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Studies on effect of biofertilizers and biostimulant on economics of guava (*Psidium guajava* L.) cv. Allahabad Safeda under meadow planting system

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Abstract
The study was carried out at the Fruit research station, Sangareddy, Sri Konda Laxman Telangana State Horticultural University, Hyderabad during the period of June, 2019 to January, 2020 (Mrig bahar crop) to find out the effect of biofertilizers and biostimulant on economics of guava (*Psidium guajava* L.) cv. Allahabad Safeda under meadow planting system. Among the different treatment combinations of biofertilizers and biostimulant, application of B_3S_3- *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1} recorded maximum benefit: cost ratio (2.70) when compared to all other treatments.

Keywords: Guava, *Azotobacter*, phosphate solubilizing bacteria, seaweed extract, benefit-cost ratio

Introduction
Guava (*Psidium guajava* L.) is one of the most popular fruit grown in tropical and subtropical regions of India, which belongs to the family Myrtaceae and originated in Tropical America. In India, guava is cultivated in an area of 2,64,000 hectares with a production of 40.53 lakh tonnes and productivity 15.3 MT ha^{-1}. Uttar Pradesh has highest area and production Andhra Pradesh leads in productivity (Anonymous, 2017-18). Telangana has 2,560 ha area in guava with production of 38,740 MT (Anonymous, 2017-18). Winter guava is mostly preferred in the state which gives flowering in June-July and comes to harvest during Nov - Dec.

Generally, guava is cultivated using traditional planting system (6.0 x 6.0 m), under which it is difficult to achieve desired levels of production, because large trees provide low production per unit area and need high labour inputs. Moreover, large trees take several years before they come into bearing and overall cost of production per unit area is further increased. Hence, there is an overriding need to improve the existing planting system (Gorakh Singh, 2001) [4].

Certain important strategies have been identified for enhancing guava production in India in order to be competitive in the world market. It involves adaptation of modern, innovative and hi-tech plantation methods e.g. high-density planting (3 x 1.5 m) or meadow orchard (2.0 x 1.0 m) coupled with pruning. In context of globalization era, there is a definite shift in farmer's perception from production to productivity and profitability which can be achieved through high density planting (Singh, 2008) [7].

Among various aspects that influenced growth, development and quality of guava, nutrition is one of the important element of crop production. Indiscriminate use of chemical fertilizers has lead to several detrimental effects both on soil and environment. The soil, water and even air got polluted by the use of agro-chemicals. The residues left over by the inorganic fertilizers got into the food chain causing health problems to the human as well as animals. The chemical fertilizers are in short supply and considered as expensive input for developing countries like India. There is great demand for organically grown produce. All these necessitated to search alternate and cost effective materials for cultivation of crops. Switch over to the organic materials, which are natural source of nutrients, appears an effective alternative.

Materials and Methods
The experiment was carried out during the period of June, 2019 to January, 2020 (Mrig bahar crop) at Fruit Research Station (FRS), Sangareddy, SKLTSHU, Telangana. The soil type was sandy clay loam having pH 8.26, EC 0.20 dSm^{-1}, low in available N (120.61 kg ha^{-1}), low in available P (20.14 kg ha^{-1}) and medium in available potash (162.56 kg ha^{-1}). The experiment

was laid out in Factorial Randomized Block Design (FRBD) in three replications with 12 treatment combinations comprised of three levels of biofertilizers *viz*., B_1- *Azotobacter* @ 50 g tree^{-1}, B_2- PSB @ 50 g tree^{-1}, B_3- *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} and four levels of biostimulant *viz*., S_1- Seaweed extract @ 25 g tree^{-1}, S_2- Seaweed extract @ 50 g tree^{-1}, S_3- Seaweed extract @ 75 g tree^{-1} and S_0- Control (without seaweed extract). The treatment combinations include B_1S_1: *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}, B_1S_2: *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 50 g tree^{-1}, B_1S_3: *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 75 g tree^{-1}, B_1S_0: *Azotobacter* @ 50 g tree^{-1} + Control (without seaweed extract), B_2S_1: PSB @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}, B_2S_2: PSB @ 50 g tree^{-1} + Seaweed extract @ 50 g tree^{-1}, B_2S_3: PSB @ 50 g tree^{-1} + Seaweed extract @ 75 g tree^{-1}, B_2S_0: PSB @ 50 g tree^{-1} + Control (without seaweed extract), B_3S_1: *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}, B_3S_2: *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Sea weed extract @ 50 g tree^{-1}, B_3S_3: *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1}, B_3S_0: *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Control (without seaweed extract)

*__Note__: Vermicompost @ 5 kg tree^{-1} is common to all the treatments

PSB: Phosphate solubilizing bacteria

Results and Discussion

1. Yield per hectare (t ha^{-1})

Interaction between biofertilizers and biostimulant had significant effect on yield per hectare (t ha^{-1}). Maximum yield per hectare (22.56 t ha^{-1}) was recorded with the application of B_3S_3- *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1}, followed by B_3S_2- *Azotobacter* @ 50 g tree^{-1} + PSB @ 50 g tree^{-1} + Sea weed extract @ 50 g tree^{-1} (20.88 t ha^{-1}). The minimum yield per hectare (5.61 t ha^{-1}) was recorded with the application of B_1S_0- *Azotobacter* @ 50 g tree^{-1} and without seaweed extract.

