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Assessment of quality parameters of brinjal (*Solanum melongena* L.) based on potential of organic substances & bio-inoculants

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Abstract

A field experiment was conducted at research farm, KVK, Damoh, Madhya Pradesh during the *rabi* session in two consecutive years; 2021 and 2022 to evaluate the effect of organic manure and bio-inoculant on the qualitative attributes of Brinjal. There were nineteen treatments comprising of different combinations of organic manures andbio-inoculants evaluated in randomized block design with three replications. Two different organic manures were vermicompost and Farm yard manure taken in varied amounts along with bioinoculants (*Azotobacter,* Phosphate solubilizing bacteria and Potassium solubilizing bacteria) in different concentrations. At the time of transplanting the brinjal in the plot, all of the organic manures and bioinoculants were applied in accordance with the doses that are to be administered in the plot. The results revealed that the highest ascorbic acid 14.48 mg/100g,total soluble solid 4.69 (°Brix), protein content in fruit 0.963%, total sugar 2.41 mg/g and shelf life of fruit 10.44 days was received from the treatment T_{18} (Vermicompost (3t/ha) + *Azotobacter* +PSB+KSB (7.5 L / ha).The highest titrable acidity (1.98%) and pH content (5.11) was received from the treatment T_{16}-Vermicompost (3t/ha)+ *Azotobacter*+ PSB+ KSB (2.5 L / ha).The outcome showed that the application of vermicompost (3t/ha) along with KSB (7.5l/ha) significantly enhanced the qualitative aspect of Brinjal and improved the shelf life.

Keywords: Brinjal, Vermicompost, FYM, shelf life, ascorbic acid and titrable acidity

Introduction

Brinjal (*Solanum melongena L.*) or eggplant belongs to the family Solanaceae having chromosome number 2n=24 (Khadka *et al.,* 2022) [14]. Brinjal is popularly grown vegetable crop in India and a staple vegetable in the tropical countries of the World (Palia *et al.,* 2021) [18] Brinjal fruits are quite high in nutritive value and can justifiably be compared with tomato. Brinjal is a good source of vitamins like A, B and C. The fruit comprises of 92.7g moisture, 1.4g of protein, minerals of 0.3g, fiber content 1.3g, 4.0g carbohydrate, oxalic acid 18mg, phosphorus 47mg, iron 0.9mg, ascorbic acid 10mg, riboflavin 0.11mg, thiamine 0.04mg and vitamin-A 124I.U and moreover medicinal property such as white brinjal is better for Diabetics patients (Aykroyd, 1963) [4] and Palia *et al.*, 2021) [18] Bitterness in brinjal is due to the presence of high amount of glycoalkaloids (20 mg/100 g fresh weight).

Brinjal being a long duration crop, requires a good amount of manures and fertilizers. The current agricultural system completely relies on the use of chemical fertilisers, pesticides, and growth regulators to increase crop yield, the need to investigate alternatives to chemical agriculture has gradually arisen. High input methods like chemical fertilisers, insecticides, and herbicides are used to increase output, but there is rising concern about the negative impacts of chemical use on environmental quality, human health, and soil productivity (Sharma *et al.*, 2012 and Manickam *et al.*, 2021) [25, 15]. It is a well-known fact that the organic matter is heart of fertile soil. Therefore, balanced application of manures and fertilizers is very important for sustainable crop production. It governs the physio-chemical and biological properties of the soil and finally crop productivity. The vermicomposting is known to modify the physical, chemical and biological properties of soil favourably, enhance nutrient cycling in the soil and increase the concentration of exchangeable Ca, Na, Mg, K and available N, P and Mo in the soil.

Since using inoculants would significantly reduce the need for chemical fertilisers, its usage is considered as being highly desirable, and a growing number of inoculants are currently being commercialised for a variety of crops (Anayat *et al.*, 2021) [3]. A class of helpful bacteria called phosphate solubilizing bacteria (PSB) may hydrolyze both organic and inorganic phosphorus from insoluble substances. It is well acknowledged that the release of low molecular weight organic acids is a component of the process by which PSB strains solubilize mineral phosphate (Singh *et al.*, 2020) [26].

A limited number of studies have also shown that organic amendments promote fruit growth, yield, and quality (Christo *et al.*, 2011; Sarhan *et al.*, 2011; Agbo *et al.*, 2012) [7, 23, 2]. A research was conducted to assess the impact of various nutrient management practises including the application of vermicompost and FYM in different doses and varied concentrations of *Azotobacter*, PSB and KSB on the fruit quality of brinjal plants.

