International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 3310-3313

Received: 19-05-2020
Accepted: 21-06-2020

Har Mohan Singh Yadav
Deptt. of Agricultural Chemistry & Soil Science, R B S College Bichpuri, Agra, Uttar Pradesh, India

Devendra Pal
Krishi Vigyan Kendra Sambhal (SVPUA & T Meerut), Uttar Pradesh, India

Nidhi Nagar
Deptt. of Agricultural Chemistry & Soil Science, R B S College Bichpuri, Agra, Uttar Pradesh, India

Vipin Kumar
Deptt. of Agricultural Chemistry & Soil Science, R B S College Bichpuri, Agra, Uttar Pradesh, India

Vinay Singh
Deptt. of Agricultural Chemistry & Soil Science, R B S College Bichpuri, Agra, Uttar Pradesh, India

BS Kherawat
SMS Soil Science, KVK, Bikaner-II, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Corresponding Author:
Har Mohan Singh Yadav
Deptt. of Agricultural Chemistry & Soil Science, R B S College Bichpuri, Agra, Uttar Pradesh, India

To study the effect of iron and manganese on yield, nutrients content and their uptake by spinach crop at various cuttings

Har Mohan Singh Yadav, Devendra Pal, Nidhi Nagar, Vipin Kumar, Vinay Singh and BS Kherawat

DOI: https://doi.org/10.22271/chemi.2020.v8.i4ao.10161

Abstract
A pot experiment was conducted at pot culture yard in Department of Agricultural chemistry and soil science of R.B.S. College Bichpuri, Agra, (U.P.). To study the effect of iron and and manganese on yield, nutrients content and their uptake by spinach crop at various cuttings. Four levels (0, 5, 10, 20 ppm) of each iron and manganese were evaluated in factorial design with three replications. The results revealed that the consistent and significant increase in green foliage and dry matter yield was noted with increasing levels of Fe and Mn at various cuttings. The highest green foliage (18.63 g/pot) and dry matter yield (2.08 g/pot) was recorded with 10 ppm iron and Mn treatments. Higher yield of green foliage and dry matter was noted with the advancement of growth. Highest dose (20 ppm) of iron and manganese caused reduction in yield of green foliage dry matter in both the cuttings. Nutrient composition of spinach plants at both cuttings in respect of N, P, Fe, Mn content was consistently and significantly increased up to (10 ppm) dose of iron and manganese level. Thereafter, decrement was noted. Similar tend was noted in nutrient uptake by spinach plants at various cuttings. Investigations also revealed that Fe and Mn has antagonistic relation in respect of their content and uptake in both the cuttings of spinach plants.

Keywords: Yield, nutrients content, uptake, spinach crop

Introduction
In order to boost up crop production per unit area per unit time, increasing emphasis is being laid on cultivation of high yielding varieties of crops intensive cropping heavy fertilization and modern techniques of cultivation. In this context, importance of micronutrients can hardly be over emphasized as in many areas their supply in soil may become a limiting factor in obtaining maximum levels of crop yields. In several parts of the country micronutrients disorders have been recognized as major cause of crop failure and poor productivity (Takkar and Randhawa, 1978) [12]. Substantial improvement in the performance of crop have been reported as a result of micronutrient supplement of soil for crop from different parts of country (Kanwar and Randhawa, 1974, Katyal, 1986) [7]. Thus the need for knowledge of micronutrients status of soil assumes still greater importance in view of increased hectare yields. Among various micronutrients, manganese is especially important owing to its typical and complex behavior in soils besides, its vital and indispensable role in plant growth. Manganese functions in the activation of numerous enzymes concerned with carbohydrate metabolism, phosphorylation reactions and the citric acid cycle and with other metal in the activation of such enzymes as arginase, cystein, desulphydnase, deoxyribonuclease and yeast phosphatase. Apparently it is specific activator of the enzymes prolidase and glutomyl transferase. Antagonist relationship between Fe and Mn has been reported in soils and plants (Agarwala and Associates, 1964, Pathak *et al*., 1979) [1] and likewise they influence yield of crop differently. Baser and Saxena (1970) [2] obtained increased rice yield by the application of Fe and Mn. Ratios of Fe and Mn either in soil and plant have no significant impact on crop yield, only their addition in optimum concentration is of great significance (Agarwala and Associates, 1964) [1]. Such information available in this respect, so far is rather meagre in soils of Agra. Hence the study is being undertaken with a view to study the Fe and Mn effect on yield, their content and uptake by Spinach crop.

