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Evaluation of macro and micro nutrient status of pomegranate orchards from Maharashtra region by soil and leaf analysis

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Abstract
The present investigation entitled "Studies on macro and micro nutrient status in soil and leaf tissue of pomegranate (*Punica Granatum* L.) orchads of Marathwada region" was carried out during 2017-2018. For this purpose leaf sampling was done from the twigs of current season growth at 8th leaf from the apex in January - February 2017 with 50 leaves sample. The average value of soil pH at surface (0-15 cm) and subsurface (15-30 cm) soil samples showed that, the soils were neutral to alkaline in reaction and electrical conductivity of pomegranate orchard soil at surface (0-15 cm) and subsurface (15-30 cm) soil samples was in safe limit for the crop growth. These soils were calcareous to highly calcareous in nature and low to medium in organic carbon content at surface (0-15 cm) and subsurface (15-30 cm) layer. The soils are categorized as low, medium and high in N, P and K content respectively in pomegranate orchard soils of Marathwada region at both the depth i.e. (0-15 cm) and (15-30 cm) respectively. The exchangeable calcium and magnesium were in high range at surface (0-15 cm) and subsurface (15-30 cm) soil and sulphur status were found in medium to high content. These soils were low to medium in available DTPA Fe and Zn whereas, high in DTPA Mn and low to high in DTPA Cu content at surface (0-15 cm) and subsurface (15-30 cm) soil samples. The leaf nitrogen and potassium was found in higher amount while, phosphorus was low to high in pomegranate leaf samples. The micronutrients *viz.*, zinc and copper were found to be marginal to deficient in leaves of pomegranate while, leaf iron and manganese were marginal to sufficient in pomegranate leaves.

Keywords: Macronutrients, micro nutrients, soil analysis, leaf analysis

Introduction
Pomegranate (*Punica granatum* L.) is the most important fruit crop grown in tropical, subtropical and temperate regions. It is a non climacteric fruit and one of the drought resistant horticultural crops, has proved to be the best profitable crop under dry land condition. In India 1.24 lakh hectare area is under pomegranate crop mainly grown in Maharashtra and Gujarat followed by Rajasthan, Uttar Pradesh, Haryana, Andhra Pradesh and Karnataka. Maharashtra ranks first in the country in pomegranate production. In the state nearly 98,901 hectare area is under this crop and production of pomegranate crop is 5,55,500 MT. In Maharashtra pomegranate crop is mainly grown in Solapur, Nashik, Ahmadnagar, Pune, Sangali, Latur, Jalana, Aurangabad, Beed and Osmanabad districts.

In advance agriculture, soil health has received due attention because of the fact that availability of plant nutrients depends upon various physical and chemical characteristics of the soil. Multinutritional deficiencies in horticultural crops are very common everywhere in the World and their application has been noted to influence plant growth and productivity in variety of ways. Deficient nutrient not only reduces the productivity of the crops but also reduce the use efficiency of applied nutrient. However, information on the optimum range of nutrients in soil and plant for maintaining yield potential and quality of fruit in Vertisols and associated black soil of Marathwada region is lacking.

Plant analysis, some time referred to as leaf analysis, a technique for correlating the elemental content of the whole plant or one of its parts with its physical appearance, growth rate, yield or quality of harvested product. Further, foliar analysis is based on the concept that concentration of a nutrient at a time is an integrated value of all the factors that are responsible for influencing the concentration of particular nutrient in the soil solution upto the time of plant sampling.

No adequate scientific study concerning Pomegranate leaf diagnostic norms and soil fertility status in the Marathwada region has been made till date. Hence, the present investigation was undertaken to generate sufficient data base of balanced fertilization for optimum and good quality production of Pomegranate.