Materials and methods

The experiment based on studying the potential of organic substances & bio-inoculants for promotion of fruit quality of brinjal (*Solanum melongena* L.)" was conducted at research farm, KVK, Damoh, Madhya Pradesh during the *rabi* session in two consecutive years; 2021 and 2022. The experiment was laid out using randomized block design with 19 treatments in three replications comprising of different doses of vermicompost and farm yard manure along with varied concentrations of *Azotobacter*, PSB and (Table 1) KSB. The plot size was 3m X 1.6 m with a spacing of 60 x 40 cm. The land was brought to fine tilth by ploughing and tillage. Proper irrigation was maintained. Healthy and uniform sized seedlings of 30 days old were transplanted to the field. The organic manures were applied of week before the transplanting and the layout was laid where the organic manures and bio-inoculants were applied treatment wise. All cultural practices were followed regularly during the crop growth and observations were recorded. Qualitative analysis was done to estimate Vitamin C content, Titrable Acidity, TSS, Protein content, total sugar and shelf life. Vitamin-C content was determined by 2, 6-dichlorophenol indolphenol, visual titration method (A.O.A.C, 1997) [1] and expressed in mg/100g. The total soluble solids were measured by hand Refractometer (Erma, 0-32 ^{0}Brix). Protein content was estimated by micro-Kjeldahl distillation method (A.O.A.C., 1997) [1]. Soluble carbohydrates were estimated by anthrone reagent (Dubios *et al.*, 1951) [6] method. The shelf life of fruits was determined by recording the number of days the fruits were remained in good condition in storage at room temperature.

Table 1: Treatment details

	Treatments
T_0	Control
T_1	FYM (10t/ha)+*Azotobacter*+ PSB+KSB (2.5 L / ha)
T_2	FYM (10t/ha)+*Azotobacter* +PSB+ KSB (5 L/ha)
T_3	FYM (10t/ha)+*Azotobacter* +PSB+KSB (7.5 L/ha)
T_4	FYM (20t/ha)+*Azotobacter* +PSB+KSB (2.5 L / ha)
T_5	FYM (20t/ha)+*Azotobacter* +PSB+KSB (5 L / ha)
T_6	FYM (20t/ha)+*Azotobacter* +PSB+ KSB (7.5 L/ha)
T_7	FYM (30t/ha)+*Azotobacter* +PSB+ KSB (2.5 L/ha)
T_8	FYM (30t/ha)+*Azotobacter* +PSB+ KSB (5 L/ha)
T_9	FYM (30t/ha)+*Azotobacter* +PSB+KSB (7.5 L / ha)
T_{10}	Vermicompost (1t/ha)+*Azotobacter* +PSB+ KSB (2.5 L/ha)
T_{11}	Vermicompost (1t/ha) + *Azotobacter* +PSB+ KSB (5 L/ha)
T_{12}	Vermicompost (1t/ha) + *Azotobacter*+ PSB+ KSB (7.5 L/ha)
T_{13}	Vermicompost (2t/ha)+*Azotobacter*+ PSB+KSB (2.5 L/ha)
T_{14}	Vermicompost (2t/ha) + *Azotobacter*+ PSB+KSB (5 L / ha)
T_{15}	Vermicompost (2t/ha) + *Azotobacter*+ PSB+ KSB (7.5 L/ha)
T_{16}	Vermicompost (3t/ha)+*Azotobacter*+ PSB+ KSB (2.5 L/ha)
T_{17}	Vermicompost (3t/ha) + *Azotobacter* +PSB+ KSB (5L/ha)
T_{18}	Vermicompost (3t/ha) + *Azotobacter* + PSB+ KSB (7.5 L/ha)

