The Pharma Innovation Journal 2023; 12(8): 2841-2843

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 2841-2843

www.thepharmajournal.com
Received: 26-06-2023
Accepted: 30-07-2023

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A comprehensive evaluation of bio fertilizer on mango and sapota

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Abstract
The present study aimed to assess comprehensive evaluation of bio fertilizers, *e.g.,* Azotobacter, Phosphorus Solubilizing Bacteria (PSB) and Potash Mobilizing Bacteria (KMB), on mango and sapota yield in farmer's fields. The bio fertilizer demonstrated plot of Mango resulted in 92.00 q/ha and Sapota plot recorded 128.50 q/ha fruit yield. The technology gap was 13.00 q/ha in mango and 21.50 q/ha in sapota, whereas the technology index was 12.38% in mango and 14.33% in sapota. In mango, the net return in the demonstration plot was 1,71,433 Rs/ha, while in the check plot it was 1,45,730 Rs/ha. In the Sapota crop, the net return in the demonstration plot was 1,49,004 Rs/ha, while in the check plot it was 1,21,981 Rs/ha. Furthermore, a net return increase of mango (17.64%) was lesser than Sapota (22.15%). The findings from this study provide valuable insights into the potential benefits of employing bio fertilizers in fruit cultivation, contributing to sustainable agriculture practices.

Keywords: Bio fertilizers, extension gap, mango, sapota and yield

Introduction
Farmers in South Gujarat employ various cultivation practices, including proper orchard managing, water supply, plant protection and post-harvest handling, to ensure good yields and high-quality fruits. The region's proximity to markets and transportation infrastructure enables efficient distribution of mangoes and sapotas within Gujarat and other parts of the country.
Mango (*Mangifera indica* L.) and Sapota [*Manilkara acharas* (Mill.)] are major fruit crops cultivated commercially in Navsari region of Gujarat (Bhalekar and Chalak, 2016) [2]. Its cultivation significantly contributes to the local economy, providing employment opportunities and playing a vital role in the agricultural sector. Mango is King of all fruit. Its domestic and international market demand is very high due to its taste colour aroma and nutrients. Sapota, on the other hand, is a delicious fruit popularly used in milkshakes and provides consistent income to farmers for around 5 to 6 months in a year. (Gurjar *et al*., 2022) [6]. However the yield of these two crops is decreasing day by day and farmers are facing economic crises.
Less use of well-rotten FYM and surplus use of chemical fertilizers have given hazardous impact on soil properties. This caused in the distortion of soil's properties causing in hindrance in the yield and if the tendency remains, it will have devastating results (Hiwale *et al*., 2010) [9]. The use of organic matter along with bio-fertilizer improves the availability of nutrients from the soil. (Ram and Rajput, 2000) [13].
By utilizing chemical fertilizers haphazardly farmers obtained better yield initially. However, the excess use of chemical stimulants reflects undesirable impacts on yield, environment, soil health and overall production costs. Biofertilizers, which are eco-friendly and sustainable alternatives, offer several benefits such as enhancing soil fertility, reducing pollution, promoting biodiversity, and supporting plant growth. While biofertilizers cannot completely replace chemical fertilizers, they are cost-effective, lower input costs, and address environmental concerns. Factors like climate, soil type and crop species influence their effectiveness, necessitating site-specific considerations and expert advice for optimal use. Therefore, a comprehensive evaluation of biofertilizers [azotobacter, phosphorus solubilising bacteria (PSB) and potash mobilizing bacteria (KMB)] on mango and sapota in farmer's fields, KVK Navsari conducted demonstrations with the objectives of:
To find out the influence of bio fertilizers on mango and sapota yield
Evaluating the economic viability of bio fertilizer usage
To evaluate the overall productivity of the crops

