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Study on nutrient status of aonla orchard soils in Sikar district of Rajasthan

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Abstract

Studies were conducted on the mineral nutrition status of aonla fruit orchards located in Sikar district of Rjasthan. Electrical conductivity was found to be in normal range and soil pH was in the high ranging from 7.70 to 9.18. The organic carbon content and available nitrogen of aonla orchard soils were found low whereas available phosphorus, available iron, zinc, copper, and manganese were found low to medium. Available potassium was found medium whereas available sulphur was found low in range. The soils were found medium to high in exchangeable Ca and Mg. There was wide variation found in the calcium carbonate percentage at different soil depths in orchards.

Key words: Aonla, orchards, nutrient status.

Introduction

India is second largest producer of fruits after china with 49.29 million tonnes production from 4.96 million ha area (Anonymous, 2005). India has large arid zone covering an area of 317090 sq. km scattered mainly in the north-west parts of country and Rajasthan alone covers 62.00 per cent of area under arid zone. In Rajasthan, fruit cultivation is practised over an area 19795 ha and total production is 238475 tonnes (Anonymous, 2005).The area of Sikar district forms a part of Thar desert which covers an area of 774244 square kilometres situated in the North Eastern Rajasthan. The district has moderate climate with seasonal temperature variation with scanty rainfall to the magnitude of 450-500 mm per annum during normal rainfall years. The high temperature (up to 48^{0}C) along with high wind velocity, low soil fertility status, low water retention capacity of soil, high soil pH, salinity, calcium carbonate concretion in sub soil etc. are hard impediment in successful cultivation of many fruit crops in arid region. Increasing the production of fruits thus has sufficient scope in arid region of Rajasthan. In Sikar district, the area under fruit crops is 0.002 lac ha with production of 0.02 lac metric tonnes (Anonymous, 2005). There is a vast potential of increasing area under fruit cultivation in arid region of Rajasthan provided irrigation facilities are available. These areas are suitable for cultivation of fruit crops such as aonla, ber, beal citrus, pomegranate etc. Presently Sikar district has nearly 2,12,096 lac hectares irrigated area through tube wells/wells. Irrigation facilities has opened great avenues for cultivation of fruit crops likes ber, aonla, bael, lime, pomegranate, datepalm, guava, jamun, karonda, phalsa etc, besides traditionally grown fruits such as Ker (*Capparis decidua*), Gonda (*Cordia myxa*), Pilu (*Salvadora oleiodes*), Khejri (*Prosopis cineraria*) etc. Inspite of all vagaries, the farmers of Sikar district has shown tremendous response towards fruit cultivation particularly of ber, bael, lime and aonla fruits.

Aonla is an important fruit crop which has high nutritive and medicinal value. It is one of the richest source of vitamin 'C' ranging from 500 to 1500 mg/100 g pulp (Chandra and Chandra, 1997). Fruits are also rich in pectin and minerals like iron, calcium, phosphorus. The aonla has been recommended by Ayurveda for balanced diet and sound health and is important ingredient of triphala and chavanprash. Due to multipurpose uses, the demand of aonla fruits is increasing day by day. Because of wide adaptive nature, this fruit crop is mainly grown on dry land and waste land soils where major nutrients are deficient and limited irrigation facilities are available. Its cultivation has become quite popular in arid irrigated regions of Rajasthan, owing to its high nutritive and medicinal value and having higher productivity even in the wasteland. It is also a value added horticultural crop which has bright future prospects for export, particularly to European countries.

