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INFLUENCE OF SOIL NUTRIENT STATUS ON YIELD AND QUALITATIVE ATTRIBUTES OF POMEGRANATE (*Punica granatum* L.) AND BER (*Zizyphus mauritiana* LAMK.)

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ABSTRACT: Pomegranate and ber are important fruits find favour especially in arid/ semi-arid areas of tropics all across the globe. Bright sun-shine and light soil offer premium quality in harvest unmatching to the harvest obtained from any where else in the world. However, the share of India in world trade is abysmally low. Quality of the produce matching to international standard is proved as the hard impediment in this regard. It is obvious that the quality of produce depends a lot upon the inherent fertility and productivity of soil. To have an account of all such factors study was undertaken selecting ten representative orchards of pomegranate cv. Ganesh and also of ber cv. Gola of Bikaner district and it was attempted to study the inherent nutrient status of orchards and its impact on physicochemical characteristics of fruits. Soil samples were collected from each orchard from 0-60 cm soil depth. From the investigation it was found that the level of organic carbon, nitrogen, zinc, phosphorus and sulphur was low to medium and potassium content was in medium range in soils of selected sites in orchards in Bikaner district. All soil nutrients were found positively correlated with nutrient status of leaves, fruit yield and qualitative attributes of ber except phosphorous and zinc contents in leaves.

Keywords : *Soil nutrient status, inherent fertility, yield, quality, fruit crops.*

The growth and production of fruit crops depend a lot upon the nutrient status of the soil. This holds especially true for arid region where sandy soils with poor inherent fertility status are predominantly distributed. Working out available nutrient status of the soil become further necessary as in stress environment where sunshine is harsh and humidity is bare minimum, the growth and production of fruit crops become a serious constraint. However, fruit crops being tolerant to hardy climate and amenable to growth even under stress atmospheric conditions, preference is given to grow them. In the study area of Bikaner, sandy soils are major soil type. These soils are characterized by very poor in organic carbon, nitrogen and zinc. Even though, farmers cultivate the fruit crops without taking additional care for available nutrient status of soil. It is also a matter of investigation that how nutrient status affect yield and qualitative attributes, how much relation exist between soil fertility status and yield and qualitative attributes etc.

With such considerations, under present investigation an attempt was made to determine available nutrient status of orchards and their impact on yield and qualitative attributes of fruits of pomegranate cv. Ganesh and also of ber cv. Gola.

MATERIALS AND METHODS

The leaves and soil samples were collected from well grown 10 orchards of the pomegranate cv. Ganesh and also of ber cv. Gola during the month of July to August 2003 and fruit samples were collected as per the maturity of fruits (December –January 2004) from the same orchards of Bikaner district. The soil and leaf samples were air dried, ground and passed through 2 mm sieve and subjected to various analyses. The experiment was laid out in a Completely Randomized Design with 10 treatments and three replications. The amount of organic carbon in soil was determined by Walkely and Black's (23) rapid titration method, available nitrogen by Alkaline Potassium Permagnate method as suggested by Subbiah and

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Asija (20), available phosphorus by Olsen *et al.* (16) and the method as suggested by Metson (13) and available sulphur by extracting the soil using mono calcium phosphate solution, as suggested by Chesnin and Yien (7). Available zinc in soil and plant was determined by DTPA extract estimation using Atomic Absorption Spectrophotometer as suggested by Lindsay and Norwell (12).