Materials and Methods

Krishi Vigyan Kendra, Navsari planned for awareness about bio fertilizers in front line demonstrations on scientific cultivation practices for mango (Kesar variety) and sapota (Kalipatti variety) in Navsari district during the Kharif season of 2022-23. A total of 110 FLDs covering 43.20 hectares were conducted for mango and 123 FLDs covering 53.60 hectares were conducted for sapota. The demonstrations took place on farmers' fields in Navsari, Jalalpore, and Gandevi taluka of Navsari district, with irrigation and good drainage facilities. The demonstration followed Choudhary's (1999)[3] suggestions, including site selection, farmer selection, and layout. Farmers were chosen through surveys and meetings, and they received training on scientific cultivation and plant protection at the KVK campus. Navsari Agricultural University provided bio-fertilizers (azotobacter, phosphorus solubilizing bacteria, and potash mobilizing bacteria) in 2 liter quantities (50 ml per plant) to each farmer. The demonstration plots used recommended doses of fertilizers and manure based on crop type. Traditional practices were continued in the control plots of farmer. Yield statistics from both the technology exhibited plot and check plots were collected and the benefit-cost ratio was calculated. Operational cost and monetary gain data were gathered for commercial viability of bio fertilizers in mango and sapota farming. The technology gap, extension gap and technology index were computed using the methodologies proposed by Eswaraprasad *et al*., (1993) [4] and Samui *et al*., (2000) [14].

Extension Gap = Demonstration Yield - Farmer Yield
Technology Gap = Potential Yield - Demonstration Yield
Technology Index = (Technology Gap / Potential Yield) * 100

Results and Discussion

The use of different bio fertilizers, such as PSB, KMB and Azotobacter had a noteworthy impact on the yield of mango and sapota fruit crops. In a demonstration field plot, the yields were higher (92.00 and 128.50 q/ha) in comparison to the control field (81.00 and 111.50 q/ha) for mango and sapota crops, respectively. The use of bio fertilizers resulted in a yield increase of 13.58% and 15.25% for mango and sapota, respectively. These results are consistent with previous studies conducted by Meena *et al.*, (2012) [11].

Furthermore, the mango demonstration plot yield (92.00 q/ha) was lesser than the national average (96.64 q/ha). However, it was recorded higher than the state (74.20 q/ha) and district averages (91.92 q/ha). Similarly, in the sapota demonstration plot, the yield (128.50 q/ha) surpassed the national (121.24 q/ha), state (110.44 q/ha) and district averages (126.90 q/ha). This results are in support of Gurjar *et al*., (2023) [7]. The higher yields in the demonstration plots were attributed to the use of bio fertilizers and farmyard manure, which improved nutrient availability and plant capacity. Comparable conclusions were identified in studies by Kapur *et al*. (2020) [10] in brinjal, Patel and Naik (2010) [12], Gawande *et al*., (1998) [5] in sapota and Shaktawat and Chundawat (2021) [15] in oilseeds.

In the Navsari district, the potential yield for Kesar Mango was 105.00 q/ha, while for sapota, it was 150.00 q/ha for 25-year-old trees planted with a distance of 10 m x 10 m (Anonymous, 2018) [1]. However, there was an extension gap of 11.00 q/ha in mango and 17.00 q/ha in sapota, indicating a lack of alertness about systematic orchard managing and the use of organic manure and biofertilizers. Farmers require training on proper cultivation methods through meetings, training sessions, problem-solving visits, and perception clearance. The technology gap was 13.00 q/ha in mango and 21.50 q/ha in sapota, emphasizing the need for farmer education on the adoption of systematic production skill. The technology index was 12.38% in mango and 14.33% in sapota, with sapota showing more feasibility compared to mango. These results align closely with Gurjar *et al*. (2023) [8].

In terms of economic analysis, the gross cost in the bio-fertilizer demonstration plot was 1,04,567 Rs/ha, while in the mango check plot, it was 97,270 Rs/ha. The increase in cost can be attributed to the expenses associated with bio-fertilizer and its use in the orchard. The mango demonstration plot recorded a higher gross return of 2,76,000 Rs/ha compared to the check plot (2,43,000 Rs/ha). In the demonstration plot, the net return was recorded at 1,71,433 Rs/ha, whereas in the check plot, it amounted to 1,45,730 Rs/ha. The BCR was higher in the demonstration plot (2.64) compared to the check plot (2.50), which can be attributed to improved nutrient absorption from the soil. The use of PSB, KMB, and Azotobacter in Mango cultivation resulted in a significant net return increase of 17.64% was observed. This improvement was achieved with an additional cost of 3,120 Rs/ha, leading to an additional return of 25,703 Rs/ha. These findings are in corroboration with Gurjar *et al*., (2023) [8].

