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RESPONSE OF ONION TO IRON AND ZINC NUTRITION IN AN ALLUVIAL SOIL

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ABSTRACT

A field experiment was conducted at R. B. S. College Research farm Bichpuri, Agra (U.P.) during rabi season to study the effect of graded levels of iron (0,5,10,20 kg Fe ha^{-1}) and Zn (0, 2.5, 5.0 and 10.0 kg Zn ha^{-1}) on yield attributes, yield, quality and uptake of nutrients in onion (Allium cepa L). The experiment was laid out in randomized block design with three replications. Results revealed that the weight of a bulb, bulb yield and bulb dry matter yield increased linearly up to 10 kg Fe ha^{-1} and 5 kg Zn ha^{-1}. The bulb yield (23.81 t ha^{-1}) at 10 kg Fe ha^{-1} was 14.1% higher than that obtained in the control. Similarly, application of 5 kg Zn ha^{-1} gave the highest yield of bulb (24.85 t ha^{-1}), which was 23.0% more in comparison with that of the control. Similarly dry matter yield of onion bulbs increased significantly with 10 kg Fe ha^{-1} and 5 kg Zn ha^{-1} over their respective controls. The content and yield of protein in onion bulbs increased significantly with an increase in level of iron. Similarly, application of zinc increased the content (3.87%) and yield (14.63 q ha^{-1}) of protein up to 10 and 5 kg Zn ha^{-1}, respectively. The uptake of Fe and Zn by bulbs significantly increased up to 20 kg Fe ha^{-1} and 5 kg Zn ha^{-1}, respectively. An increase in Fe uptake was noted up to 5 kg Zn where as Zn uptake decreased up to 20 kg Fe ha^{-1} addition. The minimum value of Zn uptake by onion bulbs was recorded at 20 kg Fe ha^{-1}. Iron application up to 10 kg ha^{-1} significantly increased the uptake of N, P, K and S by the onion bulb over control followed by a reduction at 20 kg Fe ha^{-1}. A phenomenal increase in uptake of nutrients was recorded in onion bulbs due to increasing levels of Zn up to 5 kg ha^{-1}, thereafter a reduction was noted at 10 kg Zn ha^{-1}.

Key words: Iron, zinc, yield, quality, nutrient uptake onion.

INTRODUCTION

Onion (Allium cepa L) is one of the most important commercial vegetable crops grown in India. Onion requires substantial amount of plant nutrients and responds very well to the added nutrients. Iron and zinc deficiencies and neglect to give equal importance to these nutrients in fertilization programme has resulted in low productivity of onion. Intensive cropping along with lower use of organic manures and very low rates of application or practically no use of iron and zinc in soils have led to depletion of the reserves of Fe and Zn in soils, limiting the crop productivity. The low yields of bulb crops and poor quality of the produce are due to various constraints including micronutrient management. Iron is a structural component of porphyrin molecules cytochromes, haemes, hematin, ferrichrome and leg-haemoglobin involved in oxidation-reduction reactions in respiration. It is an important part of the enzyme nitrogenase which is essential for nitrogen fixation through nitrogen fixing bacteria. The ferrodoxins are Fe-S proteins and are the first stable redox compound of the photosynthetic electron transport chain (Havlin *et al.* 2014). Zinc plays a significant role in various enzymatic and physiological activities of the plant body. Zinc catalyses. The process of oxidation in plant cells and plays a vital role in transformation of carbohydrates, regulates the consumption of sugar, increases, the source of energy for the production of chlorophyll, adds in the formation of auxins and promotes absorption of water. Zinc is also important micronutrient reported deficient in Indian soils and plays a significant role in various enzymatic and physiological activities of plant bodies. Response to applied zinc for better growth and yield of vegetable crops has also been reported from almost all corners of country (Solanki *et al.* 2010).Iron shows interaction with Zn and affects the Zn nutrition of crops like mustard (Kumar *et al.* 2006), wheat (Mohammed and Mohammad 2009) and other crops. However, such information is not available for onion under agro-climatic conditions of Agra region. Therefore, a field experiment was

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conducted to study the effect of Fe and Zn application on yield, quality and nutrient uptake by onion in alluvial soil.

