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Survey on quality and yield parameters of pomegranate orchards along with the correlation coefficient of soil parameters among the quality of fruits and leaf nutrient status in Jalna district

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Abstract
Nutrient depletion has become more pronounced consequent to other exploitation of natural resources to meet the food requirement in view of an ever-increasing population. It is therefore important to examine the fertility status of soils from time to time. A systematic investigation was conducted on soil fertility status of the low and high yielding pomegranate orchards in Jalna district. Fifty pomegranate orchards were surveyed during 2016-17. The yield of pomegranate fruits obtained from selected pomegranate orchard was in between 7.82 t ha^{-1} to 45.67 t ha^{-1} with an average 23.23 t ha^{-1}.TSS and reducing sugar were positively significant with $CaCO_3$ and soil pH, respectively. Leaf Mn was showed positive and significant relation with exchangeable Na^{+s} and Zn content of soil. The better management practices by the farmers ensure higher yields.

Keywords: Quality, yield parameter, correlation coefficient, pomegranate, Jalna

1. Introduction
India ranks first in the world with respect to Pomegranate area and production. It is an ideal crop for the sustainability of small holdings because of its adaptability to topography, soil and agro-climatic condition prevailing in arid and semiarid regions of India. Climate change has resulted in low productivity of some high value crops like apple, forcing the growers to shift to crops like Pomegranate, which are suitable for arid and semiarid regions facing water scarcity condition.

In India major Pomegranate producing states are Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Rajasthan. Maharashtra is in the leading state with 90 thousand ha area with annual production of 9.45 lakh Mt tones and productivity of 10.5 Mt/ha. Maharashtra state accounts for 78 per cent of the total area in India and 84 per cent of the total production in the country. Though area and production is more in Maharashtra, Tamil Nadu state rank first in productivity with 32.7 Mt/ha. The prominent pockets where Pomegranate cultivated area are concentrated are Solapur, Nashik, Sangli, Satara and Ahmednagar districts of western region of Maharashtra while, new pockets are also emerging from Marathwada region mainly from Osmanabad, Aurangabad, Jalna, Jalna and Beed districts. In these districts majority of the land was barren and soils are very light where the cultivation of field crops and other horticultural crops was not economically viable. By growing Pomegranate in these area farmers not only brought barren lands under cultivation but also harvested quality fruits. Famers are fetching good prices in the local as well as international market. An AEZ (Agricultural Export Zones) for Pomegranate has been set up in districts of Solapur, Sangli, Ahmednagar, Pune, Nasik, Osmanabad and Jalna for integrated development of this crop.

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. Multi-nutritional 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 nutrients.

Mineral nutrition plays an important role in influencing the quality of fruits and it is fact that the soil health deteriorates due to continuous use of chemical fertilizer.

In India, more than 70% of the total production is used as table purpose and there is a high demand of fresh fruits both in domestic and international market. For higher production of quality fruits in a sustainable manner application of nutrients at proper doses is very important. It is reality that proper dose of nutrients to be standardized for a set of agro-climatic conditions which in turn to be economically acceptable, viable and eco-friendly suitable. In India, most of the fertilizer recommendations in Pomegranate is on the basis of higher quantity of inorganic fertilizers. Use of such higher quantity of N, P and K although helpful for increasing the production but may have dangerous effect on the soil environment.

In Jalna district Pomegranate is grown on different soil types viz. very deep soil, moderately deep soil, shallow and very shallow soil. The present yield of heavy textured soil is much below the optimum yield. The suitability of soil and economic viability are the two important aspects which can guide the farmer's improper site selection and management of Pomegranate orchards to bring down the cost of production. In order to increase the area under production of Pomegranate, it is necessary to take up the intensive study of soil to ascertain soil parameter responsible for influencing productivity. For increasing the productivity and quality of fruit, it should have suitable for soil quality and environment and it is of prime importance to characterize and evaluate the soil site characteristics which are dynamic and complex attributes that directly influence the growth and performance of Pomegranate.

2. Material and Methods

Collection of Fruit Samples

The ten fruits were collected from each orchard at maturity during March-2016. The collected fruits were used for chemical analysis.

2.1 Quality Parameters

2.1.1 Total soluble solids (TSS) Total soluble solids (°Brix) was determined with the help of digital refracto meter and values were corrected to 20 °C with the help of temperature correction chart (AOAC. 1975) [1].