In the cultivation of sapota fruit, the gross cost within the exhibited plot amounted to 1,07,996 Rs/ha, while in the check plot, it was 1,01,019 Rs/ha. The progression in the gross cost within the exhibited plot can be attributed to the inclusion of charges associated with the demonstration itself and its subsequent application in the field. Similarly, the gross return stood at 2,57,000 Rs/ha, as opposed to 2,23,000 Rs/ha in the check plot. The net return within the exhibited plot was 1,49,004 Rs/ha, while within the check plot, it amounted to 1,21,981 Rs/ha. Furthermore, the BCR within the exhibited plot showed a higher value (2.38) in comparison to the check plot (2.21). This enhanced performance could potentially be attributed to improved nutrient uptake from the soil, resulting in a augmented yield. A parallel observation was made by Gurjar *et al*. (2023) [7].

Furthermore, a net return increases of 22.15%. The additional cost incurred for this demonstration was also 3,120 Rs/ha, resulting in an additional return of 27,023 Rs/ha. These findings highlight the potential benefits of incorporating PSB, KMB, and Azotobacter in crop cultivation, as they contribute to increased net returns and improved yields. These results are in corroboration with Gurjar *et al*., (2023) [8].

Table 1: Area and Total participant data during the year 2022-23.

	FLD organized			Area	Total	National average	State average yield	District average yield
Sr. No.	Crop	Variety	Season	(ha)	Participant	yield (q/ha)	(q/ha)	(q/ha)
1	Mango	Kesar	Kharif	43.20	110	96.64	74.20	91.92
2	Sapota	Kalipatti	Kharif	53.60	123	121.24	110.44	126.90

Average yield is taken from Horticultural statistics at a glance. (Anonymous, 2018) [1].

Table 2: Yield performances and calculations of FLDs organized during the year 2022-23.

Sr. No.	Demonstration detail	Age of the tree Planting (10 m *10 m)	Yield obtained (q/ha)		Yield increase (%)	Potential yield of the demo variety (q/ha)	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
			Demo Average	Check Average					
1	PSB, KMB and Azotobacter in mango	25	92.00	81.00	13.58	105.00	11.00	13.00	12.38
2	PSB, KMB and Azotobacter in sapota	25	128.50	111.50	15.25	150.00	17.00	21.50	14.33

Table 3: Monetory return of FLDs organized during the year 2022-23.

Sr. No.	Demonstration detail	Expenditure and Returns (Rs./ha)									Additional	
		Demo				Check						
		Gross Cost (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B: C ratio	Gross Cost (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B: C ratio	Net Return increase %	Cost Rs/ha	Return Rs/ha
1	PSB, KMB and Azotobacter in Mango	1,04,567	2,76,000	1,71,433	2.64	97,270	2,43,000	1,45,730	2.50	17.64	3,120	25,703
2	PSB, KMB and Azotobacter in sapota	1,07,996	2,57,000	1,49,004	2.38	1,01,019	2,23,000	1,21,981	2.21	22.15	3,120	27,023

Conclusion

The use of bio fertilizers, such as PSB, KMB and Azotobacter, significantly increased the yield of mango and sapota fruit crops. The demonstration plots showed higher yields compared to the check plot and the use of bio fertilizers improved nutrient availability and plant capacity. These results align with previous studies and highlight the importance of adopting scientific production technology and educating farmers on proper cultivation methods. The economic analysis also demonstrated that the use of bio fertilizers resulted in higher gross returns, net returns and benefit-cost ratios compared to the check plots.

Acknowledgement

We express our sincere gratitude to the Goddess of Knowledge, Devi Saraswati, for her blessings and guidance, which have served as a constant source of inspiration and strength in implementing innovative ideas in the field of education. We also extend our heartfelt thanks to the Senior Scientist and Head of KVK, Bio Fertilizer Unit, Dept. of Plant Pathology, NMCA, as well as the Director of Extension, NAU, Navsari, Gujarat, for their valuable permission, support, and provision of facilities during the research and survey process. We are deeply grateful for the collective efforts and support of my colleagues and all individuals and institutions involved, as their contributions have been instrumental in the success of this endeavour. Furthermore, we would like to acknowledge The Pharma Innovation Journal for their invaluable contribution in publishing this research paper. Their dedication to sharing knowledge and disseminating research results has played a crucial role in spreading our findings to a global audience.

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