Influence of Soil Application through Integrated Nutrient Management on Soil Characteristics of Sweet Orange Orchard in Gird Region of Madhya Pradesh, Bharat

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ABSTRACT

"Influence of Soil Application Through Integrated Nutrient Management on Soil Characteristics of Sweet Orange Orchard in Gird Region of Madhya, Bharat" is the title of the current study. The experiment was carried out from November 2020 to March 2022 at the RVSKVV College of Agriculture's Research Farm, located in Gwalior (M.P.), in the Department of Horticulture. Three replications and a Randomized Block Design were used to set up the experiment. The all soil characteristics analysis both initial and final level after experiment respectively minimum soil pH (7.05, 7.49), EC dsm^{-1} (0.225, 0.220) and maximum Organic carbon % (2.117, 3.263), NitrogenKg ha^{-1} (177.14,187.29), Phosphorus Kg ha^{-1} (13.38, 13.58) and Potassium Kg ha^{-1} (207.88, 229.45) quality parameters were most effectively achieved with treatment T_5 RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron).Because sweet orange orchards are located in the Gird Region of Madhya Pradesh, this particular treatment is most suited for use there.

Keywords: Sweet orange; bio fertilizer; Vermicompost; Nitrogen; Phosphorus; Potassium

1. INTRODUCTION

Sweet orange (*Citrus Sinensis* L.) is an important fruit crop which belongs to family Rutaceae, especially citrus fruit which are generally known to be rich in these vitamins and minerals. Sweet oranges need a well-drained medium or soft loam soil with a 2-3 cm depth of slightly heavier subsoil. Cultivation generally avoided in shallow soils. It grows in a wide variety of soil types, from clay to light sandy, and is salt tolerant.Mineral elements are acquired by plant roots from soil solution under optimum soil moisture and temperature. The nutrient availability and uptake is influenced by soil physical, chemical, mineralogical and biological properties. The important soil properties that affect the nutrient availability include soil depth, soil PH, BC, CaCO, content, organic carbon content and plant nutrients concentration in soil solution. Sometimes soil possesses sufficient amount of nutrient concentration in soil media but its availability become to plant is hindered due to some external lectors, under such situation foliar feeding of nutrient become necessary to save the crop. yield and quality of produce.

The integrated nutrient management infuses long term sustainability in the productivity level because of availability of nutrients in soil for next season crop. Incorporation of organic fertilizers is a common practice to improve the yield of many fruit crops. It also limits chemical intervention and finally minimizes the negative impact on the wider environment. it is the important alternative source, which is not only beneficial to maintain the soil health but also to sustain the fruit production. Application of organic manure combined with chemical fertilizer is associated with increased soil fertility and improved soil physical and chemical properties, thus it can increase crop production.

2. MATERIAL AND METHODS

2.1 Site of experiment

In the academic year of 2021–22, the experiment was carried out in the Research Farm of the Department of Horticulture at RVSKVV College of Agriculture, Gwalior (Madhya Pradesh. The Gwalior is situated at 260 13' N latitude and 780 14' E longitudes at an altitude of 211.5 m above mean sea level (MLS) in Gird region. It has a subtropical climate with hot and summer where maximum temperature exceeds 45°C in May June. The winters are cold and are minimum temperature reaches as low as 2°C in December and January. Frost generally occurs from the last week of December to first week of February. Usually the monsoon arrives in the second fortnight of June and lasts mid of September.

The experiment was laid out in completely randomized design considering the uniformity of 10-year-old cv. Mosambi plants (6 x 6 m) with thirteen treatments and replicated thrice during the two years (2021 and 2022) of research.

Table 1 describes the different treatments.