2.1.2 Reducing Sugars (%)

Reducing sugar was estimated by using Nelson Smogyi method. In this method DNS reagent used and absorbance was noted at 540 nm and accordingly graph plotted by standard glucose solution.

2.1.3 Titrable Acidity (%)

The acidity of fruit was determined by titrating by a known quality of sample diluted with water against standard sodium solution using phenolphthalein indicator and expressed in percentage as citric acid (AOAC, 1975) [1].

2.2 Yield

2.1 Yield per hectare (t)

The yield data was collected from farmers field (Randomly five plants were finalized and ten fruits per plant were collected for manipulation of yield data).

2.3 Statistical analysis

Correlation study was undertaken to find out the relation of soil parameter with yield and quality of pomegranate as per procedure described by Pause and Sukhatme (1967) [5].

3. Results

3.1 Yield and quality of pomegranate orchards

The results regarding yield and quality were recorded and presented in Table 1 and 2.

3.1.1 Yield of pomegranate

The data (Table 1) indicated that the yield obtained from selected pomegranate orchards for study was found in between 7.82 t ha-1 to 45.67 t ha-1 with an average 23.23 t ha-1 of district. The highest (45.67 t ha-1) yield of pomegranate was recorded in orchard JPO-13 and JPO-28 which was followed by the orchard JPO-3 (38.66 t ha-1). However, the lowest (7.82 t ha-1) yield was recorded in orchard JPO-12 from. The lowest yield (7.82 t ha-1) in JPO-12 could be due to wider spacing and production of less number of fruits along with faulty orchard management practices might have resulted in reducing the yield level. Such type of variations in yield were also reported by Reddy *et al*. (2003) [8], Patil (2010) [6] in Mango, Rathore *et al*. (2012) [7] and Singh and Kumar (2012) [11] in pomegranate and ber orchards from Rajasthan. On the basis of categorization, the data (table 15) revealed that out of 50 orchards studied, 11 (22%) orchards were found in category A. while, 36 (72%) and 3 (6%) orchards were found under category B and C, respectively. Such type of result studied by Roman (2015) [9].

3.1.2 Quality of pomegranates

The data regarding chemical quality parameter of fruits from different pomegranate orchards are presented in Table 2. The results showed significant variations in all the parameters.

3.1.2.1 Total soluble solids (0 Brix)

As regards the total soluble solids, significant variations in TSS of fruits was observed. The highest TSS (17.5 0Brix) was recorded in pomegranate fruits collected from orchard JPO-20 and JPO-24, respectively and the lowest TSS (14.0 0Brix) was noted in fruits collected from orchard JPO-32 and JPO-44, respectively with mean value of 15.92 0Brix.

Table 1: Yield of pomegranate fruit from selected orchard of Jalna district

S. No.	Orchard No.	Variety	Area (ha)	Yield (t ha-1)
1	JPO-1	Bhagwa	1.00	33.81
2	JPO-2	Bhagwa	1.60	25.52
3	JPO-3	Bhagwa	0.80	22.91
4	JPO-4	Bhagwa	1.00	22.94
5	JPO-5	Bhagwa	2.80	28.42
6	JPO-6	Bhagwa	1.20	8.82
7	JPO-7	Bhagwa	0.40	31.57
8	JPO-8	Bhagwa	0.80	28.63
9	JPO-9	Bhagwa	1.20	29.08

