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Effect of Microbial Inoculants on Growth, Yield and Quality Attributes of Brinjal

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Abstract

The present investigation was carried outduring May- August, 2021 at DAV University, Jalandhar, Punjab to find out the effect of microbial inoculants on growth, yield and quality attributes of brinjal (*Solanum melongena* L.). The experiment consisted of different microbial inoculants (*Rhizobium, Trichoderma* and Phosphate Solubilizing Bacteria) and three varieties (Pusa Purple Long, BR-112 and Pusa Purple Round) laid out in Randomized Block Design (RBD) with three replications. Observations were recorded on days to first flowering, days to 50% flowering, plant height (cm), stem diameter (cm), number of primary branches, number of secondary branches, number of leaves per plant, fruit length (cm), fruit diameter (cm), number of fruits plant^{-1}, average fruit weight (g), yield plant^{-1} (kg plant^{-1}), yield plot^{-1} (kg plot^{-1}), TSS, ascorbic acid (mg 100 g^{-1}) and titratable acidity (%). Analysis of variance (ANOVA) revealed significant effect of microbial inoculants, varieties and their interaction for all the characters under study. It was observed that plants which were treated with *Rhizobium* resulted in superior performance for most of the traits studied. Among varieties, desirable results were observed in Pusa Purple Long. Considering the interaction of microbial inoculants and varieties it was concluded that Pusa Purple Long treated with *Rhizobium* resulted in superior performance with respect to growth, yield and quality parameters of brinjal.

Keywords: Brinjal, microbial inoculants, phosphate solubilizing bacteria, *Rhizobium*, *Trichoderma*

1. Introduction

Brinjal (*Solanum melongena* L.) or eggplant is an important member of Solanaceae family. It is widely grown in sub-tropics and tropics region of the world due to its high nutritional and medicinal values. The cultivated brinjal is of Indian origin and has been in cultivation for long time and center of origin is in the Indo Burma region (Vavilov, 1951). India ranks second followed by China with the production of 12.35 mt (Anonymous, 2020a). West Bengal is the largest producer of brinjal in India. In Punjab, brinjal occupies 12th rank in area (5.42 ha) and production is 119.65 t ha^{-1} (Anonymous, 2020b).

It is grown for its immature, unripe fruits which are used in the variety of ways as cooked vegetable in curries. It is used in a variety of culinary preparations since ancient times. It is popular among people of all social strata and hence, it is rightly called as vegetable of masses (Patel and Sarnaik, 2003). It is a good source of vitamins like A, B and C. Each 100 g of fresh eggplant fruits contains 92.7g water, 1.4 g protein, 4 g carbohydrates, 0.3 g fat, 1.3 g fibre, 24 calories, 18 mg oxalic acid also contain mineral salts such as potassium 2 mg, phosphorus 47 mg, magnesium 15 mg, calcium 18 mg, iron 0.38 mg, zinc 0.22 mg, sodium 3 mg, sulfur 44 mg, and copper 0.12 mg (Alias et al., 2021). Some medicinal use of eggplant tissues and extract include treatment of diabetes, asthma, cholera, bronchitis and diarrhoea, its fruit and leaves are reported to lower certain levels of blood cholesterol (Thingujam et al., 2016).

In India the productivity of brinjal is quite low in India. Generally, solanaceous vegetables are heavy feeders with higher requirement of fertilizers like nitrogen, phosphorus and potassium, in addition to secondary nutrients such as calcium and sulphur for better growth, fruit and seed yield. There exists a good scope to improve its average productivity in India to full fill both domestic and national needs by way of providing adequate amount of fertilizers to the crop. The inorganic source of fertilizers is not only costly but also continuously harming the ecological niche. The use of microbial inoculants or biofertilizer in such situation is therefore a practically paying proposal.