The increase in yield per hectare might be due to the reason that application of biofertilizers and seaweed extract regulates the plant bio-physiological activities like increasing chlorophyll content in the leaf, nutrient uptake, photosynthetic activity and synthesis of plant growth regulators during growth and development of fruit which might have ultimately increased yield per hectare. The present results were in agreement with those of Dhomane and Kadam (2013) [3], Sharma *et al*. (2013) [6], Yadav *et al*. (2013) [8] and Kumar *et al*. (2017) [5] in guava.

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

The cost of cultivation of guava varied from INR 142582 ha^{-1} to 250634 ha^{-1} because different doses of biofertilizers and biostimulant are used in different treatment combinations. The maximum cost of cultivation (250634 INR ha^{-1}) was recorded in the treatment 11. While minimum was observed in the treatment 4.

3. Gross Income (Rs ha^{-1})

The highest gross income (INR 676800 ha^{-1}) was recorded in the treatment with application of *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1}. While lowest gross income (INR 168284 ha^{-1}) was found in treatment *Azotobacter* @ 50 g tree^{-1} + Control.

4. Net returns (Rs ha^{-1})

Net returns (INR 426166 ha^{-1}) was recorded maximum in the treatment *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1} and the treatment with *Azotobacter* @ 50 g tree^{-1} + Control recorded minimum net returns (INR 25702 ha^{-1}).

5. Benefit-cost ratio

Among the different treatment combinations of biofertilizers and biostimulant, application of B_3S_3- *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1} recorded maximum benefit: cost ratio (2.70), followed by B_3S_2- *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 50 g tree^{-1} (2.58). Minimum benefit: cost ratio (1.18) was recorded with application of B_1S_0- *Azotobacter* @ 50 g tree^{-1} + Control.

It is evident from the data that, maximum benefit: cost ratio was recorded with application of B_3S_3- *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1} . This might be due to higher fruit yield per hectare as compared to other treatment combinations.

Table 1: Effect of biofertilizers and biostimulant on economics of guava cv. Allahabad Safeda under meadow planting system

Treatment combinations	Cost of cultivation (Rs ha^{-1})	Yield per hectare (t ha^{-1})	Gross Income (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit-cost ratio
T_1 (B_1S_1): *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}	182426	9.53	285897	103471	1.56
T_2 (B_1S_2): *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 50 g tree^{-1}	198256	12.81	384296	186040	1.60
T_3 (B_1S_3): *Azotobacter* @ 50 g tree^{-1} + Seaweed extract @ 75 g tree^{-1}	210427	14.34	430198	219771	2.04
T_4 (B_1S_0): *Azotobacter* @ 50 g tree^{-1} + Control	142582	5.61	168284	25702	1.18
T_5 (B_2S_1): Phosphate solubilizing bacteria @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}	185968	10.68	320392	134424	1.72
T_6 (B_2S_2): Phosphate solubilizing bacteria @ 50 g tree^{-1} + Seaweed extract @ 50 g tree^{-1}	214134	14.11	423273	209139	1.97
T_7 (B_2S_3): Phosphate solubilizing bacteria @ 50 g tree^{-1} + Seaweed extract @ 75 g tree^{-1}	220985	15.41	462268	241283	2.09
T_8 (B_2S_0): Phosphate solubilizing bacteria @ 50 g tree^{-1} + Control	152123	6.34	190186	38063	1.25
T_9 (B_3S_1): *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Seaweed extract @ 25 g tree^{-1}	234657	18.21	546271	311614	2.32
T_{10} (B_3S_2): *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 50 g tree^{-1}	242368	20.88	626397	384029	2.58

T_{11} (B_3S_3): *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1}	250634	22.56	676800	426166	**2.70**
T_{12} (B_3S_0): *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Control	158216	7.08	212394	54178	1.34

Note: Price received by the farmer = ₹ 30 per Kg

Conclusion

Among the different treatment combinations of biofertilizers and biostimulant, application of B_3S_3 *Azotobacter* @ 50 g tree^{-1} + Phosphate solubilizing bacteria @ 50 g tree^{-1} + Sea weed extract @ 75 g tree^{-1} recorded maximum benefit: cost ratio (2.70) when compared to all other treatments.

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