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IMPACT OF BIO-ENHANCERS AND BIO-FERTILIZERS ON THE PRODUCTION ECONOMICS OF WINTER SEASON GUAVA

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ABSTRACT

To assess the economic effects of bio-enhancers and bio-fertilizers on winter season guava production, an experiment was carried out in the Kalyanpur Nursery, Department of Fruit Science, Chandra Shekhar Azad University of Agricultural and Technology, Kanpur over two consecutive years, i.e. 2022-23 and 2023-24. Utilizing a randomized block design with ten treatments, each was replicated thrice. The findings clearly show that the combination of bio-enhancers and bio-fertilizers, as in treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}), achieved the highest Benefit: cost ratio (3.96) and net returns (Rs. 352400.00 hectare^{-1}). The total fixed cost for cultivation was estimated at Rs. 71022.00 hectare$^{-1,}$ with the maximum yield recorded in the same treatment (T_9) reaching 8.81 t hectare^{-1}. These results underscore the significant potential of using bio-enhancers and bio-fertilizers to enhance guava production by providing substantial economic benefits to the growers.

Keywords **:** Bio-enhancers, Bio-fertilizers, Benefit: Cost ratio, Guava, Panchagavya, Yield.

Introduction

Guava (*Psidium guajava* L.) is a member of the family Myrtaceae and is indigenous to Tropical America, stretching from Mexico to Peru (Agnihotri *et al.*, 2013). It is a rapidly growing evergreen shrub or small tree, typically reaching to a height between 3 to 16 meters and characterized by a shallow root system. The species tends to produce low, drooping branches from the base, as well as root suckers. The trunk is slender and approximately 20 cm in diameter, which is covered by smooth green to reddish-brown bark that exfoliates in thin flakes and young twigs exhibit pubescence. The leaves are arranged in opposite pairs, which are elliptic to oblong in shape, measuring 5 to 10 cm in length and 3 to 5 cm in width. They are finely pubescent and veined on the underside, while the upper surface is glabrous. Guava flowers are white, about three cm in diameter, and appear singly or in clusters of two to three in the axils of newly emerging lateral shoots. The fruit is a fleshy berry, either pyriform or ovoid, weighing up to 500 g (Orwa *et al.*, 2009).

Guava is important because it is a hardy fruit that can be grown in poor, alkaline or poorly-drained soil. It can grow in soils with a pH range of 4.5 to 8.5. Guava is the most promising fruit crop in India. It is considered one of the most exquisite, nutritionally valuable, and high (with an area of 3.14 lakh ha^{-1} with 4.92 million tons of production) remunerative crops (Goswami *et al.,* 2024).

The Guava fruit is an excellent source of vitamin C (210-305 mg 100 g^{-1} fruit pulp) and pectin (0.5-1.8%) but has low energy (66 cal. 100g^{-1}). The ripe fruits contain 12.3-26.3% dry matter, 77.9-86.9% moisture, 0.51-1.02% ash, 0.10-0.70% crude fat, 0.82-1.45% crude protein and 2.0-7.2% crude fiber (Mitra and Bose 2001).

Bio-enhancers like Panchagavya, Jeevaamrit, and Amritpani, derived from the fermentation of animal products and plant residues, offer an alternative

approach for improving soil health and promoting microbial activity (Devakumar *et al.,* 2008). For instance, cow urine, traditionally used in crop production, is recognized for its anti-fungal properties and ability to provide essential plant nutrients (Pradhan *et al*., 2018). Bio-enhancers have proven effective as a soil amendment, improving soil properties and increasing crop yields while contributing to long-term carbon sequestration when stored in soils.

The application of farm yard manure provides essential nutrients necessary for plant growth and development. It enhances the physical, chemical, and biological properties of the soil. It is a significant source of organic carbon, which supports the soil microbial activity (Ghoshal and Singh, 1995).

Bio-fertilizers are microorganisms that can fix nitrogen and solubilize phosphorus, living or dormant, and can convert soil nutrients into a usable form using biological processes in the soil (Kundu *et al*., 2011). *Azotobacter,* a nitrogen-fixing bio-fertilizer, can fix approximately 15-20 kg of atmospheric nitrogen per hectare. *Azotobacter* bio-fertilizers have been shown to increase crop yields (Ramprasad *et al*., 2009). Phosphate solubilizing bacteria (PSB) is a bio-fertilizer used as an inoculant that improves the plant's phosphorus uptake, thereby augmenting the crop yield (Tripathi *et al*., 2017).

