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Impact of bio-fertilizers and inorganic fertizers on growth parameters of Sapota *(Manilkara achras* (Mill.)). CV. Kalipatti

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Abstract
The experimentation entitled, "Studies on effect of bio-fertilizers and inorganic fertilizers on growth yield and quality of sapota (*Manilkara achras* (Mill.)). cv. Kalipatti" was carried out on field of Horticulture Research Scheme (Pomology), V. N. M. K. V, Parbhani, during mrig bahar in 2014-15. The experiment was laid out in factorial randomized block design with two factors i.e. bio-fertilizers and chemical fertilizers. These factors consist of four and three levels respectively, twelve treatment combination and three replications, The result revealed that, The experiment was conducted on twelve year old sapota plants Kalipatti cultivar. Among the different treatment combination the treatment N_1B_3 (100 % NPK + Azospirillum + PSB) application of Azospirillum and PSB with full dose of chemical fertilizers reported the highest plant growth in respect to days required for sprouting of new shoots, length of shoot, Girth of shoots, No. of leaves per shoots. The flowering and fruit set was greatly influenced by combined application of Azospirillum and PSB with 100 percent dose of chemical fertilizer and also reduced the maturity days for harvesting of fruits.

Keywords: Sapota, kalipatti, NPK, Azospirillum, PSB, growth, FRBD, azospirillium

1. Introduction
Sapota (*Manilkara achras* (Mill.)) is one of the important tropical fruit crop belonging to family Sapotaceae.. It is a native of Tropical America and probably originated in Southern Mexico. 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) [4].

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, Phosphorus 27.0 mg (Shanmungavelu and Shrinivasan, 1973) [6].

At national level area under the sapota is 1,60,000 ha with a production of about 14,24,000 metric tonnes and productivity 8.9MT/ha (Anonymous, 2013). In Maharashtra area of sapota is about 56,896 ha, concentrated in coastal region particularly in Thane district. Production of Maharashtra is about 2,05,360 metric tons. The Kalipatti cultivar is the main choice of the farmers and therefore 99% area under sapota is under this cultivar. Sapota crop is highly responsive to fertilizers, (Durrani *et al* 1982) [5]. Organic fertilizers not only increase the yield but also improve physical, chemical, and biological properties of soil that improve productivity of that crop (Blane *et al*, 1989) [3]. The release of plant growth hormone by micro – organism causes elongation of root and shoot leading to improve the growth and yield.

The some biofertilizer micro-organisms are either free living or symbiotic with plant and some micro-organisms are nitrogen fixing i.e Rhizobium, Azatobactor, Azospirillium and other like Phosphate solubilizing and Phosphate mobilizing i.e PSB and VAM (Phosphate solubilizing Bacteria and Vesicular Arbascular Micorrhizae) 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 Application of 50% organic nitrogen and 75% organic P enhances enzyme activity is due to VAM colonization which play greater role in disease resistance, plant growth and development. (Aneesa Rani and Shathiamoorty, 1997) [1] The farmers who adopt bio-fertilizer felt that the cost of inputs has been relatively low and gives improve the quality and quantity of produce. (Veermani, 2007). By keeping in view importance of bio-fertilizers in sustainable fruit production a field experiment is conducted on

Sapota cultivar Kalipatti to study

2. Material and Methods

The present investigation on was carried out during the year 2014-15, at Horticulture Research Scheme, (Pomology) Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani district, experiment were laid out in Factorial Randomized Block Design Treatment details are given below

Table 1: Treatment details

Factor	Sr. No.	Symbol	Treatment
Factor:1 Bio-fertilizer	1	B0	Control
	2	B1	Soil application of Azospirillum 200 g / plant
	3	B2	Soil application of PSB (Phosphate Solubilizing bacteria) 200 g / plant
	4	B3	Soil application of Azospirillum and PSB. 200g / plant each
Factor:2 Inorganic fertilizer	1	N1	100% of NPK (Whole RDF i.e. 1000:500:500 g per Plant)
	2	N2	75% of NPK (RDF)
	3	N3	50% of NPK (RDF)

