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Effect of integrated nutrient management (INM) on available micro nutrients of pomegranate (*Punica granatum* L.) orchard soil

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Abstract

A field experiment was conducted on “Effect of Integrated Nutrient Management on Disease Resistance of Pomegranate (*Punica granatum* L.) Orchards” during 2017-18 and 2018-19 at College of Agriculture, Golegaon, VNMKV, Parbhani. The experiment was laid out in randomized block design with seven treatments i. e. T₁- Absolute Control, T₂- Farmer’s Practices (½ RDF), T₃- RDF (625:250:250 g N, P₂O₅, K₂O tree⁻¹), T₄- INM (15 kg FYM + 8 ml *Azotobacter*, 8 ml PSB, 100 g *Trichoderma* + RDF), T₅- RDF + Antibiotics (Streptocycline @ 250 ppm), T₆- T₄ + Antibiotics, T₇- T₄ + UMBER (*Ficus racemosa*) Rhizosphere Hybridised Soil (URHS @ 25 kg per tree) and four replications.

The result showed that maximum DTPA extractable micronutrients content i.e. Fe (5.88 and 4.81mg kg⁻¹), Zn (1.59 and 1.33mg kg⁻¹), Cu (4.05 and 3.79mg kg⁻¹), Mn (12.24 and 11.02mg kg⁻¹) and available B (1.00 and 0.98mg kg⁻¹) was recorded at flowering stage in FYM @ 15 kg, *Azotobacter* @ 8 ml per tree, PSB @ 8 ml per tree and *Trichoderma* @ 100 g per tree, 625:250:250 g N, P₂O₅ and K₂O per tree and URHS @ 25 kg per tree (T₇) at 0-22.5 and 22.5-45 cm depth, respectively. Similar trend was noticed at harvesting stage. However, minimum DTPA extractable Fe, Zn, Cu, Mn and available B content were recorded at absolute control.

Keywords: INM, DTPA extractable micronutrients 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). Pomegranate (*Punica granatum* L), being a favourite table fruit of tropical and subtropical regions of the world, has emerged as commercial fruit in many Indian states including Maharashtra, Andhra Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Karnataka and Tamil Nadu (Mondal and Sharma, 2009) [6].

The increasing cost of fertilizers with poor purchasing capacity 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. Integrated Nutrient Management (INM) is a system that helps to restore and sustain crop productivity, and also assists in checking the emerging micro-nutrient deficiencies.

Material and Methods

The present research programme 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 Marathawada Krushi Vidyapeeth, Parbhani. The experimental soil is characterized by strong brown colour. The soil is dominated with smectite clays particularly montmorillonite mixed with chlorite, albite and quartz.

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The domination of montmorillonite leads to deep cracks on drying and expansion on wetting due to high coefficient of expansion and shrinkage. 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. DTPA (0.005M) extractable Fe, Mn, Zn and Cu were determined as the procedure outlined by Lindsay and Norvell (1978) [3] using atomic absorption spectrophotometer. Available boron was determined by hot water soluble (HWS) method by using Azomethine-H (Berger and Trough, 1939) [1].

Result and Discussion

Table 1: Effect of Integrated Nutrient Management on DTPA -iron of pomegranate orchard soil

