

Nutrient status of acid lime orchard soils in Sikar district of Rajasthan

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Abstract

Studies were conducted on the mineral nutrition status of acid lime fruit orchards located in Sikar district of Rajasthan. Electrical conductivity was found to be in normal range and soil pH was in the high ranging from 7.73 to 9.31. The organic carbon content and available nitrogen of acid lime 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: Acid Lime, orchards, nutrient status.

Introduction

The Sikar 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°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 oleoides*), Khejri (*Prosopis cineraria*) etc. In spite of all vagaries, the farmers of Sikar district has shown tremendous response towards fruit cultivation particularly of ber, bael, lime and aonla fruits. Citrus is an important fruit crop of India. It is next to banana and mango in acreage and economic point of view. Citrus industry in India is the third largest industry of the country. Acid lime (*Citrus aurantifolia*) is the third important fruit after mandarin and sweet orange. India is perhaps the largest producer of acid lime. Citrus

cultivation particularly of acid lime has become quite popular in arid irrigated areas of Western Rajasthan. Acid lime fruits are highly appreciated for their medicinal and nutritional value.

People inhabitation in arid areas is known to suffer from a number of nutritional disorders owing to lower intake of protective foods like fruits and vegetables. 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 in spite 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.

Materials and Methods

A detailed soil survey 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 acid lime orchards were selected covering different tehsils viz.

Srimadhopur, Laxmangarh, Danta Ramgarh and Piparali. The details of locations and name of the fruit growers are given below.

S.No.	Name of fruit grower	Village	location
1.	Shri Prahalad	Raghunathgarh	Raghunathgarh
2.	Shri Panna Ram	Pachar	Pachar-IV
3.	Shri Ram Dev Singh	Purohit Ka Bas	Purohit Ka Bas-II
4.	Shri Roopchand Pipliwal	Pachar	Pachar-V
5.	Shri Hanumana Ram	Sanwalod	Sanwalod
6.	Shri Pokhar Mal	Purohit Ka Bas	Purohit Ka Bas-III
7.	Shri Guljari Kumawat	Jorawar Nagar	Jorawar Nagar
8.	Shri Harlal Singh	Palsana	Palsana-III

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.

Results and Discussion

Organic carbon, electrical conductivity and pH of soil

The organic carbon status of acid lime orchard soils was generally poor. It varied from 0.058 to 0.230 per cent with a mean value of 0.156 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 acid lime 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 acid lime orchard soils ranged from 0.053 to 0.270 dsm^{-1} with a mean value of 0.112 dsm^{-1} for all the depths. The electrical conductivity of different acid lime 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 mmhos/cm for normal, critical for germination and severe

injury to crops. Data indicated that all the acid lime 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 7.73 to 9.31 with mean value of 8.67 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 acid lime orchard soils

The available nitrogen content ranged between 73.00 to 139.00 kg ha^{-1} with a mean value of 112.22 for all the depths. The data presented on available nitrogen content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992a), the soils having <125 mg kg^{-1} have been categorized under low category. All the acid lime 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).

The available phosphorus content varied from 6.46 to 29.48 kg ha^{-1} with a mean value of 15.83 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 (1992a), 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 75 per cent whereas, 25 per cent orchards were medium in respect to available phosphorus in 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), Ghosh and Hassan (1979) and Sharma and Mahajan (1990).

The available potassium content ranged between 110.00 to 183.00 kg ha^{-1} with a mean value of 148.78 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 (1992a), the soils having <58.03 to 149.55 mg kg⁻¹ falls under medium category. All the soil samples of acid lime 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 2.66 to 3.83 cmol kg⁻¹ with a mean value of 3.32 for all the depths. The exchangeable magnesium content of these orchard soils ranged from 1.44 to 2.22 cmol kg⁻¹ with a mean value of 1.75 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