Materials and Methods

In order to know the soil and leaf nutrient status, fifty pomegranate orchards located in different districts of Marathwada region were randomly selected and soil samples were collected from the selected pomegranate orchards within the canopy of 0.5 m away from tree trunk and at the depth of 30 cm as per procedure during 2017-2018. The leaf sampling was done from the twigs of current season growth at 8th leaf from the apex in April 2017 with sample size at 50 leaves (Bhargava and Dhandar, 1987) [1]. The collected leaf samples were brought to the laboratory. The samples were air dried on perfectly clean surface at room temperature for 2-3 days in dust free atmosphere free from any kind of contaminants. Samples were placed in oven at 600°C for 48 hr. and grinded in an electric stainless steel mill using 0.5 mm sieve. The standard methods were followed for determination of total nutrients in leaves. Total nitrogen in the leaf sample was determined by modified Kjeldahl's method by using kelplus digestion and distillation unit (Piper, 1966) [9]. Total phosphorus was determined by spectro photometrically by vanadomolybdate phosphoric acid yellow color method, from diacid extract described by Jackson (1967) [4]. Total potassium content was determined by using flame photometer (Jackson, 1967) [4]. Fe, Zn, Mn and Cu was estimated by standard procedure (Piper, 1966) [9] these four metals were determined in the di-acid digest of plant tissues using Atomic Absorption Spectrophotometer.

Results and Discussion

1. Categorization of physico-chemical properties in pomegranate orchard soil

On the basis of categorization of pomegranate orchard soils, overall observation about soil pH showed the neutral to alkaline nature of soil and it has shown decreasing trend with increase in depth, which may be due to the higher organic matter content in surface soil. All orchards were found to be low with respect to EC. The electrical conductivity of all soils was observed normal and it showed an irregular trend with an increase in soil depth. This could be due to leaching of soluble salts and runoff transportation due to high precipitation. out of 50 orchards, 20 (40%) orchards were categorized in low category, 29 (58%) were medium and 1(2%) was found in high with respect to organic carbon content. The surface soils showed higher content of organic carbon, which decreased with an increase in soil depth. The high content of organic carbon in surface soil was due to natural vegetation and addition of organic matter by farmers. Calcium carbonate content of pomegranate orchard growing soils, out of 50 orchards, 3 (6 %) were non calcareous, 23 (46 %) were calcareous and 24 (48 %) were rated as highly calcareous in range. The calcium carbonate content increased with depth, which could be attributed to leaching of bases from surface to subsurface soil. Similar results were also reported by Talib (1984) [11] and Kher and Singh (1993) [5].

2. Categorization of macronutrient status in pomegranate orchard soil

On the basis of categorization of pomegranate orchard soil, it has been observed that, (100%) samples were low in available nitrogen status in both surface and subsurface soil. The available nitrogen was high in surface soil with decreasing in depth which may be due to the higher content of organic matter in surface soil than subsurface. Among 50 orchards, 47 orchards (94%) were categorized in low and 3 orchards (6%) were medium in available phosphorus content. out of 50 orchards, 3 orchards (6%) were medium and 47 orchards (94%) were high in available potassium content. The high content of K was due to presence of potassium rich mineral in Vertisols associated with black soils. Chaudhari and Kadu (2007) [3] reported that, the available K of soil with an average value of 428.2 kg ha^{-1} was recorded in soils of Dhule tahsil of Dhule district and also similar findings of available K content was found in soil of Parola tahsil of Jalgaon district.

3. Categorization of secondary macronutrient status in pomegranate growing soils

On the basis of categorization of pomegranate orchard soil, in both cases (0-15 and 15-30 cm) all 50 orchards (100 %) were found high in exchangeable calcium content. In general exchangeable calcium content of sub-surface soil was higher than the surface soil, which might be due leaching of calcium from surface to sub-surface soil. In both cases all orchards (100%) were found high in exchangeable magnesium content. Exchangeable magnesium content was high in these soils, which may be due to presence of illite and chlorite type of minerals. Among 50 orchards, 23 orchards (46%) were medium and 27 orchards (54%) were high in available sulphur content. The results might be attributed to the temperate environmental conditions resulting in low mineralization of organic matter, thus lower release of available sulphur. The results are in conformity with the findings of Sharma *et al.*, (2005) [10] and Yogeshappa *et al.* (2013) [12].