Treatments	DTPA-Fe (mg kg ⁻¹)											
	Depth 0-22.5 cm						Depth 22.5- 45 cm					
	Flowering			Harvesting			Flowering			Harvesting		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁ : Absolute Control	4.26	4.33	4.29	4.20	4.28	4.24	3.89	3.92	3.91	3.88	3.96	3.92
T ₂ : Farmer's practices (1/2 RDF)	4.86	4.92	4.89	4.81	4.89	4.85	3.96	3.98	3.97	3.90	3.97	3.93
T ₃ : RDF(625:250:250 g N, P ₂ O ₅ , K ₂ O tree ⁻¹)	5.28	5.38	5.33	5.08	5.16	5.12	4.14	4.24	4.19	4.16	4.26	4.21
T ₄ : INM (FYM + Solubilizers +RDF)	5.45	5.57	5.51	5.19	5.29	5.24	4.45	4.56	4.51	4.27	4.37	4.32
T ₅ : RDF + Antibiotics (Streptocycline)	5.63	5.70	5.67	5.23	5.33	5.28	4.54	4.64	4.59	4.35	4.45	4.40
T ₆ : T ₄ + Antibiotics	5.67	5.76	5.71	5.41	5.51	5.46	4.74	4.66	4.70	4.46	4.56	4.51
T ₇ : T ₄ + Umber (<i>Ficus racemosa</i>) Rhizosphere Hybridised Soil (URHS)	5.80	5.96	5.88	5.70	5.83	5.77	4.66	4.97	4.81	4.63	4.76	4.69
Average	5.28	5.38	5.33	5.09	5.18	5.14	4.34	4.42	4.38	4.24	4.33	4.28
S.Em.±	0.19	0.18	0.13	0.19	0.18	0.13	0.16	0.15	0.11	0.12	0.12	0.09
CD at 5%	0.56	0.54	0.38	0.55	0.55	0.38	0.46	0.46	0.31	0.36	0.36	0.25
Initial value	4.20	4.28	4.24	4.20	4.28	4.24	3.87	3.90	3.89	3.87	3.90	3.89

DTPA extractable zinc

It is evident from the pooled data (Table 2) in flowering as well as harvesting (1.59 and 1.33mg kg⁻¹; 1.27 and 1.10mg kg⁻¹, respectively) maximum DTPA extractable zinc content was recorded with application of INM (compost + solubilizers + RDF) along with Umber (*Ficus racemosa*) rhizosphere

DTPA extractable iron

The data given in Table 1 at flowering stage, showed maximum DTPA extractable iron content (5.88 and 4.81mg kg⁻¹) in INM (compost +solubilizers +RDF) along with Umber (*Ficus racemosa*) Rhizosphere Hybridized Soil (T₇) at 0-22.5 and 22.5-45 cm depth, respectively and was found to be statistically at par with treatment T₆ [INM (Compost +Solubilizers +RDF) +Antibiotics], T₅ [Antibiotics (Streptocycline) + RDF] and T₄ [INM (Compost +Solubilizers + RDF)]. While, at harvesting stage, the highest DTPA extractable iron content (5.77 and 4.69mg kg⁻¹) was observed at treatment T₇ which was remains at par with treatment T₆. Minimum DTPA extractable iron content was observed in absolute control (T₁) i.e 4.29 and 3.91mg kg⁻¹ at flowering and 4.24 and 3.92mg kg⁻¹ at harvesting with 0-22.5 and 22.5-45 cm depth, respectively. Further, result specified that the DTPA extractable iron in soil was increased over initial DTPA extractable iron content of orchard soil.

hybridized soil (T₇) at 0-22.5 and 22.5-45 cm depth, respectively during both the years. However, minimum DTPA extractable zinc content was recorded in absolute control (T₁) at flowering and harvesting. The result specified that the DTPA-Zn in soil was increased at both the growth stages than the initial soil sample except T₁ treatment.

Table 2: Effect of Integrated Nutrient Management on DTPA zinc of pomegranate orchard soil

