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EFFECT OF LIQUID AND CARRIER-BASED BIOFERTILIZERS ON SOIL HEALTH AND NUTRIENT UPTAKE IN GUAVA (*PSIDIUM GUAJAVA* L.) CV. TAIWAN WHITE

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ABSTRACT

A two-year field study was conducted at the College of Horticulture, Venkataramannagudem, Andhra Pradesh, to evaluate the effects of liquid and carrier-based biofertilizers along with inorganic fertilizers on soil properties and nutrient uptake in guava cv. Taiwan White. The experiment followed a factorial randomized block design with three replications. Application of 100% RDF along with liquid biofertilizers significantly improved soil NPK content (260.50, 62.01, and 232.96 kg/ha respectively) and microbial populations compared to other treatments. Liquid biofertilizers consistently outperformed carrier-based counterparts. The combination of 80% RDF + liquid biofertilizers provided comparable benefits, indicating a sustainable reduction in chemical inputs.

Key words: Guava, Soil fertility, Nutrient uptake, Liquid fertilizers, Sustainable agriculture

Introduction

Guava (*Psidium guajava* L.), a tropical fruit of high nutritional value, is widely cultivated across India and ranks fifth among major fruit crops in terms of area and production. Known as the “apple of the tropics,” guava is rich in vitamin C, minerals, and dietary fibre, making it a valuable fruit for both fresh consumption and processing industries. In India, it covers approximately 2.65 lakh hectares with a productivity of 15.3 MT/ha, and Andhra Pradesh contributes significantly to its production (NHB, 2020).

Intensive cultivation practices often rely on chemical

fertilizers, which, while effective in boosting yields, have detrimental effects on soil health and the environment when used excessively. This necessitates the adoption of sustainable nutrient management strategies that ensure long-term soil fertility and crop productivity. Biofertilizers, comprising beneficial microorganisms capable of fixing atmospheric nitrogen, solubilizing phosphorus, and mobilizing potassium, offer an eco-friendly and cost-effective alternative. Among these, nitrogen-fixing bacteria such as *Azotobacter*, phosphate-solubilizing bacteria (PSB), and potassium-solubilizing bacteria (KSB) have shown significant potential in enhancing nutrient

Table 1: Influence of different levels of RDF and biofertilizers on soil nitrogen, phosphorous and potassium content in guava cv. Taiwan White (Pooled data of 2019-20 & 2020-21).

Fertilizers (F)	Biofertilizers (B)											
	Soil nitrogen (kg/ha)				Soil phosphorous (kg/ha)				Soil potassium (kg/ha)			
	B ₁	B ₂	B ₃	Mean	B ₁	B ₂	B ₃	Mean	B ₁	B ₂	B ₃	Mean
F ₁ (100% RDF)	253.57	260.50	242.43	252.17	57.10	62.01	51.86	56.99	227.26	236.64	213.22	225.71
F ₂ (80% RDF)	236.83	258.02	225.50	240.12	54.29	60.39	45.33	53.34	222.22	232.96	206.17	220.45
F ₃ (60% RDF)	231.67	237.17	192.17	220.33	47.89	50.50	36.37	44.92	208.30	211.89	195.53	205.24
Mean	240.69	251.90	220.03	237.54	53.09	57.63	44.52	51.75	219.26	227.16	204.97	217.13
Factor	SEm _±			CD at 5%	SEm _±			CD at 5%	SEm _±			CD at 5%
Fertilizers (F)	0.59			1.78	0.33			0.99	0.46			1.39
Biofertilizers (B)	0.59			1.78	0.33			0.99	0.46			1.39
F × B	1.03			3.08	0.57			1.71	0.80			2.41
Initial values	186				34.02				189.00			

F₁- 100 % RDF (400:160:400 g NPK per tree); F₂- 80 % RDF (320:128:320 g NPK per tree); F₃- 60 % RDF (240:96:240 g NPK per tree); B₁- Carrier based biofertilizers (NFB + PSB + KSB) @ 100 g per tree; B₂- Liquid biofertilizers (NFB + PSB + KSB) @ 5 ml per tree; B₃- Without biofertilizers

uptake and plant growth. Liquid biofertilizers, in particular, have emerged as an improved formulation over carrier-based ones, owing to their higher microbial count, longer shelf life, and better field applicability.