Treatments symbol	Treatments details
T_1	RDF(Recommended Dose of Fertilizer) 100 % (800:400:400 g/plant) Control
T_2	RDF 90 % + Vermicompost
T_3	RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB)
T_4	RDF 90 % + Vermicompost + (Zn + Cu + Fe + Boron)
T_5	RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron)
T_6	RDF 80 % + Vermicompost
T_7	RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB)
T_8	RDF 80 % + Vermicompost + (Zn + Cu + Fe + Boron)
T_9	RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron)
T_{10}	RDF 70 % + Vermicompost
T_{11}	RDF 70 % + Vermicompost + (Azotobacter + PSB + KMB)
T_{12}	RDF 70 % + Vermicompost + (Zn + Cu + Fe + Boron)
T_{13}	RDF 70 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron)

2.1.1 Methods of application of treatments

For application of manure and fertilizers the top soil around the tree (equal to the leaf canopy of the tree) is dug up to 30 cm and the fertilizers were uniformly mixed into the soil and thereafter, it was levelled. Irrigation was supplied immediately after fertilizer application.

- Recommended dose:800 g N_2/plant, 400 g P_2O_5 /plant, 400 g K/plant
- Urea, di ammonium phosphate and murate of potash were used as the source of nitrogen, phosphorus and potassium. The dose of NPK was given as per treatment.
- Vermicompost, PSB, KMB and Azotobacter were also applied as per treatment.
- Zn, Cu, Iron and Boron were also applied as a micro nutrient.

3. RESULTS AND DISCUSSION

The results (Table 2,3 and 4) showed the initial and final soil analysis levels for various applications of integrated nutrient management in sweet orange orchards.

3.1 Soil pH

The minimum soil pH at initial and final level (6.80,7.62, 7.05 and 7.64, 7.64, 7.55 during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) that reported soil pH at initial and final level of 7.55,7.25, 7.50 and7.62, 7.62, 7.62 during first, second and pooled year respectively. The maximum soil pH at initial and final level (7.74, 7.85, 7.68 and7.85, 7.87, 7.86 during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). Naik and Babu (2007) reported that there was increase in soil pH due to the application of different organic amended plots. This could be due to low buffering action of organic fertilizers and soil (Biswas et al., 1971).

3.2 Soil Electrical conductivity (dsm^{-1})

The minimum electrical conductivity (dsm^{-1}) at initial and final level (0.265, 0.175, 0.225 and 0.265, 0.175, 0.220 during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) that reported electrical conductivity (dsm^{-1}) at initial and final level of 0.267, 0.253 and 0.260 and 0.267, 0.253, 0.260 during first, second and pooled year respectively. The maximum electrical conductivity (dsm^{-1}) at initial and final level (0.378, 0.362, 0.370 and 0.378, 0.362, 0.370during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). The increase in total salt from added organic manures was probably high which in turn affected EC of the soil Beri et al. (1992).

3.3 Organic carbon %

The maximum organic carbon % at initial and final level (2.117, 2.257, 2.278 and 2.994, 3.532, 3.263 during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) that reported organic carbon % at initial and final level of 2.117, 2.254, 2.185 and 2.851, 3.322, 3.086 during first, second and pooled year respectively. The minimum organic carbon % at initial and final level (0.996, 1.117, 1.056 and 1.318, 1.371, 1.344 during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). This might be due to the increase in soil micro flora which decomposes organic matter in soil resulting in to release of nitrogen in available form (Syed, 2009) in banana.

3.4 Nitrogen (kg ha^{-1})

The maximum available nitrogen (kg ha^{-1}) at initial and final level (167.76, 186.52, 177.14 and 176.34, 198.24, 187.29 during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) that reported available nitrogen (kg ha^{-1}) at initial and final level of 167.49, 185.87, 176.68 and 175.62, 197.50, 186.56 during first, second and pooled year respectively. The minimum available nitrogen (kg ha^{-1}) at initial and final level (157.67, 173.35, 165.51 and 162.98, 184.58, 173.78 during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). The use of microbial consortia in conjunction with organic manures and inorganic source of NPK proved efficient in maintaining soil nitrogen levels because the microbial population was substantially greater under such treatments. Mahendra et al. (2009).

3.4 Phosphorus (kg ha^{-1})

The maximum available phosphorus (kg ha^{-1}) at initial and final level (13.22, 13.54, 13.38 and 12.96, 14.19, 13.58 during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) reported available phosphorus (kg ha^{-1}) at initial and final level of 12.97, 13.40, 13.19 and 12.81, 14.14, 13.47 during first, second and pooled year respectively. The minimum available phosphorus (kg ha^{-1}) at initial and final level (10.12, 11.24, 10.68 and 10.48, 10.98, 10.73 during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). Generally, addition of organic manures with inorganic fertilizers has been reported as beneficial in increasing the phosphorus availability (Dixit and Gupta, 2000).

