The Pharma Innovation Journal 2021; 10(11): 1672-1676

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 1672-1676
© 2021 TPI
www.thepharmajournal.com
Received: 16-09-2021
Accepted: 20-10-2021

Gajbhiye Bhagyaresha R
Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Patil VD
Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Kachave Tejswini R
Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Bhagyaresha R Gajbhiye
Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Effect of integrated nutrient management on soil health of pomegranate (*Punica granatum* L.) Orchard

Gajbhiye Bhagyaresha R, Patil VD and Kachave Tejswini R

Abstract
The present investigation entitled "Studies on Effect of Integrated Nutrient Management on Soil Health, Disease Resistance and Nutrition of Pomegranate (*Punica granatum* L.) Orchards" was carried out during the year 2017-18 and 2018-19 on the research farm of College of Agriculture, Golegaon, Vasantrao Naik Marathwada Krushi Vidyapeeth, Parbhani. The experiment was planned in randomized block design with seven treatments i. e. T_1- Absolute Control, T_2- Farmer's Practices (½ RDF), T_3- RDF (625:250:250 g N, P_2O_5, K_2O tree^{-1}), T_4- INM (15 kg FYM + 8 ml *Azotobactor*, 8 ml PSB, 100 g *Trichoderma* + RDF), T_5- RDF + Antibiotics (Streptocycline @ 250 ppm), T_6- T_4 + Antibiotics, T_7- T_4 + Umber (*Ficus racemosa)* Rhizosphere Hybridised Soil (URHS @ 25 kg per tree) and four replications.
The result revealed that soil pH, EC, organic carbon and calcium carbonate content were improved due to application of FYM @ 15 kg, *Azotobacter* @ 8 ml per tree, PSB@ 8 ml per tree and *Trichoderma* @ 100 g per tree, 625:250:250 g N, P_2O_5 and K_2O per tree and 25 kg URHS (T_7). Soil pH, EC and calcium carbonate content were not reached to the significance level. The highest organic carbon content was recorded in surface and subsurface soil, due to application of treatment T_7 at flowering. Also the same treatment registered maximum available nitrogen, phosphorus and potassium at flowering and harvesting at 0-22.5 and 22.5-45 cm depth, which was superior over all the treatments. In case of available N and P treatment T_7 remains at par with treatment T_6 receiving FYM @ 15 kg, *Azotobacter* @ 8 ml per tree, PSB@ 8 ml per tree and *Trichoderma* @ 100 g per tree, 625:250:250 g N, P_2O_5 and K_2O per tree and Streptocycline @ 250 ppm

Keywords: Organic carbon, available N, P, K, umber (*Ficus racemosa)* rhizosphere hybridised soil and pomegranate

Introduction

Pomegranate (*Punica granatum* L.) belongs to family 'Punicaceae' and is native to Iran but extensively cultivated in Mediterranean region especially in Spain, Morocco, Egypt and Afghanistan. It is also grown in Burma, China, Japan, USA, Russia, Bulgaria and Southern Italy. In India it is cultivated over an area of 246.00 thousand hectare with a production of 2865.00 thousand MT (NHB, 2018-19). Amongst different states growing pomegranate, Maharashtra is the largest producer with a total area of 147.91 thousand hectare and production of 1789.47 thousand MT followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan (Horticulture Statistics Division, 2018). The continuous and excess use of chemical fertilizers beyond the recommended dose has degraded the soil health in terms of fertility and has also caused soil pollution. The reduction in the soil fertility has resulted in low productivity of the crop. Besides, the increasing cost of fertilizers and their negative effect on soil health has led to intensified attempts to the use of bio-fertilizers and organic matter along with inorganic fertilizers. 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.

Materials and Methods

The experimental soil is dominated with smectite clays particularly montmorillonite mixed with chlorite, albite and quartz. The domination of montmorillonite leads to deep cracks on drying and expansion on wetting due to high coefficient of expansion and shrinkage. The soils are derived from basaltic trap parent material and according to USDA soil taxonomy it falls under mixed montmorillonitic hyperthermic typic haplusterts (Malewar, 1977). The soil samples were collected from the selected pomegranate orchards within the canopy at 0.5 m away from tree trunk at the depth of 0-22.5 and 22.5-45 cm of each tree for estimation of different nutrients in order to know the soil nutrient status of the orchard soil. The soil samples were collected at flowering and after harvesting of pomegranate. The soil samples were analyzed by adopting standard procedures and methods and all the data were subjected to analysis of variance.

