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EFFECT OF ORGANIC MANURES AND BIO INOCULANTS ON QUALITY AND MICROBIOLOGICAL PARAMETERS OF BITTER GOURD (*MOMORDICA CHARANTIA* L.)

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2024–25 at College of Agriculture, UAS Dharwad, to evaluate the influence of organic manures and bio-inoculants on quality and microbiological parameters of bitter gourd (*Momordica charantia* L.). The experiment followed a Factorial Randomized Block Design with nine treatment combinations involving vermicompost, farmyard manure (FYM), mycorrhizal consortium, methylobacterial consortium, and an RDF control. Quality traits (moisture, TSS, ascorbic acid) and soil microbiological indicators (dehydrogenase activity, phosphatase activity and root colonization) were assessed. Significant differences were observed across treatments. Moisture content ranged from 80.56% to 92.43%, with the maximum in S_2M_1 and the minimum in control. The highest TSS (8.12 °Brix) and ascorbic acid content (72.03 mg/100 g) were recorded in S_3M_2, closely matching the control. FYM (M_2) and the integrated inoculant treatment S_3 consistently improved quality parameters compared to vermicompost. Microbiological properties responded strongly to organic amendments. S_3M_2 recorded the highest dehydrogenase activity (1.74 µg TPF g^{-1} soil d^{-1}), phosphatase activity (36.82 µg pnp g^{-1} soil h^{-1}) and root colonization (95.63%), indicating enhanced microbial biomass, nutrient mineralization and symbiotic association. The control recorded the lowest biological activity. Overall, the combination of FYM with mycorrhizal and methylobacterial consortia (S_3M_2) proved most effective in improving fruit quality and soil biological health. The study highlights the potential of integrating organic manures and bio-inoculants as a sustainable nutrient management strategy for bitter gourd cultivation.
***Keywords*:** Bitter gourd, organic manures, bio-inoculants, FYM, PPFM, mycorrhizal fungi, vine growth, fruit yield, sustainable cultivation, residue-free production.

Introduction

Bitter gourd (*Momordica charantia* L.), known as *Hagala kai* in Karnataka and *Karela* in Hindi, is a unique cucurbit whose bitterness is due to the alkaloid momordicine rather than cucurbitacins. The genus *Momordica* possesses a somatic chromosome number of 2n=22, with tropical Africa hosting about 23 species, among which *M. charantia* is the most economically important. Domesticated in Eastern India and Southern China, this cross-pollinated monoecious species exhibits wide genetic variability.

Globally valued as both a vegetable and pharma-nutraceutical crop, bitter gourd is rich in nutrients, notably 88mg vitamin C and 1.8mg iron per 100g, making it superior among cucurbits. Immature fruits are consumed fresh or processed, while compounds such as charantin have hypoglycemic properties useful in diabetes management (Behera, 2004). In 2023–24, India cultivated bitter gourd on 1.34 million ha, producing 1.727 million tonnes. Karnataka recorded 1.768 thousand ha, with a productivity of 8.99 t/ha (Shetty *et al.,* 2005).

Excessive use of chemical inputs has led to pest resistance, toxic residues, and environmental issues. Organic nutrient management using farmyard manure (FYM), vermicompost, neem cake, coir pith compost, and liquid organics like cow urine, vermiwash, and *jeevamrutha* offers a sustainable alternative. FYM supplies essential nutrients, improves soil physical and chemical properties, and fosters microbial activity, while vermicompost serves as a microbially active bio-fertilizer rich in humic substances and growth regulators.

Bio-inoculants, containing beneficial microbes, enhance nutrient uptake through mechanisms such as nitrogen fixation, phosphorus solubilization, and phytohormone production. Arbuscular mycorrhizal fungi (AMF) improve nutrient and water absorption, soil aggregation, pathogen protection, and biodiversity. Epiphytic pink-pigmented facultative methylotrophs (PPFM), mainly *Methylobacterium* spp., metabolize methanol, fix nitrogen, solubilize phosphate, regulate ethylene, and induce systemic resistance, while tolerating radiation via carotenoid pigments.

Integrating organic manures, bio-inoculants, AMF, and PPFM can significantly enhance bitter gourd growth, yield, and quality while improving soil health, reducing chemical residues, and ensuring environmental safety (Majeed *et al.,* 2021).

Material and Methods

A field experiment entitled "Effect of organic manures and bio-inoculants on growth, yield and quality of bitter gourd *(Momordica charantia* L.*)"* was conducted during the *rabi* season of 2024–25 at the Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Dharwad.

Experimental Site and Design

The study was carried out at the Hi-Tech Horticulture Unit, Saidapur Farm, MARS, Dharwad, located at 15°26′ N latitude, 75°07′ E longitude, and 678 m altitude under mild tropical rainy climate. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with nine treatments and three replications using Indam Sindhu F1 hybrid. Spacing of 120 × 90 cm was maintained, and organic manures and bio-inoculants were applied as per treatment details.