Estimation of nitrogen in plant samples was done with wet digestion of plant samples with H_2SO_4 and H_2O_2 by Colorimetric method using Spectronic -20 after development of colour with nessler's reagent as suggested by Snell and Snell (18), phosphorus with the wet digestion of plant samples with triacid mixture using vanado molybodphosphoric acid yellow colour method on spectrophotometer as suggested by Jakson (10), potassium by flame photometer as suggested by Bhargava and Raghupathi (5), available sulphur by digesting the plant leaves with nitric and perchloric acid and the sulphate content was determined turbidititimetrically as $BaSO_4$ by barium chloride gelatin procedure as suggested by Tabatabai and Bremner (21). Ten fruits from each tree were taken randomly at the time of harvesting and weighed and measured for recording fruit length and breadth. Total soluble solids (^{o}Brix) of selected fruits was observed using Hand Refractometer of 0-30 per cent range (AOAC, 1). Estimation of total sugar content was done by colorimetric method using anthrone reagents as suggested by Dubios *et al.* (8). Acidity was analyzed by diluting the known volume of juice and titrating the same against N/10 NaOH, using phenolphthalein as indicator (AOAC, 1). Pulp percentage was known after weighing the total fruit and deducting the weight of stone. Pulp to stone ratio in case of ber was worked out by dividing pulp weight by stone weight.

RESULTS AND DISCUSSION

Yield and qualitative attributes of pomegr- anate under influence of soil nutrient status

Data related to the electrical conductivity of soils of pomegranate orchards of Bikaner district is presented in Table 1. The mean value of EC was recorded as 0.16 dSm ^{1}. The minimum 0.053 dSm ^{1} and maximum 0.303 dSm ^{1} value of EC were recorded in orchards of Gadwala-II and Husansar –II, respectively. As per the limit given by Muhr *et al.* (14), the soil was categorized into three categories having EC of <1, 1-2 and >3 and dSm ^{1} identifying normal, critical for germination and severely injurious to crops. On the basis of those limits, all samples of pomegranate orchards were in the category of normal soils. It might be due to the application of canal irrigation water and sandy texture of the soils. Also in most of the tube well's the water quality was found good in the study area. The organic carbon is a very important from fertility point view. The maximum 0.21 per cent and minimum 0.10 per cent values of organic carbon were observed in orchards of Nokha and 13 JMD, respectively with the mean value of 0.17 per cent. As per the rating given by Muhr *et al.* (14), the soils having <0.5 per cent organic carbon were categorized under low category. All orchards were found low in organic carbon content of the soils appeared to be mainly due to the sandy nature soil and hot arid climate in the study area. Low organic carbon content, absence of the vegetation and excessive sand drift from the upper soil surface due to the high wind erosion in the area. The results are in complete agreement with the findings of Kameriya (11).

Data as regard to available soil nutrient status of pomegranate orchards as presented in Table 1 indicates the mean value of nitrogen content in soil as 82.41 ha ^{1}. The minimum 60.75 kg ha ^{1} and maximum 102.60 kg ha ^{1} contents of nitrogen were recorded on orchards of Husansar-I and Nokha, respectively. As per the rating given by Tandon (22) the soils having <125 kg ha ^{1} nitrogen were categorized under low category. All the soil samples were found low in available nitrogen content in the study area. The low available nitrogen content in all the soil samples had been due to the absence of natural vegetation, low organic carbon along with other climate and edaphic factors. The results of the present

Table 1: EC, soil organic carbon, available nitrogen, phosphorus, potassium, sulphur and zinc status of different locations of pomegranate cv. Ganesh orchards of Bikaner district.

Treatments (Orchard Location)	EC (dSm ^{1})	Organic Carbon (%)	Nitrogen (Kg ha ^{1})	Phosphorus (Kg ha ^{1})	Potassium (Kg ha ^{1})	Sulphur (Kg ha ^{1})	Zinc (Kg ha ^{1})
Gadwala-I	0.057	0.198	99.00	14.91	137.16	16.00	0.32
Gadwala-II	0.053	0.186	83.70	14.62	136.28	13.50	0.32
Husansar-I	0.077	0.135	60.75	10.92	81.46	9.00	0.23
Husansar-II	0.303	0.207	93.15	25.37	142.21	16.28	0.35
Husansar-III	0.190	0.189	78.30	13.17	123.64	11.27	0.21
Raisar	0.180	0.174	85.05	23.50	136.16	13.75	0.26
13 JMD	0.187	0.100	70.00	19.23	130.00	15.65	0.40
Khichia	0.077	0.153	68.85	11.46	120.00	12.45	0.49
Nokha	0.170	0.210	102.60	10.39	116.33	11.72	0.38
Bikaner	0.190	0.192	87.70	**15.45**	**126.33**	**1**8.00	0.40
Average	0.160	0.170	82.41	15.90	125.02	13.76	0.33
CD(P=0.05)	0.019	0.016	8.22	1.774	6.32	1.530	0.033
CV(%)	4.84	5.47	5.86	6.55	2.97	6.54	5.87