4. Categorization of soil for micronutrient status.

On the basis of categorization, out of 50 orchards, 18 orchards (36%) were low and 32 orchards (64%) were medium in DTPA iron content In general, surface soil was rich in DTPA iron than sub-surface soils and iron content decreased with soil depth. This may be due to sufficient organic matter present in surface soils. Among 50 orchards, 16 (32%) were in medium and 34 orchards (68%) were high in DTPA manganese content. DTPA manganese content of surface soils was higher than sub-surface soils and showed a decreasing trend after increasing the depth of soil, which may be due to high organic matter in surface soil layers, among 50 orchards, 49 orchards (98 %) were low and 1 orchards (2 %) were medium in DTPA zinc content. The surface soils showed higher content of DTPA zinc than sub-surface soils, which exhibited a decreasing trend with increase in soil depth, which might be due to higher organic carbon at surface soils, as organic carbon is a major contributor of DTPA zinc in soils. Among 50 orchards, 30 orchards (60%) were low, 12 orchards (24 %) were medium and 8 orchards (16%) were high in DTPA copper content. A decreasing trend of DTPA copper content was observed with increase in depth and surface soils were rich in DTPA copper content, which might be due to higher organic matter and regular addition of fertilizers and manures and spraying of insecticides and pesticides on plants. The results are in agreement with the findings of Bhat *et al.* (2017) [2] and Patiram *et al.* (2000) [8].

5. Categorization of pomegranate orchards for macronutrient status in Leaves

Categorization of the pomegranate orchards, among the 50 orchards, 6 orchards (12%) were in medium and 44 orchards (88%) were in high total nitrogen content. Among 50 orchards, 16 orchards (32%) were low in total phosphorus, 5 orchards (10%) were medium and 29 orchards (58%) were high in total phosphorus content. The categorization of

pomegranate orchards, among 50 orchards, 2 orchards (04%) were in medium and 48 orchards (96%) were high in total potassium content. Patil (2017) [7] reported that, the K content was ranged from 1.62 to 9.98 per cent and Kolekar (2016) [6]

6. Categorization of pomegranate orchards based on micronutrients content in Leaves.

Categorization of pomegranate orchards, among 50 orchards, 21 orchards (42%) were in low and 29 orchards (58%) were in medium in total zinc content among the 50 orchards, 34 orchards (68%) were in medium and 16 orchards (32%) were high in total iron content. among 50 orchards, 48 orchards (96%) were in medium and 2 orchards (4 %) were high in total manganese content. among 50 orchards, 39 orchards (78%) were in low and 11 orchards (22%) were medium in total Cu content. These findings are in accordance with the findings of Patil (2017) [7]

7. Correlation between soil parameters and leaf nutrient content.

The data pertaining to correlation coefficient between soil parameters and leaf nutrients status of pomegranate orchard of soils from Marathwada region are presented in Table 14.

The soil pH was positively correlated with leaf Mn, K, Zn as well as Cu and negatively correlated with leaf N, P, and Fe.

The soil EC was positively correlated with leaf N, P, Zn, Cu, and Fe and negatively correlated with K and Mn. Soil EC has not shown significant relationship with all leaf parameters.

The soil organic carbon was positively correlated with leaf N, P, Fe, Cu and negatively correlated with K, Zn, Mn and not significantly correlated with all leaf parameters.

The soil calcium carbonate was positively correlated with leaf P, K and Cu and negatively correlated with leaf N, Zn and Fe, and significantly positively correlated with leaf Mn which was evident by "r" value 0.349*.

Table 1: Categorization of physico-chemical properties in pomegranate orchard soil

	Category	**Acidic**		**Neutral**		**Alkaline**	
	Depth	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**
pH	No. of Orchards	00	00	14	26	36	24
	%	00	00	28	52	72	48
EC	Category	Safe		Moderate Safe		Unsafe	
	No. of Orchards	50	46	00	04	00	00
	%	100	92	00	8	00	00
Organic carbon	Category	Low		Medium		High	
	No. of Orchards	20	23	29	27	01	00
	%	40	46	58	54	2	00
CaCo3	Category	No Cal.		Cal.		H. Cal.	
	No. of Orchards	7	3	27	23	16	24
	%	14	6	54	46	32	48

Table 2: Categorization of macronutrient status in pomegranate orchard soil

	Category	**Low**		**Medium**		**High**	
	Depth	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**
Available N	No. of orchards	50	50	00	00	00	00
	%	100	100	00	00	00	00
Available P	Category	Low		Medium		High	
	No. of orchards	43	47	7	3	00	00
	%	86	94	14	6	00	00
Available K	Category	Low		Medium		High	
	No. of orchards	00	00	3	5	47	45
	%	00	00	6	10	94	90

Table 3: Categorization of secondary macronutrient status in pomegranate growing soils