Table 2: Treatment combinations

S. No	Treat. No.	Treat. Combination	Treatment Details
1	T_1	$N_1 B_0$	(100%RDF) 1000:500:500 g NPK / Plant.
2	T_2	$N_2 B_0$	(75% RDF) 750:375:375 g NPK / plant.
3	T_3	$N_3 B_0$	(50% RDF) 500:250:250 g NPK / plant.
4	T_4	$N_1 B_1$	(100% RDF) +Azospirillum 1000:500:500 g NPK + 200 g Azospirillum /Plant.
5	T_5	$N_2 B_1$	(75% RDF)+Azospirillum 750:375:375 g NPK + 200 g Azospirillum / Plant.
6	T_6	$N_3 B_1$	(50% RDF)+Azospirillum 500:250:250 g NPK +200 g Azospirillum / Plant
7	T_7	$N_1 B_2$	(100%RDF)+PSB 1000:500:500 g NPK + 200 g PSB / plant.
8	T_8	$N_2 B_2$	(75% RDF)+PSB 750:375:375 g NPK + 200 g PSB / Plant.
9	T_9	$N_3 B_2$	(50% RDF)+PSB 500:250:250 g NPK +200 g PSB / Plant.
10	T_{10}	$N_1 B_3$	(100% RDF) + Azospirillum + PSB 1000: 500: 500 g NPK + 200g Azospirillum+200g PSB /Plant
11	T_{11}	$N_2 B_3$	(75% RDF)+ Azospirillum + PSB 750:375:375 + 200g NPK Azospirillum+200g PSB / Plant.
12	T_{12}	$N_3 B_3$	(50% RDF)+ Azospirillum + PSB 500:250:250+ 200g NPK Azospirillum+200g PSB / Plant.

PSB - Phosphate solubilizing bacteria Recommended dose of fertilizers

1. Recommended dose of inorganic fertilizers @ 1000:500:500 g/ tree 2. Recommended dose of Bio-fertilizers, a. Azospirillum @ 200 g/tree. b. PSB @ 200 g/tree.

3. Results and Discussion

3.1 Days required for sprouting of new shoots

The data pertaining to days required for sprouting of new shoots are presented in Table 3. The days required for sprouting of new shoots was reduced by alone and combined application of bio-fertilizers with reduced level of chemical fertilizers. The average days required for sprouting of new shoots recorded was 27.06.

3.1.1 Bio-fertilizers Effect

The bio-fertilizers application significantly affects the days required for sprouting of new shoots. The combined application of Azospirillum (B_1) and PSB (B_2) recorded minimum days required for sprouting of new shoots (25.43) followed by B_2 (PSB) i.e 28.44. The maximum days required for sprouting of new shoots (29.13) was recorded without bio-fertilizer application in B_0.

3.1.2 Inorganic Fertilizers Effect

The chemical fertilizers with reduced level also significantly affect the days required for sprouting of new shoots. The treatment N_1 (100 % NPK) recorded lowest days required for sprouting of new shoots (26.17) compare to 50 % NPK (N_3) recorded highest days required for sprouting of new shoots (29.58).

3.1.3 Interaction Effect

The interaction of bio-fertilizers and chemical fertilizers also significantly reduced the days required for sprouting of new shoots are presented in Table 4. The treatment combination N_1B_3 (100 % NPK + Azospirillum +PSB) recorded minimum days required for sprouting of new shoots (24.30) followed by N_2B_3 (75 % NPK+ Azospirillum +PSB). The treatment combination N_1B_0, N_1B_1, N_3B_3, and N_1B_2 were also recorded minimum days required for sprouting of new shoots. The maximum days required for sprouting of new shoots (31.33) was recorded with 50 % NPK.

Table 3: Effect of Bio-fertilizers and Inorganic fertilizers on days required for sprouting of new shoots.