Despite growing interest in liquid biofertilizers, comparative studies evaluating their effects on soil health and nutrient dynamics in fruit crops like guava remain limited. Therefore, the present study was undertaken to assess the impact of liquid and carrier-based biofertilizers on soil health parameters and nutrient uptake (NPK) in guava under field conditions.

Materials and Methods

The present study was conducted at the College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Tadepalligudem, Andhra Pradesh, under tropical climatic conditions and red sandy loam soils favourable for guava cultivation. The experiment was designed using a Factorial Randomized Block Design (FRBD) with three replications, comprising two factors: three levels of recommended dose of fertilizers (RDF) and three types of biofertilizer applications. The RDF levels included 100% (400:160:400 g N:P₂O₅:K₂O per tree), 80% (320:128:320 g N:P₂O₅:K₂O per tree), and 60% (240:96:240 g N:P₂O₅:K₂O per tree). The biofertilizer treatments consisted of carrier-based biofertilizers (B1) with NFB, PSB, and KSB applied at 100 g/tree, liquid-based biofertilizers (B2) applied at 5 ml/tree, and a control (B3) with no biofertilizer application. Biofertilizers were applied near the root zone of guava trees, with liquid biofertilizers administered through drip fertigation to ensure even distribution and effective uptake. Soil samples were collected at a depth of 0–30 cm before

and after the experiment to assess soil health and nutrient status. Soil pH and electrical conductivity (EC) were measured using standard pH and EC meters. Available nitrogen (N) was estimated by the alkaline permanganate method, phosphorus (P) by the Olsen's method, and potassium (K) using flame photometry. The microbial population in the soil was assessed by enumerating the colony-forming units (CFU) of nitrogen-fixing bacteria (NFB), phosphate-solubilizing bacteria (PSB), and potassium-solubilizing bacteria (KSB) using serial dilution and pour plate techniques on specific media.

Results and Discussion

Soil pH

Biofertilizer application significantly influenced soil pH, although RDF levels and their interactions did not show a significant effect across both years and in pooled data. The soil pH decreased slightly from an initial value of 7.20 to 7.15 in pooled data. Among treatments, liquid biofertilizers recorded the lowest pH (7.13), followed by

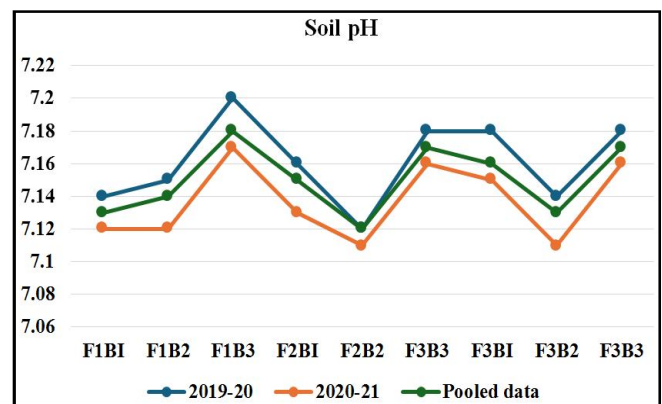
**Fig. 1:** Effect of biofertilizers in combination with different levels of RDF on soil pH in guava cv. Taiwan White.

Table 2: Influence of different levels of RDF and biofertilizers on nitrogen fixing bacteria(NFB), phosphate solubilizing bacteria (PSB) and potassium solubilizing bacteria (KSB) microbial count (1×10^7 CFU) in guava cv. Taiwan White (Pooled data of 2019-20 & 2020-21).

