International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 1377-1380

Received: 12-01-2018
Accepted: 18-02-2018

Ram Chandar Jat
Ph D Scholar Department of Soil Science and Agricultural Chemistry, College Of Agriculture Swami Keshwanad Rajasthan Agriculture University, Bikaner, India

Yogesh Sharma
Professor Department of Soil Science and Agricultural Chemistry, College Of Agriculture Swami Keshwanad Rajasthan Agriculture University, Bikaner, India

RK Jakhar
Assistant Professor and Corresponding Author Department of Soil Science and Agricultural Chemistry, College Of Agriculture Swami Keshwanad Rajasthan Agriculture University, Bikaner, India

RK Sharma
Associate Professor, Department Of Soil Science and Agricultural Chemistry, College Of Agriculture Swami Keshwanad Rajasthan Agriculture University, Bikaner, India

Correspondence
RK Jakhar
Assistant Professor and Corresponding Author Department of Soil Science and Agricultural Chemistry, College Of Agriculture Swami Keshwanad Rajasthan Agriculture University, Bikaner, India

Effect of phosphorus, zinc and iron on Physico-chemical properties of soils and yield of wheat in loamy sand soils

Ram Chandar Jat, Yogesh Sharma, RK Jakhar and RK Sharma

Abstract
A field experiment was carried out during two consecutive *rabi* seasons of 2009-10 and 2010-11 at the Agronomy farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner to find out the effect of phosphorus, zinc and iron on yield and quality of wheat (*Triticum aestivum* L.) in Loamy sand soils of Western Rajasthan with ten treatments comprising 4 levels of phosphorus (0, 20, 40 and 60 kg ha^{-1}) and zinc (0, 3 and 6 kg ha^{-1}) in main plots and 3 levels of iron (0, 3 and 6 kg ha^{-1}) in split-plot design with three replications. Application of phosphorus up to 40 kg P_2O_5 ha^{-1} significantly increased the grain, straw and biological yields beyond which it increased non-significantly and registered a mean increase of 30.6 per cent over control. Application of phosphorus significantly improved the available phosphorus status of the soil after harvest of wheat while available Zn and Fe content in soil declined significantly during the study, however, Increasing levels of phosphorus did not significantly influence the pH, EC, CEC, organic carbon, nitrogen and potassium content of the soil after harvest of wheat. Application of zinc significantly improved the zinc status of the soil after harvest of wheat while available Fe content in soil declined significantly. Application of iron and did not influence the pH, EC, CEC, organic carbon, nitrogen, phosphorus and potassium of the soil after harvest of wheat but have antagonistic effect with zinc.

Keywords: Phosphorus, zinc, iron, yield, physico-chemical properties

1. Introduction

With the increase in the high yielding varieties, irrigated area, fertilizer use and appropriate agro-technology, it has been possible to achieve continuous increase in production and productivity of wheat but at the same time, nutrient removal by crop has also increased. Therefore, nutrient must be supplied to replace those removed from the soil to achieve higher yield from limited land resources. To meet these demands, nutrient needs must be accurately worked out. Large scale depletion of soil fertility is an index towards the occurrence of even more extensive and acute nutrient deficiencies. This calls for a serious thought on the nutrient management to sustain food grain production. Fertilizer is the single most important input in modern agriculture to raise the crop productivity. It has, therefore, become imperative to dwell upon the rationalization of efficient and balanced use of fertilizers for increasing the wheat productivity.

Among the essential nutrients, phosphorus occupies a key place in intensive agriculture and is considered as a backbone of any fertilizer management programme. Application of phosphorus not only increases the crop yield but also improves crop quality and imparts resistance against diseases. It is involved in wide range of plant processes as permitting cell division, development of sound root system and ensuring timely and uniform ripening of crop. It participates in metabolic activities as a constituent of nucleoprotein and nucleotides and also plays a key role in the formation of energy rich bond phosphate like Adenosine diphosphate and Adenosine triphosphate. Micronutrients play a vital role in enhancing crop productivity. Intensification of agriculture with high yielding varieties, continuous use of high analysis fertilizers, restricted supply of organic manures and negligible crop residue return to soil led to micronutrient deficiency. The overall deficiency of micronutrient in Indian soil was found to be 47 per cent for Zn, 2 per cent for Cu, 13 per cent for Fe and 4 per cent for Mn (Sakal and Singh, 2001) [13].