Treatment No.	Factor / Treatment	Days required for sprouting of new shoots
1	B0-control	29.13
2	B1-Azospirillum	28.50
3	B2-PSB	28.44
4	B3-Azospirillum +PSB	25.43
SE+		0.24
CD at 5%		0.72
1	N1-100% NPK	26.17
2	N2-75% NPK	27.87

3	N3-50 NPK	29.58
SE+		0.21
CD at 5%		0.62
Interaction Effect		
T1	N1B0- 100% NPK	26.08
T2	N2B0- 75% NPK	30.00
T3	N3B0- 50% NPK	31.33
T4	N1B1- 100% NPK+ Azospirillum	26.91
T5	N2B1- 75 % NPK+ Azospirillum	28.16
T6	N3B1- 50% NPK+ Azospirillum	30.41
T7	N1B2- 100% NPK+PSB	27.21
T8	N2B2- 75% NPK+PSB	27.66
T9	N3B2- 50% NPK +PSB	30.25
T10	N1B3- 100%NPK +Azospirillum +PSB	24.30
T11	N2B3- 75%+NPK+ Azospirillum +PSB	25.66
T12	N3B3- 50%NPK + Azospirillum+PSB	26.33
SE+		0.42
CD at 5%		1.24

3.2 Length of Shoot

Data on length of shoot were significantly affected by different treatments of bio-fertilizers and chemical fertilizers are presented in Table 4. The average length of shoot recorded was 11.73 cm.

3.2.1 Bio-fertilizers effect

The bio-fertilizer application (Azospirillum and PSB) alone and in combination, significantly affects the plant growth. The combined application of Azospirillum and PSB (B_3) recorded the maximum length of shoot in (12.40 cm) followed by alone application of PSB (B_2) i.e 11.63 cm. The minimum length of shoot was recorded in (B_0) was without bio-fertilizer.

3.2.2 Inorganic fertilizers effect

The reduced level of inorganic fertilizers also significantly influences the growth of plant. The N_1 (100 % NPK per plant) recorded maximum length of shoot (12.34 cm). The minimum length of shoot was recorded with application of 50 % NPK per plant (N_3) i.e 11.18 cm.

3.2.3 Interaction Effect

The interaction effect of bio-fertilizer and inorganic fertilizers also significantly influenced the length of shoot are presented in Table 5. The treatment combination N_1B_3 (100% NPK + Azospirillum +PSB) recorded maximum length of shoot (12.64 cm), followed by N_1B_1, N_2B_3, N_1B_2 recorded maximum length of shoot. The treatment N_1B_0, N_3B_3, were at par with N_1B_1. The minimum length of shoot was recorded with 50 % NPK application.

Table 4: Effect of Bio-fertilizers and Inorganic fertilizers on length of shoots (cm) and girth of shoots (cm).

Treatment No.	Factor/Treatment	Length of shoot (cm)	Girth of shoot (cm)
1	B0-control	11.39	1.49
2	B1-Azospirillum	11.47	1.64
3	B2-PSB	11.63	1.66
4	B3-Azospirilum +PSB	12.40	1.86
SE+		0.081	0.022
CD at 5%		0.23	0.067
1	N1-100% NPK	12.34	1.87
2	N2-75% NPK	11.65	1.67
3	N3-50 NPK	11.18	1.45
SE+		0.07	0.01
CD at 5%		0.20	0.058
Interaction effect			
T1	N1B0- 100% NPK	12.16	1.71
T2	N2B0- 75% NPK	11.34	1.49
T3	N3B0- 50% NPK	10.68	1.27
T4	N1B1- 100% NPK+ Azospirillum	12.31	1.87
T5	N2B1- 75 % NPK+ Azospirillum	11.34	1.64
T6	N3B1- 50% NPK+ Azospirillum	10.76	1.40
T7	N1B2- 100% NPK+PSB	12.25	1.84
T8	N2B2- 75% NPK+PSB	11.47	1.67
T9	N3B2- 50% NPK +PSB	11.18	1.48
T10	N1B3- 100%NPK +Azospirillum +PSB	12.64	2.06
T11	N2B3- 75%+NPK+ Azospirillum +PSB	12.45	1.88
T12	N3B3- 50%NPK + Azospirillum+PSB	12.10	1.64
SE+		0.14	0.039
CD at 5%		0.41	0.116

4.3 Girth of Shoot

The girth of shoot of plant was significantly affected by combined application of bio-fertilizer with reduced level of inorganic fertilizers. The data related to girth of shoot is presented in Table 4. The average girth of shoot recorded was 1.66 cm.