Preparations of micro-organisms that can mobilize nutritive elements from non-usable form through biological process are called biofertilizers or microbial inoculants and these include bacteria, fungi and algae. They are also found to improve the soil physical properties, organic carbon, soil tilth and soil health in general and enhance nutrient utilization, efficiency and grain quality besides being cheaper and pollution free and their production are based on the renewable energy resources (Sundararasu and Jeyasankar, 2014). Phosphate solubilizing bacteria (PSB) can hydrolyze organic and inorganic phosphorus from insoluble compounds. It may also aid the growth of plants stimulating the efficiency of biological nitrogen fixation, synthesizing phytohormones and enhancing the availability of some trace elements as zinc and iron. *Trichoderma* are potential opportunistic, avirulent plant symbionts and biological agent against different soil-borne pathogens (Uddin et al., 2018) and thus increase the productivity. *Pseudomonas fluorescens* is an eco-friendly biological fungicide which is highly active on root and stem rots, sheath blights / leaf spots, mildews and other fungal diseases.

Each gram of carrier of biofertilizers contains at least 10 million viable cells of a specific strain and thus its tiny dose is sufficient to produce desirable results (Anandaraj and Delapierre, 2010). Keeping in view the importance of crop and the importance of use of microbial inoculants in enhancing the growth and productivity of brinjal, the present study was planned and executed.

2. Materials and Methods

The present investigation was carried out during May–August, 2021 at DAV University, Jalandhar, Punjab, India. The experiment consisted of three microbial inoculants (*Rhizobium, Trichoderma* and Phosphate Solubilizing Bacteria) and three varieties (Pusa Purple Long, BR-112 and Pusa Purple Round) laid out in Randomized Block Design (RBD) with three replications. Observations were recorded on days to first flowering, days to 50% flowering, plant height (cm), stem diameter (cm), number of primary branches, number of secondary branches, number of leaves plant^{-1}, fruit length (cm), fruit diameter (cm), number of fruits plant^{-1}, average fruit weight (g), yield plant^{-1} (kg plant^{-1}), yield plot^{-1} (kg plot^{-1}), TSS, ascorbic acid (mg 100 g^{-1}) and titratable acidity (%). All the observations on growth and yield attributes of brinjal were recorded after harvesting of the crop except days to first flowering and days to 50% flowering. The quality attributes were recorded using standard methods. TSS were recorded with the help of hand refractrometer, ascorbic acid was calculated by 2,6- dicholophenol indophenols visual titration method and titratable acidity was measured by standard alkali solution of known concentration using phenolphthalein as an indicator to a light pink color. The collected information in the form of data was analysed on OPSTAT software.

3. Results and Discussion

3.1. Analysis of variance

Analysis of variance revealed that the treatments significantly affected all the characters studied in the present investigation

3.2. Growth parameters

The observations on different growth parameters as influenced by microbial inoculants and varieties have been presented in Table 1. The minimum number of days to first flowering (39.31 days) and days to 50% flowering (50.44 days) was recorded in I_4 (Phosphate Solubilizing Bacteria) which was significantly superior over the remaining treatments. While, I_1 (Control), resulted in maximum days to 50% flowering (53.82

Table 1: Effect of microbial inoculants and varieties on growth parameters of brinjal

Treatment	Days to first flowering	Days to 50% flowering	Plant height (cm)	Stem diameter (cm)	No. of primary branches	No. of secondary branches	No. of leaves plant^{-1}
Microbial Inoculants							
I_1	42.71	53.82	65.58	0.98	2.84	10.98	40.29
I_2	41.29	51.04	72.69	1.03	3.20	11.73	42.47
I_3	42.82	52.60	66.58	1.21	3.00	11.27	41.64
I_4	39.31	50.44	66.84	1.31	3.11	11.47	41.18
CD (p=0.05)	1.19	1.62	3.37	0.03	0.21	0.25	0.57
SEd±	0.57	0.77	1.61	0.02	0.10	0.21	0.28
Varieties							
V_1	41.02	51.18	69.83	1.15	3.17	11.47	41.70
V_2	42.27	51.80	65.86	1.16	2.88	11.42	41.58
V_3	41.32	52.95	68.31	1.09	3.07	11.20	40.90
CD (p=0.05)	1.03	1.40	2.92	0.03	0.18	0.22	0.50
SEd±	0.49	0.67	1.40	0.01	0.09	0.11	0.24

days).