Table 1. Nutrient status of acid lime 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	7.73-8.90	8.43	7.84-9.03	8.53	7.89-9.11	8.59	8.00-9.14	8.65
EC(dsm ⁻¹)	0.103-0.270	0.146	0.093-0.267	0.135	0.090-0.250	0.126	0.087-0.243	0.118
OC(%)	0.101-0.230	0.175	0.098-0.227	0.171	0.093-0.222	0.166	0.089-0.219	0.161
N(kgha ⁻¹)	99.00-139.00	123.38	93.00-136.00	120.00	91.00-134.00	117.00	88.00-129.00	113.13
P(kgha ⁻¹)	12.04-29.48	18.91	10.80-28.21	17.61	10.12-26.46	16.50	8.95-26.26	15.90
K(kgha ⁻¹)	127.00-183.00	161.00	125.00-179.00	158.00	123.00-178.00	154.50	120.00-176.00	151.13
Ca(cmmolekg ⁻¹)	2.66-3.44	3.16	2.76-3.62	3.22	2.81-3.67	3.27	2.87-3.70	3.32
Mg(cmmolekg ⁻¹)	1.44-1.85	1.66	1.45-1.92	1.66	1.47-1.94	1.68	1.50-1.97	1.71
S(mgkg ⁻¹)	6.84-9.06	7.87	6.76-9.00	7.81	6.64-8.88	7.59	6.41-8.72	7.28
Fe(mgkg ⁻¹)	3.81-6.38	4.71	3.79-6.36	4.69	3.76-6.33	4.65	3.71-6.31	4.61
Zn(mgkg ⁻¹)	0.393-1.017	0.796	0.367-0.997	0.775	0.347-0.970	0.753	0.317-0.947	0.728
Cu(mgkg ⁻¹)	0.157-0.420	0.285	0.140-0.397	0.269	0.137-0.370	0.250	0.130-0.340	0.229
Mn(mgkg ⁻¹)	1.88-5.15	3.25	1.74-5.07	3.15	1.68-5.00	3.09	1.62-4.95	3.03
Caco ₃ (%)	2.44-3.92	3.33	2.55-3.94	3.38	2.65-3.99	3.45	2.76-4.01	3.51
Soil depths/ characters	60-75 cm.		75-90 cm.		90-105 cm.		105-120 cm.	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	8.08-9.19	8.72	8.15-9.24	8.77	8.22-9.27	8.83	8.25-9.31	8.89
EC(dsm ⁻¹)	0.080-0.233	0.110	0.073-0.223	0.102	0.063-0.200	0.090	0.053-0.173	0.076
OC(%)	0.083-0.211	0.156	0.077-0.205	0.149	0.069-0.198	0.143	0.058-0.188	0.134
N(kgha ⁻¹)	86.00-127.00	110.75	81.00-121.00	107.63	78.00-118.00	104.50	73.00-116.00	101.38
P(kgha ⁻¹)	8.65-26.05	15.47	7.58-25.38	14.69	6.95-25.00	14.08	6.46-24.75	13.54
K(kgha ⁻¹)	116.00-174.00	147.38	114.00-172.00	143.63	112.00-164.00	139.13	110.00-159.00	135.50
Ca(cmmolekg ⁻¹)	2.91-3.73	3.35	2.96-3.77	3.39	3.02-3.81	3.43	3.04-3.83	3.46
Mg(cmmolekg ⁻¹)	1.54-2.00	1.74	1.62-2.14	1.82	1.60-2.18	1.85	1.65-2.22	1.90
S(mgkg ⁻¹)	6.18-8.59	7.11	6.09-8.43	7.03	5.90-8.35	6.94	5.75-8.14	6.86
Fe(mgkg ⁻¹)	3.69-6.25	4.57	3.64-6.20	4.53	3.58-6.15	4.48	3.54-6.10	4.43
Zn(mgkg ⁻¹)	0.300-0.917	0.705	0.273-0.897	0.682	0.253-0.867	0.656	0.247-0.780	0.609
Cu(mgkg ⁻¹)	0.120-0.317	0.218	0.117-0.310	0.204	0.113-0.290	0.194	0.103-0.270	0.173
Mn(mgkg ⁻¹)	1.57-4.90	2.98	1.51-4.83	2.92	1.43-4.79	2.87	1.37-4.74	2.81
Caco ₃ (%)	2.83-4.10	3.61	2.88-4.15	3.65	2.95-4.21	3.75	3.02-4.26	3.77

drawn from acid lime 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 acid lime orchards were found having fairly good amount of exchangeable magnesium content. Bhatnagar *et al.* (2000) reported similar results.

The available sulphur content ranged between 5.75 to 9.06 mgkg⁻¹ with a mean value of 7.31 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 (1992a), 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 acid lime 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) and Kumar (2004) are almost similar to the results of present investigations.