In Indian fruit industry, poor nutrition is the major cause of low orchard efficiency resulting poor productivity and poor fruit quality. Sufficient information on nutrient management in fruit crops has been generated, but response and requirement of nutrients of perennial fruit crops vary markedly in a particular area depending on soil and climatic conditions and also depend on growth, bearing habit, age, root stock and management practices. Balanced nutrition of fruit crops is paramount importance particularly in arid areas having largely sandy soils of poor fertility status. For knowing the exact status of mineral nutrition in the fruit trees, survey of the orchards for their fertility status and plant nutrients is done. A number of nutritional surveys have been conducted on various fruit crops in northern and western states of the country viz., Punjab, Haryana, Himachal Pradesh and Maharashtra to study fertility status of soil. Studies on nutritional survey of arid fruits in Rajasthan are meagre inspite of their great importance and relevance. Therefore, present investigation was conducted to survey the fruit orchards in Sikar district of Rajasthan to gain information about their nutrient status.

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Materials and methods

A detailed soil survey during the year 2007-2008 was conducted in Sikar district of Rajasthan. Orchards were selected in such a way that these can represent general conditions of area under study. Eight orchards were selected covering different tehsils viz. Laxmangarh, Reengus, Danta Ramgarh and Piparali.The details of locations and name of the fruit growers are given below. Soil samples were collected from fruit orchards, on the basis of variability and orchard performance at different locations of Sikar district. Thereafter, from each selected orchards, three soil profiles, based on soil fertility variation and plant performance were taken up. The sampling was done in each profile up to depth of 120 cm i.e. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm. from orchards. The soil samples were analysed for organic carbon, available nitrogen, available phosphorus and available potash by Walkley and Black rapid titration method (Jackson, 1973), Alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Olsen *et al.*, 1954) and Flame photometer method (Jackson 1973), respectively. The available Fe, Cu, Zn, and Mn were extracted with DTPA solution as per Procedure of Lindsay and Norvell (1978) and were determined by atomic absorption spectrophotometry. Exchangeable Ca and Mg were determined by method given by Richards, 1954. Available sulphur was determined by the method given by Chesnin and Yien, 1957.

Name of fruit grower	Location	Tehsil
Shri Balbir Singh	Rashidpura	Laxmangarh
Shri Dana Ram	Rehnawa	Laxmangarh
Shri Raju Sen	Laxmangarh	Laxmangarh
Shri Puran Mal Shartma	Sargoth	Reengus
Shri Roopchand Pipliwal	Pachar-I	Danta Ramgarh
Shri Kana Ram	Pachar-II	Danta Ramgarh
Shri Panna Ram	Pachar-VI	Danta Ramgarh
Govt. Nursery	Palsana-I	Piparali

Results and Discussion

Organic carbon, electrical conductivity and pH of soil

The organic carbon status of aonla orchard soils was generally poor. It varied from 0.056 to 0.171 per cent with a mean value of 0.118 for all the depths. The data presented on organic carbon content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Muhr *et al.* (1963), the soils having organic carbon <0.5 per cent organic carbon have been categorized under low category. All the aonla orchard soils were found low in organic carbon content. Low content of organic carbon in the soils of Sikar district appears to be mainly due to the type of climate of the region. It is difficult to build up organic matter in the soils of arid regions on account of high temperature which causes rapid oxidation of organic matter.

The electrical conductivity of aonla orchard soils ranged from 0.050 to 0.360 dsm^{-1} with a mean value of 0.189 dsm^{-1} for all the depths. The electrical conductivity of different aonla orchard soils revealed a decreasing trend with increase in depth. As per the limits given by Muhr *et al.* (1963), the soils have been categorized into three i.e. 1, 1-2 and >2 mm hos/cm for normal, critical for germination and severe injury to crops. Data indicated that all the aonla orchard soil samples were having electrical conductivity values less than 1 dsm^{-1}. A comparative low conductivity value of most of the soils may be attributed to leaching of soluble salts from the soil column, being high permeability of light textured soils.

The pH of soils was found to be high as it ranged from 7.70 to 9.18 with mean value of 8.49 for all the soil depths. The relatively high pH of these orchard soils might be due to their fairly high base saturation.

