinjal. Wang and Kale (2004) reported 74 per cent increase in yield of brinjal over the recommended rate of N fertilizer due to inoculation with mixture of Azotobacter + *Azospirillum.*

Economics

Cost of cultivation

The management practices showed large variation inthe cost of cultivation due to the use of different inputs. The per hectare cost of cultivation was the highest (Rs. 93,344) in plots treated with 100% of nutrient sources as organic manures. This was due to the higher cost incurred towards vermicompost and farmyard manure when compared to other treatments. The lowest per hectare cost of cultivation (Rs. 69,516) was recorded in the recommended dose of fertilizers alone applied plots (Figure 1).

Table 2. Effect of treatments on growth characters of brinjal

Treatments	Plant height at harvest (cm)	Number of branches $plant^{-1}$	Number of leaves $plant^{-1}$
MP_1-I : 50% N requirement through FYM + 50 % N requirement through Vermicompost	131.6	24.3	121.2
MP_1-II : 50% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg ha^{-1}, Jeevamrit @ 500 litres ha^{-1} $time^{-1}$ twice a month with irrigation water	123.4	21.8	101.3
MP_2-I : Recommended Dose of Fertilizers (RDF) alone	120.7	17.9	92.0
MP_2-II : State recommendation / Farmer's practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF)	139.6	29.0	127.6
MP_3-I : 50% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + 50% N requirement through inorganic fertilizers	129.8	23.0	110.2
MP_3-II : 25% N requirement through organic manures (50 % FYM + 50 % Vermicompost) + 25% N requirement through inorganic fertilizers + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg ha^{-1} + Jeevamrit @ 500 litres ha^{-1} time $^{-1}$twice a month with irrigation water	122.9	21.6	97.4
S.Ed	3.70	2.91	7.48
CD(P=0.05)	7.71	6.08	15.59

Gross return

The gross return was worked out based on the prevailing market prices. Fruits obtained from organic treatments (MP_1-I and MP_1-II) were sold at premium price (25 % extra). This led to a higher gross return per hectare (Rs. 2,51,676) in plots applied with 100% of nutrient source as organic manures and in plots applied with 50% as organic manures + 50% as jeevamrith, ghanajeevamrith (Rs. 2,31,213). The lowest gross return of Rs. 1,72,206 was registered in the recommended dose of fertilizer alone applied plots(Figure 1).

Table 3. Effect of treatments on yield and quality characters of brinjal

Treatments	Number of fruits plant^{-1}	Fruit weight (g)	Fruit girth (mm)	Titrable acidity (%)	Ascorbic acid (mg 100 g^{-1})	Fruit Yield (Kg ha^{-1})
MP_1-I	13.9	57.2	47.5	0.32	14.84	20134
MP_1-II	12.5	53.7	44.4	0.36	15.39	18074
MP_2-I	11.1	52.8	43.6	0.20	13.56	17221
MP_2-II	16.0	59.3	48.4	0.22	13.95	21703
MP_3-I	13.1	55.7	46.4	0.28	14.25	18565
MP_3-II	12.0	53.4	46.3	0.30	14.52	18497
S.Ed	0.77	2.47	1.83	0.03	0.30	344.03
CD(P=0.05)	1.64	NS	NS	0.07	0.63	717.65

Net Return

The plots applied with 100% of nutrient source as organic manures had fetched the highest net return per ha (Rs. 1,58,332) as it produced higher yield and sold with premium prices (Figure 1). It was followed by plots applied with the nutrient source in the form of 50% as organic manures + 50% as jeevamrith, ghanajeevamrith (Rs. 1,49,878). The lowest net return of Rs. 1,02,689 was observed in the recommended dose of fertilizers alone applied plots.

Benefit-Cost Ratio (BCR)

The benefit-cost ratio computed from the study is furnished in Figure 1, revealed that the maximum BCR of 2.84 was associated with the management practice MP_1-II (50% as organic manures + 50% as jeevamrith, ghanajeevamrith). It was closely followed by MP_1-I (100% organic manures) (2.70). Lower BCR (2.28) was observed in plots treated with 50% organic + 50% inorganic fertilizers.

CONCLUSION

The experimental results revealed that the growth and yield parameters were better under state-recommended management practices (FYM @ 25t ha^{-1} + Azophos @ 2kg ha^{-1} + RDF) implying a highly productive package. While fruit quality and economic parameters were recorded to be the maximum under the organic management practices. Hence, for economically sustainable and viable brinjal production, 50% N requirement through organic manures (50 % FYM + 50 % vermicompost) + seedling treatment with Beejamrit + application of Ghanajeevamrit @ 250 kg ha^{-1}, Jeevamrit @ 500 litres ha^{-1} time^{-1} twice a month with irrigation water can be recommended from the results of the present study.

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Ethics statement

Specific permits were not required for the above field studies because no human or animal subjects were involved in this research.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the manuscript. No separate external data source is required. If anything is required from the manuscript, certainly, this will be extended by communicating with the corresponding author through corresponding official mail; smanickam@tnau.ac.in

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