134 **Table2:Influence of soil applications through Integrated Nutrient Management on Soil pH and electrical conductivity in Sweet Orange**
135 **Orchard cv. Mosambi (*Citrus Sinensis* L.**

Treatments symbol	Soil pH Initial level			Soil pH Final Level			Electrical conductivity initial level dsm^{-1}			Electrical conductivity final level dsm^{-1}		
	Year 2021	Year 2022	Pooled	Year 2021	Year 2022	Pooled	Year 2021	Year 2022	Pooled	Year 2021	Year 2022	Pooled
T_1	7.47	7.68	7.41	7.65	7.73	7.71	0.321	0.272	0.297	0.321	0.272	0.297
T_2	7.66	7.83	7.56	7.83	7.83	7.83	0.373	0.354	0.364	0.373	0.354	0.364
T_3	7.46	7.47	7.40	7.63	7.62	7.63	0.273	0.263	0.268	0.273	0.263	0.268
T_4	7.43	7.63	7.38	7.64	7.65	7.65	0.277	0.264	0.270	0.277	0.264	0.270
T_5	6.80	7.62	7.05	7.64	7.64	7.55	0.265	0.175	0.225	0.265	0.175	0.220
T_6	7.74	7.85	7.68	7.85	7.87	7.86	0.378	0.362	0.370	0.378	0.362	0.370
T_7	7.67	7.27	7.62	7.73	7.73	7.73	0.353	0.274	0.314	0.353	0.274	0.314
T_8	7.53	7.73	7.48	7.78	7.78	7.70	0.363	0.286	0.325	0.363	0.286	0.325
T_9	7.55	7.25	7.50	7.62	7.62	7.62	0.267	0.253	0.260	0.267	0.253	0.260
T_{10}	7.77	7.86	7.72	7.86	7.88	7.87	0.385	0.374	0.379	0.385	0.374	0.379
T_{11}	7.60	7.61	7.53	7.83	7.83	7.58	0.354	0.284	0.319	0.354	0.284	0.319
T_{12}	7.59	7.76	7.52	7.76	7.77	7.77	0.373	0.353	0.363	0.373	0.353	0.363
T_{13}	7.47	7.64	7.41	7.74	7.73	7.49	0.284	0.266	0.275	0.284	0.266	0.275
SE(m)	**0.12**	**0.06**	**0.09**	**0.01**	**0.01**	**0.01**	**0.009**	**0.001**	**0.005**	**0.003**	**0.008**	**0.005**
CD (5%)	**0.35**	**0.19**	**0.32**	**0.04**	**0.03**	**0.36**	**0.026**	**0.004**	**0.058**	**0.010**	**0.023**	**0.057**

Table3: Influence of soil applications through Integrated Nutrient Management on Soil organic carbon and nitrogen in Sweet Orange Orcharcv. Mosambi (*Citrus Sinensis* L.)