Results

Effect of INM on physico-chemical properties of pomegranate orchard soil

Soil pH

The initial pH of pomegranate growing soil was 7.96 and 7.93 at 0-22.5 cm depth while, 8.22 and 8.20 at 22.5-45 cm depth during 2017-18 and 2018-19 (Table 1). Soil pH was increased from flowering to harvesting. At flowering, soil pH was varied from 7.62 to 7.95 and 8.08 to 8.21at 0-22.5 and 22.5-45 cm depth, respectively. While at harvesting, it was varied from 7.64 to 7.97 and 8.09 to 8.22 at 0-22.5 and 22.5-45 cm depth, respectively. Soil pH was recorded low and high values with treatment T_7 (INM (Compost + Solubilizers + RDF) + Umber *(Ficus racemosa)* Rhizosphere hybridized soil) and T_1 (absolute control), respectively at flowering and harvesting stage of pomegranate. The pH found to be increased at lower depth of pomegranate soil.

Electrical conductivity

The initial electrical conductivity of pomegranate orchard soils during 2017-2018 and 2018-19 were 0.25 and 0.23 dSm^{-1} at 0-22.5 cm while, 0.32 and 0.28 dSm^{-1} at 22.5-45 cm depth, respectively (Table 1). EC was not reach to the significant level in both the years of experimentation and in pooled. Minimum soil electrical conductivity was recorded with treatment T_7 - INM (Compost + Solubilizers + RDF) + Umber *(Ficus racemosa)* Rhizosphere hybridized soil at 0-22.5 and 22.5-45 cm depth, respectively in both growth stages. Maximum soil electrical conductivity was recorded at flowering (0.34 dSm^{-1}) and harvesting (0.44 dSm^{-1}).

Organic carbon

It is one of the most effective soil property in context of soil properties and crop growth. In present study the organic carbon content was decreased from initial stage to harvesting (Table 2 and Fig. 1). In the treatments, devoid of RDF and FYM i.e. absolute control. However, the highest organic carbon content was recorded in surface and subsurface soil, due to application of treatment T_7 [INM (Compost + Solubilizers + RDF) + Umber *(Ficus racemosa)* Rhizosphere hybridized soil]. Further, it was very clear that the organic carbon content was increased in orchard soil at flowering and after harvest of pomegranate than the initial organic carbon of orchard soil (5.06 and 4.51 g kg^{-1}).

Calcium carbonate

The data (Table 2) showed that $CaCO_3$ content varied from 61.3 to 79.3 and 59.1 to 79.6 g kg^{-1} with an average content 70.3 and 69.4 g kg^{-1} at flowering and harvesting, respectively during 2017-18 and 2018-19. It is decreased from flowering to harvesting and increased with depth. Application of treatment T_7 - INM (Compost + Solubilizers + RDF) + Umber *(Ficus racemosa)* Rhizosphere hybridized soil showed numerical decrease in $CaCO_3$ content.

Effect of INM on available macro nutrients of pomegranate orchard soil

Available nitrogen

The available nitrogen was gradually increased from flowering to harvesting and decreased with depth (Table 3). Significantly maximum available nitrogen was noted at flowering (220.75 and 208.78 kg ha^{-1}) and harvesting (214.79 and 201.46 kg ha^{-1}) at 0-22.5 and 22.5-45 cm depth, respectively with application of INM (compost + solubilizers + RDF) along with Umber *(Ficus racemosa)* rhizosphere hybridized soil (T_7). Which was at par with treatments T_6 - INM (compost + solubilizers + RDF) + Antibiotics (214.31and 199.69 kg ha^{-1}), T_5 - Antibiotics (Streptocycline) + RDF (210.84 and 190.87 kg ha^{-1}) and T_4 - INM (Compost + Solubilizers + RDF) (207.84; 181.61 kg ha^{-1}) at flowering at 0-22.5 and 22.5-45 cm depth, respectively. After harvesting of pomegranate, treatment T_6 followed by treatments T_7 and T_5 at 0-22.5 22.5-45 cm depth, respectively. The available nitrogen was noted minimum with treatment T_1 (absolute control) at both depths i. e. 0-22.5 and 22.5-45 cm. Further, data showed that there was increase in available N in orchard soil as that of initial available N content of soil.