10	JPO-10	Bhagwa	0.60	20.24
11	JPO-11	Bhagwa	0.80	15.68
12	JPO-12	Bhagwa	0.80	7.82
13	JPO-13	Bhagwa	1.20	45.67
14	JPO-14	Bhagwa	1.60	24.69
15	JPO-15	Bhagwa	1.00	18.40
16	JPO-16	Bhagwa	2.80	19.98
17	JPO-17	Bhagwa	1.60	23.22
18	JPO-18	Bhagwa	0.80	22.42
19	JPO-19	Bhagwa	0.80	21.68
20	JPO-20	Bhagwa	1.20	8.45
21	JPO-21	Bhagwa	0.40	11.62
22	JPO-22	Bhagwa	0.40	30.06
23	JPO-23	Bhagwa	0.80	38.66
24	JPO-24	Bhagwa	1.00	17.04
25	JPO-25	Bhagwa	0.80	15.79
26	JPO-26	Bhagwa	0.80	13.2
27	JPO-27	Bhagwa	0.80	17.2
28	JPO-28	Bhagwa	1.20	45.67
29	JPO-29	Bhagwa	2.80	31.72
30	JPO-30	Bhagwa	1.00	35.81
31	JPO-31	Bhagwa	1.60	25.69
32	JPO-32	Bhagwa	0.40	33.27
33	JPO-33	Bhagwa	2.80	15.99
34	JPO-34	Bhagwa	0.80	35.66
35	JPO-35	Bhagwa	1.00	17.05
36	JPO-36	Bhagwa	2.80	29.57
37	JPO-37	Bhagwa	0.60	20.24
38	JPO-38	Bhagwa	0.80	30.12
39	JPO-39	Bhagwa	0.80	22.25
40	JPO-40	Bhagwa	1.60	24.12
41	JPO-41	Bhagwa	0.80	15.67
42	JPO-42	Bhagwa	1.00	20.05
43	JPO-43	Bhagwa	0.40	11.35
44	JPO-44	Bhagwa	0.40	22.43
45	JPO-45	Bhagwa	0.80	25.11
46	JPO-46	Bhagwa	1.00	17.22
47	JPO-47	Bhagwa	2.80	29.57
48	JPO-48	Bhagwa	1.00	16.22
49	JPO-49	Bhagwa	1.00	19.18
50	JPO-50	Bhagwa	0.80	14.12
-	Range	-	-	7.82-45.67
-	Mean	-	-	23.23

(*JPO-Jalna Pomegranate Orchard)

Firake and Kumbhar (2002) [2] found that TSS ranged from 17.10 to 18.75 0Brix, in orchards of M.P.K V Rahuri. Rathore *et al*. (2012) [7] and Singh and Kumar (2012) [11] also reported similar results which are in conformity with present findings of present study.

3.1.2.2 Acidity (%)

In fruit acidity, the significant variations were observed. The highest acidity of fruits (0.79%) was recorded in fruits collected from orchard JPO-39 and the lowest acidity (0.24%) was noted in fruits collected from orchard JPO-16 Samdia and Pareek (2006) [10] observed that acidity ranged from 0.34 to 0.59 per cent in the hybrids of pomegranates under hot arid climate. and Singh and Kumar (2012) [11] also reported similar results in Ganesh varity of pomegranate.

3.1.2.3 Reducing sugars (%)

The data on reducing sugar indicated that the maximum (14.80%) reducing sugars was recorded in fruits collected from orchard JPO-16. While, it was minimum (10.01%) in fruits collected from orchard JPO-26 and JPO-49, respectively. Ghosh *et al*. (2012) [3] found that reducing sugar (9.0 to 12.0%) were recorded significantly in pomegranate growing orchards of Midnapore district of West Bengal. Kazi *et al*. (2012) [4] reported that reducing sugar of sweet orange ranged from 0.86 to 1.0 per cent in the year 2007 while 1.6 to 2.5 per cent respectively during 2008 on Inceptisol of Aurangabad district of Maharashtra. Firake and Kumbhar (2002) [2] reported similar results which are in conformity with present findings.