4.3.1 Bio-fertilizers Effect
The bio-fertilizer significantly affects the girth of shoot. The combined application of Azospirillum and PSB (B_3) recorded highest girth of shoot (1.86 cm) followed by alone application of PSB (B_2). The lowest girth of shoot was recorded by without bio-fertilizer (B_0) application to the plants.

4.3.2 Inorganic Fertilizers Effect
The data revealed that reduced level of inorganic fertilizers also significantly increased girth of shoot. The 100% NPK per plant (N_1) recorded maximum girth of shoot (1.87 cm) and 50% NPK per plant recorded minimum girth of shoot (1.45cm).

4.3.3 Interaction Effect
The interaction effect of bio-fertilizers and inorganic fertilizers application significantly affects the girth of shoot. The data are presented in Table 4. The treatment combination N_1B_3 recorded highest girth of shoot (2.06 cm) followed by N_2B_3 (1.88 cm). The treatment N_1B_2 and N_2B_3 were at par with N_1B_1. The minimum girth of shoot (1.27 cm) was recorded with the application of 50 percent NPK (N_1B_0).

4.4 Number of leaves per shoot
The bio-fertilizer application (Azospirillum and PSB) alone and in combination significantly increased the number of leaves per shoot are presented in Table 5. The average number of leaves per shoot recorded was 9.35.

4.4.1 Bio-fertilizers effect
The bio-fertilizer application (Azospirillum and PSB) alone and in combination was significantly affects the number of leaves per shoot. The bio-fertilizer B_2 (PSB) recorded highest leaves per shoot (9.37) followed by combined application of azospirillum and PSB (B_3) i.e 9.36. The minimum leaves per shoot was recorded by without bio-fertilizer application.

Table 5: Effect of Bio-fertilizers and Inorganic fertilizers on Number of leaves and Leaf area (cm^2).

Treatment No.	Factor / Treatment	Number of leaves per shoot	Leaf area (cm^2)
1	B0-control	9.30	19.01
2	B1-Azospirillum	9.36	18.89
3	B2-PSB	9.37	18.91
4	B3-Azospirillum +PSB	9.36	19.09
SE+		0.015	0.081
CD at 5%		0.46	0.237
1	N1-100% NPK	9.60	19.46
2	N2-75% NPK	9.56	18.94
3	N3-50 NPK	8.88	18.53
SE+		0.013	0.07
CD at 5%		0.040	0.20
Interaction Effect			
T1	N1B0- 100% NPK	9.56	19.70
T2	N2B0- 75% NPK	9.51	18.04
T3	N3B0- 50% NPK	8.85	18.50
T4	N1B1- 100% NPK+ Azospirillum	9.59	19.45
T5	N2B1- 75 % NPK+ Azospirillum	9.62	18.87
T6	N3B1- 50% NPK+ Azospirillum	8.88	18.51
T7	N1B2- 100% NPK+PSB	9.60	19.21
T8	N2B2- 75% NPK+PSB	9.62	19.02
T9	N3B2- 50% NPK +PSB	8.88	18.51
T10	N1B3- 100%NPK +Azospirillum +PSB	9.67	19.48
T11	N2B3- 75%+NPK+ Azospirillum +PSB	9.49	19.19
T12	N3B3- 50%NPK +Azospirillum+PSB	8.92	18.61
SE+		0.027	0.14
CD at 5%		0.080	0.41

4.4.2 Inorganic Fertilizers Effect
The inorganic fertilizers with reduced level of NPK also significantly affects the leaves per shoot. The treatment N_1 (100 % NPK) recorded highest no. of leaves per shoot (9.60) as compared to lowest application of fertilizer (50 % NPK) 8.88 (N_3).