In India, main wheat growing states are UP, Punjab, Haryana, M.P., Rajasthan and Bihar.

In Rajasthan, wheat has an area of 2.94 million hectares with the production of 9.86 million tonnes. The average productivity of wheat in the state is 33.65 q ha^{-1} (Anonymous, 2014-15) [1]. This clearly indicates that in spite of considerable improvement in genetic potential of the crop, productivity is still very poor in the country as well as in the state of Rajasthan. The high productivity of wheat can only be achieved by the adoption of suitable variety and improved agronomic practices with balanced and judicious use of chemical fertilizers in an integrated way. The present investigation was carried out to evaluate and describe the fertilizer phosphorus, zinc and iron application on yield of wheat and physico- chemical properties of soils after crop harvest in Western Rajasthan.

2. Material and Method

The experiment was conducted at the Agronomy farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* seasons of 2009-10 and 2010-11. The experimental site is located at 28.01^0N latitude and 73.22^0E longitude at an altitude of 234.7m above mean sea level and falls under Agro-ecological region No. 2 (M9E1) under Arid ecosystem (Hot Arid Eco-region), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity and hot and arid climate. The soils of experimental field was loamy sand in texture having pH -8.2, EC -0.22 dS m^{-1}, available N – 90.1 kg ha^{-1}, available P_2O_5 – 14.2 kg ha^{-1}, available K_2O – 160.4 kg ha^{-1}, avalable Zinc- 0.34 mg kg^{-1}, avalable iron- 2.90 mg kg^{-1} and organic carbon-0.15%.

The field experiment on wheat in *rabi* seasons of 2009-10 and 2010-11 was laid out comprising 4 levels of phosphorus (0, 20, 40 and 60 kg ha^{-1}) and zinc (0, 3 and 6 kg ha^{-1}) in main plots and 3 levels of iron (0, 3 and 6 kg ha^{-1}) in sub plots. A total of 36 treatment combinations were tested in split plot design with three replications. The treatment details are follows:

(A) Main plot treatments
Phosphorus levels

P_0 = Control, P_1 = 20 Kg ha^{-1}, P_2 = 40 Kg ha-1 and P3 = 60 Kg ha^{-1}

Zinc levels

Zn_0 = Control, Zn_1 = 3 Kg ha^{-1} and Zn_2 = 6 Kg ha^{-1}

(A) Sub plot treatments
Iron levels

Fe_0 = Control, Fe_1 = 3 Kg ha^{-1} and Fe_2 = 6 Kg ha^{-1}

Nitrogen was applied @ 120 kg N ha^{-1} was applied RDF. Half dose was applied as basal through urea after adjusting the quantity of N supplied by DAP. Remaining half dose of N was applied through broadcasting of urea in two equal split doses just after irrigation at 25 and 75 DAS. Potassium was applied @20 kg K_2O ha^{-1} was applied through muriate of potash before sowing. Phosphorus: Phosphorus was applied through DAP, zinc was applied through zinc sulphate and iron was applied through ferrous sulphate before sowing as per treatment. Seeds were treated with thiram (2 g kg^{-1} seed) as prophylactic measures against seed borne diseases. The wheat variety 'Raj-3077' was sown by "*kera"* method at a depth of 5 cm in rows spaced at 22.5 cm apart on 25^{th} and 28^{th} November in the years 2009-10 and 2010-11, respectively using seed rate of 120 kg ha^{-1}.

The grain yield of each net plot was recorded in kg $plot^{-1}$after cleaning the threshed produce and was converted as kg ha^{-1}. Straw yield was obtained by subtracting the grain yield (kg ha^{-1}) from biological yield (kg ha^{-1}). The soil samples (0- 15 cm) were taken from each plot after harvest. The samples were analyzed for pH, EC, CEC, Organic carbon and available nitrogen, phosphorus, potash, zinc and iron as per standard methods.