Materials and Methods

An experiment was carried out in the Kalyanpur Nursery, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, over two consecutive years, i.e., 2022-23 and 2023-24. A randomized block design was used to incorporate ten treatments, each replicated thrice.

Table 1: Treatment details

Sl. No.	Treatments	Symbols
1.	Control [FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw)]	**T_1**
2.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (50g tree^{-1})	**T_2**
3.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (50g tree^{-1})	**T_3**
4.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (50g tree^{-1})	**T_4**
5.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB (50g tree^{-1})	**T_5**
6.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1})	**T_6**
7.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB (50g tree^{-1})	**T_7**
8.	FYM (10 kgtree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB (50g tree^{-1}) +*Azotobacter* (50g tree^{-1})	**T_8**
9.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (50g tree^{-1}) + *Azotobacter* (50g tree^{-1})	**T_9**
10.	FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (50g tree^{-1}) + *Azotobacter* (50g tree^{-1})	**T_{10}**

The treatments were randomly assigned to the experimental units using the Fisher and Yates random table method (Panse and Sukhatme, 1985). This process was repeated three times to ensure statistical reliability.

Results and Discussion

Fruit yield (t ha^{-1})

The highest yield was recorded with T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) resulted in the maximum fruit yield of 8.81 tons ha^{-1} indicating its superior effect on plant followed by T_{10}-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) with 7.84 t ha^{-1}. In contrast, the control treatment (T_1) recorded the lowest fruit yield of 3.46 tons ha^{-1} (Table 4).

The effectiveness of Panchagavya can be attributed due to its rich content of both major and minor nutrients, along with various microorganisms, mainly bacteria. These beneficial microorganisms, including bacteria, yeast, actinomycetes, and photosynthetic bacteria, enhance plant growth, metabolic functions, and resistance to pests and diseases. They improve the soil ecosystem and increase nutrient availability from the soil to the plant, which can enhance the production and quality of various fruit crops. The current findings are in conformity with the report of Tripathi *et al.* (2014) in strawberry and Bhadauria and Tripathi (2023) in mango and Adak *et al.* (2014), Sahu *et al.* (2014), and Kumar *et al.* (2017).

Cost of production (Rs. ha^{-1})

The cost of production due to the effect of bio-fertilisers and bio-enhancers was calculated for a hectare guava crop according to treatments (Table 4). The maximum cost of production, *i.e.* Rs. 71022.00 ha^{-1} observed with the treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) followed by T_{10}-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) had the cost of Rs.69176.00 ha^{-1} (Fig. 2). The minimum cost of production was recorded in control treatment (T_1) with a cost of Rs.56250.00 ha^{-1}. The expense of cultivating guava tends to rise when using bio-fertilisers because of the extra costs involved in obtaining and applying these bio-inoculants. Although these products enhance yield and soil health, the initial investment in quality inoculants and labour and equipment costs for application lead to a higher overall production cost (Conti *et al.*, 2014).

Cost and return (Rs. ha^{-1})

Including all the details required for guava cultivation, the total fixed cost came to Rs.47940.00 ha^{-1} (Table 2).

Table 2 : Total fixed cost of guava production (Rs. ha^{-1})

Particulars	Unit and Frequency	Rate ha^{-1} (Rs.)	Total fixed cost (Rs.)
Ploughing	Tractor (one time)	2400.00	2400.00
Cultivator	Tractor (one time)	2400.00	2400.00
Layout	Labour (10 unit)	300 labour^{-1}	3000.00
Weeding	6 Labor (3 times)	300 labour^{-1}	5400.00
Irrigation	4 times	1000 irrigation^{-1}	1000.00
Labour	6 unit	300 labour^{-1}	1800.00
FYM	2 tons	2000 tons^{-1}	40000.00
Spraying	3 labours (3 times)	300 labour^{-1}	2700.00
Harvesting and Packaging	Labour (15 units)	300 labour^{-1}	4500.00
Miscellaneous	-	-	1740
Total			47940

The cost of production for the effect of bio-fertilisers and bio-enhancers was calculated for a hectare guava crop according to the treatments (Table 3). The maximum cost of production *i.e.* Rs. 71022.00 ha^{-1} was observed with the treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}). The lowest value of the cost of production was recorded by control treatment (T_1) with a cost of Rs.56250.00 ha^{-1} (Fig. 1).