4.4.3 Interaction Effect
The interaction effects also shown significant effect on no. of leaves per shoot and are presented in Table 6. The treatment combination N_1B_3 recorded maximum leaves per shoot (9.67) followed by $N_2B_1$and N_2B_2. The treatment combination N_1B_2 and N_1B_1 were at par with treatment N_1B_3. The minimum leaves per shoot (8.85) was recorded in treatment combination of 50 per cent NPK with no bio-fertilizer application (N_3B_0).

4.5 Leaf Area (cm^2)
The different bio-fertilizers with different levels of inorganic fertilizers are also influences the leaf area presented in Table

5. The average leaf area recorded was (19.03 cm^2).
4.5.1 Bio-fertilizers effect
The combined and alone application of bio-fertilizer (Azospirillum and PSB) was significantly affects leaf area. The trees which received combined dose of Azospirillum and PSB (B_3) recorded maximum leaf area (6.18). The minimum leaf area (18.89 cm ^{2}) were recorded in treatment with Azospirillum bio-fertilizer (B_1) application.

4.5.2 Inorganic fertilizers effect
The reduced level of inorganic fertilizers also significantly influenced on leaf area. The N_1 (100% NPK) recorded maximum leaf area (19.46 cm ^{2}) as compared with N_3 (50 % NPK) with minimum leaf area (18.53 cm ^{2}).

4.5.3 Interaction effect

The interaction effect of bio-fertilizer and chemical fertilizers were significantly affected the leaf area are presented in Table The maximum leaf area (19.70 cm^2) was recorded in plant with fertilizer applied 100% NPK (N_1B_0) followed by 100 % NPK + Azospirillum and PSB (N_1B_3). The treatment combination N_1B_1, N_1B_2, and N_2B_3 were at par with N_1B_3. The minimum leaf area (18.50 cm^2) was observed in plant with lowest fertilizer dose (N_3B_0).

4.6 Days to initiation of flowering from application of treatment

The bio-fertilizer along with reduced level of inorganic fertilizers also greatly reduced the days to initiation of flowering from application of treatment are presented in Table The average days required to initiation of flowering recorded was 83.63.

4.6.1 Bio-fertilizers Effect

The application of bio-fertilizer significantly affects the days to initiation of flowering. The combined application of Azospirillum and PSB (B_3) was greatly reduced the days to initiation of flowering was recorded minimum 82.58 days it was followed by alone application of Azospirillum (83.22). The maximum days (84.63) required to initiation of flowering was observed in the treatment without bio-fertilizer (B_0) applied plant.

4.6.2 Inorganic Fertilizers Effect

The inorganic fertilizers also affected the days to initiation of flowering significantly. The full dose of chemical fertilizers (N_1) recorded the minimum days to initiation of flowering (81.12).The lower dose of inorganic fertilizers required maximum days to initiation of flowering from application of treatment (85.45).

Table 6: Effect of Bio-fertilizers and Inorganic fertilizers on Days to initiation of flowering from application of treatment and No. of flowers per shoot

Treatment No.	Factor / Treatment	Days to initiation of flowering from application of treat.	No. of flowers per shoot.
1	B0-control	84.63	9.30
2	B1-Azospirillium	83.22	9.36
3	B2-PSB	84.00	9.36
4	B3-Azospirilium +PSB	82.58	9.37
SE+		0.31	0.015
CD at 5%		0.90	0.046
1	N1-100% NPK	81.12	9.60
2	N2-75% NPK	84.14	9.56
3	N3-50 NPK	85.45	8.88
SE+		0.26	0.013
CD at 5%		0.78	0.040
Interaction effect			
T1	N1B0- 100% NPK	81.16	9.56
T2	N2B0- 75% NPK	85.17	9.51
T3	N3B0- 50% NPK	87.58	8.85
T4	N1B1- 100% NPK+ Azospirillum	81.08	9.59
T5	N2B1- 75 % NPK+Azospirillum	83.58	9.61
T6	N3B1- 50% NPK+ Azospirillum	85.00	8.88
T7	N1B2- 100% NPK+PSB	81.75	9.60
T8	N2B2- 75% NPK+PSB	84.91	9.62
T9	N3B2- 50% NPK +PSB	85.33	8.88
T10	N1B3- 100%NPK + Azospirillum +PSB	80.51	9.67
T11	N2B3- 75%+NPK+ Azospirillum +PSB	82.91	9.49
T12	N3B3- 50%NPK + Azospirillum+PSB	83.91	8.92
SE+		0.53	0.027
CD at 5%		1.57	0.080

