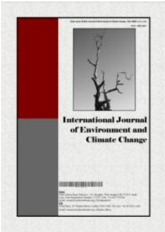

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Response of Organic, Inorganic and Bio-fertilizers on Qualitative, Yield and Economics of Bottle-gourd (*Lagenaria siceraria* (Molina) Standl) c.v. BB0G-3-1

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The current study was carried out during the 2019 *Kharif* season at the Department of Vegetable Science, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, to determine the impact of organic manures and chemical fertilizers on the yield attributing characters, quality, and economics of Bottle gourd (*Lagenaria Siceraria* L.) cv. BBOG-3-1. The experiment consisted of Twelve treatments and three replications. Organic manures, inorganic fertilizers and Bio-fertilizers were used in twelve different treatments. viz.,T_1(Control),T_2(100% RDF) (80:50:50 Kg NPK ha^{-1}), T_3 (FYM @15 t ha^{-1}), T_4 (Vermicompost @ 5 t ha^{-1}], T_5 (50% RDF + FYM @ 7.5 t ha^{-1} +Biofertilizer), T_6 (50%RDF+ Vermicompost@2.5tha^{-1}+ Biofertilizer), T_7 (FYM @ 7.5 t ha^{-1} +Biofertilizer),T_8(50%RDF+Biofertilizer),T_9(Vermicompost@2.5tha+Biofertilizer),T_{10}(100%RDF+FYM @7.5tha^{1}+Biofertilizer),T_{11}(100%RDF+Vermicompost @ 2.5 t ha^{-1} + Biofertilizer) and T_{12}(50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer), Out of these, an application of 50%RDF+FYM@7.5t ha^{-1} + Vermicompost @ 2.5t ha^{-1}+ Biofertilizer (T_{12}) had a beneficial effect on

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minimum days to the first fruit harvest(59.00days), maximum days to last harvest(92.00days), Average Fruit weight(1231g), TSS(4.97°Brix), Ascorbic acid(8.60 mg100gm^{-1}), Reducing Sugar (3.78%), Non-Reducing Sugar(1.89%), Total Sugar(5.67%),Yield (44.82kg plot^{-1}),Yield(280.13qha^{-1}) and B:C ratio (2.92).

Keywords: Bottle gourd; growth; quality; yield; vermicompost; FYM; NPK; biofertilizer.

1. INTRODUCTION

A large population in a developing country like India constantly poses serious challenges to agricultural scientists. Growers are rarely able to think beyond the prolific bearing vegetables due to limited resources and high demand [1]. Vegetables are edible herbaceous plants or portions of plants that are ingested raw or cooked, are high in vitamins and minerals, have a low calorific value, and neutralise the acid substances created during the digestion of high energy foods. Vegetables contribute to a healthy diet by delivering not only energy but also important protective nutrients such as minerals and vitamins. Scientists in India conducted multiple meticulous trials to determine how much of each nutrient is required by people of various ages on a daily basis. The need varies with age, with men requiring more calories (energy) and proteins than women. Vegetables are easily accessible and cheaper sources of vitamins, minerals and other elements essential for human being. The role of vegetables in combating malnutrition and deficiency disorders in human being is well conceived nowadays. Bottle gourd *[Lagenaria siceraria* (Molina) Stand!.] arguably the most important cucurbit in India belongs to the family Cucurbitaceae [1]. It is one of the most significant vegetable crops and plays very important role in our diet. Its 100 g edible portion contains water about 95 percent, protein 0.2 per cent, carbohydrate 3.5 percent, minerals 0.5 percent, thiamine 0.04 percent, fat 0.1 percent, oil 45 percent, vitamin 'A' 10IU, vitamin'C'11mg, riboflavin 0.023mg, phosphorous 14 mg, calcium 16 mg, energy 63 cal and Iron 0.4 mg [2]. A decoction produced from the leaf is an excellent treatment for treating jaundice. It is beneficial to those who suffer from biliousness and indigestion. Green and tender fruit is used to make vegetables, desserts, pickles and raita. Young fruits are typically utilised in vegetable dishes. Syrups (juice) from the green fruits are good for chest pain and curing diabetes and hypertension.