Gross return

The gross return of different treatments of bio-fertilisers and bio-enhancers was directly correlated with the yield of guava (Table 4). The highest gross return, *i.e.* Rs.352400.00 ha^{-1} was recorded with the treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}). The minimum gross return was recorded in the control treatment (T_1) with a gross return of Rs.138400.00 ha^{-1} (Fig. 2). The gross return in guava increases with the use of bio-enhancers and bio-fertilisers due to higher fruit yield and quality. These bio-inoculants enhance nutrient availability, improve plant health, and reduce disease incidence,

leading to more marketable produce and increased farmer profitability. Similar findings have also been reported by Bhadauria and Tripathi (2023) in mango and Ram and Verma (2017) in guava.

Net return

The highest net return recorded with the treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) *i.e.* Rs.281378.00 ha^{-1} followed by T_{10}-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy) + Jivamrit (20%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) had the return of Rs.244424.00 ha^{-1} (Table 4). Whereas the minimum net return was recorded by control treatment (T_1) with Rs. 82150.00 ha^{-1} (Fig. 2). Previous studies support these results, as higher economic return has been reported with the application of bio-enhancers and bio-fertilisers. For instance, reports of Gurjar *et al.* (2023) in sapota and Tyagi *et al.* (2021) in guava are in accordance with the present findings.

Benefit: cost ratio

After calculating the values, data from Table 4 shows that highest B: C ratio was recorded with the treatment T_9-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) had a ratio of 3.96 followed by 3.53 in the treatment T_{10}-FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}). Whereas the lowest B: C ratio (1.46) was recorded with the (T_1) control treatment (Fig. 3). Thus, the results indicated that the use of bio-enhancers with bio-fertilisers increases the guava yield, which ultimately gives a higher return to the guava growers and will maintain the soil health. Ram and Pathak (2007) also expressed similar studies on guava.

Conclusion

The effectiveness of bio-enhancers and bio-fertilisers on crop economics was significant. Plants treated with the combined application of FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1}) + *Azotobacter* (50g tree^{-1}) gave the highest net Benefit of Rs.281378.00 ha^{-1} and Benefit: cost ratio (3.96) that is economical, highly profitable and remunerative of Guava fruits.

Table 3: Effect of bio-enhancers and bio-fertilisers on the cost of treatments (Rs. ha^{-1})

Sl. No.	Treatments	Fixed cost	Variable cost	Total cost
1.	**T_1-** Control [FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw)]	47940.00	8310.00	56250.00
2.	**T_2-** FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (50g tree^{-1})	47940.00	18005.00	65945.00
3.	**T_3-** FYM (10 kg tree^{-1} year^{-1}) +Organic mulch (Paddy straw) +Panchagavya (3%) + *Azotobacter* (50g tree^{-1})	47940.00	21234.00	69176.00
4.	**T_4-** FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (50g tree^{-1})	47940.00	19390.00	67330.00
5.	**T_5-** FYM (10 kg tree^{-1} year^{-1}) +Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (50g tree^{-1})	47940.00	18005.00	65945.00
6.	**T_6-** FYM (10 kg tree^{-1} year^{-1}) +Organic mulch (Paddy straw) + Panchagavya (3%) + PSB (50g tree^{-1})	47940.00	21234.00	69176.00
7.	**T_7-** FYM (10 kg tree^{-1} year^{-1}) +Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (50g tree^{-1})	47940.00	19390.00	67330.00
8.	**T_8-** FYM (10 kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (50g tree^{-1}) + *Azotobacter* (50g tree^{-1})	47940.00	19849.00	67789.00
9.	**T_9-** FYM (10 kg tree^{-1} year^{-1}) +Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (50g tree^{-1}) + *Azotobacter* (50g tree^{-1})	47940.00	23082.00	71022.00
10.	**T_{10}-** FYM (10kg tree^{-1} year^{-1}) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (50g tree^{-1}) + *Azotobacter*(50g tree^{-1})	47940.00	21234.00	69176.00