Treatments

T1–T4 included vermicompost (2.5 t/ha) with or without mycorrhizal and methylobacterial consortia; T5–T8 used FYM (25 t/ha) with or without bio-inoculants; T9 was RDF (63:50:50 kg NPK/ha) as control. Mycorrhizal consortium was soil-applied (20 kg/ha), while methylobacterial consortium was foliar-sprayed (2%) at 15, 30, and 45 DAS.

Soil was well-prepared, sown with quality seeds, and irrigated at regular intervals. Pheromone traps (Cue-lure) were used for eco-friendly fruit fly management. Growth and yield parameters, including vine length, leaf area, fruit yield, and quality traits (moisture, TSS, ascorbic acid), were recorded from five tagged plants per plot.

Quality Parameters

Moisture (%):

Moisture content was determined by oven-drying samples at 60°C for 72 hours until constant weight. Moisture (%) was calculated from weight loss between fresh and dry weights.

$$\text{Moisture (\%)} = \frac{\text{Fresh wt} - \text{Dry wt}}{\text{Dry wt}} \times 100$$

Total Soluble Solids (°Brix):

TSS of bitter gourd fruits was measured using a Mettler Toledo RE50 refractometer based on the total reflection method, and readings were expressed in °Brix.

Ascorbic Acid (mg/100 g):

Ascorbic acid was estimated by titrating juice diluted in 3% metaphosphoric acid with standardized 2,6-dichlorophenol-indophenol dye until a faint pink endpoint appeared (Nielsen, 2024).

Results and Discussion

Quality parameters

Moisture content varied from 80.56% to 92.43%, with the highest in S2M1 and the lowest in S3M2, while the control showed 80.01%. Mean moisture was higher under S2 and in M1. For TSS, S3M2 recorded the maximum (8.12 °Brix), followed by S3M1, whereas S2M1 showed the lowest (7.03 °Brix). M2 and S3 showed higher mean TSS, and the control recorded the highest (8.15 °Brix). Ascorbic acid content was highest in S3M2 (72.03 mg/100 g) and lowest in S2M1. M2 and S3 performed better, while the control recorded the maximum value (73.55 mg/100 g). Jamil *et al.* (2024), Yasmin *et al.* (2022), Vedasree *et al.* (2023) in bitter gourd, Mohan *et al.*

(2016) in cucumber, Meerabai *et al.* (2007), Thriveni *et al.* (2015) in bitter gourd, Lalitha *et al.* (2010) in ridge gourd, Das *et al.* (2015) in bottle gourd, Amulya *et al.* 2022, Alekar *et al.* (2015) similar result found while working in pumpkin, El-Khayat *et al.* (2023), Mohammad *et al.* (2007), in bitter gourd and also in similar results by with Parmar *et al.* (2011) in cucumber and Sreenivas *et al.* (2000) also found similar results in ridge gourd. Also Pateliya (2011) finding similar result while working in bottle gourd.

Table 1: Moisture %, TSS and Ascorbic acid as influenced by organic manures and bio- inoculants on quality of bitter gourd

Moisture %				**Total soluble solids (^{0}Brix)**				**Ascorbic acid content(100/mg)**			
M×S	M_1	M_2	Mean	M×S	M_1	M2	Mean	M×S	M_1	M_2	Mean
S_1	84.56	81.56	83.06	S_1	7.91	7.58	7.75	S_1	64.62	70.25	67.44
S_2	92.43	90.23	91.33	S_2	7.03	7.45	7.24	S_2	62.73	63.31	63.02
S_3	82.92	80.56	81.74	S_3	8.01	8.12	8.07	S_3	65.31	72.03	68.67
Mean	86.64	84.12		Mean	7.05	7.72		Mean	64.22	68.53	
Control	80.01			Control	8.15			Control	73.55		
	S.Em.±	CD @ 5%			S.Em.±	CD @ 5%			S.Em.±	CD @ 5%	
M	0.66	4.02		M	0.07	0.43		M	0.55	3.33	
S	2.12	6.92		S	0.19	0.63		S	1.7	5.56	
M×S	3	9.79		M×S	0.27	0.89		M×S	2.41	7.86	
Control	2.62	8.07		Control	0.24	0.75		Control	2.13	6.57	

Note:

M=Main plot S=Sub-plot

M_1=Vermicompost (2.5t ha^{-1}) S_1= Soil application of Mycorizzhal consortium (20 kg ha^{-1})

M_2= FYM (25 t ha^{-1}) S_2= Methylobacterial consortium foliar spray 2% as a foliar spray at 15, 30, 45 days after planting

S_3= Mycorizzhal consortium + Methylobacterial consortium

C= Control, RDF=NPK:63:50:50 kg ha^{-1}

M×S= Interaction between main plot and sub-plot

Moisture content varied significantly, with the highest in S2M1 (92.43%) and the lowest in the control (80.01%). M1 and S2 recorded higher mean moisture, likely due to improved root activity and nutrient uptake, while lower moisture in S3 and the control favored better shelf life. TSS was highest in S3M2 (8.12 °Brix), with M2 and S3 showing superior performance, comparable to the control (8.15 °Brix). Ascorbic acid content was maximum in S3M2 (72.03 mg/100 g), followed by M2 and S3, while the control remained highest overall (73.55 mg/100 g), reflecting improved nutrient uptake and metabolic activity.