Results and discussion

Quality parameters: The result is given below

1. Vitamin – C (Ascorbic acid (mg/100g))

Ascorbic acid, often known as vitamin C, is an antioxidant molecule that is required for plant and animal metabolism. Aside from its nutritional importance, higher ascorbate has been linked to enhanced post-harvest fruit quality (Manickam *et al.*, 2021) [15]. The ascorbic acid in brinjal fruit were differed significantly to each other as mentioned in Table 2. The significantly highest ascorbic acid 14.48 mg/100g was received from the treatment T_{18}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (7.5 L / ha)] followed by 14.40 mg/100g in the treatments T_{17}-[Vermi Compost (3t/ha) + *Azotobacter*+ PSB+KSB (5 L/ha)], 14.37 mg/100g in the treatments T_{16}- [Vermi Compost (3t/ha) + *Azotobacter* + PSB+ KSB (2.5 L/ha)] and 13.92 mg/100g in the treatments T_9 [FYM (30t / ha)+ *Azotobacter*+ PSB+KSB (7.5 L/ha)]. While the minimum ascorbic acid 5.67 mg/100g was recorded in treatment T_0-(control). These results are in conformity with those of Gajella and Chatterjee (2019) [7] concluded that the foliar application of panchagavya 3% at 20, 40 and 60 DAS. The increase in vitamin C content in fruit by spray of liquid organic manures may be due to translocation of more amount of carbohydrates to developing fruits and utilization of nutrients from basal applied farm yard manure and vermicompost. Similar observation was recorded earlier by Sangeeta *et al.*, (2018) [22], Manickam *et al.*, 2021 [15] in Brinjal and Sharma *et al.*, (2022) [24] in cherry tomato.

2. Titrable acidity (%)

Nutrient management practises have had a considerable impact on brinjal titrable acidity. The titratable acidity was determined as a percentage of citric acid by titrating 10 mL of tomato juice to pH 8.2 with 0.1N NaOH. Lower acidity is an important consideration in brinjal processing since it saves processing time. The titrable acidity percentage in brinjal fruit were differed significantly to each other. The significantly highest titrable acidity 1.98% was received from the treatment T_{16}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (2.5 L/ha)] followed by 1.72% in the treatments T_{10}-[Vermicompost (1t/ha)+*Azotobacter*+ PSB+KSB (2.5 L/ha)] and 1.41% in the treatments T_{18} [Vermicompost (3t/ha) + *Azotobacter*+ PSB +KSB (7.5 L / ha)] while the minimum titrable acidity 0.32% was recorded in treatment T_1-[FYM (10t/ha) +*Azotobacter*+ PSB +KSB (2.5 L/ha)]. Prabakaran and Pichai (2003) [19] found that organic manure application resulted in higher titrable acidity in tomato; Rekha Eda *et al.* (2018) [20] discovered that RDF application via FYM and vermicompost resulted in higher titrable acidity in papaya compared to inorganic fertiliser application. These results are in conformity with those of Kandoliya *et al.*, (2015) [9] who found titrable acidity (0.20-0.32%) in a pulp of brinjal fruits and Gharezi *et al*. (2012) [12] & Sharma *et al*., (2022) [24] in cherry tomato.

3. TSS (°Brix)
The total soluble solid (°Brix) in brinjal fruit were differed significantly to each other. The significantly highest total soluble soild 4.69 (°Brix) was received from the treatment T_{18}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (7.5 L / ha)] followed by 4.64 (°Brix) in the treatments T_{17}-[Vermi Compost (3t/ha) + *Azotobacter*+ PSB + KSB (5 L/ha)] andT_9 [FYM (30t / ha)+ *Azotobacter*+ PSB + KSB (7.5 L/ha)]. 4.49 (°Brix) in the tretments T_{16}-[Vermi Compost (3t/ha)+ *Azotobacter*+ PSB+KSB (2.5 L/ha)] while the minimum total soluble solid 2.58 (°Brix) was recorded in treatment T_0-(control).Present findings supported that the findings of Singh *et al.*, (2020) [14] the Total Soluble Solids (ºBrix) was recorded maximum in treatments T_9 (RDF + VAM @ 25% + PSB @ 50% + AZ @ 25%) with (8.83ºBrix) which is statistically at par with treatment T_8 and T_4 which is significantly superior over the other treatment. These findings are in close conformity with Solanki *et al*. (2010) [29], Mishra *et al.* (2017) [17], Singh *et al.* (2020) [14].

4. Protein content in Fruit (%)
The protein content (Table 2) in brinjal fruit were differed significantly to each other. The significantly maximum protein contentin fruit 0.963% was received from the treatment T_{18}-[Vermicompost (3t/ha) + *Azotobacter* +PSB+ KSB (7.5 L / ha)] and treatment T_9 [FYM (30t / ha)+ *Azotobacter* + PSB+KSB (7.5 L/ha)]followed by 0.962% in the treatments T_{12} [Vermicompost (1t/ha) + *Azotobacter*+ PSB+ KSB (7.5L / ha)]**,** and 0.961% in the treatments T_{17}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB+KSB (5 L/ha)]. While the minimum protein content 0.916% was recorded in treatment T_0-(control).These results are in agreement with the finding of Vijayakumari *et al.*, (2012) [15] in soybean, Chaudhary *et al.*, (2017) [3], Gajella and Chatterjee (2019) [7] who concluded that the application of organic formulations on crop increases the protein content.