investigation are in accordance with those as reported by Arora *et al.* (3). Data related to available phosphorus are presented in Table 1. The range of it varied from 10.39 to 25.37 kg ha ^{1} with the mean value of 15.90 kg ha ^{1}. The maximum value was recorded in the orchard of Husanasar-II and minimum in the orchard of Nokha. The rating as suggested by Tandon (22), the soils having <10.26 kg ha ^{1} phosphorus have been categorized under low while those having phosphorus 10.26 to 25.85 kg ha ^{1} falls under medium category. All samples were sufficient in phosphorous content. The results of present investigation are similar to those reported by Sacheti and Saxena (17).

The data pertaining to available potassium (Table 1) indicate that the mean value of available potassium content of soil was 125.02 kg ha ^{1}. The minimum 18.46 kg ha ^{1} and maximum 142.21 kg ha ^{1} values of potassium were recorded in the orchards of Husansar-I and Husansar –II, respectively. All soil samples were found medium in available potassium content as per the classification given by Tondon (22). The medium status of potassium may be due to the presence of potassium bearing minerals like muscovite, biotite and feldspar (Ghosh and Hassan, 9).

Table 1 indicates that the average value of available sulphur in soils of these orchards was 13.76 ppm. The minimum 9.00 ppm and maximum 18.00 ppm values of sulphur were recorded in the orchards of Husansar –I and Bikaner, respectively. The above findings are similar to findings of Bhatanagar (6).

It is evident from the data (Table 1) that available zinc content in orchards of study area ranged from 0.21 to 0.53 ppm with the mean value of 0.32 ppm. The maximum and minimum values were recorded in the orchards of Nokha and Khichia, respectively. As per the rating given by Tandon (22), the soils having less than 0.6 ppm of zinc falls under low category. Thus, all the soils of orchards was under low available zinc content. Similar findings were reported by Seth *et al.*(19).

The data related to nutrient content in leaves are presented in Table 2. The maximum content of nitrogen (1.056 per cent), phosphorus (0.276 per cent), potassium (1.584 per cent), and sulphur (0.211 ppm) were recorded in the leaves of Husansar-II orchard and maximum zinc (23.00 ppm) in the plants of Raisar and 13 JMD orchards. The minimum nitrogen (0.928 per cent) and potassium (1.392 per cent were recorded in plant leaves of orchard of 13 JMD, phosphorus (0.184) in orchards of Bikaner, sulphur (0.188 ppm) in plant leaves in orchard at Raisar and zinc (9.25 ppm) in plant leaves of orchard of Husansar-III. The mean value of nitrogen, phosphorus, potassium, sulphur and zinc were 0.990 per cent, 1.475 per cent, 0.197 ppm and 18.55 ppm, respectively.

It is revealed (Table 3) that the fruit weight varied significaltly in different orchards due to spacially zinc differences and prevailing soil conditions in the study area. The maximum fruit weight (243.30 g) was recorded in the fruit of orchard of Gadwala-I whereas, minimum fruit weight (88.33 g) was recorded in the fruit orchard of Husansar-I. The recorded average fruit weight was 197. 67 g. These findings are similar to that of Bhatanagar (6).

Data related to total soluble solids (TSS) under different locations of orchards of Bikaner district are presented in Table 3. The maximum total soluble solids of 15.99 °Brix and minimum 10.44 °Brix were recorded in the orchard of Husansar-II and Gadwala-II, respectively with the mean value of 13.76 °Brix.

