INDIAN JOURNAL OF
ARID HORTICULTURE
2017, Vol. 12 (1-2):1-15

Status of micronutrient cataions in arid irrigated acid lime orchard soil profiles in Sikar District of Rajasthan

Balbir Singh* and Atul Chandra
S.K. Rajasthan Agricultural University, Bikaner
* Present Address: Assistant Professor (Hort.), BKVK, Fatehpur Shekhawati, Distt. – Sikar (Rajasthan)
*Corresponding author's e mail: balbirdr@gmail.com
(Received: 18.01.2017; Accepted: 16.06.2017)

Abstract

The present study on distribution of micronutrient cataions in arid irrigated acid lime orchard soil profiles in Sikar district of Rajasthan was conducted during March 2007-2008. The study included analysis of soil profiles with respect to micronutrients. The available iron ranged between 3.54 to 6.38 mg kg^{-1}, available zinc between 0.247 to 1.017 mg kg^{-1}, available copper between 0.103 to 0.420 mg kg^{-1} and available manganese between 1.37 to 5.15 mg kg^{-1}. All the micronutrients were found to be low to medium in range.

Key words: *Acid Lime, Orchards, Micronutrients*

Introduction

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°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.

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 is done. Studies on nutritional survey of arid fruits in Rajasthan are meagre inspite of their great importance and relevance. With this aim, the present study was undertaken to evaluate the micronutrient fertility status of different orchards in Sikar district.

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. Danta Ramgarh, Piparali, Laxmangarh and Srimadhopur.The details of locations and name of the fruit growers are given in table 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 eight 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. One hundred ninety two representative composite soil samples at different soil depths viz., 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm. were collected. After processing, the soil samples were analyzed for micronutrients. 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.

RESULTS AND DISCUSSION

The distribution of DTPA extractable micronutrients as depth wise in 8 acid lime fruit orchards in Sikar district of Rajasthan was studied.

DTPA extractable Iron:

Distribution of DTPA extractable iron content showed a regular decreasing trend with increasing depths. The DTPA extractable iron content of soil depths viz. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm varied from 3.81 to 6.38, 3.79 to 6.36, 3.76 to 6.33, 3.71 to 6.31, 3.69 to 6.25, 3.64 to 6.20, 3.58 to 6.15 and 3.54 to 6.10 mg kg^{-1} with their mean value 4.71, 4.69, 4.65, 4.61, 4.57, 4. 53, 4.48, and 4.43 mg kg^{-1}, respectively. On overall mean basis according to soil depths, the maximum DTPA extractable iron (4.71 mg kg^{-1}) was recorded at 0-15 cm soil depth and it decreased progressively at increasing soil depths and was recorded minimum (4.43 mg kg^{-1}) at 105-120 cm soil depth. The mean DTPA extractable iron on the basis of location wise was found maximum (6.26 mg kg^{-1}) at Jorawar Nagar and it was recorded minimum (3.69 mg kg^{-1}) at Pachar-IV. Data in table 1 revealed that 50 per cent soil samples drawn from surface soil depth of acid lime orchards were deficient and remaining were sufficient in DTPA extractable iron in the present study.

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. 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 and Chandra (2003) and Kumawat (2005). These finding are in conformity to the results of present investigation.

DTPA extractable zinc:

Data related to DTPA extractable zinc content in acid lime orchards is presented in the table 2. From the data presented in the table, it is evident that the DTPA extractable zinc content of soil depths viz. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm varied from 0.393 to 1.017, 0.367 to 0.997, 0.347 to 0.970, 0.317 to 0.947, 0.300 to 0.917, 0.273 to 0.897, 0.253 to 0.867 and 0.247 to 0.780 mg kg^{-1} with their mean value 0.796, 0.775, 0.753, 0.728, 0.705, 0.682, 0.656 and 0.609 mg kg^{-1}, respectively. On overall mean basis according to soil depths, the maximum DTPA extractable zinc (0.796 mg kg^{-1}) was recorded at 0-15 cm soil depth and it decreased progressively at increasing soil depths and was recorded minimum (0.609 mg kg^{-1}) at 105-120 cm soil depth. The mean DTPA extractable zinc on the basis of location wise was found maximum (0.909 mg kg^{-1}) at Pachar-V and it was recorded minimum (0.312 mg kg^{-1}) at Raghunathgarh. Data in table 2 revealed that 25 per cent soil samples drawn from surface soil depth of acid lime orchards were deficient and 75 per cent were sufficient in DTPA extractable iron in the present study. Distribution of DTPA extractable zinc content exhibited a regular decreasing trend with increasing 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. 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. These results are in accordance with the findings of Bhatnagar and Chandra (2003) and Kumawat (2005).