5. Total sugar (mg/g)
The sugar concentration of fruits is controlled by plant nutrients such as vermicompost and biofertilizers, water supply, and light intensity, and sugar level impacts brinjal flavour qualities (Sharma *et al.*, 2022) [24]. The Total sugar (mg/g) in brinjal fruit were differed significantly. The maximum total sugar 2.41 mg/g was obtained when the plants were grow nunder the treatment T_{18}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB+KSB (7.5 L / ha)] followed by 2.37mg/g in the treatments T_{17}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB+KSB (5 L/ha)], 2.34mg/g in the treatments T_{16}-[Vermicompost (3t/ha) +*Azotobacter*+ PSB+ KSB (2.5 L/ha)] and T_9 [FYM (30t / ha) + *Azotobacter*+ PSB + KSB (7.5 L/ha)]. While the minimum total sugar 1.54 mg/g was recorded in treatment T_0 (control).These results are close agreement with those reported by Chaudhary *et al.*, (2023) [5] total sugars (12.14% and 12.07%).

6. pH content
The pH content in brinjal fruit were differed significantly to each other. The significantly highest pH content 5.11 pH was received from the treatment T_{16}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (2.5 L/ha)] followed by 5.04 pH in the treatments T_{10}-[Vermicompost (1t/ha) + *Azotobacter*+ PSB + KSB (2.5 L/ha)], and 5.03 pH in the treatments T_{18}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (7.5 L / ha)].While the minimum pH content 4.02 pH was recorded in treatment T_2 [FYM (10t / ha) + *Azotobacter*+ PSB+KSB (5 L/ha)]. These results are close agreement with those reported by Sahane *et al.*, (2016) [12] concluded that the organic manures reduced the pH of soil. This is due to increasing organic matter content in soil, during the decomposition and mineralization process which producing the organic acids and soluble salts, some are leaching and some are utilized by the crop.

7. Shelf life of fruit (day)
The shelf life of brinjal fruit were differed significantly to each other. The significantly maximum Shelf life of fruit 10.44 days was received from the treatment T_{18}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (7.5 L/ha)] followed by 10.24 days in the treatments T_{17}-[Vermicompost (3t/ha) + *Azotobacter*+ PSB + KSB (5 L/ha)], 10.23 days in the treatments T_9-[FYM (30t / ha) + *Azotobacter*+ PSB+KSB (7.5 L/ha)], and 10.04 days in the treatments T_{16}-[Vermicompost (3t/ha) + *Azotobacter* +PSB+ KSB (2.5 L/ha)]. While the minimum shelf life of fruit 6.04 days was recorded in treatment T_0 (control). These results are close agreement with those reported by Manogna *et al.*, (2023) [11] the high heritability coupled with high genetic advance as per cent of mean was recorded for the shelf life of fruit.

Conclusion
It could be concluded from the field investigation that highest ascorbic acid 14.48 mg/100g, highest total soluble soild 4.69 (°Brix) protein content in fruit 0.963%, total sugar 2.41 mg/g, pH content 5.11 and shelf life of fruit 10.44 days was received from the treatment T_{18}-[Vermicompost + *Azotobacter*+ PSB + KSB], the highest titrable acidity 1.98% was received from the treatment T_{16}-[Vermicompost + *Azotobacter*+ PSB + KSB].

Table 2: Effect of organic manure and bio-inoculants on Vitamin – C/ascorbic acid, titrable acidity, TSS, protein content in fruit and total sugar