Available phosphorus

It is seen that (Table 3) available phosphorus of pomegranate orchard soil was decreased slowly from flowering to harvesting stage of pomegranate. Application of INM (compost + solubilizers + RDF) along with Umber *(Ficus racemosa)* Rhizosphere Hybridized Soil (T_7) registered maximum available phosphorus at flowering and harvesting at 0-22.5 and 22.5-45 cm depth, which was superior over all the treatments. However, minimum available phosphorus was registered at absolute control (T_1) *i.e* 19.87 and 17.24 kg ha^{-1} at flowering and 17.78 and 15.85 kg ha^{-1} at harvesting at 0-22.5 and 22.5-45 cm depth, respectively. Further, data indicated that the available P_2O_5 in soil was improved over initial soil P content.

Available potassium

The available potassium of pomegranate orchard soil was decreased from flowering to harvesting of pomegranate with depth (Table 3). Application of INM (compost + solubilizers + RDF) along with Umber *(Ficus racemosa)* Rhizosphere Hybridized Soil (T_7) recorded maximum available potassium at flowering (1045.58 and 1037.40 kg ha^{-1}) and harvesting (1029.60 and 1013.44 kg ha^{-1}) over rest of the treatments and remains at par with treatment T_6 [INM (Compost + Solubilizers + RDF) + Antibiotics] with values 988.98 and 963.16 kg ha^{-1} at flowering and 961.63 and 955.84 kg ha^{-1} at harvesting with 0-22.5 and 22.5-45 cm depth, respectively. Nevertheless, minimum available potassium was recorded 866.33 and 827.24 kg ha^{-1} at flowering and 814.11 and 630.10 kg ha^{-1} at harvesting with treatment T_1 (absolute control) at 0-22.5 and 22.5-45 cm depth, respectively. Further, data indicated that the available K_2O in soil was increased at both the growth stages than the initial soil sample.

Discussion

The results regarding pH, EC, organic carbon and calcium carbonate content revealed that there was overall improvement in these properties of soil due to application of Umber rhizosphere soil along with FYM, solubilizers and

RDF. Decrease in alkaline pH, reduction in salt concentration, increase in organic carbon content and reduction in calcareousness of soil are the positive effects recorded and in turn making a soil healthy for pomegranate growth. These results are in accordance with the results of Cheke *et al.* (2016) [4] in sweet orange. Pandey and Palni (2007) [11] reported decrease in the pH of rhizosphere soil over the corresponding non rhizosphere soil. The reasons assigned for decrease in pH are root exudation, increased microbial activity and release of H^+ ions by roots during nutrient uptake (Wang and Zabowski, 1998) [17]. Mir *et al.* (2013) [10] reported that conjoint application of organic manure and mineral fertilizers changed soil pH towards neutral range in pomegranate orchard soil. In general, organic sources have tendency bring the soil towards neutral pH. The maximum reduction of soil pH, EC were recorded with application of FYM + 100% NPK + *Azotobacter* + PSB (Srivastava *et al.*, 2014) [14]. It might be due to the production of acidity with fertilizer application and organic acid from FYM decomposition, resulted reduction in these parameters.

Bielinska (2008) [3] proved that the amount of organic carbon released by plants to the rhizosphere can amount to 40% of the total dry mass produced lower soil temperature below the tree species further reduce the oxidation rate of organic matter and hence organic matter get build up. Dutta *et al.* (2016) [7] further showed that vermicompost or FYM-treated soil gave maximum content of organic carbon followed by biofertilizer-treated soil in mango orchard. The increase in organic carbon of soil may be due to the addition of organic matter through organic manure and microbes and recycling of organic materials in the form of crop residue, which brings the soil pH nearer to neutral and increases the nutrient availability. These results are in close conformity with earlier findings of Dutta and Kundu, 2012 [6]. The calcium carbonate content tends to decrease with application of organic matter (Patil, 1997) [12] and stressed that rather application of high doses of organic matter is the only way to mitigate the detrimental effect of high calcium carbonate on plant growth.