The maximum plant height (72.69 cm) was recorded in I_2 (*Rhizobium*) which was significantly superior over the remaining microbial inoculants. The minimum plant height(66.57 cm) was recorded with I_1 (Control). The treatments I_3 (*Trichoderma*) (66.57 cm) and I_4 (Phosphate Solubilizing Bacteria) (66.84 cm) were statistically at par with I_1 (Control) (65.58 cm). The maximum stem diameter (1.31 cm) was recorded in I_4 (Phosphate solubilizing bacteria) which was significantly highest among all the microbial inoculants. The minimum stem diameter (0.98 cm) was recorded with I_1 (Control) which was significantly minimum among all the microbial inoculants.

The maximum number of primary branches(3.20) was recorded in I_2 (*Rhizobium*) and the treatment I_3 (*Trichoderma*) (3.00)and I_4 (Phosphate Solubilizing Bacteria) (3.11) were statistically at par with I_2. The minimum number of primary branches (2.84) was recorded in I_1 (Control) and the treatment I_3 (*Trichoderma*) (3.00) was statistically at par with I_1. Among microbial inoculants, maximum number of secondary branches (11.73) was recorded in I_2 (*Rhizobium*) which was significantly maximum among all the microbial inoculants while, significantly minimum number of secondary branches (10.98) was recorded in I_1 (Control). It was observed that I_2 (*Rhizobium*) produced maximum number of leaves plant^{-1} (42.47) which was significantly superior over all the microbial inoculants. The minimum number of leaves per plant (40.29) was recorded in I_1 (Control) which was significantly lowest among all the microbial inoculants.

Among varieties, earliness in terms of days to first flowering (41.02 days) and days to 50% flowering (51.18 days) was recorded in V_1 (Pusa purple long). Varieties V_2 (BR-112) (42.27 days to flowering and 51.80 days to 50% flowering) and V_3 (Pusa Purple Round) (41.32 days to flowering and 52.95 days to 50% flowering) showed delayed flowering.V_1 (Pusa Purple Long) also surpassed the other varieties in terms of plant height (69.83 cm), number of primary branches (3.17), number of secondary branches (11.47) was recorded and the variety V_3 (Pusa Purple Round) (68.31 cm) and number of leaves plant^{-1} (41.70). While, the maximum stem diameter (1.16 cm) was recorded in V_2 (BR-112) and the variety V_1 (1.15 cm) was statistically at par with V_2.

Interaction effect of microbial inoculants and varieties on different growth parameters have been presented in Table 2, Table 3. It revealed that I_4×V_3 (Phosphate Solubilizing Bacteria×Pusa purple round) took minimum days to first flowering (37.73 days) and days to 50% flowering (48.93 days). The treatment I_4×V_1 (Phosphate Solubilizing Bacteria ×Pusa Purple Long) (39.13 days) and I_2×V_3 (*Rhizobium*×Pusa Purple Round) (39.33 days) were statistically at par I_4×$V_3$for earliness in terms of days to flowering while, the treatments viz., I_2×V_2 (*Rhizobium*×BR-112) (51.07 days), I_3 ×V_2 (*Trichoderma*×BR-112) (51.13 days), I_4×V_2 (Phosphate solubilizing bacteria×BR-112) (49.73 days) and I_2×V_1 (*Rhizobium*×Pusa purple long) (49.80 days) were statistically at par I_4×V_1 for earliness in terms of days to 50% flowering. It was observed that the application of Phosphate Solubilizing Bacteria had positive and accelerated effect on flowering. This could be due to accelerated