4.6.3 Interaction Effect

The interaction effect of bio-fertilizer and inorganic fertilizers were significantly affected the days to initiation of flowering from application of treatment are presented in Table 6. The interaction effect of Azospirillum and PSB with full dose of NPK (N_1B_3) recorded minimum days to initiation of flowering from application of treatment (80.50) it was followed by the treatment combination N_1B_1 i.e. 100 % NPK + azospirillum (81.08). The treatments N_1B_0, $N_1B_1$and N_1B_2 were at par with treatment N_1B_3. The maximum days (87.58) to initiation of flowering from application of treatment was observed in trees which were supplied lowest fertilizer dose (N_3B_0) i.e. 50 percent NPK only.

4.7 Number of flowers per shoot

The bio-fertilizers along with reduced level of inorganic fertilizers also greatly influenced the number of flowers per shoot are presented in Table 6. The average number of flowers per shoot recorded was 9.35.

4.7.1 Bio-fertilizers Effect

The application of bio-fertilizers significantly affects the number of flowers per shoot. The alone application of and PSB (B_2) was greatly influenced the number of flowers per shoot was recorded maximum (9.37) it was followed by combined application of Azospirillum + PSB (9.36). The minimum number of flowers per shoot (9.30) was observed in the treatment without bio-fertilizer (B_0) applied plant.

4.7.2 Inorganic Fertilizers Effect

The inorganic fertilizers also affect the number of flowers per shoot significantly. However, the full dose of chemical fertilizers (N_1) recorded the maximum number of flowers per

shoot (9.60). However, the lowest dose of chemical fertilizers recorded minimum number of flowers (8.88).

4.7.3 Interaction Effect
The interaction effect of bio-fertilizers alone and in combination with inorganic fertilizers were significantly affected the number of flowers per shoot are presented in Table 6. The interaction effect of azospirillum and PSB with full dose of NPK (N_1B_3) recorded the maximum number of flowers per shoot (9.67). It was followed by the treatment combination N_2B_2 (9.62) and N_2B_1 and (9.61). The minimum number of flowers per shoot (8.85) was observed in the trees which were supplied lowest fertilizer dose (N_3B_0) i.e. 50 percent NPK only.

4.8 Fruit Set (%)
Different levels of inorganic fertilizers and bio-fertilizer significantly influenced the fruit set percentage and data presented in Table 7. The average fruit set percentage was recorded 40.82 (%).

4.8.1 Bio-fertilizers Effect
The bio-fertilizer (Azospirillum and PSB) was significantly influenced on fruit set percentage. The treatment B_3 (Azospirillum + PSB) recorded maximum fruit set percentage (41.68) which was followed by application of PSB (B_2). The B_0 recorded the minimum fruit set percentage (41.19).

4.8.2 Inorganic Fertilizers Effect
The application of inorganic fertilizer also significantly influenced on fruit set percentage. The tree that were applied full dose of chemical fertilizers i.e. 100 percent NPK (N_1) recorded maximum fruit set percentage (43.21) followed by 75 percent chemical fertilizers (N_2) applied trees (40.85). The 50 percent fertilizer (N_3) applied tree recorded lowest fruit set percentage (38.39).

Table 7: Effect of Bio-fertilizers and Inorganic fertilizers on Fruit set (%) and Number of fruits per shoot.