Treatments symbol	Organic Carbon % initial level			Organic Carbon % final level			Nitrogen initial level (Kg ha^{-1})			Nitrogen Final level (Kg ha^{-1})		
	Year 2021	**Year 2022**	**Pooled**	**Year 2021**	**Year 2022**	**Pooled**	**Year 2021**	**Year 2022**	**Pooled**	**Year 2021**	**Year 2022**	**Pooled**
T_1	1.367	1.335	1.351	2.758	2.767	2.763	163.52	184.00	173.76	174.29	193.81	184.05
T_2	1.112	1.225	1.169	1.547	1.892	1.720	159.59	175.46	167.53	164.90	187.60	176.25
T_3	2.112	2.151	2.131	2.834	3.036	2.935	167.27	185.74	176.51	175.59	197.49	186.54
T_4	1.552	2.116	1.834	2.809	2.924	2.866	166.66	185.34	176.00	175.12	196.93	186.02
T_5	2.117	2.257	2.187	2.994	3.532	3.263	167.76	186.52	177.14	176.34	198.24	187.29
T_6	0.998	1.182	1.090	1.451	1.396	1.424	158.17	173.38	165.78	163.74	186.97	175.35
T_7	1.224	1.332	1.278	2.700	2.708	2.704	163.26	183.18	173.22	173.76	192.71	183.23
T_8	1.189	1.227	1.208	2.433	2.313	2.373	162.93	178.70	170.81	168.45	187.65	178.05
T_9	2.117	2.254	2.185	2.851	3.322	3.086	167.49	185.87	176.68	175.62	197.50	186.56
T_{10}	0.996	1.117	1.056	1.318	1.371	1.344	157.67	173.35	165.51	162.98	184.58	173.78
T_{11}	1.220	1.324	1.272	2.447	2.447	2.447	163.17	180.38	171.78	173.34	191.70	182.52
T_{12}	1.115	1.227	1.171	2.017	2.279	2.148	161.93	177.25	169.59	166.85	187.64	177.25
T_{13}	1.415	1.342	1.378	2.775	2.792	2.784	163.68	185.06	174.37	174.62	196.16	185.39
SE(m)	**0.010**	**0.023**	**0.016**	**0.277**	**0.175**	**0.226**	**1.15**	**0.99**	**1.07**	**1.23**	**0.90**	**1.06**
CD (5%)	**0.030**	**0.068**	**0.288**	**0.812**	**0.514**	**0.391**	**3.37**	**2.91**	**3.96**	**3.61**	**2.65**	**2.93**

Table 4: Influence of soil applications through Integrated Nutrient Management on Soil phosphorus and potassium in Sweet Orange Orchard c.v. Mosambi (*Citrus Sinensis* L.

TREATMENTS SYMBOL	PHOSPHORUS INITIAL LEVEL (KG HA^{-1})			PHOSPHORUS FINAL LEVEL (KG HA^{-1})			POTASSIUM INITIAL LEVEL (KG HA^{-1})			POTASSIUM FINAL LEVEL (KG HA^{-1})		
	YEAR 2021	YEAR 2022	POOLED	YEAR 2021	YEAR 2022	POOLED	YEAR 2021	YEAR 2022	POOLED	YEAR 2021	YEAR 2022	POOLED
T_1	11.78	12.27	12.03	12.36	12.87	12.62	184.37	223.60	203.98	202.27	237.83	220.05
T_2	11.16	11.49	11.32	11.32	10.56	10.94	173.27	222.17	197.72	195.40	233.27	214.33
T_3	11.90	13.26	12.58	12.87	13.74	13.31	187.30	224.97	206.13	208.07	243.73	225.90
T_4	12.07	12.96	12.52	12.54	13.51	13.03	187.23	224.83	206.03	208.03	242.43	225.23
T_5	13.22	13.54	13.38	12.96	14.19	13.58	188.63	227.13	207.88	213.67	245.23	229.45
T_6	11.45	10.93	11.19	10.48	10.98	10.73	176.90	218.07	197.48	195.27	232.80	214.03
T_7	11.42	11.99	11.71	12.28	12.04	12.16	184.23	222.53	203.38	199.13	237.67	218.40
T_8	12.52	10.35	11.43	11.45	12.38	11.91	180.40	219.83	200.12	197.67	235.77	216.72
T_9	12.97	13.40	13.19	12.81	14.14	13.47	187.67	226.80	207.23	213.13	244.90	229.02
T_{10}	10.12	11.24	10.68	10.82	11.76	11.29	173.43	217.90	195.67	193.93	232.53	213.23
T_{11}	10.79	12.45	11.62	11.70	12.47	12.08	183.40	220.53	201.97	198.53	236.90	217.72
T_{12}	10.49	12.33	11.41	12.12	11.27	11.70	177.67	219.40	198.53	197.57	233.67	215.62
T_{13}	12.25	12.69	12.47	12.82	13.12	12.97	186.10	223.93	205.02	203.77	239.50	221.63
SE(M)	**0.521**	**0.543**	**0.532**	**0.45**	**0.55**	**0.50**	**0.90**	**1.40**	**1.15**	**1.13**	**0.94**	**1.03**
CD (5%)	**1.53**	**1.59**	**1.94**	**1.33**	**1.63**	**1.34**	**2.64**	**4.12**	**6.33**	**3.32**	**2.78**	**4.53**