Table 2: Interaction effect of microbial inoculants and varieties on growth parameters of brinjal

Microbial inoculants	Days to first flowering			Days to 50% flowering			Plant height (cm)			Stem diameter (cm)		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	41.40	42.60	44.13	53.80	55.27	52.40	63.03	67.61	67.61	1.05	0.99	0.90
I_2	41.07	43.47	39.33	49.80	51.07	52.27	72.34	72.82	72.90	0.95	1.10	1.10
I_3	42.47	41.93	44.07	52.20	51.13	54.47	75.25	53.13	71.35	1.21	1.06	1.06
I_4	39.13	41.07	37.73	48.93	49.73	52.67	68.69	70.41	61.40	1.39	1.32	1.32
CD (p=0.05)		2.06			2.80			5.84			0.60	
SEd±		0.70			1.34			2.80			0.30	

Table 3: Interaction effect of microbial inoculants and varieties on growth parameters of brinjal

Microbial inoculants	No. of primary branches			No. of secondary branches			No. of leaves plant^{-1}		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	2.93	2.60	3.00	10.40	11.47	11.07	40.20	40.47	40.20
I_2	3.33	3.20	3.07	11.73	11.93	11.53	42.47	43.07	41.87
I_3	3.27	2.53	3.20	11.87	10.93	11.00	42.80	41.67	40.47
I_4	3.13	3.20	3.00	11.47	11.33	11.20	41.33	41.58	41.07
CD (p=0.05)		0.36			0.44			0.10	
SEd±		0.17			0.21			0.48	

photosynthesis and rapid translocation of photosynthates towards initiating flower buds in the early flowering (Ademola and Agele, 2015). The early flowering with the application of biofertilizer was also observed by Kiran et al. (2010), in brinjal; Kumar et al. (2021) in chilli and Meena et al. (2019) in okra.

The maximum plant height (75.25 cm) were recorded in $I_3×V_1$ (*Trichoderma*×Pusa purple long). The treatments $I_2×V_1$ (*Rhizobium* ×Pusa Purple Long) (72.34 cm), $I_2×V_2$ (*Rhizobium* ×BR-112) (72.82 cm), $I_2×V_3$ (*Rhizobium*×Pusa purple round) (72.90 cm), $I_3×V_3$ (*Trichoderma*×Pusa Purple Round) (71.35 cm) and $I_4×V_2$ (Phosphate Solubilizing Bacteria×BR-112) (70.41 cm) were statistically at par with $I_3×V_1$. It was reported that $I_3×V_2$ (*Trichoderma*×BR-112) resulted in minimum plant height (53.13 cm) which was significantly lowest among all the interaction effects.The plant height was maximum where the *Rhizobium* was supplied and minimum in control where no biofertilizers was applied. Increased plant height with the application of biofertilizer may be attributed to the increased uptake of nutrients in the plants leading to enhanced chlorophyll content and carbohydrates synthesis and increased activity of hormones which in turn helped better proliferation of root growth and uptake of other nutrients to the greater extent. So that the enlargement in cell size and cell division, which might have helped in plant height (Upadhya et al.2018). The finding are also in line with finding of earlier researchers Ramesh et al.(2019); Ayub et al.(2022)and Dilip et al.(2023) in brinjal.

$I_4×V_1$ (Phosphate Solubilizing Bacteria×Pusa Purple Round) also surpassed other interactions in terms of stem diameter (1.39 cm). The treatment $I_3×V_2$ (*Trichoderma*×BR-112) (1.37 cm) was statistically at par with it. It was recorded that $I_1×V_3$ (Control×Pusa purple round) produced minimum stem diameter (0.90 cm). The treatment $I_2×V_1$ (*Rhizobium*×Pusa purple long) (0.95 cm) was statistically at par with $I_2×V_1$. The maximum stem diameter was found in Phosphate Solubilizing Bacteria and minimum in control. The results were in agreement with the finding of Doifode and Nandkar (2014), Singh et al. (2020) and Ayub et al. (2022) who observed that a secretion of growth hormones and availability of nutrients and moisture influenced the stem diameter positively in brinjal and Kamal et al. (2018) in tomato.