Organic manure application improves soil fertility, Structure and moisture-holding capacity. Vermicompost, and FYM provide a low quantity of main nutrients but have the capacity to give all needed elements for longer periods of time. It increases the soil's physicochemical and biological qualities, such as soil structure, water retention capacity, and microbial population. Biofertilizers are agriculturally important living microorganisms that have the able to transform nutritious important components from useless to usable forms via physiological processes. They not only give nutrients at a much slower rate, but they also add the necessary biomass to prevent soil deterioration [1,3]. They are inexpensive, plant nutrients that are both efficient and renewable and effective, that can be utilised instead of inorganic fertilizer.

The production of any crop depends on certain factors like irrigation, fertilizer management, weeding, plant protection measures and varieties. Nutrient management is one of the most significant production aspects. Integrated plant nutrition management (IPNM) is the most cost-effective way to maximize crop productivity. As we are aware that to realize maximum crop yield with good quality, 17 essential elements are required. It is a fact that for, the food production increases year after year which could not keep pace with the ever-growing population, the sole organic agriculture cannot support the required/current level of crop production. The financial and economic viability, availability of organic inputs and technical know-how are also limiting factors. Current intensive agriculture, on the other hand, is detrimental to the soil, the ecology, and human health.

FYM, Vermicompost and Biofertilizer used wisely may be helpful not only in protecting crop yield and soil health, but also in replenishing crop chemical fertilizer requirements. Several studies have found that combining organic amendments and biofertilizers increases the nutrition quality of several vegetable crops while also sustaining crop production [4,5,6,7, and 8].

2. MATERIALS AND METHODS

The current study was initiated at the Department of Vegetable Science, Odisha University of Agriculture and Technology (OUAT), (Bhubaneswar), India, during the 2019 *Kharif* season. The investigation farm is situated about 7 km apart from the university and nearer to Bus-stand. As shown in (Tables.1), twelve treatments with various nutrient management combinations were applied to the bottle gourd variety BBOG-3-1, including different levels of inorganic fertilizers, and organic manure (FYM, Vermicompost), and Bio fertilizers (*Azospirillum, Azotobacter*, and PSB@4kg/ha).The experiments used a Randomized Block Design that was three times replicated. There were twelve treatments involving various organic manures as well as chemical fertilizers. BBOG-3-1 has been released as a National check name Utkal Sobha under the agro-climatic situation of Odisha. Plants were planted 1.5m X 1.5m apart in each $16m^2$ plot size before sowing. A basal dose of Vermicompost, Farmyard manure, and Biofertilizer was applied to the soil as part of the treatments. In two equal parts, nitrogen in the form of urea was used as a basal dose and a follow-up dose at the flowering stage. Only DAP and MOP have been used as phosphorus and potassium basal doses, respectively. During the cultivation process, traditional cultural practices and crop management were used. As a representative sample, Each treatment plot had five plants chosen at random. For each individual observation, the mean scores of each treatment in each replication were calculated. Panse and Sukhatme [9] described the appropriate statistical analysis method for the data.

Table 1. Treatment details

T_1	Control
T_2	100% RDF (80:50:50 NPK Kg ha^{-1})
T_3	FYM @15 t ha^{-1}
T_4	Vermicompost @ 5 t ha^{-1}
T_5	50% RDF + FYM @ 7.5 t ha^{-1} +Biofertilizer
T_6	50% RDF + Vermicompost @ 2.5 t ha^{-1}+ Biofertilizer
T_7	FYM @ 7.5 t ha^{-1} + Biofertilizer
T_8	50% RDF +Biofertilizer
T_9	Vermicompost @ 2.5 t ha^{-1} + Biofertilizer
T_{10}	100% RDF +FYM @7.5 t ha^{-1} + Biofertilizer
T_{11}	100% RDF + Vermicompost @ 2.5 t ha^{-1} + Biofertilizer
T_{12}	50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer

**Biofertilizer (Azotobacter, Azospirillium and PSB@ 4 kg ha^{-1})*

3. RESULTS AND DISCUSSION

3.1 Impact of Various Nutrient Management Strategies on Bottle Gourd Yield Attributing Characteristics

Combination of organic, inorganic, and Bio-fertilizers nutrient sources influenced yield and yield attributing characteristics. Perhaps it was due to enhanced physical, chemical, and biological soil characteristics, which resulted in increased nutrient availability and nitrogen from nutrient sources that are both organic and inorganic which had a strong influence in mobilising nutrients from the non-availability form of nutrients.