Nutrient status of aonla orchard soils

The available nitrogen content ranged between 68.00 to 121.00 kg ha^{-1} with a mean value of 97.62 for all the depths. The data presented on available nitrogen content of orchard soils showed a decreasing trend with increase in depths (Table 1. As per the ratings given by Tandon (1992), the soils having <125 mg kg^{-1} have been categorized under low category. All the aonla orchard soils were found low in available nitrogen content. The cause of low available nitrogen content in all these soils had been due to the absence of natural vegetation, low organic carbon, low precipitation and high temperature which aggravates decomposition of organic matter by enhancing oxidation and aeration. The results of present study are in confirmation with those reported by Bhatnagar *et al.* (2000) and Rohitash (2007).

The available phosphorus content varied from 9.08 to 32.01 kg ha^{-1} with a mean value of 23.00 for all the depths. The data presented on available phosphorus content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <10.26 mg kg^{-1} have been categorized under low soils whereas those having 10.26 to 25.85 mg kg^{-1} falls under medium category. A close examination of data revealed that available phosphorus was low in 13 per cent

Table 1. Nutrient status of aonla orchard soils of Sikar district of Rajasthan

Soil depths/ characters	0-15 cm.		15-30 cm.		30-45 cm.		45-60 cm.	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	7.70 8.83	8.21	7.83 8.93	8.38	7.88 8.97	8.45	7.93 9.02	8.50
EC(dsm^{-1})	0.360 0.093	0.239	0.080 0.317	0.215	0.073 0.303	0.205	0.070 0.297	0.196
OC(%)	0.091 0.171	0.136	0.089 0.168	0.133	0.083 0.161	0.128	0.078 0.157	0.123
N(kgha^{-1})	85.0 121.0	106.13	81.0 118.0	104.13	79.0 116.0	101.38	76.0 112.0	98.38
P(kgha^{-1})	11.39 32.01	25.56	10.28 31.07	24.56	9.82 28.87	23.12	9.72 28.64	22.82
K(kgha^{-1})	124.0 162.0	139.0	121.0 158.0	135.50	118.0 152.0	131.50	114.0 147.0	127.75
Ca(cmolekg^{-1})	2.59 3.81	3.35	2.67 3.89	3.43	2.71 3.94	3.49	2.76 3.99	3.53
Mg(cmolekg^{-1})	1.49 1.94	1.82	1.47 1.96	1.84	1.50 1.98	1.85	1.53 2.00	1.88
S(mgkg^{-1})	6.31 8.60	6.91	6.28 8.56	6.86	6.02 8.23	6.67	5.80 8.31	6.37
Fe(mgkg^{-1})	2.50 6.51	4.56	2.47 6.48	4.54	2.46 6.48	4.51	2.44 6.44	4.47
Zn(mgkg^{-1})	0.357 0.990	0.663	0.340 0.973	0.642	0.313 0.953	0.621	0.293 0.927	0.599
Cu(mgkg^{-1})	0.177 0.493	0.295	0.163 0.467	0.278	0.150 0.443	0.262	0.140 0.420	0.246
Mn(mgkg^{-1})	1.84 5.19	3.26	1.69 5.09	3.15	1.62 5.01	3.08	1.57 4.95	3.02
$CaCO_3$ (%)	2.58 3.96	3.51	2.63 3.99	3.53	2.68 4.02	3.52	2.71 3.96	3.56
Soil depths/ characters	60-75 cm.		75-90 cm.		90-105 cm.		105-120 cm.	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	7.98 9.07	8.56	7.51 9.11	8.52	8.06 9.15	8.64	8.09 9.18	8.67
EC(dsm^{-1})	0.067 0.287	0.186	0.063 0.273	0.176	0.060 0.257	0.160	0.050 0.237	0.141
OC(%)	0.071 0.150	0.116	0.067 0.143	0.110	0.061 0.137	0.105	0.056 0.131	0.098
N(kgha^{-1})	75.0 111.0	96.38	73.0 108.0	94.25	71.0 106.0	91.75	68.0 103.0	88.63
P(kgha^{-1})	9.96 28.09	22.55	9.64 27.58	22.17	9.48 27.21	21.80	9.08 26.96	21.49
K(kgha^{-1})	110.0 143.0	124.25	108.0 140.0	120.75	105.0 135.0	117.25	101.0 130.0	113.38
Ca(cmolekg^{-1})	2.79 4.02	3.56	2.82 4.17	3.60	2.86 4.26	3.64	2.49 4.29	3.68
Mg(cmolekg^{-1})	1.57 2.03	1.91	1.65 2.09	1.98	1.64 2.16	2.02	1.75 2.20	2.07
S(mgkg^{-1})	5.12 8.21	6.09	5.08 8.17	6.05	5.05 8.14	6.02	5.03 8.10	5.99
Fe(mgkg^{-1})	2.41 6.38	4.43	2.38 6.35	4.39	2.32 6.30	4.34	2.28 6.25	4.34
Zn(mgkg^{-1})	0.270 0.903	0.574	0.237 0.880	0.551	0.233 0.843	0.532	0.203 0.770	0.519
Cu(mgkg^{-1})	0.130 0.407	0.233	0.123 0.377	0.216	0.120 - 0.357	0.202	0.110 0.330	0.183
Mn(mgkg^{-1})	1.51 4.90	2.97	1.46 4.84	2.91	1.42 4.78	2.84	1.36 4.73	2.79
$CaCO_3$ (%)	2.74 3.97	3.60	3.11 4.01	3.69	3.15 4.07	3.73	3.21 4.12	3.78

