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RESEARCH PAPER

Studies on effect of liquid bio-fertilizer and inorganic fertilizer on yield and quality of Sapota [*Manilkara achras* (Mill.) Foresberg.] Cv. Kallipatti

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Abstract : The experiment was laid out in Factorial Randomized Block Design with two factors; these factors consist of four and three levels respectively, twelve treatment combination and three replications. Among the different treatment combinationthe treatment T_{10}-N_1B_3 (125%NPK + Azotobacter + PSB) application of Azotobacter and PSB with 125% dose of fertilizer reported that the highest number of fruits per tree (1415.62), Yield per tree (105.02 kg), yield per hectare (108.38), Weight of fruit (g)(86.50), TSS (%), Acidity (0.18), Reducing sugar (15.00%) and Non-reducing sugar (5.63%) of sapota were recorded highest with the application of 125% RDF+ Azotobacter (100ml) + PSB (100ml). The treatment N_1B_3 with application of 125% NPK combined with Azotobacter (100ml) and PSB (100ml) significant than the other treatments.

Key Words : Sapota, Biofertilizers, Chemical fertilizers, Azotobacter, PSB

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INTRODUCTION

Sapota [*Manilkara achras* (Mill.) Forseberg] is one of the important tropical fruit crop belonging to family sapotaceae. Sapota is commonly called chiku in India. It is not known when sapota first introduced in India, but sapota cultivation was taken up for the first time in Maharashtra in 1898 at village Gholwad in district Thane (Chaddha, 1993).

Sapota is a best source of digestible sugar which ranges from 12 to 18 percent. Composition of ripe sapota per 100 g of edible portion is moisture 73.7 g, carbohydrates 21.4 g, protein 0.7 g, fat 1.1 g, calcium 28.0 mg and phosphorus 27.0 mg (Shanmungavelu and Shrinivasan, 1973).

Biofertilizers are the live or latent cells of efficient strain of nitrogen fixing, phosphate solubilizing or cellulitic micro-organism used in soil or seed treatment with the objective of augment the availability and accesses nutrients to the plant. The some biofertilizer micro-organisms are either free living or symbiotic with plant and some micro-organisms are nitrogen fixing *i.e.Rhizobium, Azotobacter, Azospirillum* and other like Phosphate solubilizing and Phosphate mobilizing i.e. PSB

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Treatment details			
Factor	Sr. No.	Symbol	Treatment
	1	B0	Control
Factor:1	2	B1	Soil application of Azotobacter 100 ml / plant
Bio-fertilizer	3	B2	Soil application of PSB (Phosphate Solubilizing bacteria) 100 ml / plant
	4	B3	Soil application of Azotobacter and PSB. 100ml / plant each
Factor:2	1	N1	125% of NPK (Whole RDF *i.e.* 1250:650:650 g per Plant)
Inorganic fertilizer	2	N2	100% of NPK (RDF)
	3	N3	75% of NPK (RDF)

Treatment combinations			
Sr. No.	Treatment No.	Treatment combination	Treatment details
1.	T_1	$N_1 B_0$	(125%RDF)1250:650:650 g NPK / Plant.
2.	T_2	$N_2 B_0$	(100% RDF)1000:500:500 g NPK / plant.
3.	T_3	$N_3 B_0$	(75% RDF)750:375:375 g NPK / plant.
4.	T_4	$N_1 B_1$	(125% RDF)+Azotobacter 1250:650:650g NPK + 100 ml Azotobacter /Plant.
5.	T_5	$N_2 B_1$	(100% RDF)+Azotobacter 1000:500:500 g NPK + 100 ml Azotobacter / Plant.
6.	T_6	$N_3 B_1$	(75% RDF)+Azotobacter 750:375:375 g NPK +100 ml Azotobacter / Plant
7.	T_7	$N_1 B_2$	(125%RDF)+PSB 1250:650:650 g NPK + 100 ml PSB / plant.
8.	T_8	$N_2 B_2$	(100% RDF)+PSB 1000:500:500 g NPK + 100 ml PSB / Plant.
9.	T_9	$N_3 B_2$	(75% RDF)+PSB 750:375:375 g NPK +100 ml PSB / Plant.
10.	T_{10}	$N_1 B_3$	(125% RDF)+Azotobacter+PSB 1250:650:650gNPK+100ml Azotobacter+100ml PSB /Plant
11.	T_{11}	$N_2 B_3$	(100% RDF)+ Azotobacter + PSB 1000:500:500NPK + 100ml Azotobacter+100ml PSB / Plant.
12.	T_{12}	$N_3 B_3$	(75% RDF)+ Azotobacter + PSB 750:375:375NPK+100ml Azotobacter+100mlPSB / Plant.