$I_2×V_1$ (*Rhizobium*×Pusa purple round) produced maximum number of primary branches (3.33) which was statistically at par with $I_3×V_1$ (*Trichoderma*×Pusa purple long) (3.27), $I_4×V_1$ (Phosphate Solubilizing Bacteria×Pusa Purple Long) (3.13), $I_2×V_2$ (*Rhizobium*×BR-112) (3.20), $I_4×V_2$ (Phosphate Solubilizing Bacteria×BR-112) (3.20), $I_3×V_3$ (*Trichoderma*×Pusa Purple Round) (3.20), $I_2×V_3$ (*Rhizobium*×Pusa purple round) (3.07), $I_1×V_3$ (Control×Pusa purple round) (3.00) and $I_4×V_3$ (Phosphate solubilizing bacteria×Pusa purple round) (3.00). Whereas, $I_2×V_2$ (*Rhizobium*×BR-112) (11.93) produced maximum number of secondary branches which were significantly at par with $I_2×V_3$ (*Rhizobium*×Pusa purple round) (11.53), $I_2×V_1$ (*Rhizobium*×Pusa purple long) (11.73) and $I_3×V_1$ (*Rhizobium*×Pusa purple long) (11.87). The minimum number of primary branches (2.53) was recorded in $I_3×V_2$ (*Trichoderma*×BR-112). The treatment $I_1×V_2$ (Control×BR-112) (2.60) were statistically at par $I_3×V_2$. The minimum number of secondary branches(10.40) was recorded in $I_1×V_1$ (Control×Pusa purple long) which was significantly lowest among all the interaction effects. Number of branches per plant is a yield contributing characters which leads to increase in number of flowers and fruits and thus promises better yield and productivity. The number of branches significantly increased with the application of *Rhizobium*. Significant increase in number of branches per plant could be due to increased absorption of nutrients which resulted in enhanced activity of hormones by biofertilizers. The results in are in line with the findings of Ramesh et al. (2021); Ayub et al. (2022) and Dilip et al. (2023) in brinjal; Kumar et al. (2021) in chilli, who observed improved growth parameters with the use of biofertilizers.

3.3. Yield parameters

The data on different yield parameters as influenced by microbial inoculants and varieties have been presented in Table 4. It revealed that the significantly maximum fruits length (13.38 cm) was observed in I_2 (*Rhizobium*) and significantly maximum fruit diameter (9.18 cm) was recorded in I_4 (Phosphate solubilizing bacteria). While, significantly minimum fruits length (7.53 cm) and fruit diameter (5.84 cm) was recorded in I_1 (Control). It was observed that I_2 (*Rhizobium*) resulted in the maximum number of fruits plant^{-1} (19.56) which was statistically at par with number of fruits plant^{-1} recorded in I_4 (Phosphate Solubilizing Bacteria) (19.47). I_2 (*Rhizobium*) resulted in significantly maximum average fruit weight (215.05 g). Significantly maximum yield plant^{-1} (3.00 kg) and yield plot^{-1} (9.20 kg) was observed in I_2 (*Rhizobium*). The minimum number of fruits plant^{-1} (16.84), average fruit weight (193.67 g), yield plant^{-1} (2.43 kg), and yield plot^{-1} (6.72 kg) was recorded in I_1 (Control).

Among varieties, the significantly maximum fruits length (10.19 cm) was recorded in V_1 (Pusa purple long) and fruit diameter (8.22 cm) was recorded in V_3 (Pusa Purple Round). While the significantly minimum fruits length (cm) was recorded in V_3 (Pusa purple round) (9.10 cm) and fruit diameter (7.22 cm) was recorded in V_1 (Pusa purple long). V_1 (Pusa purple long) also showed significant superiority for number of fruits plant^{-1} (19.10), average fruit weight (209.30 g), yield plant^{-1} (2.76 kg) and maximum yield plot^{-1} (8.14 kg) than all other varieties under the present study.