The maximum organic acid (0.457 per cent) was found in juice of fruit of pomegranate at Raisar orchard whereas, minimum acid content (0.300 per cent) was recorded in fruits of Husansar-II orchards with mean value of 0.400 per cent (Table 3). These results are in accordance with the findings of Aggarwal and Chandra (2) who reported total acidity of cv. Ganesh varying from 0.420–0.500 per cent.

Data related to percentage of sugar in fruits of study area varied from 7.84 to 8.65 per cent with mean value of 8.22 per cent. The maximum and minimum sugar contents were recorded in Husansar-II and Bikaner respectively. These results are similar to the findings of Bhatanagar (6).

The maximum, minimum and average value

Table 2: Nitrogen, phosphorus, potassium, sulphur and zinc content of pomegranate cv. Ganesh leaves on orchards of Bikaner district.

Treatments (Orchard Location)	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Sulphur (ppm)	Zinc (ppm)
Gadwala-I	1.015	0.259	1.521	0.203	17.00
Gadwala-II	1.011	0.245	1.516	0.202	17.25
Husansar-I	0.976	0.196	1.463	0.195	16.50
Husansar-II	1.056	0.276	1.584	0.211	20.00
Husansar-III	0.979	0.230	1.411	0.192	9.25
Raisar	0.959	0.222	1.438	0.188	23.00
13 JMD	0.928	0.226	1.392	0.186	23.00
Khichia	0.990	0.203	1.424	0.190	20.00
Nokha	1.028	0.257	1.541	0.205	22.50
Bikaner	0.972	0.184	1.459	0.194	17.00
Average	0.990	0.230	1.475	0.197	18.55
CD(P=0.05)	0.58	0.021	0.201	0.013	1.620
CV(%)	3.46	5.48	4.02	4.02	5.16

of aril percentage were 73.00 per cent, 56.67 per cent and 64.67 per cent, respectively in study area (Table 3). Similar findings have also been reported by Bhatanagar (6).

The maximum (52.00 per cent) and minimum (35.68 per cent) juice contents were recorded in fruits of Husansar-II and Husansar-I, respectively with the mean value of 44.67 per cent (Table 3). These results are similar to the findings of Bhatanagar (6).

Yield and qualitative attributes of ber under influence of soil nutrient status

Data as regard to available organic carbon, nitrogen, phosphorus, potassium, sulphur and zinc in ber orchard are presented in Table 4. The mean value of organic carbon was 0.18 per cent, nitrogen 86.05 kg ha ^{1}, phosphorous 14.11 kg ha ^{1}, potassium 130.73 kg ha ^{1}, sulphur 12.13 ppm and that of zinc was 0.32 ppm. Among all the orchards of the study area, the maximum organic carbon content of 0.22 per cent was found at Gadwala orchard. The maximum nitrogen content 111.00 kg ha ^{1}, P 16.46 kg ha ^{1}, K 156.00 kg ha ^{1} and S 13.86 ppm were found in orchard of Pemasar and the maximum zinc content of 0.53 ppm was found in the orchard at Nokha. However, the maximum N content 52.50 kg ha ^{1}, P 8.84 kg ha ^{1} and S 9.38 ppm were found in orchard of Sagar–I. In respect to organic carbon the value was 0.11 per cent. K 108.00 kg ha ^{1} and Zn 0.18 ppm in the orchard of Raisar- I.

The data related to nutrient content in leaves are presented in Table 5. The maximum nitrogen

Table 3: Fruit weight, T.S.S., acidity, total sugars, aril percentage and juice percentage of fruit of pomegranate cv. Ganesh orchards of Bikaner district.