and VAM (Phosphate solubilizing Bacteria and Vesicular Arbuscular Mycorrhizae) *Azospirillum* and PSB are the main bio-fertilizers for horticultural crops. Bio-fertilizers helps in saving 50-70% of the requirement of inorganic nitrogen per hectare (Jitendra Singh 2011).

MATERIAL AND METHODS

Experiment was conducted on fifteen years old orchard of sapota cultivar "Kalipatti"on Khirni (*Manilkarahexandra* Roxb.) rootstock spaced at 10x10 meters located at Horticulture Research Scheme, (Pomology) Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani district. The experiment was laid out in factorial randomized block design with 12 treatments and 3 replication on 15 years sapota Cv. Kalipatti.The climate is semi arid with hot dry summer, followed by humid monsoon and subsequent short cold winter.Above dose of bio fertilizers were applied 15 days before flowering in the month of May. Then after 15 days half dose of Nitrogen and full dose of Phosphate and Potassium in the form of Urea, SSP and MOP and the remaining half dose of nitrogen was applied after fruit set.Application of fertilizers was done in 1.5 meter periphery from the stem of the tree in ring method having a 15 inch depth and then covered with soil.

RESULTS AND DISCUSSION

Number of fruits per tree :

The interaction between bio-fertilizer and chemical fertilizers were found superior in number of fruits per tree and results arepresented in Table 1. The fertilizer combination N_1B_3 (125%NPK +Azotobacter + PSB) recorded maximum fruits per trees (1415.62) was followed by treatment N_2B_3(100% NPK with combination of Azotobacter and PSB (13.50). The treatment combination N_3B_0 (75% NPK) without bio-fertilizer recorded minimum fruits per tree (802.04).The Patel *et al*. (2009) reported that higher fruit number and yield per plant may be due to better plant growth and canopy spread by AMF and Azospirillum treated plant. Increased yield and yield attributing characters largely may be consequences of vigorous plant growth Sah *et*

al. (2010); Meena *et al*. (2013) in and Sahu *et al.* (2014) in guava.

Yield per tree (kg) :

The fertilizer combination of bio-fertilizer with reduced level of inorganic fertilizers also significantly increased the yield per tree were presented in Table 1. The treatment combination (N_1B_3) recorded maximum yield per tree (105.02 kg) it was followed by N_1B_2. The treatment combination N_3B_0 recorded minimum yield per tree (66.10 kg) application of chemical fertilizers only. Patil *et al.* (2013) reported that increase in yield/ha in banana, Sharma *et al.* (2016) in mango,Verma *et al.* (2013) in phalsa.

Yield per hectare (q) :

The fertilizer combination of bio-fertilizer with reduced level of inorganicfertilizers also significantly increased the yield per ha and results are presented in Table 1. The treatment combination (N_1B_3) recorded maximum yield per tree (108.38 kg) it was followed by N_1B_2. The treatment combination N_3B_0 recorded minimum yield per tree (66.37 kg) application of chemical fertilizers only. The treatment combination, N_1B_1 N_1B_2 and N_3B_3 were closely at par with treatment N_1B_3. Medhi *et al*. (2007); Dalal *et al*. (2009); Deware and Waghmare (2009) reported that 100 % NPK+ FYM+ Azotobactor and PSB increases the fruit yield.