DTPA extractable copper:

Data related to DTPA extractable copper content in acid lime orchards are presented in the table 3. From the data presented in the table, it is evident that the DTPA extractable copper content of soil depths viz. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm varied from 0.157 to 0.420, 0.140 to 0.397, 0.137 to 0.370, 0.130 to 0.340, 0.120 to 0.317, 0.117 to 0.310, 0.113 to 0.290 and 0.103 to 0.270 mg kg^{-1} with their mean value 0.285, 0.269, 0.250, 0.229, 0.218, 0.204, 0.194 and 0.173 mg kg^{-1}, respectively. On overall mean basis according to soil depths, the maximum DTPA extractable copper (0.285 mg kg^{-1}) was recorded at 0-15 cm soil depth and it decreased progressively at increasing soil depths

and was recorded minimum (0.173 mg kg^{-1}) at 105-120 cm soil depth. The mean DTPA extractable copper on the basis of location wise was found maximum (0.339 mg kg^{-1}) at Palsana-III and it was recorded minimum (0.127 mg kg^{-1}) at Jorawar Nagar. Data in table 3 revealed that 25 per cent soil samples drawn from surface soil depth of acid lime orchards were deficient and 75 per cent were sufficient in DTPA extractable iron in the present study.Distribution of DTPA extractable copper content showed a regular decreasing trend with increasing 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. 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. Similar types of results have also been reported by Bhatnagar and Chandra (2003) who reported available copper status in sandy soils of Rajasthan varied from 0.0.08 to 0.51 ppm.

DTPA extractable manganese:

Distribution of DTPA extractable manganese content showed a regular decreasing trend with increasing depths. The data presented on DTPA extractable manganese content of orchard soils showed a regular decreasing trend with increase in depths. Data related to DTPA extractable manganese content in acid lime orchards is presented in the table 4. From the data presented in the table, it is evident that the DTPA extractable manganese content of soil depths viz. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm varied from 1.88 to 5.15, 1.74 to 5.07, 1.68 to 5.00, 1.62 to 4.95, 1.57 to 4.90, 1.51 to 4.83, 1.43 to 4.79 and 1.37 to 4.74 mg kg^{-1} with their mean value 3.25, 3.15, 3.09, 3.03, 2.98, 2.92, 2.87 and 2.81 mg kg^{-1}, respectively. On overall mean basis according to soil depths, the maximum DTPA extractable manganese (3.25 mg kg^{-1}) was recorded at 0-15 cm soil depth and it decreased progressively at increasing soil depths and was recorded minimum (2.81 mg kg^{-1}) at 105-120 cm soil depth. The mean DTPA extractable manganese on the basis of location wise was found maximum (4.93 mg kg^{-1}) at Sanwalod and it was recorded minimum (1.60 mg kg^{-1}) at Raghunathgarh. Data in table 4 revealed that 25 per cent soil samples drawn from surface soil depth of acid lime 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 acid lime orchards is now coming. 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 Bhatnagar and Chandra (2003) and Kumawat (2005).

Table 1: DTPA Extractable Iron (mg kg^{-1}) in Acid lime Orchards at Different Soil Depths in Sikar District

