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Interaction effect of bio-fertilizers along with reducing level of chemical fertilizers on physico-chemical characters of sweet orange (*Citrus sinensis* Osback)

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ABSTRACT : The present experiment was conducted on six year old sweet orange cv. Nucellar trees of uniform growth at Sweet Orange Research Station, Badanapur, Dist-Jalna (M.S.) during Mrig bahar (May-June) in 2012-13. It confirmed that the alone or in combination of *Azospirillum* and PSB along with chemical fertilizers enhanced the quality and biochemical parameters of sweet oranges. Among the various twelve combinations, overall performance of treatment T_{10} (N_1B_3) received recommended dose of chemical fertilizers (800:400:400 g NPK) along with biofertillizers (200 g *Azospirillum* +200 g PSB per tree) was superior over other all treatments. This was farther followed by treatment T_9 (75% NPK +200 g *Azospirillum* +200g PSB per tree). It was helpful to enhance the quality and physico-chemical characters of sweet orange.

KEY WORDS : Sweet orange, Bio-fertilizers, Chemical fertilizer

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Nutrient management of sweet orange integration of bio-fertilizers along with reduced level of chemical fertilizers is emerged as major aspect for quality fruit production. Bio-fertilizers such as *Azospirillum* and phosphate solubilizing bacteria (PSB) are important sources of nitrogen and phosphorus to enrich the plants. Increasing trend towards organic farming use of organic and bio-fertilizers occupies a significant place in today's agriculture. Recently application of bio-fertilizers in fruit crop has been increased due to their environment friendly nature. Therefore, the present study was under taken to investigate the interaction effect of bio-fertilizer along with reducing level of chemical fertilizers on physico-chemical characters of sweet orange.

RESEARCH METHODS

The experiment was conducted on six year old sweet orange cv. Nucellar trees of uniform growth at sweet orange Research Station, Badanapur, Dist-Jalna (M.S.) during Mrig bahar (May-June) in 2012-13. They were spaced at 6x6 meters. The experiment was laid out in Randomized Block Design. Bio-fertilizers and chemical fertilizers had twelve treatments *viz.*, N_1B_0 (100 % NPK only), N_2B_0 (75 % NPK only), N_3B_0 (50 % NPK only), N_1B_1 (100 % NPK + *Azospirillum*), N_2B_1 (75 % NPK +*Azospirillum*), N_3B_1 (50 % NPK + *Azospirillum*), N_1B_2 (100 % NPK + PSB), N_2B_2 (75 % NPK + PSB), N_3B_2 (50 % NPK + PSB), N_1B_3 (100 % NPK +*Azospirillum* + PSB), N_2B_3 (75 % NPK +*Azospirillum* + PSB), N_3B_3 (50 % NPK +*Azospirillum* + PSB) replicated thrice. Bio-fertillizers consist of alone and combined application of *Azospirillum* and PSB (phosphate solubilizing bacteria) 200g each and chemical fertilizer consisted of application of 100, 75 and 50 per cent dose of NPK (recommended dose- 800:400:400 g NPK per tree).The recommended dose of organic manure (FYM) was applied at the rate of 50 kg per plant.

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Physical characters:

Physical characters of fruit were significantly influenced by bio-fertilizer application with reduced levels of chemical fertilizers are presented in Table 1. The average weight of fruits recorded was 250.33 g. The fertilizer combination of N_2B_3 produced maximum average weight of fruit (271.75). The treatment combination having fertilizer application 50 per cent NPK with *Azospirillum* (N_3B_1) showed lowest weight of fruits. The fertilizer combination N_1B_3 (100% NPK+ *Azospirillum*+ PSB) produced maximum fruit diameter (8.36cm) and treatment combination of N_1B_0 (100%NPK) was 8.36cm followed by N_1B_1 *i.e.* 8.26cm. The trees which were applied 50 per cent NPK (400:200:200 g NPK/ Tree) without application of bio-fertilizer (N_3B_0) reported the lowest value of fruit diameter (7.23 cm). The interaction effect of bio-fertilizer with inorganic fertilizer also greatly influenced fruit length. The treatment combination N_1B_3 (100 %+ *Azospirillum* + PSB) recorded highest fruit length (8.40 cm) followed by N_1B_0 (8.23 cm). The treatment combination N_1B_1, N_1B_2, N_3B_2, N_3B_2 and N_2B_3 were at par with N_1B_3. Patel *et al.* (2009) in sweet orange found similar results.