Weight of fruit (g), No of seeds per fruit (g) and weight of seeds per fruit (g) :

The interaction effect influenced the weight of fruit and datapresented in Table 2. The fertilizer combination of N_1B_3 produced maximum weight of fruit (86.50 g).Treatment N_1B_3 was at par with $N_2B_3$and N_3B_3.The treatment combination having fertilizer application75 per

Table 1: Effect of liquid Bio-fertilizers and Inorganic fertilizers on number of fruits per tree, Yield per tree (kg) and Yield per ha (q)

Treatment No.	Factor / Treatment	No. of fruits per tree	Yield per tree (kg)	Yield per ha (q)
1	B0-control	1047.07	78.25	80.46
2	B1-Azotobacter	1077.97	85.34	85.70
3	B2-PSB	1172.63	87.04	88.78
4	B3-Azotobacter +PSB	1185.96	92.59	79.34
SE+		19.61	1.46	1.63
CD at 5%		57.51	24.47	4.80
1	N1-125% NPK	1256.12	95.10	80.46
2	N2-100% NPK	1130.86	85.67	85.70
3	N3-75 NPK	975.73	76.65	88.78
SE+		16.98	1.26	1.42
CD at 5%		49.81	3.70	4.15
		Interaction Effect		
T_1	N1B0- 125% NPK	940.67	71.73	73.03
T_2	N2B0- 100% NPK	850.35	71.65	70.38
T_3	N3B0- 75% NPK	802.04	66.10	66.37
T_4	N1B1- 125% NPK+ Azotobacter	1125.33	96.69	94.01
T_5	N2B1- 100 %NPK+Azotobacter	1113.38	89.40	86.71
T_6	N3B1- 75% NPK+ Azotobacter	1035.89	71.73	78.33
T_7	N1B2- 125% NPK+PSB	1260.64	101.01	107.30
T_8	N2B2- 100% NPK+PSB	1171.91	91.68	87.64
T_9	N3B2- 75% NPK +PSB	1035.64	79.37	81.64
T_{10}	N1B3- 125%NPK +Azotobacter +PSB	1415.62	105.02	108.38
T_{11}	N2B3- 100%+NPK+Azotobacter +PSB	1350.21	94.02	92.68
T_{12}	N3B3- 75%NPK +Azotobacter+PSB	1300.24	85.32	86.38
SE+		17.09	2.52	2.83
CD at 5%		50.07	7.39	8.31

cent NPK only (N_3B_0) shown minimum weight of fruit (79.77g).

Interaction effect of bio-fertilizer with reduced level of chemical fertilizers significantly influenced the number of seeds per fruits are presented in Table 2. The treatment combination N_1B_3(125% NPK + Azotobacter+ PSB) recorded minimum seeds per fruit (2.20) followed by N_1B_2 (125% + PSB) *i.e.* 2.38. The maximum number of seeds (3.61) were observed in 75 per cent NPK (N_3B_0).

The combination of bio-fertilizers with reduced level of chemical fertilizer significantly affected the weight of seeds per fruit and data presented in Table 2. The treatment combination (N_1B_3) recorded minimum weight of seeds per fruit (2.24 g) it was followed by N_2B_3,N_3B_3,N_1B_2, N_1B_2. The treatment combination N_3B_0 recorded maximum (2.50) weight of seeds per fruit which observed by lowest application of chemical fertilizers and without biofertilizer application. The

Table 2: Effect of liquid Bio-fertilizers and Inorganic fertilizers on Weight of fruit (g), No. of seeds per fruit, Weight of seeds per fruit (g)