3. Results and Discussion

3.1 Effect of Phosphorus

Application of phosphorus at 40 kg P_2O_5 ha^{-1} significantly increased the grain yield, straw yield and biological yield over control in pooled analysis (Table 1).The significant increase in grain yield of wheat due to application of phosphorus up to 40 kg P_20_5 ha^{-1} was largely a function of improved growth and the consequent increase in different yield attributes. The grain yield of wheat increased by 762 kg ha^{-1} due to application of 40 kg P_2O_5 ha^{-1} over control. These results are corroborates with the findings of Jain and Dahama (2006) and Jat *et al.* (2007) [7, 8].

The biological yield is a function of grain and straw yields. Thus, significant increase in biological yield with the application of phosphorus could be ascribed to the increased grain and straw yields. The faster rate of improvement in grain yield as compared to straw yield to phosphorus fertilization led to significant improvement in biological yield thereby suggesting better source and sink relationship. These results are in conformity with those of Jat *et al.* (2007) and Sepat and Rai (2013) [8, 16].

Increasing levels of phosphorus to the soil did not affect the EC, pH, ESP and organic carbon of soil significantly in pooled mean. The results further revealed that different levels of phosphorus significantly influenced the available phosphorus status of the soil. As expected, the P availability in soil after harvest of wheat increased significantly with increase in the level of applied phosphorus up to 60 kg P_2O_5 ha^{-1} (Table 2). Contrary to phosphorus availability, the availability of zinc and iron in the soil after harvest of wheat during both the years, decreased significantly with increasing level of phosphorus. This could be ascribed to established fact that phosphorus with zinc and iron interaction in soil have antagonistic relationship (Mathur, 1995). This has also been reported that zinc availability above pH 7.9 is controlled by precipitation of zinc as $Zn(OH)_2$ or $ZnCO_3$. Besides, possibility of formation of $Zn_3(PO_4)_2$ compound cannot be ruled out. Similar findings are reported by Dadhich *et al.* (2011).

3.2 Effect of zinc

Application of zinc at 3 kg ha^{-1} significantly increased the number of yield of wheat over control during both the years (Table 1). The increase in the yield due to zinc application may be attributed to the fact that the initial status of available zinc in the experimental soil was low. The increase in yield attributes may be due to increased supply of available zinc to plants by way of its addition to soil which resulted in proper growth and development. The significant increase in straw yield due to zinc fertilization could be attributed to the increased plant growth and biomass production, possibly as a result of the uptake of nutrients. Similar results were reported by Singh *et al.* (2015) [17] and Arshad *et al.* (2016) [2].

A perusal of data revealed that application of increasing levels of Zn could not bring any significant effect on EC, pH, ESP and organic carbon of soil significantly in pooled mean (Table

2). As expected a linear increase in available zinc content in soil was observed with increasing level of zinc up to 6 kg ha^{-1} after harvest of the crop during both the years. The experimental soil being low in available zinc might have resulted in increased available zinc with the increasing level of zinc application. There could be a 'Priming effect' which possibly caused solubilization of native zinc with increase in the rate of zinc application. These results are corroborates with the findings of Dube *et al*. (2001) and Kulandaivel *et al*., (2004). The available phosphorus content of the soil after the harvest of the wheat crop during both the years, decreased non-significantly however, iron content decreased significantly with the increase in the level of zinc up to 6 kg ha^{-1}. The decrease in the available phosphorus and iron due to increasing level of zinc could be ascribed to the established fact that phosphorus with zinc and iron has antagonistic relationship which might have worked in the present case. This has been reported that Zn availability above pH 7.9 is controlled by precipitation of zinc as $Zn(OH)_2$ or $ZnCO_3$. Besides, possibility of formation $Zn_3(PO_4)_2$ compound cannot be ruled out. Similar results are reported by Kulandaivel *et al*. (2004) and Keram *et al*. (2012) [10, 11].