Treatments	Vitamin – C (mg/100 g)			Titrable acidity (%)			TSS (°Brix)			Protein content in fruit (%)			Total sugar (mg/g)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_0	5.53	5.80	5.67	0.50	0.52	0.51	2.58	2.57	2.58	0.913	0.920	0.916	1.55	1.54	1.54
T_1	11.90	12.11	12.00	0.30	0.33	0.32	3.72	3.67	3.69	0.890	0.892	0.891	2.02	2.01	2.01
T_2	12.23	12.26	12.24	0.60	0.63	0.62	3.77	3.73	3.75	0.930	0.927	0.929	2.04	2.05	2.05
T_3	12.36	12.39	12.37	0.92	0.94	0.93	3.86	3.85	3.86	0.9213	0.926	0.924	2.07	2.06	2.06
T_4	12.52	12.56	12.54	0.80	0.82	0.81	3.93	3.91	3.92	0.925	0.934	0.930	2.10	2.11	2.11
T_5	12.69	12.71	12.70	1.06	1.09	1.08	4.03	4.01	4.02	0.937	0.954	0.945	2.13	2.13	2.13
T_6	12.73	12.76	12.74	1.16	1.19	1.18	4.07	4.06	4.06	0.946	0.959	0.952	2.15	2.14	2.14
T_7	13.74	13.75	13.75	0.92	0.93	0.93	4.43	4.38	4.40	0.947	0.947	0.947	2.29	2.27	2.28
T_8	13.78	13.79	13.79	1.06	1.09	1.07	4.48	4.46	4.47	0.966	0.956	0.961	2.33	2.31	2.32
T_9	13.91	13.93	13.92	0.98	1.04	1.01	4.65	4.64	4.64	0.963	0.963	0.963	2.35	2.33	2.34
T_{10}	12.12	12.14	12.13	1.70	1.74	1.72	3.96	3.94	3.95	0.948	0.932	0.940	2.19	2.17	2.18
T_{11}	12.17	12.19	12.18	1.23	1.29	1.26	4.04	4.02	4.03	0.958	0.958	0.958	2.21	2.20	2.20
T_{12}	12.23	12.25	12.24	1.02	1.05	1.03	4.10	4.06	4.08	0.962	0.962	0.962	2.22	2.21	2.22
T_{13}	12.74	12.75	12.74	0.90	0.96	0.93	4.25	4.23	4.24	0.949	0.949	0.949	2.25	2.24	2.24
T_{14}	12.99	13.03	13.01	1.05	1.07	1.06	4.29	4.27	4.28	0.946	0.955	0.950	2.27	2.26	2.27
T_{15}	13.15	13.18	13.16	1.09	1.10	1.09	4.31	4.29	4.30	0.950	0.957	0.953	2.30	2.32	2.31
T_{16}	14.36	14.38	14.37	1.97	2.0	1.98	4.50	4.48	4.49	0.948	0.960	0.954	2.34	2.33	2.34
T_{17}	14.39	14.41	14.40	1.20	1.21	1.20	4.66	4.63	4.64	0.960	0.961	0.961	2.38	2.37	2.37
T_{18}	14.47	14.50	14.48	1.40	1.42	1.41	4.71	4.68	4.69	0.964	0.963	0.963	2.42	2.40	2.41
SEm±	0.44	0.39	0.29	0.096	0.106	0.049	0.197	0.194	0.101	0.005	0.008	0.003	0.04	0.05	0.03
CD at 5%	1.28	1.14	0.83	0.276	0.305	0.141	0.566	0.558	0.291	0.014	0.018	0.101	0.13	0.14	0.09

Table 3: Effect of organic manure and bio-inoculants on pH content, shelf life of brinjal fruit (days)

Treatments	pH content			Shelf life of fruit (days)		
	2021	2022	Pooled	2021	2022	Pooled
T_0	5.01	5.02	5.01	6.11	5.97	6.04
T_1	4.5	4.53	4.51	6.27	6.23	6.25
T_2	4.01	4.03	4.02	6.46	6.39	6.42
T_3	4.45	4.47	4.46	6.76	6.59	6.67
T_4	4.9	4.92	4.91	7.23	6.49	6.86
T_5	4.5	4.51	4.50	7.31	7.20	7.26
T_6	4.70	4.72	4.71	7.88	7.74	7.81
T_7	4.90	4.92	4.91	9.43	9.27	9.35
T_8	4.92	4.78	4.85	10.24	10.06	10.15
T_9	4.99	5.01	5.00	10.32	10.15	10.23
T_{10}	5.03	5.05	5.04	8.45	8.34	8.39
T_{11}	4.88	4.9	4.89	8.59	8.48	8.54
T_{12}	4.72	4.74	4.73	8.65	8.54	8.59
T_{13}	4.45	4.46	4.45	9.50	9.39	9.44
T_{14}	5.00	5.02	5.01	9.73	9.62	9.67
T_{15}	5.02	5.04	5.03	9.95	9.50	9.72
T_{16}	5.11	5.12	5.11	10.10	9.99	10.04
T_{17}	4.20	4.23	4.21	10.33	10.22	10.27
T_{18}	4.30	4.33	4.32	10.50	10.39	10.44
SEm±	0.08	0.09	0.04	0.452	0.455	0.450
CD at 5%	0.24	0.25	0.12	1.297	1.306	1.297

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