The fertilizer combination of bio-fertilizer with reduced level of chemicals fertilizer also significantly increased the peel thickness, number of seeds, weight of peel and peel to juice ratio at large extents are presented in Table 1. The treatment combination (N_1B_3) recorded minimum peel thickness and the treatment combination N_2B_1 recorded maximum (0.88 cm) peel thickness.

The treatment combination N_1B_3 (100% NPK + *Azospirillum*+ PSB) and N_2B_3 (75% NPK + *Azospirillum*+ PSB) recorded minimum seed per (17.00) followed by N_3B_2 (50% + *Azospirillum*+ PSB) *i.e.* 18.00. The highest numbers of seeds (20.00) were observed in 75 per cent NPK with *Azospirillum* (N_2B_1).

The interaction were also found significant on weight of peel. N_2B_3 recorded the highest weight of peel (106.70) followed by N_1B_3. The treatment N_1B_3 was at par with N_2B_3. The minimum weight of peel (81.00) was recorded in N_2B_2. The interaction of bio-fertilizer and reduced level of chemical fertilizers also significantly influenced weight of juice. The treatment combination N_2B_3 showed highest weight of juice (119.26 g) with application of 75 per cent NPK +*Azospirillum* +PSB followed by treatment N_1B_3 (100% + *Azospirillum*+ PSB) it recorded 118.46 g. The treatment N_1B_3, N_1B_0, N_1B_1, N_2B_1, N_2B_1 and N_3B_3 were at par with N_2B_3. The treatment combination with 50 per cent NPK without bio-fertilizer (N_3B_0) showed lowest weight of juice (95.40 g). The interaction effect of bio-fertilizer with chemical fertilizers also significantly influenced peel to juice ratio. The treatment

Table 1 : Interaction effect of bio-fertilizers and chemical fertilizers on physical characters of sweet orange fruits

Treatment No.	Treatment combination	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Peel thickness (cm)	Number of seed	Weight of peel (g)	Weight of juice (g)	Peel to juice ratio
T_1	N_1B_0	254.93	8.23	8.36	0.76	18.33	95.50	111.03	0.856
T_2	N_2B_0	256.01	7.60	7.83	0.80	19.33	87.46	100.00	0.873
T_3	N_3B_0	248.42	7.10	7.23	0.83	19.33	77.30	95.40	0.806
T_4	N_1B_1	234.70	8.10	8.26	0.77	18.66	95.13	109.33	0.850
T_5	N_2B_1	234.20	7.50	7.73	0.88	20.00	94.33	106.70	0.886
T_6	N_3B_1	231.93	7.40	7.53	0.88	18.66	76.96	97.63	0.796
T_7	N_1B_2	262.60	8.00	8.16	0.76	19.33	91.73	113.73	0.796
T_8	N_2B_2	247.23	7.70	7.80	0.83	19.00	81.00	100.26	0.886
T_9	N_3B_2	247.20	7.90	8.43	0.80	18.00	89.00	100.43	0.846
T_{10}	N_1B_3	257.46	8.40	8.36	0.73	17.00	105.00	118.46	0.883
T_{11}	N_2B_3	271.75	8.00	8.10	0.80	17.00	106.70	119.26	0.886
T_{12}	N_3B_3	248.06	7.73	7.86	0.83	19.66	95.50	107.06	0.880
S.E.+	-	13.50	0.21	0.17	0.02	0.48	3.46	4.42	0.03
C.D.(P=0.05)	-	39.65	0.62	0.50	0.11	1.41	10.16	12.98	-