whereas, 87 per cent orchards were medium in respect to available phosphorus in aonla orchards. The low to medium availability of phosphorus might be due to the presence of high pH, low organic carbon, calcareousness, low precipitation, high temperature and light textured coarse sandy soils. The results of present investigations are in accordance with those reported by Bhatnagar *et al.*(2000) and Sharma and Mahajan (1990).

The available potassium content ranged between 101.00 to 162.00 kg ha^{-1} with a mean value of 126.17 for all the depths. In the present study, the available potassium content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <58.03 to 149.55 mg kg^{-1} falls under medium category. All the soil samples of aonla were medium in available potassium. A satisfactory potassium status of the studied area might be due to the presence of potash bearing minerals (muscovite, biotite and feldspar) which on weathering slowly release potash. Bhatnagar *et al.* (2000) reported similar results.

The exchangeable calcium content varied from 2.59 to 4.29 cmol kg^{-1} with a mean value of 3.53 for all the depths. The exchangeable magnesium content of these orchard soils ranged from 1.47 to 2.20 cmol kg^{-1} with a mean value of 1.92 for all the depths. In the present study, the exchangeable calcium and magnesium content of orchard soils showed a increasing trend with increase in depths. All the soil samples drawn from aonla orchards were found high in exchangeable calcium and magnesium content. The high exchangeable calcium content in all these soils could be because of calcareous nature of the soils which further due to in accumulation i.e. of exchangeable calcium in the profile zone. Being high in base saturation all the soil samples of aonla orchards were found having fairly good amount of exchangeable magnesium content. Bhatnagar *et al.* (2000) and Rohitash (2007) reported similar results.

The available sulphur content ranged between 5.03 to 8.60 mg kg^{-1} with a mean value of 6.37 for all the depths. The data presented on available sulphur content of orchard soils showed a decreasing trend with increase in depths. Based on the ratings given by Tandon (1992), the soils having less than 10 mg kg^{-1} falls under low category, those having more than 10 mg kg^{-1} falls under medium category. All the soil samples of aonla orchards were found low in available sulphur content. The low content of these soils may be due to high temperature, low precipitation, very low organic matter and light textured coarse sandy soils. The findings reported by Bhatnagar *et al.* (2000), Kumar (2004) and Rohitash (2007) are almost similar to the results of present investigations.