3.3 Effect of Iron

Application of 3 kg Fe ha^{-1} significantly increased the grain yield (Table 1) over control but it was found statistically at par with 3 kg Fe ha^{-1}. An increase in grain yield may be attributed to the significant increase in number of effective tiller per plant and number of grains per ear. Further, increase in grain yield due to iron application in the soil could possibly be due to the enhanced metabolites of carbohydrates and protein and their transport to the site of grain production. Significant increase in grain and straw yield due to iron application has also been reported by Habib, (2009) [6]. The biological yield is a function of grain and straw yields. Thus, increase in biological yield with the application of iron could be ascribed to increase grain and straw yields. These results are in line conformity of findings of Gill and Walia (2014) [5].

Data presented in Table 2 revealed that increasing levels of Fe to the soil did not affect the EC, pH, ESP and organic carbon of soil significantly in pooled mean. This can be explained by the fact that Fe does not play any significant role in improvement of soil physic-chemical properties of soil. The results are line in conformity of results of Sarkar *et al.* (2000) and Sankaranarayanan *et al.* (2010) [14, 15].

Increasing levels of iron decreased the phosphorus content non-significantly and zinc content significantly in soil after harvest of wheat crop. This might be due to antagonistic effect between P and Zn with Fe. Similar results were reported by Jha *et al.* (2008) and Naga *et al.* (2013) [9, 12].

4. Conclusion

The study indicates that application of 40 kg P_2O_5 ha^{-1}, 3 kg Zn ha^{-1} and 3 kg Fe ha^{-1} with recommended dose of nitrogen (120 kg ha^{-1}) and potassium (20 kg ha^{-1}) can be recommended for optimum and maximum wheat productivity and improve the physico- chemical properties of loamy sand soils in western Rajasthan

Table 1: Effect of phosphorus, zinc and iron on yield of wheat (pooled basis)

Treatment	Grain yield kg ha^{-1}	Straw yield kg ha^{-1}	Biological yield kg ha^{-1}	Harvest index
Phosphorus levels (P_2O_5 Kg ha^{-1})				
Control	2901	4192	7093	40.01
20	3416	4975	8392	41.02
40	3663	5476	9140	40.09
60	3735	5593	9331	40.10
SEm±	36	49	80	0.55
CD (P=0.05)	101	138	228	NS
Zinc levels (Zn Kg ha^{-1})				
Control	3127	4733	7860	39.21
3	3539	5170	8709	40.77
6	3620	5275	8898	40.93
SEm±	31	42	69	0.47
CD (P=0.05)	88	120	197	NS
Iron levels (Fe Kg ha^{-1})				
Control	3109	4658	7771	39.47
3	3538	5202	8739	40.60
6	3640	5317	8957	40.85
SEm±	38	43	78	0.51
CD (P=0.05)	107	119	220	NS

Table 2: Effect of Phosphorus, zinc and iron on physic- chemical properties of soil after harvest of wheat (pooled basis)

Treatments	pH	EC (dS m^{-1})	CEC	Organic carbon (%)	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})	Zinc (ppm)	Iron (ppm)
Phosphorus levels (P_2O_5 Kg ha^{-1})									
Control	8.18	0.258	3.18	0.193	92.87	12.33	162.49	0.377	3.48
20	8.11	0.252	3.22	0.193	93.64	14.47	160.29	0.352	3.40
40	8.05	0.248	3.16	0.196	94.34	16.79	158.77	0.333	3.36
60	7.99	0.244	3.20	0.198	96.08	19.26	154.20	0.320	3.19
SEm±	0.12	0.005	0.05	0.003	1.49	0.38	2.87	0.009	0.04
CD (P=0.05)	NS	NS	NS	NS	NS	1.10	NS	0.027	0.10
Zinc levels (Zn Kg ha^{-1})									
Control	8.17	0.255	3.21	0.193	93.25	15.77	161.19	0.294	3.44
3	8.09	0.249	3.14	0.195	94.27	15.73	158.78	0.349	3.38
6	7.99	0.249	3.21	0.197	95.18	15.64	156.85	0.394	3.25
SEm±	0.10	0.004	0.05	0.002	1.29	0.33	2.49	0.008	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.023	0.09
Iron levels (Fe Kg ha^{-1})									