Treatment No.	Factor / Treatment	Weight of fruit (g).	No. of seeds per fruit.	Weight of seeds per fruit (g)
1	B0-control	82.24	2.94	2.43
2	B1-Azotobacter	83.00	2.85	2.38
3	B2-PSB	83.44	2.80	2.38
4	B3-Azotobacter +PSB	84.19	2.61	2.35
SE±		0.40	0.06	0.01
CD at 5%		1.16	0.16	0.03
1	N1-125% NPK	84.89	2.55	2.34
2	N2-100% NPK	83.16	2.77	2.39
3	N3-75 NPK	81.59	3.08	2.43
SE±		0.34	0.05	0.01
CD at 5%		1.01	2.61	0.03
		Interaction Effect		
T_1	N1B0- 125% NPK	81.31	3.06	2.48
T_2	N2B0- 100% NPK	80.74	3.18	2.45
T_3	N3B0- 75% NPK	79.77	3.61	2.50
T_4	N1B1-125% NPK+ Azotobacter	84.30	2.46	2.36
T_5	N2B1-100 % NPK+Azotobacter	82.74	2.55	2.40
T_6	N3B1- 75% NPK+ Azotobacter	81.64	2.78	2.41
T_7	N1B2- 125% NPK+PSB	84.43	2.38	2.35
T_8	N2B2- 100% NPK+PSB	83.18	2.91	2.42
T_9	N3B2- 75% NPK +PSB	82.22	2.84	2.44
T_{10}	N1B3- 125%NPK + Azotobacter +PSB	86.50	2.20	2.24
T_{11}	N2B3- 100%+ NPK+ Azotobacter +PSB	86.25	2.60	2.30
T_{12}	N3B3- 75%NPK +Azotobacter+PSB	85.51	3.01	2.29
SE+		0.69	0.10	0.02
CD at 5%		2.02	0.28	0.06

significant results are obtained by application of bio-fertilizers alone and combination with reduced level of chemical fertilizers.

This is might be due to the increased photosynthetic ability of plants supplied with Azotobacter + vermicompost, which in turn might have favoured, increased the accumulation of dry matter and Nitrogen fixers are responsible for synthesis of different growth regulators Gupta *et al*. (2012). Dalal *et al*. (2009) reported that 100% NPK in 3 splits + 100% P_2O_5 and organic + Bio-fertilizer shown significant results on quality *i.e.* fruit weight and minimum number of seeds in sweet orange. Dutta *et al*. (2009), Patel *et al*. 2009 in sweet orange and Binepal *et al*.(2013) guava found similar result.

T.S.S (%) and Titrable acidity:

The interaction effect of bio-fertilizer and chemical fertilizers significantly influenced on T.S.S of fruit present in Table 3. The treatment combination N_1B_3 recorded maximum T.S.S (20.82 %) followed by N_1B_1 (19.86) and N_1B_2(20.11). The minimum T.S.S observed in the treatment (16.83%) content in fruit was found in plant had applied 75% chemical fertilizers only.

Table 3 : Effect of liquid Bio-fertilizers and Inorganic fertilizers on TSS (%), Acidity (%)

Treatment No.	Factor / Treatment	TSS (%)	Acidity (%)
1	B0-control	17.82	0.22
2	B1-Azotobacter	18.22	0.22
3	B2-PSB	19.02	0.21
4	B3-Azotobacter +PSB	19.22	0.20
SE±		0.23	0.00
CD at 5%		0.66	0.01
1	N1-125% NPK	19.85	0.20
2	N2-100% NPK	18.31	0.21
3	N3-75 NPK	17.58	0.22
SE±		0.20	0.00
CD at 5%		0.57	0.01
	Interaction Effect		
T_1	N1B0- 125% NPK	17.45	0.22
T_2	N2B0- 100% NPK	17.10	0.24
T_3	N3B0- 75% NPK	16.83	0.25
T_4	N1B1- 125% NPK+ Azotobacter	19.86	0.19
T_5	N2B1- 100 % NPK+Azotobacter	18.60	0.21
T_6	N3B1- 75% NPK+ Azotobacter	17.72	0.22
T_7	N1B2- 125% NPK+PSB	20.11	0.21
T_8	N2B2- 100% NPK+PSB	18.91	0.21
T_9	N3B2- 75% NPK +PSB	18.02	0.20
T_{10}	N1B3- 125%NPK +Azotobacter +PSB	20.82	0.18
T_{11}	N2B3- 100%+NPK+Azotobacter +PSB	19.23	0.20
T_{12}	N3B3- 75%NPK +Azotobacter+PSB	18.31	0.21
SE+		0.39	0.01
CD at 5%		1.15	0.02