Interaction effects of microbial inoculants and varieties on the yield parameters are presented in Table 5 and Table 6. It revealed the significantly maximum fruits length (14.60 cm) in $I_2×V_2$ (*Rhizobium*×BR-112), while, the significantly minimum fruits length (7.33 cm) was recorded in $I_3×V_2$ (*Trichoderma*×BR-112). Maximum fruit diameter(10.47 cm) was recorded in $I_4×V_1$ (Phosphate Solubilizing Bacteria×Pusa Purple Long) which was statistically at par with fruit diameter

Table 4: Effect of microbial inoculants and varieties on yield and quality parameters of brinjal

Treatment	Fruit length (cm)	Fruit diameter (cm)	No. of fruits plant^{-1}	Average fruit weight (g)	Yield plant^{-1} (kg plant^{-1})	Yield per plot (kg plot^{-1})	Total soluble solids (°BRIX)	Ascorbic acid (mg 100 g^{-1})	Titratable acidity (%)
Microbial inoculants									
I_1	7.53	5.84	16.84	193.67	2.43	6.72	3.45	10.36	0.14
I_2	13.38	8.01	19.56	215.05	3.00	9.20	6.23	16.40	0.31
I_3	9.71	8.48	17.47	205.36	2.46	7.67	3.93	11.69	0.17
I_4	7.64	9.18	19.47	210.36	2.83	7.91	5.05	13.71	0.24
CD (p=0.05)	0.10	0.31	0.81	3.62	0.12	0.38	0.01	0.11	0.01
SEd±	0.05	0.27	0.39	1.73	0.06	0.18	0.01	0.05	0.01
Varieties									
V_1	10.19	7.22	19.10	209.30	2.76	8.14	5.09	13.92	0.24
V_2	9.42	8.20	17.89	203.86	2.52	7.66	4.37	12.85	0.19
V_3	9.10	8.22	18.01	205.17	2.76	7.82	4.57	12.35	0.22
CD (p=0.05)	0.09	0.31	0.70	3.13	0.11	0.33	0.01	0.10	0.01
SEd±	0.04	0.15	0.34	1.50	0.05	0.16	0.01	0.05	0.01

Table 5: Interaction effect of microbial inoculants and varieties on yield and quality parameters of brinjal

Microbial inoculants	Fruit length (cm)			Fruit diameter (cm)			No. of fruits plant^{-1}			Average fruit weight (g)			Yield plant^{-1} (kg plant^{-1})		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	8.40	7.87	7.53	5.33	6.47	5.73	19.33	17.89	15.07	196.93	195.82	188.27	2.23	2.67	2.40
I_2	12.33	14.60	13.38	4.87	8.93	10.23	20.27	20.33	18.07	217.38	207.90	219.87	2.60	3.53	2.87
I_3	12.40	7.33	9.71	8.20	7.80	9.43	19.00	15.27	18.13	204.97	208.93	202.17	3.00	2.03	2.33
I_4	7.60	7.87	7.64	10.47	9.60	7.47	17.80	19.83	20.77	217.90	202.77	210.40	3.20	1.87	3.43
SEd±		0.08			0.26			0.67			3.00			0.10	
CD (p=0.05)		0.18			0.54			1.41			6.27			0.21	

Table 6: Interaction effect of microbial inoculants and varieties on yield and quality parameters of brinjal