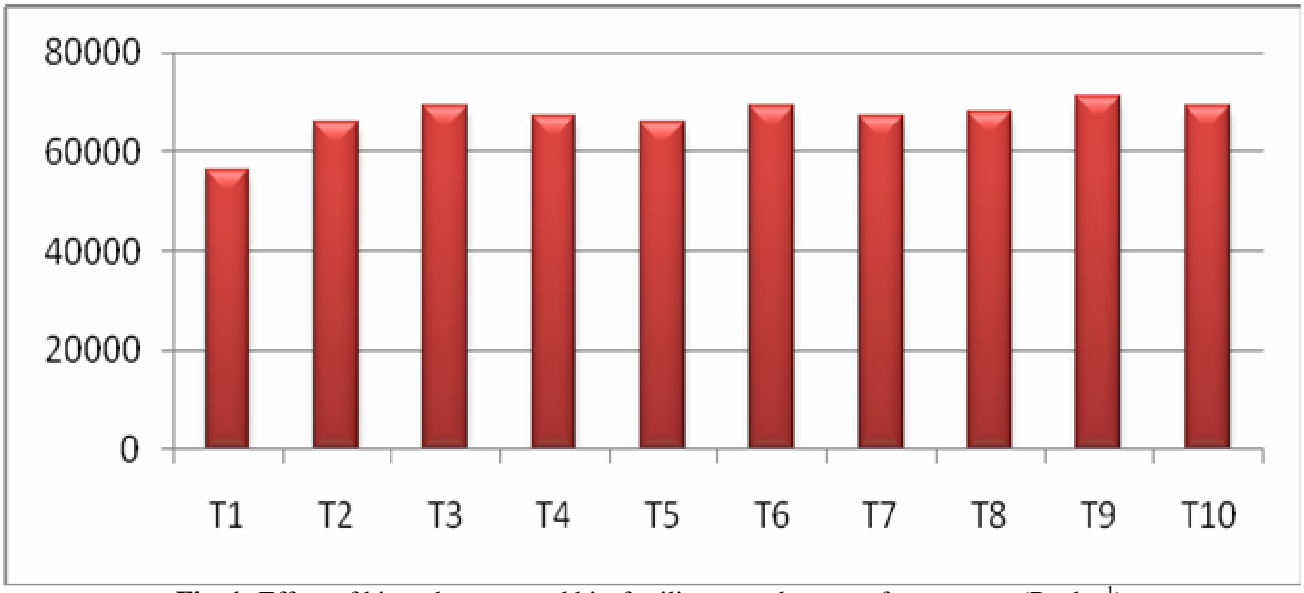

Fig. 1: Effect of bio-enhancers and bio-fertilizers on the cost of treatments (Rs. ha^{-1})

Table 4: Influence of bio-enhancers and bio-fertilisers on the economics of guava crop

Treatments	Yield (t h^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
T_1	3.46	56250.00	138400.00	82150.00	1.46
T_2	4.17	65945.00	166800.00	100855.00	1.52
T_3	4.94	69176.00	197600.00	128424.00	1.85
T_4	4.58	67330.00	183200.00	115870.00	1.72
T_5	5.43	65945.00	217200.00	151255.00	2.29
T_6	6.50	69176.00	260000.00	190824.00	2.75
T_7	5.96	67330.00	238400.00	171070.00	2.54
T_8	7.08	67789.00	283200.00	215411.00	3.17
T_9	8.81	71022.00	352400.00	281378.00	3.96
T_{10}	7.84	69176.00	313600.00	244424.00	3.53