3.1.1 Days to 1st harvest

According to the findings of this investigation (Table 2), the minimum days to 1st harvest (59.00days) of bottle gourd was found by the application of 50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer(T_{12}) with a mean value 63.27 whereas the maximum days to 1st harvest (69.00 days) of bottle gourd. This may be due to the use of medium concentration of organic and inorganic sources of nutrients along with *Azotobacter*, *Azospirillium* and PSB. Similar results were also obtained in the treatment T_2, T_4, T_6, T_{10} and T_{11}. The current findings are consistent with those of Prasad et al. [10] in bottle gourd and Patel et al., 2020 in bottle gourd.

3.1.2 Days to last harvest

Data collected on account of days to last harvest is presented in Table 2. and showed that days to last harvest are significantly influenced by different treatments under study. However, the days to last harvest (92.00days) were noted as maximum under T_{12} (50% RDF+ FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer) with a mean value of 87.11. The treatment T_2 and T_{11} were found similar to each other. The minimum days in days to last harvest i.e.,79.00days were observed under treatment T_1(control). The present findings are in conformity with Prasad et al. [10] in bottle gourd, and Patel et al., [11] in bottle gourd.

3.1.3 Average fruit Weight (g)

The data (Table 2) showed that different nutrient sources had a significant influence on average fruit weight(g). Among twelve treatment combination tested, T_{12} (50%RDF+FYM@7.5tha^{-1} +Vermicompost@2.5tha^{-1}+Biofertilizer) produced the best performance in average fruit weight (1231g) with a mean value of 944.58 whereas minimum (587g) was observed in treatment T_1(Control). This could be because of diverse physiological functions and metabolic processes, especially protein metabolism, caused by an abundance of nitrogen, phosphorus, potash, vermicompost, FYM, and biofertilizer, as well as their absorption effects. The present findings are in unison with Sarhan et al*.,* [12] summer squash, Singh [13] and Kumar et al*.,* [14] in bottle gourd.

3.2 Impact of Various Nutrient Management Strategies on Bottle Gourd Yield, as Well as Economic Projections

3.2.1 Fruit yield (Kg plot^{-1})

The results of this study (Table2.) revealed that treatmentT_{12}(50%RDF+FYM@7.5tha^{-1}+VC@2.5t ha^{-1}+ Biofertilizer) produced the highest fruit yield plot^{-1}(44.82 kg) with a mean value of 28.26, which was significantly higher than the other treatments. However, the lowest mean values in terms of Fruit yield plot^{-1}(11.84kg plot^{-1}) was observed in control(T_1). Organic nitrogen sources improve soil physical condition, increase soil microorganism activity, and increase soil porosity, all of which are directly responsible for increased bottle gourd fruit production. In bitter gourd, Prasad et al. [15] and Thriveni et al. [16] reported similar results, and Sreenivas et al. [17] in ridge gourd. This could be attributed to the auxin synthesis, growth factors, and antifungals as a result of *Azotobacter* inoculation, as well as PSB conversion of insoluble phosphate to a soluble form, which may have contributed to an increase in bottle gourd fruit yield. The findings are consistent with those of Sarhan et al. [12] in summer squash, Singh [13] in bottle gourd, and Kumar et al. [14] in bottle gourd.

3.2.2 Fruit yield (q ha^{-1})

The data analysis confirmed that treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer) had the highest fruit yield (280.13q ha^{-1}) with a mean value of 176.64, which was much higher than the other treatments, and treatment T_1 had the lowest fruit yield (74.00 q ha^{-1}) (Control). Prasad et al., [15] and Thriveni et al., [16] reported similar results in bitter gourd, and Sreenivas et al. [17] in ridge gourd. This could be due to the combination of *Azotobacter, Azospirillium,* and PSB inorganic fertiliser with organic fertilizer. The presence of nutrients from different organic sources in the plant may be increased. It is required for fruit formation and development because it increases the solubility of micronutrients in the root rhizosphere. As a result, the average fruit weight (g) and fruit yield increased (q ha^{-1}). Thus, This could be due to the, it increased average fruit weight(g) and Fruit yield (q ha^{-1}). It influenced the rate of photosynthesis, protein synthesis, and the root zone's ability to absorb nutrients. In bottle gourd, Rabari et al., [18]. The results agree with those of Sarhan et al. [12] in summer squash, Singh [13], and Kumar et al. [14] in bottle gourd.