The results (Table 3) clearly indicated that there was increase in available N and P content due to application of various inputs like fertilizers, FYM, nutrient solubilizers and Umber *(Ficus racemosa)* Rhizosphere Hybridized Soil.

These results are similar to the findings of Mir *et al.* (2013) [10]. They reported that the conjoint application of VC_{20} + B_{80} + FYM_{20} + GM + RDF (T_{20}) recorded significantly higher available N contents in pomegranate orchard. Increased availability of N and P with the application of bio-organics could be attributed to the greater multiplication of microbes which converted organically bound N to organic form. Shivakumar *et al*. (2012) [13] reported similar result in papaya. Similarly, Cheke *et al.* (2018) [5] found that Umber *(Ficus racemosa)* rhizospher soil shows very high available N content in sweet orange orchard soils. Bardgett *et al.* (1999) [2] observed microbial communities nutrient recycling and nitrogen availability to the plant markedly differ in soils planted with different plants. They explained these differences largely in terms of variations in exudation pattern and plant nutrient acquisition strategies.

Available P content improved with application of compost + solubilizers + RDF along with Umber *(Ficus racemosa)* Rhizosphere Hybridized Soil in pomegranate orchard. These results are in agreement with those reported by Tandel *et al.* (2017) [15] that available phosphorus in soil after harvest of papaya were significantly influenced by bio-compost, vermicompost, castor cake and inorganic fertilizer. Soil microbes from rhizosphere soil enhanced phosphorus activities that mobilizes sparingly the available nutrient sources and ectozymes resulting in improve phosphorous uptake. The mechanism involved in solubilizing phosphorus was due to acid production and enzyme activities *viz.*, dehydrogenase, phosphate and urenase activities. Thus, due to transport of solubilized phosphorus through hyphae to roots led to an efficient increase in phosphorus. The higher availability of phosphorus might be due to the production of organic acids by phosphorus solubilising bacteria which acts as a chelating agent and forms stable complexes with Fe and Al abundantly available in acid soils and thereby releasing phosphorus to the soil solution making it available for more uptake by the plant.

Application of compost + solubilizers + RDF along with Umber *(Ficus racemosa)* rhizosphere hybridized soil improved available K in pomegranate orchard. It might be due to increased microbial activities in rhizosphere soil have resulted in greater uptake of potassium in plant due to the solubilization action of certain organic acids produced during decomposition of organic manure and its greater capacity to hold K in available form in soil (Kuttimani *et al*., 2013) [9]. Vanilarasu and Balakrishnamurthy (2014) [16] observed that available potassium recorded maximum with combined application of organic manures, amendments and green manures. Similarly, Srivastava *et al*. (2014) [14] revealed that the maximum K content of soil was recorded with application of FYM + 100% NPK + *Azotobacter* + PSB at the depth of 0-15 and 15-30 cm in papaya. Addition of organic manures like FYM or vermicompost along with inorganic fertilizers had a beneficial effect on increasing K availability (Satisha *et al.*, 2014).

Cheke *et al.*, (2016) [4] reported that Umber rhizosphere soil recorded maximum content of available N, P and K in sweet orange growing soil.

On similar lines, Hadole *et al.* (2015) observed that available N (257.53 kg ha^{-1}), P_2O_5 (26.86 kg ha^{-1}) and K_2O (542 kg ha^{-1}) of Nagpur mandarin orchard soil were improved with RDF (100% RDF + VAM 500 g/plant) + PSB (100 g/plant) + *Azospirillum* (100 g /plant).

Table 1: Effect of Integrated Nutrient Management on soil pH and Electrical conductivity (EC) of pomegranate orchard soil

Treatments	Soil pH				EC(dSm^{-1})			
	Depth 0-22.5 cm		Depth 22.5- 45 cm		Depth 0-22.5 cm		Depth 22.5- 45 cm	
	F	H	F	H	F	H	F	H
T_1: Absolute Control	7.95	7.97	8.21	8.22	0.31	0.41	0.37	0.46
T_2: Farmer's practices (1/2 RDF)	7.87	7.89	8.19	8.19	0.30	0.40	0.36	0.42
T_3: RDF(625:250:250 g N, P_2O_5, K_2O $tree^{-1}$)	7.86	7.88	8.17	8.19	0.28	0.39	0.35	0.41
T_4: INM (FYM + Solubilizers + RDF)	7.80	7.82	8.18	8.20	0.26	0.37	0.33	0.40
T_5: RDF + Antibiotics (Streptocycline)	7.68	7.69	8.16	8.17	0.26	0.37	0.32	0.38
T_6: T_4 + Antibiotics	7.67	7.69	8.11	8.13	0.25	0.36	0.31	0.36