Materials and Methods

A pot culture experiment was carried out using spinach crop in pot culture yard in the department of soil science and agricultural chemistry, RBS College Bichpuri Agra. the experimental soil was collected from research farm of RBS college. The experimental soil was sandy loam in texture alkaline on reaction (pH 8.0) with organic carbon content 3.4 kg per hectare, available N, 160 kg per hectare, available phosphorus 8.4 kg per hectare, available potassium 115 kg per hectare, total Fe extracted with HClO4 (1.8%), available Fe-DTPA (4.5 ppm), total Mn (350 ppm), determined by methods of Willard and Greathouse (1917), available Mn (7.0ppm) extracted with DPTA and determined colorimetrically by Willard and Greathouse (1917). The experiment comprising four levels (0, 5, 10, 20 ppm) of iron and four levels (0, 5, 10, 20 ppm) of manganese was conducted in a factorial randomized design with three replications. Earthen pots of similar size and shape were selected clean and lined with polythene sheets after mixing the soil lot thoroughly 6kg of soil was filled in each pot. Iron, manganese were applied through ferrous sulphate and manganese sulphate respectively. The Basal doses of nitrogen, phosphorus and potassium over applied through urea single super phosphate and muriate of potash respectively, at the time of sowing. The crop was raised with recommended agronomic practices. First cutting of spinach was done after 15 days of sowing followed by second cutting 20 days after first cutting. The yield data in regard to green foliage and dry matter were recorded at first and second cuttings. The samples were analyzed for nitrogen content by modified Kjeldahl method (Jakson 1967). Phosphorus in di-acid (HNO_3: $HClO_4$) digest were determined by vanadomolybdate yellow colour method and flame photometre respectively. Iron and Mn in di-acid digest were determined on atomic absorption spectrophotometer uptake of nutrients was calculated by multiplying nutrient content with their respective dry matter yield.

Results and Discussion

Yield Studies

The data regarding the effect of manganese and iron on green foliage and dry matter yield of spinach are summarized in table 1. A study of table reveals that the difference in green foliage and dry matter yield due to different levels of iron were quite visible. The green foliage and dry matter yield increased significantly and consistently up to 10 ppm Fe levels. Thereafter a reduction was noted at 20 ppm Fe dose. The maximum green foliage and dry matter yield at first and second cuttings were recorded at 10 ppm iron level. The effect of manganese was well marked and the fertilized plants produced more green foliage and dry matter at both cuttings than control. However, the highest dose of Mn (20 ppm) reduced the yield over control significantly. The lower levels of Mn (5 and 10 ppm) produced significantly higher yields over control. But these two levels did not differ significantly from one another in respect of green foliage and dry matter yields at both cuttings. Lal *et al*. (2012) [9], Gupta and Singh (1982) [5] reported similar results.

Table 1: Effect of different levels of iron and manganese on green foliage and dry matter yield (g pot^{-1}) at first and second cutting of the spinach crop.

Treatment	First cutting		Second cutting	
	Green Foliage	Dry Matter	Green Foliage	Dry Matter
Fe levels (ppm)				
0	16.23	1.40	41.00	3.75
5	17.40	1.78	43.00	4.13
10	18.63	2.08	45.00	4.25
20	17.03	1.63	41.75	3.87
SEm±	0.08	0.02	0.24	0.06
CD at 5%	0.24	0.74	0.71	0.19
Mn levels (ppm)				
0	17.00	1.60	43.50	3.87
5	18.08	1.90	45.50	4.13
10	17.98	1.93	47.50	4.52
20	16.28	1.45	34.25	3.67
SEm±	0.08	0.02	0.24	0.06
CD at 5%	0.08	0.07	0.71	0.19

Chemical Composition of Plants

Nitrogen

A Perusal of the data given in table 2 reveals that the concentration of nitrogen percent at all stages of growth of spinach increased significantly with increasing level of iron and manganese. All the levels of the iron and manganese tried in the present investigation proved significantly superior over control in respect of nitrogen and manganese content in spinach crop. These levels of iron and manganese also differed significantly with each other. The maximum content of nitrogen in spinach plants was recorded under 20 ppm Fe and Mn treatment. Lal *et al*. (2012) [9], Francis and Rajgopal (1978) [3] reported that the increased plant growth and yield due to application of iron as FeSO4 complexed with cotton leaf was highly evident at all stages of crop growth.