Treatments	DTPA-Zn (mg kg ⁻¹)											
	Depth 0-22.5 cm						Depth 22.5- 45 cm					
	Flowering			Harvesting			Flowering			Harvesting		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁ : Absolute Control	0.72	0.78	0.75	0.65	0.71	0.68	0.67	0.73	0.70	0.57	0.63	0.60
T ₂ : Farmer's practices (1/2 RDF)	0.76	0.82	0.79	0.70	0.76	0.73	0.76	0.82	0.79	0.61	0.66	0.64
T ₃ : RDF (625:250:250 g N, P ₂ O ₅ , K ₂ O tree ⁻¹)	0.79	0.85	0.82	0.72	0.78	0.75	0.78	0.84	0.81	0.65	0.66	0.65
T ₄ : INM (FYM + Solubilizers + RDF)	1.03	1.10	1.07	0.77	0.84	0.80	0.85	0.92	0.89	0.66	0.73	0.70
T ₅ : RDF + Antibiotics (Streptocycline)	1.02	1.09	1.06	0.79	0.86	0.83	0.87	0.94	0.91	0.77	0.84	0.81
T ₆ : T ₄ + Antibiotics	1.11	1.18	1.14	0.86	0.93	0.89	0.89	0.96	0.93	0.97	1.04	1.00
T ₇ : T ₄ + Umber (<i>Ficus racemosa</i>) Rhizosphere Hybridised Soil (URHS)	1.55	1.63	1.59	1.23	1.31	1.27	1.29	1.37	1.33	1.06	1.14	1.10
Average	1.00	1.06	1.03	0.82	0.88	0.85	0.87	0.94	0.91	0.76	0.82	0.79
S.Em.±	0.03	0.03	0.02	0.04	0.04	0.03	0.04	0.04	0.03	0.02	0.03	0.02
CD at 5%	0.10	0.10	0.07	0.11	0.11	0.08	0.11	0.11	0.08	0.07	0.10	0.06
Initial value	0.73	0.79	0.76	0.73	0.79	0.76	0.68	0.71	0.69	0.68	0.71	0.69

DTPA extractable copper

The result about DTPA extractable copper content of pomegranate orchard soil was influenced significantly with application of different organic and inorganic sources during

both the years of investigation and the relevant data are presented in Table 3.

It is seen from the pooled data, at flowering and harvesting maximum DTPA extractable copper content was recorded

with treatment T₇ [INM (compost + solubilizers + RDF) + Umber (*Ficus racemosa*) Rhizosphere Hybridized Soil] at 0-22.5 and 22.5-45cm depth, respectively during both the years. At harvesting, treatment T₇ was remains at pat with treatment T₆ with values 3.23 and 3.03mg kg⁻¹ and treatment T₅ with values 3.19 and 2.94mg kg⁻¹ at 0-22.5 and 22.5-45 cm depth, respectively during both the years. While, DTPA extractable

copper content was recorded minimum at flowering (3.30 and 2.54mg kg⁻¹) and harvesting (2.65 and 2.33mg kg⁻¹) at 0-22.5 and 22.5- 45 cm depth, respectively with treatment T₁ (absolute control). There was increase in DTPA extractable copper content over initial soil Cu content due to administration of different treatments.

Table 3: Effect of Integrated Nutrient Management on DTPA copper of pomegranate orchard soil

Treatments	DTPA-Cu (mg kg ⁻¹)											
	Depth 0-22.5 cm						Depth 22.5- 45 cm					
	Flowering			Harvesting			Flowering			Harvesting		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁ : Absolute Control	3.29	3.31	3.30	2.64	2.66	2.65	2.53	2.55	2.54	2.32	2.34	2.33
T ₂ : Farmer's practices (1/2 RDF)	3.35	3.37	3.36	2.65	2.67	2.66	2.74	2.76	2.75	2.41	2.43	2.42
T ₃ : RDF(625:250:250 g N, P ₂ O ₅ , K ₂ O tree ⁻¹)	3.53	3.55	3.54	2.70	2.72	2.71	2.83	2.85	2.84	2.48	2.50	2.49
T ₄ : INM (FYM + Solubilizers + RDF)	3.64	3.68	3.66	2.77	2.81	2.79	3.05	3.09	3.07	2.63	2.67	2.65
T ₅ : RDF + Antibiotics (Streptocycline)	3.73	3.77	3.75	3.23	3.14	3.19	3.52	3.54	3.53	2.89	3.00	2.94
T ₆ : T ₄ + Antibiotics	3.82	3.76	3.79	3.16	3.30	3.23	3.62	3.66	3.64	3.01	3.05	3.03
T ₇ : T ₄ + Umber (<i>Ficus racemosa</i>) Rhizosphere Hybridised Soil (URHS)	4.03	4.08	4.05	3.67	3.20	3.44	3.76	3.82	3.79	3.20	3.16	3.18
Average	3.63	3.64	3.63	2.98	2.93	2.95	3.15	3.18	3.16	2.70	2.74	2.72
S.Em.±	0.16	0.15	0.11	0.12	0.14	0.09	0.14	0.14	0.10	0.13	0.13	0.09
CD at 5%	0.47	0.44	0.31	0.35	0.42	0.26	0.41	0.41	0.28	0.37	0.38	0.26
Initial value	3.30	3.34	3.32	3.30	3.34	3.32	2.55	2.58	2.57	2.55	2.58	2.57