Location of orchards	Soil depths (cm)								
	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	Mean
Raghunathgarh	4.55 ±0.90	4.52 ±0.09	4.49 ±0.10	4.44 ±0.09	4.42 ±0.72	4.37 ±1.55	4.32 ±1.62	4.26 ±0.51	4.42 ±0.92
Pachar – IV	3.81 ±0.09	3.79 ±0.09	3.76 ±0.09	3.71 ±0.08	3.69 ±0.08	3.64 ±0.08	3.58 ±0.06	3.54 ±0.48	3.69 ±0.21
Purohit Ka Bas-II	3.92 ±0.04	3.89 ±0.04	3.83 ±0.01	3.79 ±0.01	3.77 ±0.04	3.73 ±0.05	3.68 ±0.06	3.64 ±0.43	3.78 ±0.18
Pachar – V	4.91 ±0.05	4.88 ±0.05	4.84 ±0.04	4.80 ±0.84	4.78 ±1.60	4.75 ±0.04	4.69 ±0.04	4.66 ±1.11	4.79 ±0.75
Sanwalod	4.44 ±0.34	4.41 ±0.10	4.39 ±0.09	4.36 ±0.09	4.30 ±0.08	4.25 ±0.09	4.20 ±0.09	4.16 ±0.31	4.31 ±0.20
Purohit Ka Bas-III	5.82 ±0.82	5.79 ±0.75	5.69 ±0.08	5.67 ±0.08	5.61 ±0.08	5.57 ±0.08	5.50 ±0.09	5.46 ±0.36	5.64 ±0.43
Jorawar Nagar	6.38 ±0.04	6.36 ±0.04	6.33 ±0.03	6.31 ±0.02	6.25 ±0.02	6.20 ±0.02	6.15 ±0.02	6.10 ±0.41	6.26 ±0.18
Palsana – III	3.88 ±0.52	3.85 ±0.03	3.85 ±0.01	3.82 ±0.01	3.78 ±0.02	3.73 ±0.03	3.68 ±0.02	3.64 ±0.38	3.78 ±0.24
Mean	4.71	4.69	4.65	4.61	4.57	4.53	4.48	4.43	

± indicates standard deviation
Deficient – 50%
Sufficient – 50%

Table 2: DTPA Extractable Zinc (mg kg^{-1}) in Acid lime Orchards at Different Soil Depths in Sikar District

Location of orchards	Soil depths (cm)								
	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	Mean
Raghunathgarh	0.393 ±0.029	0.367 ±0.025	0.347 ±0.025	0.317 ±0.033	0.300 ±0.022	0.273 ±0.026	0.253 ±0.026	0.247 ±0.045	0.312 ±0.063
Pachar – IV	0.867 ±0.058	0.843 ±0.062	0.827 ±0.058	0.800 ±0.062	0.783 ±0.057	0.767 ±0.061	0.740 ±0.057	0.670 ±0.028	0.787 ±0.081
Purohit Ka Bas-II	0.837 ±0.025	0.817 ±0.025	0.797 ±0.025	0.777 ±0.024	0.750 ±0.028	0.727 ±0.091	0.700 ±0.022	0.647 ±0.074	0.756 ±0.076
Pachar – V	1.017 ±0.025	0.997 ±0.025	0.970 ±0.016	0.947 ±0.012	0.917 ±0.009	0.897 ±0.012	0.867 ±0.019	0.663 ±0.037	0.909 ±0.106
Sanwalod	0.950 ±0.029	0.930 ±0.029	0.907 ±0.026	0.883 ±0.024	0.863 ±0.024	0.837 ±0.019	0.813 ±0.017	0.777 ±0.033	0.870 ±0.061
Purohit Ka Bas-III	0.937 ±0.041	0.917 ±0.041	0.897 ±0.041	0.870 ±0.037	0.847 ±0.039	0.823 ±0.042	0.787 ±0.037	0.780 ±0.036	0.857 ±0.067
Jorawar Nagar	0.507 ±0.039	0.490 ±0.036	0.460 ±0.128	0.430 ±0.120	0.410 ±0.042	0.390 ±0.042	0.370 ±0.042	0.370 ±0.042	0.428 ±0.087
Palsana – III	0.863 ±0.025	0.843 ±0.025	0.817 ±0.026	0.800 ±0.014	0.767 ±0.026	0.743 ±0.184	0.720 ±0.022	0.717 ±0.009	0.784 ±0.086
Mean	0.796	0.775	0.753	0.728	0.705	0.682	0.656	0.609	

± indicates standard deviation
Deficient – 25%
Sufficient – 75%

Table 3: DTPA Extractable Copper (mg kg^{-1}) in Acid lime Orchards at Different Soil Depths in Sikar District