Table 2: Quality parameters of pomegranate fruit orchards in Jalna district

S. No	Orchard No.	TSS (%)	Acidity (%)	Reducing Sugars (%)
1	JPO-1	16.0	0.72	11.96
2	JPO-2	17.0	0.59	12.90
3	JPO-3	17.0	0.70	12.95
4	JPO-4	15.0	0.64	12.65
5	JPO-5	14.3	0.62	10.23
6	JPO-6	15.5	0.71	10.65
7	JPO-7	16.0	0.73	10.10
8	JPO-8	15.0	0.59	12.63
9	JPO-9	16.0	0.57	13.11
10	JPO-10	17.0	0.67	14.80
11	JPO-11	16.5	0.47	11.72
12	JPO-12	16.0	0.48	12.75
13	JPO-13	14.3	0.45	12.12
14	JPO-14	15.5	0.37	10.50
15	JPO-15	17.0	0.29	11.48
.16	JPO-16	16.0	0.24	12.00
17	JPO-17	16.5	0.30	11.49
18	JPO-18	17.0	0.41	10.48
19	JPO-19	17.0	0.46	11.50
20	JPO-20	17.5	0.41	13.48
21	JPO-21	15.5	0.43	12.00
22	JPO-22	15.0	0.64	13.28
23	JPO-23	16.5	0.76	12.42
24	JPO-24	17.5	0.62	10.01
25	JPO-25	14.3	0.69	11.42
26	JPO-26	14.5	0.42	14.80
27	JPO-27	16.5	0.69	13.42
28	JPO-28	16.0	0.65	13.48
29	JPO-29	16.0	0.68	14.28
30	JPO-30	15.5	0.59	10.28
31	JPO-31	14.5	0.72	10.12
32	JPO-32	14.0	0.78	14.00
33	JPO-33	16.5	0.62	12.75
34	JPO-34	17.0	0.73	11.40
35	JPO-35	16.5	0.72	12.42
36	JPO-36	16.0	0.59	10.42
37	JPO-37	15.5	0.65	10.48
38	JPO-38	15.0	0.78	11.50
39	JPO-39	15.5	0.79	13.09
40	JPO-40	16.5	0.67	12.00
41	JPO-41	17.0	0.42	13.21
42	JPO-42	16.3	0.47	11.50
43	JPO-43	17.0	0.78	10.07
44	JPO-44	14.0	0.72	10.12
45	JPO-45	16.0	0.49	11.50
46	JPO-46	15.0	0.55	10.50
47	JPO-47	15.5	0.55	12.79
48	JPO-48	15.5	0.68	11.70
49	JPO-49	14.3	0.62	14.80
50	JPO-50	17.0	0.69	12.90
-	Range	14.0-17.5	0.24-0.79	10.01-14.80
-	Mean	15.88	0.59	12.04

3.2 Correlation coefficient between soil parameters and quality of fruits

The data pertaining to correlation coefficient between soil parameters and fruit quality of pomegranate are tabulated in Table 3. The data indicated that correlation coefficient between soil parameters and quality of fruits were affected significantly as well as non-significantly.

TSS could established positive and significant correlation with CaCO3 which is evident by "r" values 0.3147*. It showed the positive relationship with pH, OC, Bulk density, N, P, K, exchangeable Ca++ and Mg++ whereas, showed negative relationship with EC, CEC, exchangeable Na+ Fe, Mn and Cu but not reach to the significant level. The data further revealed that acidity of fruit with soil parameters not reach to the significant level totally. In case of reducing sugar, only soil pH reach to the significant level with 'r' value 0.3090*. It means soil pH showed positively significant correlation with reducing sugar of fruits. On the other hand, soil parameters viz; EC, $CaCO_3$, bulk density and micro nutrients showed positive correlation with reducing sugar. Whereas, OC, CEC, N, P, K, exchangeable Ca^{++}, Mg^{++}, Na^{+} and K^{+} showed negative correlation but not reach to the sufficient level. These results are in conformity with findings of Roman (2015) [9] who reported that positive significant correlation of P with fruit quality parameters like positive correlation of P with TSS of fruit, reducing sugar and total

sugar. pH and EC has positive correlation with non-reducing sugars. Whereas, N, P and K showed significant positive correlation with TSS, reducing sugar, non-reducing sugar and total sugar and had negative correlation with acidity of fruits. Zn had negative correlation with reducing sugars. Mn and Cu had negative correlation with TSS, reducing sugars and total sugars. Ca had positive correlation with TSS and non-reducing sugars. B had negative correlation with acidity and non-reducing sugars.

Table 3: Correlation coefficient between soil parameters and quality of fruits

Soil Parameters	Quality of fruits		
	TSS	Acidity	Reducing Sugars
pH	0.0273	-0.1570	0.3090*
EC	-0.1000	0.1041	0.2391
OC	0.1465	-0.1229	-0.0491
CaCO3	0.3147*	0.2302	0.0514
BD	0.0734	0.0759	0.2546
CEC	-0.0366	0.1691	-0.0849
N	0.0952	-0.2401	-0.0055
P	0.0979	-0.0809	-0.2089
K	0.0577	-0.0554	-0.0800
Ex. Ca	0.0537	0.1472	-0.1173
Ex. Mg	0.0155	0.0701	-0.0479
Ex. Na	-0.1000	0.1274	-0.2371
Ex. K	-0.3468	0.0462	-0.1122
Zn	-0.0606	-0.0989	0.0305
Fe	-0.0768	-0.0154	0.2075
Mn	-0.0116	-0.1054	0.0229
Cu	-0.0959	-0.0301	0.1312

4. Conclusion

TSS and reducing sugar were positively significant with $CaCO_3$ and soil pH, respectively. Leaf Mn was showed positive and significant relationship with exchangeable Na^{++} and Zn content of soil.

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