Treatments (Orchard Location)	Fruit Weight (g)	TSS (°Brix)	Acidity (%)	Total Sugar (%)	Aril (%)	Juice in Fruit (%)
Gadwala-I	243.30	13.31	0.410	8.44	70.67 (57.17)	50.67 (45.34)
Gadwala-II	158.32	10.44	0.408	8.17	59.33 (50.36)	39.33 (38.82)
Husansar-I	88.33	10.46	0.410	8.11	55.67 (48.22)	35.68 (36.63)
Husansar-II	243.00	15.99	0.300	8.65	73.00 (58.69)	53.00 (46.72)
Husansar-III	226.70	14.43	0.390	8.09	64.33 (53.31)	44.32 (41.67)
Raisar	171.67	15.69	0.457	8.05	59.33 (50.37)	39.33 (38.82)
13 JMD	238.33	13.17	0.390	8.39	67.67 (55.30)	47.67 (42.62)
Khichia	228.31	14.69	0.380	7.95	65.00 (53.73)	45.00 (42.13)
Nokha	241.68	14.47	0.415	8.53	72.00 (58.05)	52.00 (46.15)
Bikaner	135.00	15.00	0.390	7.84	59.67 (50.53)	39.67 (39.00)
Average	197.67	13.76	0.400	8.22	64.67	44.67
CD(P=0.05)	22.79	1.62	0.043	0.441	4.45	4.45
CV(%)	6.77	6.94	6.32	3.15	4.04	5.85

Figures in parentheses indicate the angular transformed values.

(1.20 per cent) was noted in a orchard at Pemasar, phosphorous (0.279 per cent) in orchards of Raisar-II, potassium (1.99 per cent) and zinc (11.00 ppm) in the plant leaves of orchard at Sagar-I. Sulphur content was 0.22 ppm in the orchards at Napasar-II and minimum nitrogen (0.79 per cent) was there in orchard of Sagar-I, potassium content was 1.45 per cent in orchard of Nokha and zinc content was 6.15 ppm in orchard of Raisar-II with the mean value of N 1.01 per cent, P 0.23 per cent, K 1.81 per cent, S 0.20 ppm and Zn 7.98 ppm.

Data related to yield and qualitative attributes of ber cv. Gola are presented in Table 6. It is evident from the data that the fruit weight varied significantly in different orchards due to prevailing nutrient status of the soil condition in the study area. The maximum fruit weight (32.17 g), length (4.13 cm), T.S.S. (18.70 °Brix), pulp (94.66 %), pulp to stone ratio (17.88:1) and total sugar (10.24%) were found in orchards at Pemasar. The maximum fruit breadth (3.77 cm) was found in the orchards at Sagar-II and acidity (0.587 per cent) in the orchards at Nokha. The minimum fruit weight (14.45 g), breadth (1.97 cm), length (2.76 cm), T.S.S. (14.00 °Brix), pulp per centage (88.00 per cent), pulp to stone ratio (9.00 : 1) were noted in the orchard at Raisar – I. The fruit acidity was 0.50 per cent in the fruits in the orchard at Sargar-II and the total sugar contents was 8.84 per cent at the orchard of Sagar –I with the mean value of 22.39 g, 3.38 cm, 2.80 cm, 16.59 °Brix, 0.53 per cent, 8.4 per cent, 92.50 per cent and 13.24, respectively.

It is avident from the Table 4 that the low level of organic carbon, nitrogen and zinc may be mainly due to the sandy soil, high temperature, poor permanent vegetation, imbalanced use of nutrient and poor management of soil (Arora *et al.* 3). Phosphorous and sulphur were found in low to medium level. It may be possibly due to low organic carbon, low precipitation, sandy soil and changing cropping pattern (Bhandari, 4) in the study area. Medium level of potassium might be due to presence of potassium bearing minerals (Muscovite, Biotite and Feldspar) in the soil of study area.

All the soil nutrients were found positively correlated with all leaf nutrient and yield and qualitative attributes except phosphorous and zinc

Table 4: Available nitrogen, phosphorus, potassium, sulphur and zinc status of different locations of Ber orchards of Bikaner district.