3.2.3 Economics

The results on the profitability of integrated nutrient management on Bottle gourd caused wide variations in the benefit: cost ratio due to the adoption of different nutrient management practices imposed on the Bottle gourd crop (Fig.1). The highest benefit: cost ratio of 2.92 was found in T_{12} while the minimum in Control(T_1). In general, the benefit: cost ratio of the present study on bottle gourd were in order of $T_{12}>T_5>T_2>T_3>T_6=T_{10}>T_9>T_{11}>T_7>T_8>T_4>T_1$.

These findings are consistent with Kumar et al., [14] in bottle gourd, Rabari et al. [18] in bottle gourd, and Chaudhary et al. [19] in bottle gourd.

3.3 Impact of Various Nutrient Management Strategies on the Quality Characteristics of Bottle Gourd

3.3.1 Total Suspended Solids (ºBrix)

In general, organic, inorganic, and Biofertilizers increased all of the chemical constituents studied when compared to the control. Organic, inorganic, and Biofertilizers are used in conjunction were highly effective than other treatments. The data on TSS at harvesting stage under the influence of different levels of N, P, K, FYM, VC and Biofertilizer (*Azospirillum, Azotobacter, Phosphobacteria*) for *Kharif* seasons as shown in Table 2. In Year 2019, the outcomes revealed treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer) recorded maximum (4.97ºBrix) TSS, followed by T_{10}(100% RDF +FYM @7.5 t ha^{-1}+ Biofertilizer) with (4.33ºBrix) whereas minimum (3.08ºBrix) was recorded in treatment T_1(Control). This resulted in a balanced concentration of NPK, FYM, Vermicompost, and

Biofertilizer in the leaves and fruits, as well as improved assimilate accumulation and quality parameters. In bottle gourd, Pravallika and Deepanshu [20], and Nadoda et al. [21] demonstrated the positive effects of trying to replace inorganic fertiliser with different organic manures on TSS content.

Table 2. Effect of Organic, inorganic and Biofertilizers on yield, yield attributing and quality Characters of Bottle Gourd

Treatment	Days to 1st Harvest	Days to last Harvest	Average Fruit weight(g)	Yield ($kgplot^{-1}$)	Yield (qha^{-1})	T.S.S (ºBrix)	Ascorbic Acid (mg $100gm^{-1}$)
T_1-Control	69.00	79.00	587	11.84	74.00	3.08	5.48
T_2-100% RDF (80:50:50 Kg NPK ha^{-1})	60.97	90.33	1020	33.45	209.06	4.08	8.27
T_3-FYM @15tha^{-1}	64.00	85.00	912	27.54	172.13	4.05	7.33
T_4-Vermicompost @ 5 t ha^{-1}	61.33	89.00	907	27.34	170.88	4.03	7.58
T_5-50% RDF + FYM @ 7.5 t ha^{-1} +Biofertilizer	62.67	87.67	990	28.35	177.19	4.08	7.07
T_6-50% RDF + Vermicompost @ 2.5 t ha^{-1}+ Biofertilizer	62.00	86.67	1000	31.24	195.25	4.09	7.23
T_7-FYM@7.5 t ha^{-1} + Biofertilizer	65.33	85.33	883	20.41	127.56	3.13	7.33
T_8-50% RDF +Biofertilizer	67.00	84.00	850	14.59	91.19	3.29	5.49
T_9-Vermicompost @ 2.5 t ha^{-1} + Biofertilizer	64.95	86.33	900	26.12	163.25	3.74	7.38
T_{10}-100% RDF +FYM @7.5 t ha^{-1} + Biofertilizer	61.60	90.00	1025	33.93	212.06	4.33	8.12
T_{11}-100% RDF + Vermicompost @ 2.5 t ha^{-1} + Biofertilizer	61.33	91.00	1030	39.51	246.94	4.01	8.47
T_{12}-50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer	59.00	92.00	1231	44.82	280.13	4.97	8.60
Mean	63.27	87.11	944.58	28.26	176.64	3.91	7.36
SE (m) $\pm$	1.22	0.66	63.28	1.28	7.89	0.26	0.38
CD (5%)	3.58	1.94	185.56	3.76	23.14	0.75	1.12