Table 2 : Interaction effect of bio-fertilizers and chemical fertilizers chemical characters of sweet orange fruits

Treatment No.	Treatment combination	TSS (%)	Acidity (%)	Ascorbic acid	pH
T_1	N_1B_0	11.17	0.503	58.00	5.31
T_2	N_2B_0	10.88	0.507	51.29	5.39
T_3	N_3B_0	10.36	0.523	47.65	5.40
T_4	N_1B_1	11.36	0.493	57.84	5.33
T_5	N_2B_1	10.92	0.559	53.23	5.42
T_6	N_3B_1	10.49	0.559	48.14	5.41
T_7	N_1B_2	11.32	0.556	57.70	5.39
T_8	N_2B_2	10.96	0.563	55.23	5.32
T_9	N_3B_2	10.88	0.561	49.44	5.43
T_{10}	N_1B_3	11.86	0.497	58.51	5.28
T_{11}	N_2B_3	11.85	0.507	58.07	5.35
T_{12}	N_3B_3	10.79	0.546	50.29	5.37
S.E. +	-	0.29	0.11	0.03	0.04
C.D. (P=0.05)	-	0.87	0.36	0.10	0.12

combination N_2B_3, N_2B_2, N_2B_3, N_2B_3 and N_2B_2 recorded highest peel to juice ratio (0.886) followed by treatment N_1B_3, N_3B_3 and N_1B_1. The minimum peel juice ratio was recorded in N_3B_1 and N_1B_2 (0.796).

Migeed *et al.* (2007) in Washington navel orange, Dalal *et al*. (2009) in sweet orange reported that the application of bio-fertilizer with inorganic fertilizer increases the juice weight and reduces the peel content of fruit. Beneficial effect of bio-fertilizer on physical quality parameters of fruit may probable be due to better growth of the plants under the different treatment combinations of chemical fertilizer with bio-fertilizers like PSB and *Azotobacter* (Sah *et al*., 2001).

Chemical characters:

The interaction effect of bio-fertilizer and chemical fertilizers showed significantly influenced on TSS, acidity percentage, ascorbic acid content and pH of fruit (Table 2). The treatment combination N_1B_3 recorded highest TSS 11.86 per cent followed by N_2B_3, N_1B_1 and N_1B_2 which are at par. The fertilizer combination of N_1B_1 (100% NPK+ *Azospirillum* +PSB) recorded lower acidity percentage (0.493) followed by N_1B_3 (0.497). The maximum acidity percentage (0.563) was recorded with treatment combination N_2B_2. The treatment combinations N_2B_1, N_3B_1, N_2B_2, N_3B_2 and N_3B_0 were at par. The treatment N_1B_3 recorded highest ascorbic acid content (58.51) followed by N_2B_3 and N_1B_0. The fertilizer combination N_1B_3 recorded lowest pH of fruit (5.28) followed by N_1B_0, N_2B_3 and N_3B_3. These were at par with treatment N_1B_3.

These findings are in line with Medhi *et al.* (2007) reported highest T.S.S. and minimum acidity percentage by application of NPK with 20g *Azotobacter* and 20g PSB per year per tree in Khasi mandarin. The microbial fertilizers enhance the nutrient availability by increasing the capability of plants to better solute uptake from rhizosphere (Patel *et al*., 2009). Sah *et al.* (2009) reported that VAM converts the unavailable nutrient from rhizosphere soil to available forms resulting increased uptake of nutrient. Besides increased nutrient absorbing area of root, so increase in the chemical quality of fruits may be due to beneficial and stimulatory effect of nitrogen and other nutrient.

Conclusion:

The above results confirmed that alone or in combination of *Azospirillum* and PSB with chemical fertilizers enhanced the quality and biochemical parameters of sweet oranges. Among the various combinations, overall performance of treatment T_{10} (N_1B_3) received recommended dose of chemical fertilizers (800:400:400 g NPK) along with biofertillizers (200 g *Azospirillum* +200 g PSB per tree) was superior over other all treatments. It is helpful to enhance the quality and physico-chemical characters of sweet orange.

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