MATERIALS AND METHODS

Field experiments were conducted at R. B. S. College Research farm Bichpuri (Agra). The climate of the study area is semi-arid with an average rain fall of about 650 mm per annum, about 80% of which is received during June to September. The soil of the experimental field was sandy loam in texture, having pH 8.1, organic carbon 3.9 g kg^{-1} and available N, P, K, Fe and Zn 145, 9.2, 115 kg ha^{-1}, 4.2 and 0.55 mg kg^{-1}, respectively. The experiment was laid out in randomized block design with three replications. The treatments included four levels each of iron (0.5, 10 and 20 kg Fe ha^{-1} and Zn (0, 2.5, 2.0 and 10 kg Zn ha^{-1}). Recommended dose of N, P and K(150,kg N, 100 kg P_2O_5 and 50 kg K_2O ha^{-1}) were applied as urea, di-ammonium phosphate and muriate of potash, respectively. Potassium and phosphorus were applied at planting but the crop received nitrogen in two splits, half as basal and half at 60 days after planting. Iron and zinc were applied as ferrous oxide and zinc chloride at the time of planting. The seedlings of onion cv Nasik Red N-53 were planted in mid December during both the years. The spacing adopted was 20x10 cm. Onion crop was irrigated after planting and later as and when required. The crop was harvested at physiological maturity and yield data were recorded. The yield attributes of onion crop were recorded at harvest. Processed bulb samples were analyzed for their nutrients by digesting the samples using di-acid mixture (HNO_3 : $HClO_4$:10 : 4) followed by estimation of Fe and Zn on an AAS. Phosphorus, K and S were determined by vanado molybdo phosphoric yellow colour method, flame photometer (Jackson 1973) and turbidi metric method (Chesnin and Yien 1951), respectively. Nitrogen content was determined following micro Kjeldahl method. The proteln content was computed from the nitrogen content multiplied by a factor 6.25. The uptake of nutrients was then computed from their concentrations in bulb samples and bulb yield.

RESULTS AND DISCUSSION

Yield attribute and yield

A perusal of data (Table 1) revealed that the application of graded doses of Fe to onion significantly enhanced the weight of a bulb over control. The maximum weight (61.7 g) of a bulb was recorded with the application of 10 kg Fe ha^{-1} over rest of the levels of iron. The increase in weight of bulb may be due to low available Fe status of the soil. There was a reduction in weight of bulb with 20 kg Fe ha^{-1} over 10 kg Fe ha^{-1}. Choudhary *et al.* (2015) reported similar results. With increasing levels of zinc, successive increase was observed in weight of onion bulb up to 5 kg Zn ha^{-1} application. Thereafter, weight of a bub reduced with 10 kg Zn ha^{-1}. The weight of bulb increased from 61.0 g at control to 62.2 g with 5 kg Zn ha^{-1}. This increase in weight of bulb with Zn application may be attributed to low level of Zn in experimental soil. Similar results were reported by Singh *et al.*(2015).Application of 10 kg Fe ha^{-1} and 5 kg Zn ha^{-1} produced significantly higher bulb yield and bulb dry matter yield in comparison to control (Table 1). The highest mean bulb yield and dry matter yields of bulbs were recorded with the application of 10 kg Fe ha^{-1}, which were respectively, 14.0 and 13.8% higher than that of the control. Application of 5 kg Zn ha^{-1} recorded the highest bulb yield and bulb dry matter yield, which were respectively 23.0 and 23.5% higher than in the control. This increase might be attributed to the deficiency of these nutrients in soil. Choudhary *et al.* (2015) and Solanki *et al.* (2010) reported similar results in fennel and onion for Fe and Zn, respectively. The higher magnitude of Zn response may be due to quite low initial available Zn status of the soil. In addition, the favourable influence of Zn application on the yield of onion may be attributed to its role in various enzymic reactions, growth processes, hormone production and protein synthesis and also the transformation of photosynthates to reproductive parts thereby leading to higher yield of the crop. Solanki *et al.* (2010) and Choudhary *et al.* (2015) reported similar results in onion and fennel, respectively.