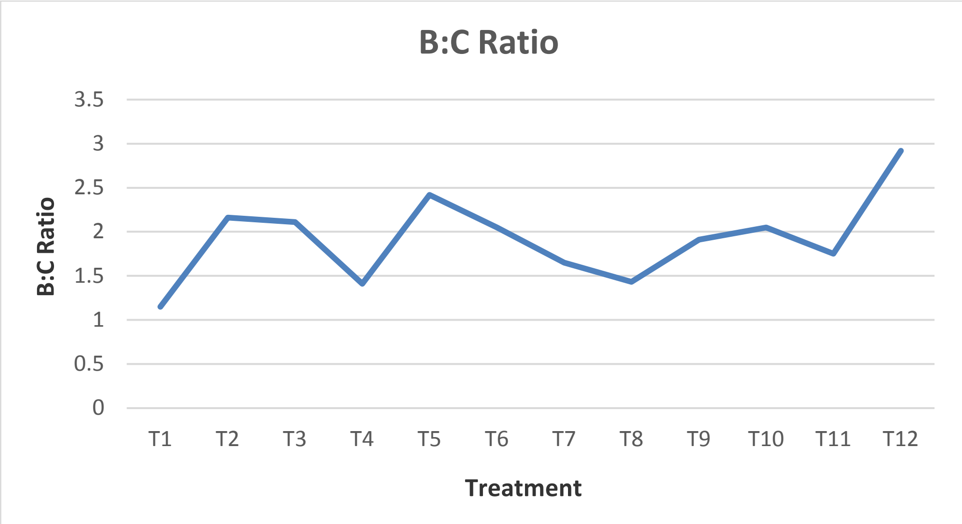

Fig. 1. Benefit Cost Ratios of Bottle Gourd Production under Different Nutrient Sources

3.3.2 Ascorbic acid (mg/100gm)

At harvesting stage, ascorbic acid under influence of various treatment levels of organic manure, inorganic fertilizers and Biofertilizers for *Kharif* seasons in year 2019 shown in Table 2. The content of ascorbic acid was greatly affected by various treatments. It ranged from 5.48 to 8.60 with a mean value 7.36. The maximum ascorbic acid content (8.60 mg100 g^{-1}) found with treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer), it was *statistically at par* with treatment T_2, T_4, T_{10}, T_{11} while the Treatment T_1(control) had the lowest ascorbic acid content (5.48 $mg100g^{-1}$). The present ascorbic acid content results are consistent with Kameswari and Narayanamma's [22] findings in ridge gourd, Pravallika and Deepanshu [20] in bottle gourd, Chaudhary et al., [19] and Imnatemsu et al*.,* [23] in bottle gourd, Nadoda et al. [21] in bottle gourd.

3.3.3 Total soluble sugar (%)

The data on % total soluble sugar content in bottle gourd fruit as strongly affected by various levels of organic manure and inorganic fertilizer are presented in Fig. 2. It was observed that treatment effect was found significantly superior in recording more TSS percent. The maximum Total Soluble Sugar (5.67%) recorded in treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer), which was *statistically at par* with T_2, T_6, T_{10} and T_{11} with a mean value of 4.34. On the other hand, minimum Total soluble sugar (2.95%) was demonstrated in treatment T_1(Control). The increase in TSS of bottle gourd may be due to the increased carbohydrates production during photosynthesis and also due to improved physiological and biochemical activities in plant system. The findings were comparable to those of Nadoda et al. [21] in bottle gourd, Nayak et al. [24] in pointed gourd, and Pateliya et al. [25] in bottle gourd.

3.3.4 Reducing SUGAR (%)

The % reducing sugar content data in bottle gourd fruit as greatly affected by various levels of organic manure and inorganic fertilizer are presented in Fig. 2. It was observed that the treatment effect was found significantly superior in recording more RSS %. The maximum RSS (3.78%) recorded in treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer), which was *statistically* comparable to T_2, T_5, T_6, T_{10} and T_{11} with a mean value of 3.24. On the other hand, minimum RSS (2.63%) was recorded in treatment T_1(Control). The current findings are consistent with those of Nadoda et al. [21] in bottle gourd and Pateliya et al. [25] in bottle gourd.