Treatment No.	Factor / Treatment	Fruit set (%).	No. of fruits per shoot.
1	B0-control	39.34	3.70
2	B1-Azospirillum	41.06	3.81
3	B2-PSB	41.19	3.82
4	B3-Azospirillum +PSB	41.68	4.10
SE+		0.20	0.020
CD at 5%		0.61	0.061
1	N1-100% NPK	43.21	4.15
2	N2-75% NPK	40.85	3.92
3	N3-50 NPK	38.39	3.52
SE+		0.18	0.018
CD at 5%		0.53	0.053
Interaction Effect			
T1	N1B0- 100% NPK	42.23	4.03
T2	N2B0- 75% NPK	38.94	3.79
T3	N3B0- 50% NPK	36.84	3.28
T4	N1B1- 100% NPK+ Azospirillum	43.24	4.13
T5	N2B1- 75 % NPK+Azospirillum	41.36	3.84
T6	N3B1- 50% NPK+ Azospirillum	38.59	3.47
T7	N1B2- 100% NPK+ PSB	43.27	4.16
T8	N2B2- 75% NPK+ PSB	41.51	3.85
T9	N3B2- 50% NPK + PSB	38.78	3.47
T10	N1B3- 100%NPK + Azospirillum + PSB	44.11	4.24
T11	N2B3- 75%NPK + Azospirillum + PSB	41.58	4.20
T12	N3B3- 50%NPK + Azospirillum+PSB	39.36	3.87
SE+		0.36	0.036
CD at 5%		1.06	0.106

4.8.3 Interaction Effect
The interaction effect of bio-fertilizers and chemical fertilizers were presented in Table 8. The fertilizer combination N_1B_3 recorded the maximum fruit set (44.11%), it was followed by N_1B_2 (43.27%). The fertilizer combination of N_3B_0 recorded the lowest fruit set (36.84 %).

4.9 Number of fruits per shoot
The bio-fertilizer along with reduced level of inorganic fertilizers also greatly influenced the number of fruits per shoot are presented in Table 7. The average number of fruits per shoot recorded was (3.86).

4.9.1 Bio-fertilizers effect
The application of bio-fertilizers significantly affected the number of fruits per shoot. The combined application of Azospirillum and PSB (B_3) was greatly influenced the maximum number of fruits per shoot (4.10) it was followed by alone application of PSB (3.82). The minimum number of fruits (3.70) was observed in the treatment without bio-fertilizer (B_0) applied plant.

4.9.2 Inorganic fertilizers effect
The inorganic fertilizers also affected the number of fruits significantly. The full dose of chemical fertilizers (N_1) recorded the maximum number of fruits per shoot (4.15). The lower dose of chemical fertilizers observed minimum number of fruits per shoot (3.52).

4.9.3 Interaction Effect
The interaction effect of bio-fertilizer and inorganic fertilizers were significantly affected the number of fruits per shoot were presented in Table 7. The interaction effect of Azospirillum and PSB with full dose of NPK (N_1B_3) i.e 100% NPK + azospirillium + PSB recorded the maximum number of fruits per shoot (4.24) it was followed by the treatment

combination N_2B_3 i.e. 75% NPK + azospirillium + PSB (4.20). The minimum fruits (3.28) number of fruits per shoot was observed in trees which were supplied lowest fertilizer dose (N_3B_0) i.e. 50 % NPK only.

4.10 Final retention of fruits per shoot

Data on final retention of fruits per shoot i.e. was significantly affected by different treatments of bio-fertilizers and inorganic fertilizers were presented in Table 8. The average final retention of fruits per shoot recorded was 13.57.

4.10.1 Bio-fertilizers effect

The bio-fertilizer application (Azospirillum and PSB) alone and in combination significantly affected the retention of fruits per shoot. The combined application of Azospirillum and PSB (B_3) recorded the maximum retention of fruits per shoot (14.14) followed by alone application of Azospirillum (B_1) i.e. 1.84. The lowest retention of fruits per shoot was recorded in (B_0) without bio-fertilizer applied tree. The B_2 and B_3 were at par with B_1.