T_7: T_4 + Umber *(Ficus racemosa)* Rhizosphere Hybridised Soil (URHS)	7.62	7.64	8.08	8.09	0.25	0.32	0.31	0.34
Average	7.78	7.79	8.16	8.17	0.27	0.37	0.33	0.40
S.Em.±	0.09	0.11	0.09	0.06	0.02	0.02	0.02	0.06
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Initial value	7.95	7.95	8.21	8.21	0.24	8.24	0.30	0.30

F- Flowering
H- Harvesting

Table 2; Effect of Integrated Nutrient Management on organic carbon and calcium carbonate of pomegranate orchard soil

Treatments	Organic Carbon (g kg^{-1})				$CaCO_3$ (g kg^{-1})			
	Depth 0-22.5 cm		Depth 22.5- 45 cm		Depth 0-22.5 cm		Depth 22.5- 45 cm	
	F	H	F	H	F	H	F	H
T_1: Absolute Control	5.05	5.04	4.53	4.49	75.8	75.8	79.6	79.6
T_2: Farmer's practices (1/2 RDF)	5.13	5.09	4.73	4.55	75.3	72.4	79.4	75.6
T_3: RDF(625:250:250 g N, P_2O_5, K_2O tree^{-1})	5.28	5.19	4.90	4.71	74.4	71.0	78.3	73.3
T_4: INM (FYM + Solubilizers + RDF)	5.58	5.33	5.33	4.82	71.1	68.9	76.3	71.5
T_5: RDF + Antibiotics (Streptocycline)	6.20	5.94	6.10	5.11	65.6	66.3	72.8	69.6
T_6: T_4 + Antibiotics	7.50	6.73	7.39	6.81	62.8	62.3	69.8	68.3
T_7: T_4 + Umber *(Ficus racemosa)* Rhizosphere Hybridised Soil (URHS)	8.03	7.74	7.75	7.39	61.3	59.1	67.3	62.1
Average	6.11	5.87	5.82	5.40	69.5	68.0	74.8	71.4
S.Em.±	0.01	0.02	0.01	0.01	0.42	0.44	0.42	0.37
CD at 5%	0.04	0.09	0.04	0.04	NS	NS	NS	NS
Initial value	5.08	5.08	4.51	0.51	7.56	7.56	7.95	7.95