Fertilizers (F)	Biofertilizers (B)											
	NFB (1×10^7 CFU)				PSB (1×10^7 CFU)				KSB (1×10^7 CFU)			
	B ₁	B ₂	B ₃	Mean	B ₁	B ₂	B ₃	Mean	B ₁	B ₂	B ₃	Mean
F ₁ (100% RDF)	13.67	16.10	7.83	12.53	8.50	11.83	4.83	8.39	8.67	14.50	4.67	9.28
F ₂ (80% RDF)	14.33	17.83	8.33	13.50	10.00	13.42	4.67	9.36	11.33	16.17	5.33	10.94
F ₃ (60% RDF)	9.50	12.33	6.17	9.33	6.50	8.75	4.17	6.47	9.33	11.00	4.33	8.22
Mean	12.50	15.42	7.44	11.79	8.33	11.33	4.56	8.07	9.78	13.89	4.78	9.48
Factor	SEm _±			CD at 5%	SEm _±			CD at 5%	SEm _±			CD at 5%
Fertilizers (F)	0.21			0.63	0.26			0.78	0.21			0.64
Biofertilizers (B)	0.21			0.63	0.26			0.78	0.21			0.64
F × B	0.37			1.09	0.45			1.34	0.37			1.12
Initial values	6.00				3.00				4.00			
F ₁ - 100 % RDF (400:160:400 g NPK per tree); F ₂ - 80 % RDF (320:128:320 g NPK per tree); F ₃ - 60 % RDF (240:96:240 g NPK per tree); B ₁ - Carrier based biofertilizers (NFB + PSB + KSB) @ 100 g per tree; B ₂ - Liquid biofertilizers (NFB + PSB + KSB) @ 5 ml per tree; B ₃ - Without biofertilizers												

carrier-based biofertilizers (7.15), while the highest pH was observed in control (7.18). The slight acidification is attributed to microbial production of organic acids. Similar pH-lowering effects of biofertilizers were reported by Berger *et al.*, (2013), Gopinath *et al.*, (2009), and Singh *et al.*, (2015).

Soil Electrical Conductivity (EC)

No significant variation in soil EC was observed across RDF levels, biofertilizer types, or their interactions during the study period. The average EC remained stable (0.22 to 0.23 dS/m), likely due to the long-term nature of changes in soil physico-chemical properties. These findings align with those of Sharma *et al.*, (2013) and Sourabh *et al.*, (2018) in guava.

Soil Nitrogen Content

Soil nitrogen content was significantly affected by both chemical fertilizer levels and biofertilizer treatments. Nitrogen content increased from an initial level of 186.00 kg/ha to 237.54 kg/ha in pooled analysis. The highest nitrogen content was recorded with 100% RDF (252.17 kg/ha), followed by 80% RDF, and the lowest with 60% RDF. Liquid biofertilizer application resulted in significantly higher nitrogen levels (251.90 kg/ha), followed by carrier-based (240.69 kg/ha), and control (220.03 kg/ha). The combination of 100% RDF + liquid biofertilizers was most effective (260.50 kg/ha). These improvements can be attributed to the nitrogen-fixing ability of Azotobacter and increased mineralization of organic matter, as supported by Hazarika and Ansari (2007), Archana (2008), and Mitra *et al.*, (2012).

Soil Phosphorus Content

Phosphorus availability in soil significantly improved

with higher RDF levels and biofertilizer application. The mean phosphorus content increased from 34.02 kg/ha to 51.75 kg/ha in pooled data. The highest values were recorded with 100% RDF (56.99 kg/ha), followed by 80% RDF (53.34 kg/ha), and the lowest with 60% RDF (44.92 kg/ha). Liquid biofertilizers showed superior performance (57.63 kg/ha) compared to carrier-based (53.09 kg/ha). Among combinations, 100% RDF + liquid biofertilizers showed maximum phosphorus levels (62.01 kg/ha). Enhanced phosphorus availability is likely due to the activity of phosphate solubilizing bacteria (PSB), which produce organic acids that mobilize P (Chandler *et al.*, 2008; Sharma *et al.*, 2013).