Control	8.13	0.254	3.13	0.193	93.02	15.80	160.78	0.370	3.17
3	8.08	0.248	3.20	0.195	94.36	15.71	159.31	0.350	3.37
6	8.04	0.251	3.24	0.197	95.32	15.64	156.73	0.316	3.53
SEm±	0.11	0.003	0.04	0.002	1.38	0.30	2.37	0.011	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.031	0.09

5. References

1. Anonymous. Economic survey of India, Ministry of Finance (Economic Division) GOI, New Delhi. 2014-15.
2. Arshad M, Adnan M, Ahmed S, Khan AK, Ali I, Ali M. et al. Integrated Effect of Phosphorus and Zinc on Wheat Crop. American-Eurasian Journal of Agriculture & Environmental Science, 2016; 16(3):455-459.
3. Dadhich SK, Somani LL, Shilpkar D. Effect of integrated use of fertilizer P, FYM and biofertilizers on soil productivity of soybean-wheat crop sequence. Journal of Advance in Development Research, 2011; 2:42-46.
4. Dube BK, Sharma CP, Chtterjee, C. Response of pigeonpea to applied zinc in ustifluvent soils of Western Uttar Pradesh. Journal of the Indian Society of Soil Science, 2001; 49(3):471-475.
5. Gill JS, Walia SS. Effect of foliar application of iron, zinc and manganese on direct seeded aromatic rice (*Oryza sativa*). Indian Journal of Agronomy, 2014; 59(1):80-85.
6. Habib M. Effect of foliar application of Zn and Fe on wheat yield and quality. African Journal of Biotechnology, 2009; 8(24):6795-6798.
7. Jain NK. Dahama AK. Direct and residual effects of phosphorus and zinc fertilization on productivity of wheat (*Triticum aestivum)* - pearl millet (*Pennisetum glaucum*) cropping system. Indian journal of Agronomy, 2006 51:165-169.
8. Jat BL, Shaktawat MS, Jat AS. Effects of phosphorus levels alone or in combination with phosphate-solubilizing bacteria (*Pseudomonas striata*) and farmyard manure on growth, yield and nutrient uptake of wheat (*Triticum aestivum)*. Journal of Agriculture and Social Sciences, 2007; 32:78-82.
9. Jha AK, Ranjan R, Dalwari MR. Effect of cadmium on iron uptake by chickpea and wheat in clay and loamy sand soils of Gujarat. International Journal of Tropical Agriculture, 2008; 26:397- 401.
10. Keram KS, Sharma BL. Sawarkar SD. Impact of zn application on yield, quality, nutrients uptake and soil fertility in a medium deep black soil (vertisol). International Journal of Science, Environment and Technology, 2012; 1(5):563-571.
11. Kulandaivel S, Mishra BN, Gangaiah B. MishraPK. Effect of levels of zinc and iron and their chelation on yield and soil micronutrient status in hybrid rice (*Oryza sativa*) - wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy, 2004; 49(2):80-83.
12. Naga SR, Yadav BL, Sharma SR. Effect of different levels of RSC in irrigation waters, zinc and iron on soil properties and yield of wheat grown on loamy sand soil. *Green Farming*, 2013; 4(3):330-333.
13. Sakal R, Singh AP.Micronutrient in relation to response and quality of crop. Journal of Agricultural Chemistry, 2001; 14:4-5.
14. Sankaranarayanan K, Praharaj CS, Nalayini P, Bandyopadhyay KK, Gopalakrishnan N. Effect of magnesium, zinc, iron and boron application on yield and quality of cotton (*Gossypium hirsutum*). Indian Journal of Agricultural Sciences, 2010; 80(8):699-703.
15. Sarkar D, Haldar A, Majumdar A, Velayguthami M. Distribution of micronutrient cations in some inceptisols and entisols of Madhubani district of Bihar. Journal of the Indian Society of Soil Science, 2000; 48:202-205.
16. Sepat S, Rai RK. Effect of phosphorus levels and sources on productivity, nutrient uptake and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy, 2013; 58(3):292-297.
17. Singh V, Javed A, Seema, Kumar A, Chauhan TM. Productivity, nutrient uptake and economics of wheat (*Triticum aestivum*) under potassium and zinc nutrition. Indian Journal of Agronomy, 2015; 60(3):426-430.