F- Flowering
H- Harvesting

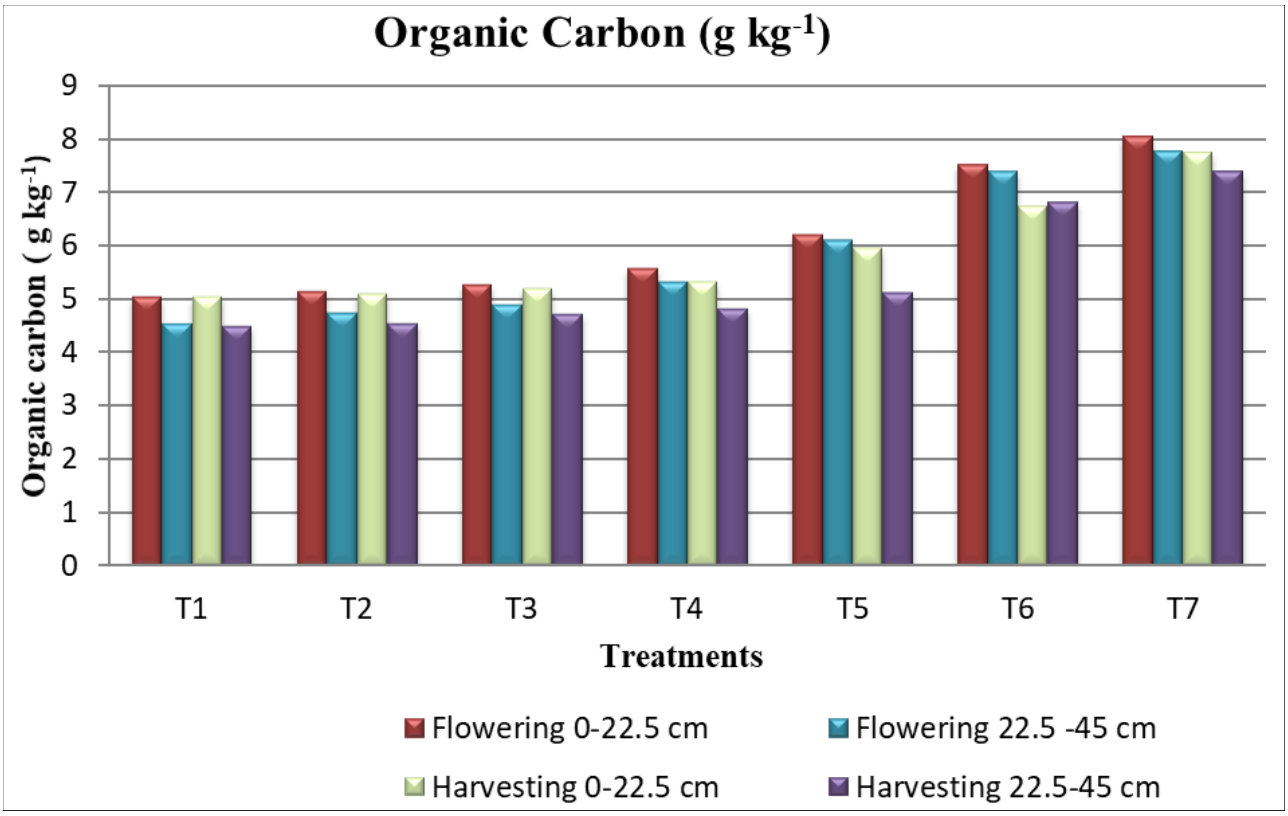

Fig 1: Effect of Integrated Nutrient Management on organic carbon content of pomegranate orchard soil

Table 3: Effect of Integrated Nutrient Management on available N, P and K of pomegranate orchard soil

Treatments	Available N (kg ha^{-1})				Available P_2O_5 (kg ha^{-1})				Available K_2O (kg ha^{-1})			
	Depth 0-22.5 cm		Depth 22.5- 45 cm		Depth 0-22.5 cm		Depth 22.5- 45 cm		Depth 0-22.5 cm		Depth 22.5- 45 cm	
	F	H	F	H	F	H	F	H	F	H	F	H
T_1	178.94	176.05	152.38	149.33	19.87	17.78	17.24	15.85	866.33	814.11	827.24	630.10
T_2	191.88	181.61	174.05	169.46	21.12	19.28	17.90	17.12	902.72	829.75	850.22	702.23
T_3	197.70	189.49	177.85	175.57	22.45	20.85	18.81	18.06	920.25	852.60	888.61	710.67
T_4	207.84	200.61	181.61	177.90	23.99	21.56	20.26	19.39	931.80	869.98	920.11	719.42

T_5	210.84	205.98	190.87	181.60	25.77	23.09	22.84	22.01	949.19	902.13	935.66	736.22
T_6	214.31	209.83	199.69	186.81	27.64	24.82	25.07	24.55	988.98	961.63	963.16	955.84
T_7	220.75	214.79	208.78	201.46	30.56	27.43	28.74	26.66	1045.58	1029.60	1037.40	1013.44
Average	203.18	196.91	183.60	177.45	24.48	22.12	21.55	20.52	943.55	894.26	917.49	781.13
S.Em.±	5.08	4.61	7.06	3.97	0.62	0.57	0.49	0.64	20.19	24.08	25.97	24.09
CD at 5%	14.58	13.24	24.43	11.39	1.78	1.64	1.41	1.82	57.96	69.12	74.55	69.14
Initial value	177.3	177.3	153.07	153.07	18.83	18.83	17.71	8.76	869.38	869.38	825.26	825.26

F- Flowering
H- Harvesting

Conclusion
Application of INM (FYM @ 15 kg, *Azotobacter* @ 8 ml per tree, PSB@ 8 ml per tree and *Trichoderma* @ 100 g per tree, 625:250:250 g N, P_2O_5 and K_2O per tree) along with Umber (*Ficus racemosa)* Rhizosphere Hybridised Soil (URHS) @ 25 kg showed gradual decrease in soil pH, EC and $CaCO_3$ while, increase in organic carbon content at flowering and harvesting at surface and subsurface. Soil fertility status (available N, P and K) improved significantly with combine application of INM practices.