Phosphorus

Table 2 embodies the data pertaining to P content of spinach at various stages of growth as affected by different treatments. The results show that the Phosphorus content in vegetative parts of spinach tended to decrease steadily with advanced in growth. The application of Fe to the soil increased the P content in spinach plants non-significantly. However, consistent increase in P content was noted with increasing levels of iron. The maximum concentration of P was recorded under 20 ppm Fe treatment. Phosphorus content in spinach plants was not affected significantly with Mn levels at any stage of growth. However, a consistent and non- significant increases in P content was recorded with increasing levels of manganese Lal *et al*. (2016) [10] reported similar results.

Iron

it is seen from table 2 that content of iron in vegetative parts of spinach increased regularly with the progress of growth. The concentration of iron of spinach plants at various growth stages was increased significantly with its addition over control. There was a consistent and significant increase in iron content in spinach plants at various cuttings. With increasing levels of iron and maximum concentration was recorded at 20 ppm dose. All the levels of iron tried in this investigation proved significantly superior over control and they also differed significantly with each other in respect of iron content. On the other hand the application of Mn tended to decrease the levels of iron in vegetative parts of spinach crop. All the levels of Mn had significant adverse effect on iron content and minimum concentration of iron in spinach plants at different cutting was recorded at 20 ppm Manganese level. Singh and Singh (1975) observed under water logged condition Fe and Mn antagonistically affected the content of each other.

Manganese

Further study of table 2 reveals Mn content in vegetative parts of spinach tended to decrease steadily with advanced in the growth. It is evident from the table 2 that the application of iron to the soil decrease the concentration of Mn in spinach plants at various cuttings. There was a gradual decline in Mn content of spinach plants with increasing levels of Fe and minimum concentration of Mn was recorded under 20 PPM Fe treatment. All the levels of Fe also differed significantly with each other in respect of Mn content in spinach plants. It is also evident from table, the concentration of Mn in spinach plants at various cuttings increased consistently and significantly with the increasing levels. All the levels of Mn proved significantly superior over control in respect of its content in spinach plants. These three levels of Mn also differed significantly with each other in respect of Mn content.

Table 2: Effect of different levels of iron and manganese application on chemical composition of spinach plant at different cuttings.

Treatment	First cutting				Second cutting			
	N (%)	P (%)	Fe (ppm)	Mn (ppm)	N (%)	P (%)	Fe (ppm)	Mn (ppm)
Fe levels (ppm)								
0	2.39	0.38	377.75	201.5	1.94	0.35	391.50	187.26
5	2.42	0.39	400.75	185.0	1.96	0.36	418.25	168.75
10	2.45	0.39	436.26	173.5	2.01	0.37	455.75	147.25
20	2.48	0.40	452.00	153.35	2.06	0.37	476.25	139.75
SEm±	0.004	0.062	0.262	0.267	0.006	0.166	0.252	0.262
CD at 5%	0.010	NS	1.507	0.768	0.013	NS	0.728	0.758
Mn levels (ppm)								
0	2.35	0.38	431.50	149.5	1.94	0.36	464.25	136.00
5	2.38	0.38	422.50	163.5	1.97	0.37	445.75	136.00
10	2.47	0.40	412.00	187.5	2.02	0.37	426.25	170.00
20	2.54	0.42	400.75	312.5	2.06	0.38	415.50	176.25
SEm±	0.004	0.052	0.261	0.266	0.004	0.155	0.252	0.262
CD at 5%	0.010	NS	1.507	0.768	0.013	NS	0.728	0.768

Uptake of Nutrients

A study of table 3 reveals that the uptake of N, P and Fe by spinach plants tended to increase with advancement of growth. The utilization of nitrogen, phosphorus and iron by spinach plants at various stages of growth increased significantly with iron application. There was consistent and significant increase in N, P and Fe uptake by spinach plants up to 10 ppm iron application. Thereafter, a significant reduction in uptake of N, P and Fe at various cuttings was recorded with 20 ppm Fe over 10 ppm Fe level. However, manganese showed antagonistic relation with iron as uptake of Mn decreased consistently with increasing levels of iron application. Manganese application proved beneficial as its addition increased the uptake of N, P and Fe by spinach plants significantly. The two levels of Mn (5 and 10 ppm) significantly increased the nitrogen, phosphorus and iron uptake over control. There was a significant and consistent increase in N, P and Fe uptake by spinach plant at various stages of growth up to 10 ppm Mn application. The uptake of N, P and Fe was declined under 20 ppm Mn significantly over 10 ppm Mn and control treatments. The highest values of Fe uptake by plants was recorded at first cutting. The effect of iron and manganese addition on iron uptake was found to be non- significant at second cutting. It is palpable from data (table-3) that Mn uptake by spinach plant at first cutting increased significantly and consistently up to 10 ppm iron application. Thereafter, reduction in Mn uptake was noted with highest (20 ppm) dose of iron. While in second cutting consistent decrease was recorded with increasing level of iron. There was a gradual increase in Mn uptake up to 10 ppm applied Mn followed by decrease at 20 ppm Mn level. But the highest dose 20 ppm of Mn also increased Mn uptake significantly over control. The maximum amount of Mn was utilized by plants at second cutting. Gangwar (1986) [4] reported that utilization of Mn increased with its application and decreased with higher levels of iron application and vice versa.