Microbial inoculants	Yield plot^{-1} (kg plot^{-1})			Total soluble solids (°BRIX)			Ascorbic acid (mg 100 g^{-1})			Titratable acidity (%)		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	7.59	7.04	5.55	3.69	3.32	3.34	10.47	10.40	10.36	0.10	0.10	0.23
I_2	9.23	8.45	9.91	6.22	6.23	6.25	16.47	16.53	16.40	0.31	0.31	0.21
I_3	8.29	7.15	7.57	4.22	3.33	4.23	12.40	10.47	11.69	0.31	0.10	0.21
I_4	7.47	8.01	8.25	6.22	4.47	4.45	16.33	12.33	13.71	0.25	0.23	0.23
CD (p=0.05)		0.66			0.02			0.22			0.02	
SEd±		0.32			0.01			0.09			0.01	

observed in I_2×V_3 (*Rhizobium*×Pusa purple round) (10.23 cm). The minimum fruit diameter (4.87 cm) was recorded in I_2×V_1 (*Rhizobium*×Pusa purple long) which was statistically at par with I_1×V_1 (Control×Pusa purple long) (5.33 cm). The fruit diameter (cm) is directly correlated with the weight of the fruit. The maximum fruit diameter (cm) observed with the application of the *Rhizobium* are supported by findings of earlier researchers *viz*., Meena et al. (2019) in okra.

I_4×V_3 (Phosphate Solubilizing Bacteria×Pusa Purple Round) produced the maximum number of fruits per plant (20.77).

The treatments $I_{2\times}V_1$ (*Rhizobium*×Pusa Purple Long) (20.76), I_4×V_2 (Phosphate Solubilizing Bacteria×BR-112) (19.83) and I_2×V_2 (*Rhizobium*×BR-112) (20.33) were statistically at par with I_4×V_3. The minimum number of fruits plant^{-1} was recorded in I_1×V_3 (Control×Pusa purple round) (15.07) which was statistically at par with I_3×V_2 (*Trichoderma*×BR-112) (15.27). The maximum number of fruits per plant was observed where *Rhizobium* is applied and minimum in control. Similar findings are supported by Suryanto et al. (2017), Ramesh et al. (2019), Allawi et al. (2019), Allias et al. (2021) and Ayub et al. (2022) in brinjal and Meena et al. (2019) in okra.

Interaction I_2×V_3 (*Rhizobium*×Pusa purple round) resulted maximum average fruit weight (219.87 g). The treatment I_2×V_1 (Rhizobium×Pusa purple long) (217.38 g) and I_4×V_1 (Phosphate solubilizing bacteria×pusa purple long) (217.90 g) were statistically at par with I_2×V_3. The minimum average fruit weight (188.27 g) was recorded in I_1V_3 (Control×Pusa purple round) which was significantly lowest among all the interactions. The findings are in line with the results of earlier researchers of Suryanto et al. (2017), Allawi et al. (2019), Allias et al. (2021) in brinjal.

Maximum yield plant^{-1} (3.53 kg) was recorded in I_2×V_2 (*Rhizobium*×BR-112) which was statistically at par with I_4×V_3 (Phosphate solubilizing bacteria×Pusa purple round) (3.43 kg). The minimum yield plant^{-1} (1.87 kg) was recorded in I_4×V_2 (Phosphate solubilizing bacteria×BR-112) which was statistically at par with treatment I_3×V_2 (*Trichoderma*×BR-112) (2.03 Kg). I_2×V_3 (*Rhizobium*×Pusa Purple Round) resulted in maximum yield plot^{-1} (9.91 kg) which was found to be significantly maximum among all the interaction effects. The minimum yield plot^{-1} (5.55 kg) was recorded in I_1×V_3 (Control×Pusa purple round) which was found to be significantly lowest among all the interaction effects.The possible reason for increased fruit yield might be associated to better inorganic nitrogen utilization in the presence of biofertilizers, which enhanced biological nitrogen fixation, better development of root system and possible higher synthesis of plant growth hormones (Gajbhiye et al*.,* 2003). Han and Lee (2005) also referred this increase in yield due to better performance of yield attribute due to biofertilizers. The application of *Rhizobium* increases the yield plot^{-1} than in control. The results are in confirmatory with the finding of earlier researchers *viz*., Doifode and Nandkar (2014), Muhammad et al. (2017), who also observed increased yield with the application of biofertilizers in brinjal.