References

1. Malewar GU. Micronutrients status, their distribution and availability in soils of Marathwada region of Maharashtra state in relation to soil types and cropping patterns. Ph.D. Thesis submitted to Punjab Agricultural University, Ludhiyana 1977.
2. Bardgett RD, Mawdsley JL, Edwards S, Hobbs PJ, Rodwell JS, Davies WJ. Plant species and nitrogen effects on soil biological properties of temperate upland grasslands. Function of Ecology 1999;13:650-660.
3. Bielinska EJ. Enzymatic activity of soil in sour chery orchard depending on cultiviation method. *Rozprawy Naukowe Akademii Rolniczej Lublinie* 2008;251:432-436.
4. Cheke AS. Studies on rhizhosphere hybridization and nutrient dynamics in sweet orange. Ph. D. thesis submitted to Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M. S.) 2016.
5. Cheke AS, Patil VD, Srivastava AK. Studies on rhizhosphere hybridization and nutrient dynamics in sweet orange seedling from pot culture experiment. Journal of Pharmacognosy and Phytochemistry 2018, 3077-3082.
6. Dutta P, Kundu S. Effect of bio-fertilizers on nutrient status and fruit quality of Himsagar mango grown in new alluvial zones of West Bengal. Journal of Crop and Weed 2012;8(1):72-74.
7. Dutta P, Das K, Patel A. Influence of organics, inorganic and bio-fertilizers on growth, fruit quality and soil characters of Himsagar mango grown in new alluvial zone of West Bengal, India. Advances in Horticultural Science 2016;30(2):81-85.
8. Hadole SS, Waghmare S, Jadhao SD. Integrated use of organic and inorganic fertilizers with bio-inoculants on yield, soil fertility and quality of Nagpur mandarin (*Citrus reticulata* Blanco). International Journal of Agricultural Sciences 2015;11(2):242-247.
9. Kuttimani R, Velayudham K, Somasundaram E. Growth, Yield Parameters and Nutrient Uptake of Banana as Influenced by Integrated Nutrient Management Practices. International Journal of Recent Scientific Research 2013;4(5):680-686.
10. Mir M, Hassan GI, Mir A, Hassan A, Sulaimani M. Effects of bio-organics and chemical fertilizers on nutrient availability and biological properties of pomegranate orchard soil. African Journal of Agricultural Research 2013;8(37):4623-4627.
11. Pandey S, Palni LMS. The rhizosphere effect in trees of the Indian Central Himalaya with special reference to altitude. Applied Ecology and Environmental Research 2007;5:93-102.
12. Patil VD. Assessment of chemical and biochemical indices for diagnosting zinc deficiency and soil associated factors of citrus nutrition. Ph. D Thesis submitted Marathwada Krishi Vidyapeeth, Parbhani. (M.S) 1997
13. Shivakumar BS, Dharmatti PR, Channal HT. Effect of organic cultivation of papaya on yield, economics and soil nutrient status. Karnataka Journal of Agricultural Sciences 2012;25(4):488-492.
14. Srivastava AK, Singh J, Singh HK. Studies on integrated nutrient management (INM) in leaf and soil nutrient status of papaya (*Carica papaya* L.) cv. CO-7. The Asian Journal of Horticulture 2014;9(2):453-458.
15. Tandel BM, Patel BN, Shah KA. Effect of integrated nutrient management on growth and nutrient status of papaya CV. Taiwan red lady. International Journal of Chemical Studies 2017;5(4):1949-1952.
16. Vanilarasu K, Balakrishnamurthy G. Influence of organic manures and amendments in soil physico-chemical properties and their impact on growth, yield and nutrient uptake of banana. The Bioscan 2014;9(2):526-529.
17. Wang X, Zabowski D. Nutrient composition of douglasfir rhizosphere and bulk soil solutions. Plant and Soil 1998;200(1):13-20.