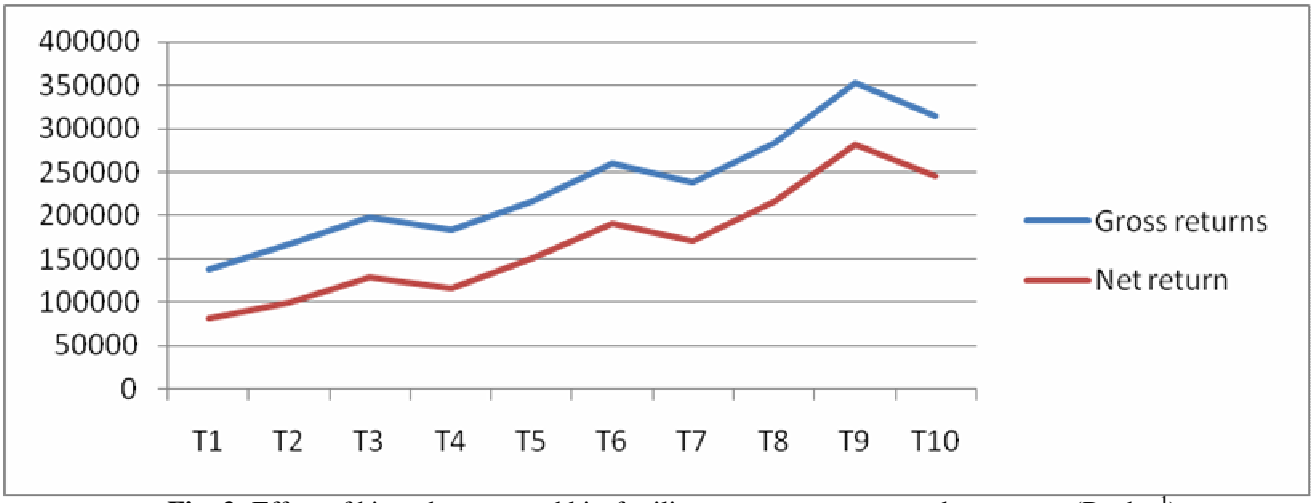

Fig. 2: Effect of bio-enhancers and bio-fertilizers on gross return and net return (Rs. ha^{-1})

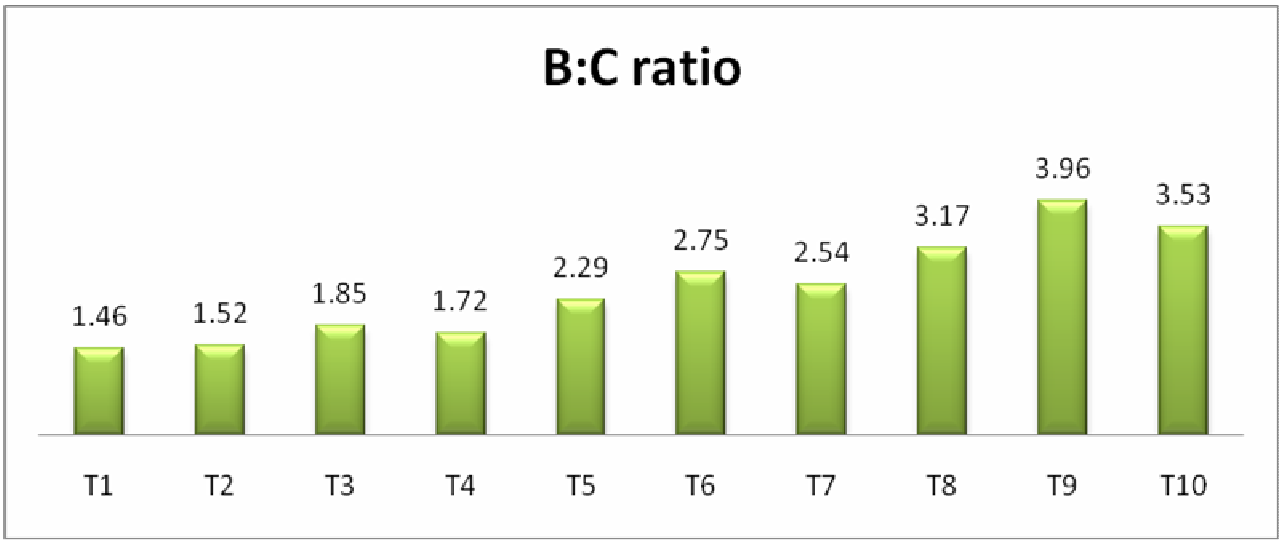

Fig. 3: Effect of bio-enhancers and bio-fertilizers on Benefit: cost ratio

References

Adak, T., Kumar K., Singha A., Shukla S.K. and Singh V.K. (2014). Assessing soil characteristics and guava orchard productivity as Influenced by organic and inorganic substrates. *The Journal of Uni. Plant Science*, **24(4),** 1157-1165.

Agnihotri, A., Tiwari R. and Singh O.P. (2013). Effect of crop regulators on growth, yield and quality of guava. *Annals of Plant and Soil Res.,* **15(1),** 54-57.