The DTPA extractable iron content ranged between 3.54 to 6.38 mgkg⁻¹ with a mean value of 4.58 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 (1992a), 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 cent per cent orchards were sufficient in respect to DTPA extractable iron in 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 0.247 to 1.017 mgkg⁻¹ with a mean value of 0.713 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 (1992a), 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. Twenty five per cent soil samples of acid lime orchards were deficient in DTPA extractable zinc. Remaining 75 per cent soil samples of acid lime 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 Kameariya (1995).

The DTPA extractable copper content ranged between 0.103 to 0.420 mgkg⁻¹ with a mean value of 0.227 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 (1992a), the soils having <0.2 mg kg⁻¹ falls under deficient category, those having >0.2 mg kg⁻¹ falls under sufficient category. Twenty five per cent soil samples of acid lime orchards were deficient in DTPA extractable copper. Remaining 75 per cent soil samples of acid lime 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 1.37 to 5.15 mgkg⁻¹ with a mean value of 3.01 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 (1992a), the soils having <2 mg kg⁻¹ falls under deficient category, those having >2 mg kg⁻¹ falls under sufficient category. Twenty five per cent soil samples drawn from surface soil depth of acid lime orchards were deficient and 75 per cent were sufficient in DTPA extractable manganese 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 CaCO₃ content and low organic carbon content. These results are in accordance with those reported by Bhatnagar *et al.* (2000); Bhatnagar and Chandra (2003) and Kumar (2004).

The calcium carbonate percentage ranged between 2.44 to 4.26 with a mean value of 3.55 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) and Kumar (2004).

References

- Anonymous, 2005. SREP prepared by ATMA district Sikar, pp. 6-7.
- Bhatnagar, P. and Chandra, A. and Gupta, P.K., 2000. Studies on nutrient status of fruit orchard soils in Bikaner district of Rajasthan. *Curr. Agric.*, 24 (1-2) : 119-122.
- Bhatnagar, P. and Chandra, A. 2003. Distribution of micronutrient cations in arid irrigated orchard soil profiles of western Rajasthan. *Journal of Eco-physiology*, 6(3-4): 93-100.
- Baser, B.L. and Lodha, P.S. 1971. Available micronutrients in sandy soils of Rajasthan. *Annals Arid Zone*, 10 : 93-

- 94.
- Chesnin, L. and Yien, C.H. 1951. Turbidimetric determination of available sulphur. *Proceedings of Soil Science Society of America*, 15: 149-151.
- Ghosh, A.B. and Hassan, R. 1976. Potassium in soils, crops and fertilizers. *Bull. Indian Soc. Sci.*, 10: 1-5
- Jackson, M.L., 1973. Soil chemical analysis. *Asia Publishing House*, Bombay.
- Kameriya, P.R. 1995. Characterization of soil of Agroclimatic zone of transitional plain of Inland drainage (Zone II-A) of Rajasthan. Ph.D. Thesis, RAU, Bikaner.
- Kumar. 2004. Studies on yield and qualitative attributes of Ber (*Zizyphus marutiana* Lamk) and pomegranate (*Punica granatum* L.) as affected by nutritional status of orchards. M.Sc. Thesis, RAU, Bikaner.
- Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, manganese and copper. *Soil Sci.Soc.Am. J.*, 42 : 421-428.
- Muhr, G.R., Datta, N.P., Shankara, Subramoney, N., Lecy, V.K. and Donahue, R.L. 1963. Soil testing in India. U.S.D.A. Publication, pp. 120.
- Olsen, S.R., Cole, V.C., Watanable, F.S. and dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Cir. U.S. Dept. Agric.*, pp : 939
- Richards, L.A. 1954. Diagnosis and improvement of saline and alkali soils. U.S.D.A., Handbook No. 60, Washington, D.C.
- Sharma, J.C. and Bhandari, A.R. 1995. Mineral nutrient status of Apple orchards in Himachal Pradesh. *J. Indian Soc. Soil Sci.*, 43 : 236-241.
- Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Curr. Sci.*, 25 : 259-260.
- Sharma, V.K. and Mahajan, K.K. 1990. Studies on nutrient status of mandarin orchards in Himachal Pradesh. *Indian J. Hort.*, 47 (20) : 180-185.
- Tandon, H.L.S. 1992a. Fertilizer Development and Consultation Organization, 202-204, A Bhanot Corner, 1-2 Pomper Enclave, New Delhi.
- Walkley, A. and Black, I.A. 1947. Rapid titration method for organic carbon of soils. *Soil Sci.*, 37 : 29-32.