	Category	**Low**		**Medium**		**High**	
	Depth	**0-15 cm**	**15-30 cm**	**0-15 cm**	**15-30 cm**	**0-15 cm**	**15-30 cm**
Excha. Ca	No.of orchards	00	00	00	00	50	50
	%	00	00	00	00	100	100
Excha. Mg	No.of orchards	00	00	00	00	50	50
	%	00	00	00	00	100	100
Available Sulphur	No.of orchards	00	00	23	27	27	23
	%	00	00	46	54	54	46

Table 4: Categorization of soil for micronutrient status

	Category	**Deficient**		**Marginal**		**Sufficient**	
	Depth	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**	**0-15cm**	**15-30 cm**
DTPA Fe (mg kg-1)	No. of orchards	8	18	42	32	00	00
	%	16	36	84	64	00	00
DTPA Mn (mg kg-1)	Category	Deficient		Marginal		Sufficient	
	No. of orchards	00	00	11	16	39	34
	%	00	00	22	32	78	68
DTPA Zn (mg kg-1)	Category	Deficient		Marginal		Sufficient	
	No. of orchards	44	49	6	1	00	00
	%	88	98	12	2	00	00

DTPA Cu (mg kg-1)	Category	Deficient		Marginal		Sufficient	
	No. of orchards	23	30	16	12	11	8
	%	46	60	32	24	22	16

Table 5: Categorization of pomegranate orchards for macronutrient status in Leaves

Total N	**Category**	**Low**	**Medium**	**High**
	No. of orchards	**00**	**06**	**44**
	%	**00**	**12**	**88**
Total P	Category	Low	Medium	High
	No. of orchards	16	05	29
	%	32	10	58
Total K	Category	Low	Medium	High
	No. of orchards	00	02	48
	%	00	04	96

Table 6: Categorization of pomegranate orchards based on micronutrients content in Leaves

Available – Fe (mg kg-1)	**Category**	**Deficient**	**Marginal**	**Sufficient**
	No. of orchards	**00**	**34**	**16**
	%	**00**	**68**	**32**
Available – Mn (mg kg-1)	Category	Deficient	Marginal	Sufficient
	No. of orchards	00	48	02
	%	00	96	04
Available – Zn (mg kg-1)	Category	Deficient	Marginal	Sufficient
	No. of orchards	21	29	00
	%	42	58	00
Available – Cu (mg kg-1)	Category	Deficient	Marginal	Sufficient
	No. of orchards	39	11	00
	%	78	22	00

Table 7: Correlation between soil parameters and leaf nutrient content

Soil parameter	**Leaf nutrient parameter**						
	Total N (%)	**Total P (%)**	**Total K (%)**	**Total Zn**	**Total Cu**	**Total Fe**	**Total Mn**
P^H	- 0.159	- 0.080	0.066	0.094	0.144	- 0049	0.091
EC	0.068	0.164	- 0.090	0.213	0.041	0.250	- 0.086
OC	0.136	0.133	- 0.047	-0.29	0.002	0.251	- 0.026
$CaCO_3$	- 0.249	0.142	0.001	-0.002	0.108	- 0.063	0.349*

(* star denotes significant correlation at 0.005 level)

Conclusion

The pomegranate soils of Marathwada region are neutral to alkaline in reaction and the electrical conductivity of soil was in safe limit for the crop growth. The organic carbon content was low to high. Soils of pomegranate orchards were calcareous in nature, low in available nitrogen, low to medium in available phosphorus and high in available potassium. The exchangeable calcium and magnesium were medium to high range. While available sulphur was ranged from medium to high category. The DTPA Fe and Zn were in low to medium in content, while DTPA Mn and Cu were low, medium and high in content.

Pomegranate leaves were medium to high in total nitrogen content whereas, total phosphorus and potassium was in low to high concentration. The micronutrient viz., Total Zn, Cu, Fe, Mn in pomegranate leaves were medium to high in total Fe and Mn. Whereas, low to medium in total zn and cu content.

Pomegranate leaf content was sufficient for nitrogen and potassium but deficient in Phosphorus content. The leaf micronutrients *viz.*, zinc and copper were found to be deficient in leaves even as, leaf iron and manganese were sufficient in pomegranate leaves. Leaf Mn showed positive and significant relationship with $CaCO_3$ content of soil.

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