Table 4: Effect of liquid Bio-fertilizers and Inorganic fertilizers on Reducing sugars (%), Non –reducing sugars (%), Total sugars (%)

Treatment No.	Factor / Treatment	Reducing sugar (%)	Non –reducing sugar (%)	Total sugar (%)
1	B0-control	10.82	3.30	13.88
2	B1-Azotobacter	11.99	3.57	16.07
3	B2-PSB	12.08	4.20	16.64
4	B3-Azotobacter +PSB	13.01	4.51	17.05
SE±		0.20	0.10	0.32
CD at 5%		0.59	0.29	0.94
1	N1-125% NPK	13.68	3.08	13.88
2	N2-100% NPK	11.25	3.75	16.07
3	N3-75 NPK	10.99	4.86	16.64
SE+		0.17	0.08	0.28
CD at 5%		0.51	0.25	0.82
Interaction Effect				
T_1	N1B0- 125% NPK	10.37	3.23	14.00
T_2	N2B0- 100% NPK	9.53	2.72	13.99
T_3	N3B0- 75% NPK	9.12	2.40	12.26
T_4	N1B1- 125% NPK+ Azotobacter	11.20	4.01	16.89
T_5	N2B1- 100 % NPK+Azotobacter	12.72	3.39	15.38
T_6	N3B1- 75% NPK+ Azotobacter	11.72	3.23	14.01
T_7	N1B2- 125%NPK+PSB	11.30	4.28	17.24
T_8	N2B2- 100% NPK+PSB	12.45	3.47	15.97
T_9	N3B2- 75% NPK+PSB	11.77	3.29	15.01
T_{10}	N1B3- 125%NPK + Azotobacter +PSB	15.00	5.63	19.24
T_{11}	N2B3- 100%+NPK+ Azotobacter +PSB	14.10	5.04	18.67
T_{12}	N3B3- 75%NPK +Azotobacter+PSB	13.91	4.75	18.24
SE±		0.35	0.17	0.56
CD at 5%		1.02	0.50	1.63

The interactions showed influence on acidity of fruit and results arepresented in Table 3. The fertilizer combination of N_1B_3 (125% NPK+ Azotobacter +PSB) recorded minimum acidity percentage (0.18 %) followed by N_2B_3 (0.20 %). The maximum acidity of fruits (0.25) was recorded with treatment combination N_3B_0 (75% NPK).

This might be due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits.

The increasing level of chemical fertilizers along with bio-fertilizers significantly influenced T.S.S and reduced Acidity percentage of sapota fruits. These findings are related with K. Beer *et al*. (2017) reported that T.S.S. slightly increased with application of vermicompost and Azotobacter, NPK in strawberry.

Reducing sugar, non-reducing sugar and total sugar (%) :

The interaction effect produced on the reducing sugar content and data are presented in Table 4. The treatment N_1B_3 recorded maximum reducing sugar content (15.00 %). The treatment N_3B_0 reported minimum reducing sugar content (9.12 %).

The interaction of the bio-fertilizer and chemical fertilizers influenced the non-reducing sugar of fruit and results are presented in Table 4. The fertilizer combination

N_1B_3 recorded maximum non-reducing sugar of fruit (5.63 %) followed by N_2B_2, N_3B_3.The treatment N_3B_0 recorded minimum non-reducing sugar (2.72 %).

The interaction effect on the total sugar content of fruit and results are presented in Table 4. The treatment N_1B_3 recorded maximum total sugar content (19.24 %) followed by N_2B_3 and N_3B_3.The treatment N_3B_0 recorded minimum total sugar content (12.26 %).

This might be due to proper supply of nutrients and induction of growth hormones results in better translocation of water uptake and deposition of nutrients. Beer *et al.* (2017) in strawberry, Binepal *et al*. (2013) in guava, Dalal *et al*. (2009) in sweet orange, Dutta *et al*. (2009) in strawberry.

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