Location of orchards	Soil depths (cm)								
	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	Mean
Raghunathgarh	0.190 ±0.016	0.177 ±0.017	0.167 ±0.009	0.147 ±0.005	0.157 ±0.012	0.147 ±0.012	0.140 ±0.008	0.123 ±0.005	0.156 ±0.023
Pachar – IV	0.320 ±0.008	0.300 ±0.008	0.277 ±0.012	0.250 ±0.014	0.230 ±0.014	0.210 ±0.014	0.193 ±0.009	0.160 ±0.014	0.243 ±0.053
Purohit Ka Bas-II	0.390 ±0.014	0.367 ±0.009	0.343 ±0.012	0.317 ±0.009	0.300 ±0.008	0.273 ±0.012	0.257 ±0.009	0.223 ±0.012	0.309 ±0.054
Pachar – V	0.193 ±0.012	0.173 ±0.021	0.157 ±0.012	0.143 ±0.017	0.137 ±0.012	0.127 ±0.012	0.130 ±0.014	0.120 ±0.014	0.148 ±0.028
Sanwalod	0.210 ±0.041	0.210 ±0.028	0.183 ±0.021	0.173 ±0.021	0.163 ±0.012	0.157 ±0.017	0.153 ±0.012	0.140 ±0.008	0.174 ±0.033
Purohit Ka Bas-III	0.400 ±0.016	0.387 ±0.012	0.363 ±0.009	0.333 ±0.017	0.317 ±0.012	0.293 ±0.017	0.273 ±0.012	0.240 ±0.014	0.326 ±0.054
Jorawar Nagar	0.157 ±0.012	0.140 ±0.014	0.137 ±0.012	0.130 ±0.008	0.120 ±0.008	0.117 ±0.005	0.113 ±0.005	0.103 ±0.005	0.127 ±0.019
Palsana – III	0.420 ±0.024	0.397 ±0.025	0.370 ±0.016	0.340 ±0.016	0.317 ±0.005	0.310 ±0.008	0.290 ±0.008	0.270 ±0.008	0.339 ±0.052
Mean	0.285	0.269	0.250	0.229	0.218	0.204	0.194	0.173	

± indicates standard deviation
Deficient – 25%
Sufficient – 75%

Table 4: DTPA Extractable Manganese (mg kg^{-1}) in Acid lime Orchards at Different Soil Depths in Sikar District

Location of orchards	Soil depths (cm)								
	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	Mean
Raghunathgarh	1.88 ±0.02	1.74 ±0.05	1.68 ±0.07	1.62 ±0.08	1.57 ±0.09	1.51 ±0.09	1.43 ±0.10	1.37 ±0.11	1.60 ±0.18
Pachar – IV	1.95 ±0.03	1.79 ±0.06	1.75 ±0.03	1.69 ±0.04	1.64 ±0.04	1.57 ±0.04	1.52 ±0.05	1.48 ±0.05	1.67 ±0.15
Purohit Ka Bas-II	2.31 ±0.23	2.23 ±0.03	2.16 ±0.05	2.09 ±0.05	2.05 ±0.05	1.99 ±0.05	1.94 ±0.06	1.89 ±0.07	2.08 ±0.17
Pachar – V	4.68 ±0.02	4.57 ±0.85	4.53 ±0.04	4.46 ±0.05	4.42 ±0.05	4.34 ±0.03	4.39 ±0.14	4.24 ±0.03	4.45 ±0.33
Sanwalod	5.15 ±0.01	5.07 ±0.82	5.00 ±0.01	4.95 ±0.02	4.90 ±0.01	4.83 ±0.02	4.79 ±0.02	4.74 ±0.02	4.93 ±0.32
Purohit Ka Bas-III	3.45 ±0.03	3.35 ±0.01	3.29 ±0.81	3.21 ±0.01	3.18 ±0.00	3.11 ±0.01	3.02 ±0.03	2.97 ±0.04	3.20 ±0.33
Jorawar Nagar	2.82 ±0.02	2.74 ±0.03	2.68 ±0.03	2.62 ±0.02	2.57 ±0.03	2.51 ±0.01	2.44 ±0.02	2.39 ±0.01	2.60 ±0.14
Palsana – III	3.79 ±0.03	3.71 ±0.02	3.63 ±0.03	3.59 ±0.02	3.54 ±0.03	3.48 ±0.03	3.41 ±0.04	3.38 ±0.05	3.57 ±0.14
Mean	3.25	3.15	3.09	3.03	2.98	2.92	2.87	2.81	

± indicates standard deviation
Deficient – 25%
Sufficient – 75%

References

Anonymous. 2005. Horticultural Data Base. National Horticultural Board, Ministry of Agriculture, Govt. of India.

Baser, B.L. and Lodha, P.S. 1971. Available micronutrients in sandy soils of Rajasthan. *Annals Arid Zone.*, 10 : 93-94.

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.

Kumawat, R. 2005. Nutrient status of soils of ber (*Zizphus mauratina* L.) orchard in Jaipur district of Rajasthan. 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.

Tandon, H.L.S. 1992a. Fertilizer Development and Consultation Organization, 202-204, A Bhanot Corner, 1-2 Pompers Enclave, New Delhi.