3.4. Quality parameters

Data on effect of different microbial inoculants and varieties on quality parameters is presented in Table 4. It was observed that the significantly superior TSS (6.23) ascorbic acid (16.40) and titratable acidity (0.31) was recorded in I_2 (*Rhizobium*) while, significantly minimum TSS (3.45), ascorbic acid (10.36) and titratable acidity (0.14) was recorded in I_1 (Control).

Among varieties, the significantly maximum TSS (5.09), ascorbic acid (13.92) and titratable acidity (0.24) was recorded in V_1 (Pusa Purple Long). The significantly minimum TSS (4.37) and titratable acidity (0.19) was recorded in V_2 (BR-112) whereas, significantly minimumascorbic acid(12.35) was recorded in V_3 (Pusa Purple Round.

Interaction effect of microbial inoculants and varieties on quality traits have been presented in Table 5 and Table 6. It was observed that I_2×V_3 (*Rhizobium*×Pusa purple round) resulted in maximum TSS (6.25) which was statistically at par with I_2×V_2 (*Rhizobium*×BR-112) (6.23) and the minimum TSS (3.32) was recorded in I_1×V_2 (Control×BR-112) which was statistically at par with I_1×V_3 (Control×Pusa Purple Round) (3.34) and I_3×V_2 (*Trichoderma*×BR-112) (3.33). Total soluble solids (TSS) is the quality character which was enhanced in a favorable way due to the application of biofertilizers resulted in higher TSS content. Similar findings were also observed by Allawi et al. (2019) who referred that the highest fruit quality might be due to the fact thatnitrogen stimulates the functioning of enzymes in the physiological processes, which in turn improved the total soluble solids content of the fruits in brinjal.

I_2×V_2 (*Rhizobium*×BR-112) produced maximum ascorbic acid (16.53) which was significantly at par with I_2×V_1 (*Rhizobium*×Pusa Purple Long) (16.47), I_4×V_1 (Phosphate Solubilizing Bacteria×Pusa Purple Long) (16.33) and I_2×V_3 (*Rhizobium*×Pusa purple round) (16.40). The minimum ascorbic acid (10.36) was recorded in I_1×V_3 (Control×Pusa purple round) which was significantly at par with treatment I_1×V_1 (Control×Pusa Purple Long) (10.47), I_3×V_2 (Trichoderma×BR-112) (10.47) and I_1×V_2 (Control×BR-112) (10.40). Ascorbic acid is the important antioxidant present in brinjal. The application of *Rhizobium* has maximum ascorbic acid than in control (no biofertilizer). Similar findings were supported by Unlu et al. (2010), Muhammad et al. (2017) who suggested that biofertilizers application affect the concentration of vitamin C in solanaceaous crops.

I_2×V_1 (*Rhizobium*×Pusa purple long), I_2×V_2 (*Rhizobium*×BR-112) and I_3×V_1 (*Trichoderma*×Pusa purple long) resulted in maximum titratable acidity (%) (0.31) which was significantly maximum among all interaction effects while, the minimum titratable acidity (0.10) was recorded in I_1×V_1 (Control×Pusa purple long), I_1×V_2 (Control×BR-112) and I_3×V_2 (*Trichoderma*×BR-112) which was significantly lowest among all the interaction effects. Titratable acidity (%) is also known as total acidity measures the total acid concentration in a food. The titratable acidity is the important quality character which enhance with the application of biofertilizers. The titratable acidity was observed maximum with the application of *Rhizobium* than in control. These results are in accordance with the findings of Meena et al. (2019) in okra.

4. Conclusion

Among the varieties studied, Pusa Purple Long showed the best results for growth, yield and quality attributes. Microbial inoculants *Rhizobium* favoured growth, yield and quality attributes and Phosphate Solubilizing Bacteria promoted earliness.

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