3.5 Potassium (kg ha^{-1})

The maximum available potassium (kg ha^{-1}) at initial and final level (188.63, 227.13, 207.88 and 213.67, 245.23, 229.45during first, second and pooled year respectively) was recorded under the treatment T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) which was significantly superior to all the treatments under study. Treatment $T_5$was followed by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) that reported available potassium (kg ha^{-1}) at initial and final level of 187.67, 226.80, 207.23 and 213.13, 244.90, 229.02 during first, second and pooled year respectively.The minimum available potassium (kg ha^{-1}) at initial and final level (173.27, 222.17, 197.72 and 193.93, 232.53, 213.23 during first, second and pooled year respectively) was recorded under T_{10} (RDF 70 % (560:280:280 g/plant/hectare) + Vermicompost). In spite of crop uptake more content of NPK was observed in soil. This may be attributed due to more activity and multiplication of nitrogen fixing bacteria and PSB in microbial consortia in the soil for further decomposition and mineralization of FYM, vermicompost and poultry manure might have contributed in availability of more nutrients in the soil Gogoi et al., (2004).

4. CONCLUSION

From the present study it may be concluded that:
The treatments had a significant effect on the nutritional status of orchard soil, viz. soil pH, soil electrical, conductivity, organic carbon%, available nitrogen, available phosphorus, available potassium were affected significantly by various treatments. Among the treatments, T_5 (RDF 90 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron) was found to be significantly superior to rest of the treatments under study. It was however followed closely by T_9 (RDF 80 % + Vermicompost + (Azotobacter + PSB + KMB) + (Zn + Cu + Fe + Boron).

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REFERENCES

Anees, M., Tahir, F.M., Shazad, J. and Mahmood, N. (2011). Effect of foliar application of micronutrients on quality of Mango (Mangifera indica L.) Dasehari fruit. Mycopathology, **9**(1): 25-28.

Beri V, Sidhu B S, Bhat A K, Singh G P and Singh B. (1992). Nutrient balance and soil properties as affeded by management of crop residues. Proceedings of the International Symposium on Nutrient management for sustained productivity. Department of Soils, Punjab Agricultural University: 133-135.

Biswas T D, Jain B L, Mandel S C. (1971). Cumulative effecs of different levels of manures on physical properties of soil. Joural of the Indian Society of Soil Science. 19 (1): 31-37.

Butani A, Chovatia R, Rankja N.J. (2012). Effect of chemical fertilizer and Vermicompost on yield and nutrient content and uptake by fruit of banana (Musa parasidiaca L.) cv. GRAND NAINE.The Asian Journal of Horticulture, Corpus ID: 130615046.

Dixit K G and Gupta B. (2000). Effect of FYM, chemical and bio-fertilizers on yield and quality of rice. Joumal of the Indian Society of Soil Science 48: 773-780.

Dutta P., Kundu S., Baur F.K., Talang H. And Majumder D. (2014). Effect of bio-fertilizers on physicochemical qualities and leaf mineral composition of guava grown in alluvial zone of West Bengal. J. Crop Weed Sci., **10**(2): 268-271.

Gogoi, D, Kotoky, U. And Hazarika, S. (2004). Effect of bio-fertilizer on productivity and soil characeristics in banana. Indian J. Hort., 61: 354-56.

Lal, G. and Dayal, H. (2014). Effect of integrated nutrient management on yield quality of acid lime (Citrus aurantifolia Swingle). Acad. J., 40(9): 2985-2991.

Mahendra, Singh H. K. and Singh J. K. (2009). Effect of integrated nutrient management on yield and quality of citrus. Asian Journal Horticulture 4:47-49.

Naik MH, Babu RS, (2007). Feasibility of organic farming in guava (Psidium guajava L.). Acta Horticulturae., 735: 365-372.

Srivastava, A. Singh, J.K. and Singh, H.K. (2014). Integrated nutrient management on growth, yield and quality of papaya (Carica papaya) cv. Co-7. The Asian J. Hort., **9**(2): 390-395.

Syed, Z., (2009). Integrated nutrient management studies in Banana (cv. Ardhapuri). The Asian J. Hort, 4 (1):126-130.