4.10.2 Inorganic Fertilizers Effect

The reduced level of chemical fertilizers also significantly influenced the retention of fruits per shoot. The N_1 (100 % NPK per plant) recorded maximum retention of fruits per shoot (14.26). The minimum Final retention of fruits per shoot recorded with application of 75% NPK (N_2) per plant i.e. 13.20. The treatment N_2 was at par with N_3.

4.10.3 Interaction Effect

The interaction effect of bio-fertilizer and inorganic fertilizers significantly influenced the final retention of fruits per shoot were presented in Table 8. The treatment combination N_1B_3 (100% NPK + Azospirillum +PSB) recorded highest final retention of fruits per shoot (16.30), followed by N_1B_1, N_1B_2 recorded highest final retention of fruits per shoot. The minimum retention of fruits per shoot was recorded with 75 % NPK only.

Table 8: Effect of Bio-fertilizers and inorganic fertilizers on final retention of fruits per shoot and days required for fruit maturity

Treatment No.	Factor / Treatment	Final retention of fruits per shoot.	Days required for fruit maturity.
1	B0-control	12.85	251.00
2	B1-Azospirillum	13.84	250.67
3	B2-PSB	13.44	250.44
4	B3-Azospirilum +PSB	14.14	250.12
SE+		0.16	0.31
CD at 5%		0.49	NS
1	N1-100% NPK	14.26	248.92
2	N2-75% NPK	13.20	250.58
3	N3-50 NPK	13.25	252.25
SE+		0.14	0.27
CD at 5%		0.42	0.80
Interaction Effect			
T1	N1B0- 100% NPK	12.97	249.67
T2	N2B0- 75% NPK	12.68	250.67
T3	N3B0- 50% NPK	12.90	252.67
T4	N1B1- 100% NPK+ Azospirillum	13.95	249.33
T5	N2B1- 75 % NPK+Azospirilium	13.80	250.33
T6	N3B1- 50% NPK+ Azospirillum	13.78	252.33
T7	N1B2- 100% NPK+PSB	13.81	248.67
T8	N2B2- 75% NPK+PSB	13.03	250.67
T9	N3B2- 50% NPK +PSB	13.47	252.00
T10	N1B3- 100%NPK +Azospirillum +PSB	16.30	248.00
T11	N2B3- 75%+NPK+Azospirillum +PSB	13.29	250.67
T12	N3B3- 50%NPK +Azospirillum+PSB	12.85	252.00
SE+		0.29	0.54
CD at 5%		0.85	1.60

4.11. Days to fruit maturity

The bio-fertilizer along with reduced level of inorganic fertilizers also greatly influenced the maturity and data presented in Table 8. The average days required to fruit maturity was recorded (250.58).

4.11.1 Bio-fertilizers Effect

The application of bio-fertilizer non significantly affected the maturity of fruits. The combined application of Azospirillum and PSB (B_3) was influenced the maturity from fruit set was recorded minimum 250.12 days it was followed by alone application of PSB (250.44). The maximum days to maturity (251.00) was observed in the treatment without bio-fertilizer (B_0) applied plant.

4.11.2 Inorganic Fertilizers Effect

The chemical fertilizers affected the maturity significantly. The full dose of chemical fertilizers (N_1) recorded the minimum days to maturity from fruit set (248.92). However, the lower dose of chemical fertilizers i.e 50% NPK took more days to maturity from fruit set (252.25).

4.11.3 Interaction Effect

The interaction effect of bio-fertilizer and chemical fertilizers were significantly affected the maturity and data presented in Table 9. The interaction effect of Azospirillum and PSB with full dose of NPK (N_1B_3) recorded the minimum days to maturity from fruit set (248.00) it was followed by the treatment combination N_2B_1 i.e. 75 % NPK + azospirillum (250.33). The treatments N_1B_0, par with treatment N_1B_3 The maximum days (252.67) required to maturity from fruit set

was observed in trees which were supplied lowest fertilizer dose (N_3B_0) i.e. 50 percent NPK only.

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