3.3.5. Non-Reducing Sugar

Fig. 2 depicts the data on the percent non-reducing sugar content of bottle gourd fruit as strongly affected by different levels of organic manure and inorganic fertilizer. The maximum NSS (1.89%) recorded in treatment T_{12} (50% RDF + FYM @7.5 t ha^{-1}+ Vermicompost @ 2.5t ha^{-1}+ Biofertilizer), which was *statistically at par* with T_{11} with a mean value of 1.10. On the other

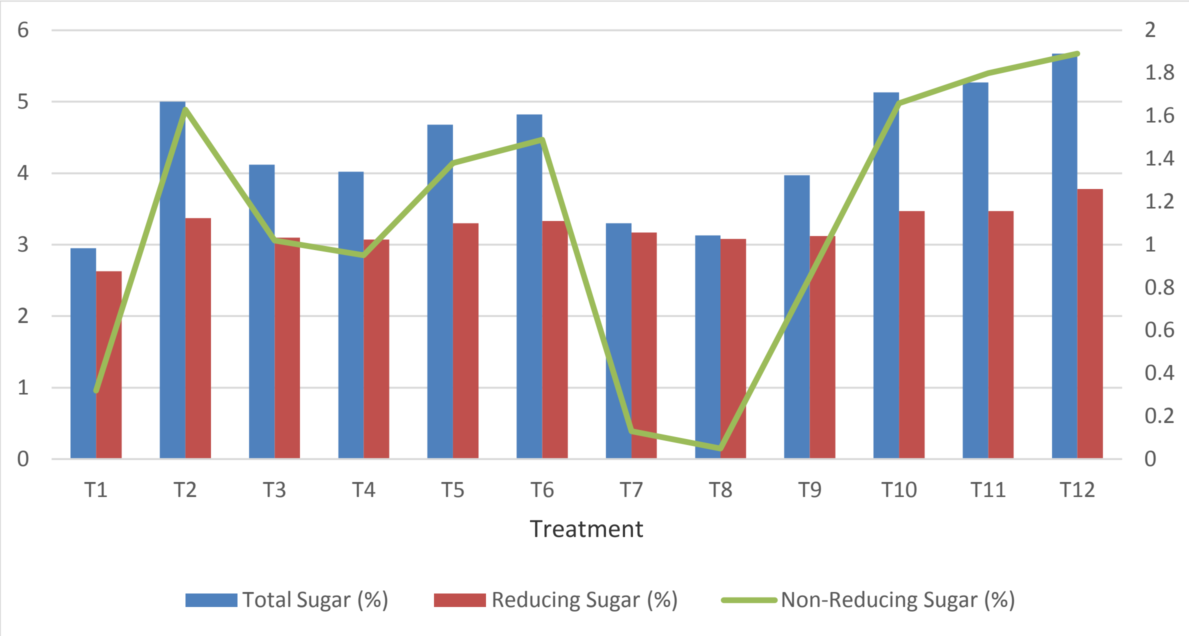

Fig. 2. Effect of different sources of nutrients on quality traits i.e., Total sugar (%), Reducing Sugar (%) and Non-Reducing Sugar (%) in Bottle gourd

hand, the lowest RSS (0.32%) was recorded in treatment T_1(Control). The current findings are consistent with those of Nadoda et al. [21] in bottle gourd and Pateliya et al. [25] in bottle gourd.

4. CONCLUSION

Based on the research experiment results, it is possible to conclude that the use of 50% RDF + FYM @7.5tha^{-1}+ Vermicompost@2.5tha^{-1} and Biofertilizer exhibited the bottle gourd cv. BBOG-3-1 lowest number of days to the first harvest, the highest number of days to last harvest, average fruit weight, highest total soluble solids, total sugar, reducing sugar, non-reducing sugar, and ascorbic acid. From this experiment it is concluded that maximum yield could not be realized with organic manures or NPK alone particularly in highly productive crops like bottle gourd but the higher yields and B:C ratio can only be obtained by combining organic manures with chemical fertilisers. As a result, an integrated approach to managing the most important natural resource base is critical, ensuring the efficient use of on-farm generated organic manures alongside mineral fertilisers, ensuring sustainable crop production. Aside from sustaining crop production, INM reduces the heavy use of inorganic fertilisers alone and improves nutrient efficiency, reducing environmental losses and, ultimately, pollution. As a result, INM can be used as part of a global strategy to ensure food security and environmental protection.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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