DTPA-extractable manganese

It is noticed from the pooled data (Table 4) that at flowering and harvesting maximum DTPA-Mn content was recorded with treatment T₇-INM (compost +solubilizers +RDF) + mber

(*Ficus racemosa*) Rhizosphere Hybridized Soil. At harvesting, treatments behave in similar fashion as that in flowering stage. In general, there was increase the DTPA-Mn in soil over initial DTP-Mn status.

Table 4: Effect of Integrated Nutrient Management on DTPA manganese of pomegranate orchard soil

Treatments	DTPA-Mn (mg kg ⁻¹)											
	Depth 0-22.5 cm						Depth 22.5- 45 cm					
	Flowering			Harvesting			Flowering			Harvesting		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁ : Absolute Control	10.20	10.29	10.24	7.35	7.43	7.39	9.52	9.60	9.56	7.23	7.31	7.27
T ₂ : Farmer's practices (1/2 RDF)	10.23	10.30	10.27	8.34	8.42	8.38	9.97	10.05	10.01	8.19	8.27	8.23
T ₃ : RDF(625:250:250 g N, P ₂ O ₅ , K ₂ O tree ⁻¹)	10.44	10.52	10.48	8.46	8.55	8.51	10.37	10.45	10.41	8.40	8.48	8.44
T ₄ : INM (FYM + Solubilizers + RDF)	10.61	10.70	10.65	8.65	8.74	8.69	10.41	10.50	10.45	8.54	8.63	8.59
T ₅ : RDF + Antibiotics (Streptocycline)	10.86	10.95	10.91	8.98	9.04	9.01	10.48	10.57	10.52	8.75	8.84	8.80
T ₆ : T ₄ + Antibiotics	10.90	10.96	10.93	9.14	9.23	9.18	10.59	10.68	10.64	9.07	9.16	9.12
T ₇ : T ₄ + Umber (<i>Ficus racemosa</i>) Rhizosphere Hybridised Soil (URHS)	11.19	11.30	11.24	10.14	10.24	10.19	10.97	11.07	11.02	9.89	9.94	9.92
Average	10.63	10.71	10.67	8.72	8.81	8.76	10.33	10.42	10.37	8.58	8.66	8.62
S.Em.±	0.23	0.23	0.16	0.41	0.40	0.29	0.27	0.27	0.19	0.30	0.30	0.21
CD at 5%	0.68	0.68	0.46	1.21	1.20	0.82	0.82	0.82	0.56	0.88	0.89	0.61
Initial value	10.21	10.28	10.25	10.21	10.28	10.25	9.50	9.59	9.55	9.50	9.59	9.55

Available boron

It is evident from the pooled data (Table 5) that available boron content declined from initial stage to harvesting gradually. However, maximum available boron content was noted with application of INM (compost +solubilizers +RDF) along with Umber (*Ficus racemosa*) Rhizosphere Hybridized Soil (T₇). Whereas, minimum available boron content was noted at absolute control (T₁). Further, result showed that the available boron content in soil was increased in both the growth stages than the initial boron content of soil due to addition of FYM, nutrient solubilizers and URHS.