Bhadauria, A. S. and Tripathi V.K. (2023). Effect of Bio-enhancers and Bio-Fertilizers on Growth and Quality of Mango cv. Amrapali under Sub-tropical Plains of Central Uttar Pradesh, India. *International Journal of Plant and Soil Science*, **35(19),** 1260-1267.

Conti, S., Villari G., Faugno S., Melchionna G., Somma S. and Caruso G. (2014). Effects of organic vs. conventional farming system on yield and quality of strawberry grown as an annual or biennial crop in southern Italy. *Scientia Horticulturae*, **180,** 63-71.

Devakumar, N., Rao G. G. E., Shubha S., Imrankhan N. and Gowda S. B. (2008). Activities of Organic Farming Research Center, Navile, Shimoga, Univ. Agric. Sci., Bengaluru, Karnataka, India.

Ghoshal, N. and Singh K. P. (1995). Effects of Farmyard Manure and Inorganic Fertilizer on the Dynamics of Soil Microbial Biomass in a Tropical Dryland Agro-ecosystem. *Biol. Fert. Soils*, **19 (2),** 231–238.

Goswami, A.K., Lal S. and Misra K.K. (2012). Integrated nutrient management improves the growth and leaf nutrient status of guava cv. Pant Prabhat. *Indian Journal of Horticulture,* **69(2),** 168-172.

Gurjar, R. A., Shah K. A., Nayaka P., Salunkhe S. R. and Chauhan, N. M. (2023). Performance of bio-fertilisers on yield of mango and sapota in Navsari district of Gujarat. *Journal of Krishi Vigyan*, **11(2),** 269-273.

Kumar, R. K., Jaganath S., Guruprasad T. R., Narayana C. K., Balakrishna A. N., Venugopalan R. and Kumar A.S. (2017). Studies on plant density and integrated nutrient management for growth, yield, quality and shelf life of guava cv. Lalit in Rainy Season. *International Journal of Pure Applied Bioscience*, **5(2),** 354-366.

Kundu, S., Datta P., Mishra J., Rashmi K. and Ghosh B. (2011). Influence of bio-fertiliser and inorganic fertiliser in pruned mango orchard cv. Amrapali. *J. Crop Weed*, **7(2),** 100-103.

Mitra, S.K. and Bose T.K. (2001). Fruit; Tropical and Sub-tropical-VI. Naya Udyog Calcutta. 610-611.

Orwa, C., Mutua A., Kindt R., Jamnadass R. and Anthony S. (2009). Agro forest Database: A tree reference and selection guide version 4.0. World Agroforestry Centre, Kenya.

Panse, V.G. and Sukhatme P.V. (1985). Statistical methods for agricultural workers. Indian Council of *Agricultural Research Publication*, 87-89.

Pradhan, S. S., Verma S., Kumari S. and Singh Y. (2018). Bio-efficacy of cow urine on crop production: A. *International Journal of Chemical Studies*, **6(3),** 298-301.

Ram, R. A., and Verma, A. K. (2017). Yield, energy and economic analysis of organic guava (Psidium guajava) production under various organic farming treatments. *Indian Journal of Agricultural Sciences,* **87(12),** 1645-1649.

Ram, R. A., Bhriguvanshi S. R. and Pathak R. K. (2007). Integrated plant nutrient management in guava (*Psidium guajava* L.) cv. Sardar. *Acta Hort*., **735,** 345-350.

Sahu, P. K., Dikshit S.N. and Sahu V. (2014). Review on suitability of bio-fertilisers in Guava cultivation's recent research and potential application in India. *International Journal of Environment and Biology*, **4(4),** 238-242.

Tripathi, V.K., Jain A., Kumar S., Dubey V. and Kumar A. (2017). Efficacy of bio-fertilisers and mulch on growth, yield and quality of Strawberry (*Fragaria* × *ananassa*) cv. Chandler. *Indian Journal of Agricultural Sciences*, **87 (9),** 1179-1183.

Tripathi, V. K., Mishra A. N., Kumar S. and Tiwari B. (2014). Efficacy of *Azotobacter* and PSB on vegetative growth, flowering, yield and quality of Strawberry cv. Chandler. *Progressive Horticulture,* **46 (1),** 48-53.

Tyagi, S.K., Kulmi G. S., and Khire A.R. (2021) Effect of integrated nutrient management on growth, yield and economics of Guava (*Psidium guajava* L.). *Journal of Krishi Vigyan*, **10(1),** 69-72.