Table 3: Effect of different levels of iron and manganese application on the uptake of N P Fe and Mn (mg pot^{-1}) by spinach plant at various stages of growth.

Treatment	First cutting				Second cutting			
	N	P	Fe	Mn	N	P	Fe	Mn
Fe levels (ppm)								
0	33.5	5.3	0.54	0.28	72.90	14.26	0.15	0.70
5	43.0	6.9	0.71	0.34	80.90	15.06	0.17	0.68
10	50.8	8.0	0.89	0.37	85.10	15.86	0.21	0.66
20	40.2	6.4	0.74	0.25	79.50	14.43	0.18	0.55
SEm±	0.63	0.08	0.008	0.016	0.60	0.17	0.046	0.025
CD at 5%	1.82	0.25	0.023	0.043	1.74	0.51	-	0.073
Mn levels (ppm)								
0	37.6	6.05	0.69	0.24	74.94	13.95	0.18	0.53
5	45.4	7.15	0.80	0.31	80.78	15.08	0.18	0.62
10	47.6	7.70	0.79	0.36	86.85	15.70	0.19	0.74
20	36.8	5.80	0.58	0.31	75.77	13.98	0.15	0.72
SEm±	0.63	0.08	0.008	0.016	0.60	0.17	0.046	0.025
CD at 5%	1.82	0.25	0.023	0.043	1.74	0.51	-	0.073

References

1. Agarwala SC. Associates Annual Progress Report of I.C.A.R. Scheme Micronutrients status of U.P. soils for the year, 1963-1964, 1964.
2. Baser BL, Saxena SN. Manganese and iron absorption by different crop species grown in soils of Rajasthan. J Indian Soc. Soil Sci. 1970; 12:421-427.
3. Francis HJ. Rajgopal Effect of organically complexed iron on the yield of CSH-5 sorghum Madras agric J. 1978; 65:585-590.
4. Gangwar MS. studies on iron and manganese in soil of Rohilkhand region of Uttar Pradesh "Ph.D. thesis Agra University Agra, 1986.
5. Gupta RK, Singh RS, Gupta Neerja, Yadav AS. Effect of phosphorus application on the Transformation of iron in soil moisture regimes. Indian Soc. of Soil Sci. 1982, 30:58-62
6. Jackson ML. Soil chemical analysis prentice Hall of India Pvt. Ltd. New Delhi, 1967.
7. Kanwar JS, Randhawa NS. Micronutrient Research in soil and plants in India. Areview I. C. A. R. New Delhi, 1974.
8. Katyal JC. Research achievements of All India coordinated schem of micronutrients in soil and plants Fertil. News. 1985; 30(4):67-80.
9. Lal Munna, Nataraja, KC, Kherawat BS, Brajendra, Kumar Arvind Effect of nitrogen and manganese on yield and uptake of nutrients by oats (*Avena sativa* L.). An Asian Journal of Soil Science. 2012; 7(1):127-13.
10. Lal Munna, Pal Kumar Anil, Agrawal Chand Mahesh, Rani Usha K, Suma Chandrika D, Singh Pratap Abhay. Effect of phosphorus and molybdenum on yield and nutrient uptake of faba bean in alluvial soil. Annals of Plant and Soil Research. 2016; 18(3):262-265.
11. Singh S, Singh SB. Effect of application of iron and manganese on their uptake and yield of rice. J Indian Soc. Soil Sci. 1976; 23:489-493.
12. Takkar PN, Randhawa NS. Micronutrients in Indian Agriculture Fertil. News. 1978; 23(8):3-26.
13. Willard HH, Greathoise LH. Colorimetric determination of manganese of oxidation with periodate J Am. chem. soc. 1917; 36:2366-2377.