The results inferred that in the present study the availability of micronutrients viz. Fe, Zn, Cu, Mn and B were higher due to application of T₇ treatment and associated other treatment comprising FYM fertilizers. These results are in agreement with the findings of Cheke *et al.* (2018) [2]. Generally, the increase in available micronutrients status of soils in

organically treated plots might be due to release of chelating agents from organics matter decomposition which might have prevented micronutrients from precipitation, oxidation and leaching (Shiva Kumar *et al.*, 2012) [8]. There was a reduction in micronutrients content in the treatments receiving only inorganic fertilizers. It was attributed to non-replenishment of micronutrients through chemical fertilizers. Mir *et al.* (2013) [5] reported that conjoint application of bio-fertilizers 80 g/tree, vermicompost 20 kg/tree, FYM 20 kg/tree, green manure (GM) sunnhemp (*Crotalaria juncea* L.) and recommended dose of fertilizers (RDF) resulted in significantly maximum Fe, Zn, Cu and Mn in pomegranate orchard soil.

Marathe *et al.* (2009) [4] reported that significant increase in available Fe, Zn, Mn and Cu were observed with organic manure either alone or in combination with inorganic or GM (*Crotalaria juncea* L.) or bio-fertilizers (*Azotobacter* + PSB)

in sweet orange soil. Moreover, the inoculation of microbial cultures, application of vermicompost and GM in conjugation with chemical fertilizers improved nutrient cycling process to increase the availability of micro-nutrient ions in the soil solution.

Increased Zn status of soil may be due to the presence of zinc in the organic manure and solubilizing effect of organic acids produced during decomposition of organic manures on Zn complexes like $ZnCO_3$, $Zn(OH)_2$ and $Zn_3(PO_4)_2$. Organic

matter binds with zinc ions and avoids formation of insoluble zinc complexes due to precipitation reaction. DTPA-extractable iron content of the soil after crop harvest has increased in the plots receiving organic manure with a blend of fertilizers. This may be due to the action of chelating agents that increased the availability of Fe and also due to the release of Fe from the added organic manures as a result of decomposition (Selvamani *et al.*, 2011) [7].

Table 5: Effect of Integrated Nutrient Management on available boron of pomegranate orchard soil

Treatments	Available B (mg kg ⁻¹)											
	Depth 0-22.5 cm						Depth 22.5- 45 cm					
	Flowering			Harvesting			Flowering			Harvesting		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁ : Absolute Control	0.49	0.51	0.50	0.42	0.44	0.43	0.47	0.49	0.48	0.40	0.42	0.41
T ₂ : Farmer's practices (1/2 RDF)	0.54	0.56	0.55	0.49	0.51	0.50	0.52	0.54	0.53	0.48	0.50	0.49
T ₃ : RDF(625:250:250 g N, P ₂ O ₅ , K ₂ O tree ⁻¹)	0.57	0.59	0.58	0.54	0.56	0.55	0.55	0.57	0.56	0.53	0.55	0.54
T ₄ : INM (FYM + Solubilizers + RDF)	0.64	0.68	0.66	0.58	0.62	0.60	0.62	0.66	0.64	0.56	0.59	0.57
T ₅ : RDF + Antibiotics (Streptocycline)	0.79	0.84	0.81	0.75	0.79	0.77	0.74	0.78	0.76	0.65	0.68	0.66
T ₆ : T ₄ + Antibiotics	0.84	0.88	0.86	0.78	0.82	0.80	0.81	0.85	0.83	0.66	0.69	0.68
T ₇ : T ₄ + Umber (<i>Ficus racemosa</i>) Rhizosphere Hybridised Soil (URHS)	0.97	1.03	1.00	0.90	0.96	0.93	0.95	1.01	0.98	0.85	0.91	0.88
Average	0.69	0.72	0.71	0.64	0.67	0.65	0.67	0.69	0.68	0.59	0.62	0.60
S.Em.±	0.02	0.02	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.06	0.06	0.04	0.08	0.08	0.06	0.07	0.07	0.05	0.05	0.05	0.03
Initial value	0.48	0.50	0.49	0.48	0.50	0.49	0.46	0.48	0.47	0.46	0.48	0.47

Conclusion

Soil fertility status (DTPA- Fe, Zn, Cu, Mn and available B) improved significantly with combine 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, P₂O₅ and K₂O per tree) along with 25 kg per tree Umber (*Ficus racemosa*) Rhizosphere Hybridised Soil.

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