The DTPA extractable iron content ranged between 2.28 to 6.51 mg kg^{-1} with a mean value of 4.44 for all the depths. The data presented on DTPA extractable iron content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <4.5 mg kg^{-1} falls under deficient category and those having >4.5 mg kg^{-1} falls under sufficient category. A close examination of data revealed that DTPA extractable iron was deficient in 50 per cent, whereas 50 per centper cent orchards were sufficient in respect to DTPA extractable iron in aonla orchards. The deficient to sufficient status of iron found in the soil might be due to calcareousness, low organic carbon content, light textured coarse sandy soils. Similar observations were reported by Bhatnagar *et al.* (2000) and Bhatnagar and Chandra (2003).

The DTPA extractable zinc content ranged between 0.203 to 0.990 mg kg^{-1} with a mean value of 0.587 for all the depths. The data presented on DTPA extractable zinc content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having less than 0.6 mg kg^{-1} falls under deficient category, those having 0.6 to 1.2 mg kg^{-1} falls under sufficient category. Fifty per cent soil samples of aonla orchards were deficient in DTPA extractable zinc. Remaining 50 per cent soil samples of aonla orchards were sufficient in DTPA extractable zinc. This range of zinc in soils might be due to the presence of quartz, feldspar or the exchange complex being such as to have sites saturated with Ca/Mg under alkaline soil reaction. Calcareous nature and low organic matter are some of the other properties where low levels of zinc are anticipated. Similar findings were reported by Sharma and Bhandari (1995) and Kameriya (1995).

The DTPA extractable copper content ranged between 0.110 to 0.493 mg kg^{-1} with a mean value of 0.238 for all the depths. The data presented on DTPA extractable copper content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <0.2 mg kg^{-1} falls under deficient category, those having >0.2 mg kg^{-1} falls under sufficient category. Fifty per cent soil samples of aonla orchards were deficient in DTPA extractable copper. Remaining 50 per cent soil samples of aonla orchards were sufficient in DTPA extractable copper. The deficient to sufficient available copper status of orchard soil might be due to high pH, calcareousness, lower organic carbon and light textured coarse sandy soils. The present results are in accordance with those reported by Baser and Lodha (1971) who reported that available copper status in sandy soils of Rajasthan varied from 0.05 to 2.38 ppm.

The DTPA extractable manganese content ranged between 1.36 to 5.19 mg kg^{-1} with a mean value of 3.00 for all the depths. The data presented on DTPA extractable manganese content of orchard soils showed a regular decreasing trend with increase in depths. As per rating given by Tandon (1992), the soils having <2 mg kg^{-1} falls under deficient category while those having >2 mg kg^{-1} falls under sufficient category. Twenty five per cent soil samples drawn from surface soil depth of aonla orchards were deficient and 75 per cent were sufficient in DTPA extractable iron in the present study. Results of DTPA extractable manganese in all the orchards clearly indicate that deficiency of manganese in the fruit orchards is now coming. Another in the present study only 1/4th orchards have shown deficient. The deficiency of DTPA extractable manganese might be due to the presence of high $CaCO_3$

content and low organic carbon content. These results are in accordance with those reported by Bhatanagar *et al.* (2000); Bhatnagar and Chandra (2003), Kumar (2004) and Rohitash (2007).

The calcium carbonate percentage ranged between 2.58 to 4.12 with a mean value of 3.61 for all the depths. Calcium carbonate percentage increased with the increasing depths. It indicates that the calcium leached down from surface soil to sub-surface soils accumulated in the form of calcium carbonate as secondary carbonate. A comparative high calcium carbonate content of soil might be due to dominance of alkaline earth carbonates in the soils. Similar results were also observed for arid and semi arid regions by Bhatnagar *et al.* (2000), Kumar (2004) and Rohitash (2007).

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