Treatments (Orchard Location)	Organic Carbon (%)	Nitrogen (Kg ha ^{1})	Phosphorus (Kg ha ^{1})	Potassium (Kg ha ^{1})	Sulphur (ppm)	Zinc (ppm)
Gadwala–I	0.220	86.00	14.61	138.60	13.40	0.20
Napasar–I	0.210	94.50	15.80	140.67	10.94	0.35
Napasar–II	0.193	87.00	16.00	141.33	11.77	0.48
Napasar–III	0.193	87.00	13.94	110.33	12.00	0.20
Raisar–I	0.187	75.00	12.61	108.00	11.43	0.18
Raisar–II	0.113	80.00	13.58	125.53	11.21	0.30
Sagar–I	0.117	52.50	8.84	116.00	9.39	0.25
Sagar–II	0.213	96.00	14.68	137.34	13.86	0.21
Nokha	0.203	91.50	14.67	133.45	13.50	0.53
Pemasar	0.153	111.00	16.46	156.00	13.86	0.50
Average	0.180	86.05	14.11	130.73	12.13	0.32
CD(P = 0.05)	0.020	9.21	1.59	10.93	1.390	0.032
CV(%)	6.72	6.29	6.64	4.91	6.75	5.97

Table 5: Nitrogen, phosphorus, potassium, sulphur and zinc contents of Ber cv. Gola leaves on orchards of Bikaner district.

Treatments (Orchard Location)	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Sulphur (ppm)	Zinc (ppm)
Gadwala – I	0.910	0.264	1.672	0.186	7.40
Napasar –I	0.972	0.212	1.789	0.199	7.20
Napasar –II	1.116	0.210	1.982	0.220	7.47
Napasar –III	1.068	0.205	1.965	0.218	7.23
Raisar –I	0.891	0.205	1.899	0.211	7.37
Raisar – II	1.004	0.279	1.848	0.205	6.15
Sagar –I	0.992	0.200	1.997	0.220	6.87
Sagar –II	1.150	0.267	1.642	0.183	11.00
Nokha	0.793	0.214	1.459	0.162	8.40
Pemasar	1.200	0.271	1.863	0.207	10.73
Average	1.01	0.230	1.810	0.201	7.98
CD(P=0.05)	0.110	0.022	0.338	0.020	0.786
CV(%)	6.59	5.80	6.09	6.09	7.79

Table 6: Fruit quality attributes of ber cv. Gola orchards of Bikaner district.

Treatments (Orchard Location)	Fruit Weight (g)	Fruit length (cm)	Fruit breadth (cm)	TSS (°Brix)	Acidity (%)	Total Sugars (%)	Pulp Percentage (%)	Pulp to stone ratio
Gadwala-I	20.32	2.90	2.30	16.00	0.547	9.20	93.00 (74.66)	13.48:1
Napasar–I	18.64	3.31	1.97	18.50	0.533	9.68	91.66 (73.15)	11.03:1
ustrightNapasar–II	24.03	3.33	2.20	18.67	0.547	9.84	93.66 (75.35)	15.19:1
Napasar–III	22.52	3.16	2.67	15.00	0.520	9.36	92.33 (73.89)	12.22:1
Raisar–I	14.45	2.76	2.27	14.00	0.540	9.52	88.00 (69.73)	9.00:1
Raisar–II	24.42	3.63	3.63	15.67	0.520	9.44	92.66 (74.21)	12.69:1
Sagar–I	22.77	3.60	2.60	17.67	0.513	8.48	93.33 (75.00)	14.27:1
Sagar –II	23.10	3.96	3.77	16.33	0.507	8.81	93.33 (75.00)	14.59:1
Nokha	21.48	3.10	3.00	15.32	0.587	9.60	92.33 (73.89)	12.09:1
Pemasar	32.17	4.13	3.59	18.70	0.540	10.24	94.66 (76.56)	17.88:1
Average	22.39	3.38	2.80	16.59	0.530	9.41	92.50	13.24:1
CD(P=0.05)	3.02	0.56	0.43	1.33	NS	0.884	2.44	1.80
CV(%)	7.95	9.91	9.19	4.74	4.92	5.55	1.55	7.98

which were antagonistically related to each other (Nyak, 15).

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