Microbiological parameters

Dehydrogenase activity varied significantly, with the highest in S3M2 (1.74) and the lowest in S2M1 (1.31). M2 and S3 showed superior mean activity compared to other treatments and the control (1.28). Phosphatase activity also peaked in S3M2 (36.82), followed by S3M1, while S2M1 recorded the lowest (25.74). M2 and S3 again outperformed other treatments. Mycorrhizal root colonization was maximum in S3M2 (95.63%), followed by S3M1, whereas S2M1 and S1M2 showed the lowest values. Overall, M2 and S3 consistently enhanced microbial activity and colonization, with all parameters showing significant treatment effects.

Table 2: Phosphatase enzyme and b) Root colonization and c) Dehydrogenase activity as influenced by organic manures and bio inoculants of bitter gourd

Dehydrogenase (µg TPF formed g^{-1} soil d^{-1})				**Phosphatase activity (µg pnp released g^{-1} soil h^{-1})**				**Mycorrhizal root colonization(%)**			
M×S	M_1	M_2	Mean	M×S	M_1	M_2	Mean	M×S	M_1	M_2	Mean
S_1	1.46	1.53	1.50	S_1	32.80	34.71	33.76	S_1	70.52	50.48	60.50
S_2	1.31	1.35	1.33	S_2	25.74	28.74	27.24	S_2	40.82	50.83	45.83
S_3	1.56	1.74	1.65	S_3	35.86	36.82	36.34	S_3	80.45	95.63	88.04
Mean	1.44	1.54		Mean	31.47	33.42		Mean	63.93	65.65	
Control	1.28			Control	27.53			Control	40.54		
	S.Em.±	CD @ 5%			S.Em.±	CD @ 5%			S.Em.±	CD @ 5%	

M	0.013	0.082	M	0.326	1.986	M	0.817	4.972
S	0.038	0.124	S	0.842	2.745	S	1.578	5.147
M×S	0.054	0.176	M×S	1.191	3.882	M×S	2.232	7.280
Control	0.047	0.144	Control	1.037	3.197	Control	1.949	6.005

Note:

M=Main plot | S=Sub-plot

M_1=Vermicompost (2.5t ha^{-1}) | S_1= Soil application of Mycorizzhal consortium (20 kg ha^{-1})

$M_{2=}$ FYM (25 t ha^{-1}) | S_2= Methylobacterial consortium foliar spray 2% as a foliar spray at 15, 30, 45 days after planting

$S_{3=}$ Mycorizzhal consortium + Methylobacterial consortium

C= Control, RDF=NPK:63:50:50 kg ha^{-1}

M×S= Interaction between main plot and sub-plot

Dehydrogenase activity varied significantly, with S3M2 (1.74) showing the highest and S2M1 (1.31) the lowest. Mean activity was greater in M2 and S3, while the control (1.28) remained lowest, indicating the positive effect of bio-inoculants on microbial metabolism. Phosphatase activity improved under bio-inoculant and organic applications due to enhanced microbial biomass, organic matter turnover, and rhizosphere stimulation, whereas control soils showed reduced activity. Mycorrhizal root colonization was highest in S3M2 due to better soil conditions supporting fungal establishment, while the control recorded minimal colonization. Overall, organics and inoculants significantly improved soil biological health. Casida *et al*. (1964), Evazi and Tabatabai (1979), Cao *et al*. (2014), Chandran *et al*. (2024) in bitter gourd, Mehboobatabassum *et al.* (2022) in vetiver.

Conclusion

The study clearly demonstrated that the combined application of organic manures and bio-inoculants significantly improved the quality and microbiological characteristics of bitter gourd. FYM (M2) and the integrated inoculant treatment (S3: Mycorrhizal + Methylobacterial consortium) consistently outperformed other treatments. The S3M2 combination proved most effective, recording the highest TSS, ascorbic acid content, dehydrogenase activity, phosphatase activity, and root colonization. These improvements reflect enhanced nutrient uptake, stronger rhizosphere interactions, and increased microbial activity. In contrast, the control recorded the lowest values for most parameters. Overall, integrating FYM with mycorrhizal and methylobacterial consortia emerged as the most beneficial strategy for improving fruit quality and soil biological health in bitter gourd production.

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