Soil Potassium Content

Potassium content also significantly increased with RDF and biofertilizer applications. From a baseline of 189.00 kg/ha, potassium content rose to 217.13 kg/ha in pooled data. The highest levels were recorded with 100% RDF (225.71 kg/ha), followed by 80% RDF, and the lowest with 60% RDF. Liquid biofertilizers resulted in the greatest potassium content (227.16 kg/ha), followed by carrier-based (219.26 kg/ha). The combination of 100% RDF + liquid biofertilizers achieved the highest potassium values (236.64 kg/ha). The improved potassium availability is attributed to the activity of potassium solubilizing bacteria (KSB), which release potassium from minerals (Archana *et al.*, 2013).

Microbial Count of Nitrogen-Fixing Bacteria (NFB)

The population of Azotobacter (NFB) was significantly influenced by all treatments. The microbial count increased from an initial 6.00 CFU/g to 11.79 CFU/g in pooled data. The application of 80% RDF + liquid

biofertilizers recorded the highest NFB population (17.83 CFU/g), followed by 100% RDF + liquid biofertilizers (16.10 CFU/g). The lowest population (6.17 CFU/g) was observed with 60% RDF without biofertilizers. Higher microbial counts are linked to improved nutrient environments and root exudation patterns, as supported by Mandic *et al.*, (2011) and Babita (2011).

Microbial Count of Phosphate-Solubilizing Bacteria (PSB)

PSB population also significantly increased with biofertilizer and RDF applications. From an initial value of 3.00 CFU/g, the count reached 8.07 CFU/g in pooled analysis. The maximum population was recorded with 80% RDF + liquid biofertilizers (13.42 CFU/g), followed by 100% RDF + liquid biofertilizers (11.83 CFU/g). Control plots recorded the lowest PSB counts (4.17 CFU/g). The increased microbial population is due to the presence of favorable microclimatic conditions and availability of carbon sources (Kumari and Kumari, 2002).

Microbial Count of Potassium-Solubilizing Bacteria (KSB)

The population of KSB increased significantly with both RDF and biofertilizer treatments. From a baseline of 4.00 CFU/g, the count rose to 9.48 CFU/g in pooled data. Liquid biofertilizers had the highest KSB counts (13.89 CFU/g), followed by carrier-based (9.78 CFU/g), and the lowest in control (4.78 CFU/g). The combination of 80% RDF + liquid biofertilizer achieved the highest microbial population. These results reflect the ability of KSB to solubilize potassium and improve plant uptake, supported by Archana (2008) and similar studies in guava and other fruit crops (Mitra *et al.*, 2012; Trivedi *et al.*, 2012).

Conclusion

The present study clearly demonstrates that the integrated application of liquid biofertilizers along with recommended doses of chemical fertilizers significantly improves soil health and nutrient availability in guava cultivation. Among the different treatment combinations, 100% RDF combined with liquid biofertilizers resulted in the highest improvement in soil NPK content and microbial populations (Azotobacter, PSB, and KSB), thereby enhancing the nutrient uptake efficiency of guava cv. Taiwan White. Notably, 80% RDF + liquid biofertilizers produced results comparable to 100% RDF, indicating a potential 20% reduction in chemical fertilizer usage without compromising soil fertility or microbial activity. This underscores the efficiency and sustainability of liquid biofertilizers over carrier-based formulations, owing to their superior microbial viability, ease of application, and

enhanced solubilization and mobilization of nutrients. The outcomes suggest that adopting liquid biofertilizer-based integrated nutrient management (INM) can serve as a cost-effective, eco-friendly, and sustainable alternative to conventional fertilizer practices in guava orchards. Future research should focus on long-term field trials and economic analysis to further validate the scalability of this approach under diverse agro-climatic conditions.

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