Table 1: Effect of iron and zinc levels on yield and quality of onion (mean of two years)

Treatments	Yield ($t\ ha^{-1}$)			Protein content (%)	Protein yield ($q\ ha^{-1}$)
	Weight of bulb (g)	Fresh bulb	Dry matter		
Iron ($kg\ ha^{-1}$)					
0	61.4	20.95	3.23	3.68	11.88
5	61.5	21.90	3.38	3.75	12.67
10	61.7	23.81	3.68	3.81	14.02
20	60.9	22.46	3.47	3.81	13.22
SEm±	0.01	0.38	0.06	0.05	0.31
CD (p= 0.05)	0.02	0.77	0.13	0.11	0.63
Zinc ($kg\ ha^{-1}$)					
0	61.0	20.17	3.11	3.62	11.29
2.5	61.5	22.10	3.41	3.75	12.79
5.0	62.2	24.85	3.84	3.81	14.63
10.0	60.8	22.00	3.39	3.87	13.12
SEm±	0.01	0.38	0.06	0.05	0.31
CD (p= 0.05)	0.02	0.77	0.13	0.11	0.63

Quality

Application of iron increased the protein content in onion bulb and this increase was significant over control. The maximum value of protein content (3.81%) was noted at 10 kg Fe ha^{-1}. Protein content increased significantly with the application of zinc, which was lowest in control (3.62%) and highest (3.87%) at 10 kg Zn ha^{-1}. This increase in protein content with iron application may be attributed to its involvement in nitrogen metabolism. Similar results were reported by Chandel *et al.* (2013).This increase in protein content may be attributed to its involvement in nitrogen metabolism.The protein production increased from 11.88 q ha^{-1} at control to 14.02 q ha^{-1} with 10 kg Fe ha^{-1}. Application of zinc increased the protein production significantly over control. The maximum protein yield (14.63 q ha_{-1}) was observed in the treatment where 5 kg Zn ha^{-1} was applied. Since, protein yield is the resultant of bulb yield and protein content, it also increased due to Fe and Zn because of increase in bulb yield. Solanki *et al.* (2010) and Choudhary *et al.* (2015) reported similar results in onion and fennel respectively.

Table 2: Effect of iron and zinc levels on uptake of N, P, K, S ($kg\ ha^{-1}$) and Fe and Zn ($g\ ha^{-1}$) by onion bulbs (mean of two years)..

Treatment	N	P	K	S	Fe	Zn
Iron ($kg\ ha^{-1}$)						
0	19.0	4.5	16.1	9.6	161.5	109.8
5	20.3	5.1	17.2	11.8	184.2	106.8
10	22.4	4.8	17.3	13.6	220.8	105.7
20	21.2	3.5	15.6	12.1	225.5	93.3
SEm+	0.58	0.02	0.48	0.59	9.8	5.1
Cd (p_2 0.05)	1.17	0.04	0.97	1.19	19.7	10.3
Zinc ($kg\ ha^{-1}$)						
0	18.1	4.1	15.3	9.0	192.8	82.7
2.5	20.5	5.1	17.0	11.6	199.8	99.0
5.0	23.4	4.4	18.4	14.6	215.0	121.7
10.0	21.0	3.4	15.6	12.2	179.0	115.3
SEm+	0.58	0.02	.48	0.59	9.8	5.1
Cd (p_2 0.05)	1.17	0.04	0.97	1.19	19.7	10.3

Nutrient uptake

The uptake of nitrogen by onion bulbs increased significantly with lower levels of iron addition followed by a reduction at 20 kg Fe ha^{-1}. The maximum value of N uptake (220.4 kg ha^{-1}) was recorded at 10 kg Fe ha^{-1}. The increase in N uptake with lower levels of iron may be due to higher bulb production. Mohammad and Mohammad (2009) also reported similar results. Nitrogen uptake by onion bulb increased significantly with increasing levels of zinc and the highest N uptake was observed with 5 kg Zn ha^{-1} i.e 23.4 kg $ha^{-1}$and lowest in the control (18.1kg ha^{-1}). Thus the beneficial effect of Zn on photosynthesis and metabolic processes augments the production of photosynthates and their translocation to different plant parts including bulb. These results are in accordance with the findings of Singh *et al.* (2015).

The utilization of P by onion bulbs increased significantly with lower levels of Fe over control. The higher level (20 kg Fe ha^{-1}) caused a significant reduction in P uptake by onion crop over 5 kg Fe ha^{-1}. This reduction may be due to reduction in dry matter yield of onion bulbs. Similar results were reported by Chandel et al (2013). Phosphorus uptake first increased due to increase in yield but at the higher dose of zinc, it increased due to decrease in P content in bulb. The decrease in P uptake with higher level of zinc might be due to antagonistic effect between P and Zn. Similar results were reported by Singh and Pandey (2006) and Singh *et al.* (2015). The K uptake by onion bulbs increased significantly and consistently up to 10 kg Fe ha^{-1}. Thereafter, a reduction in potassium uptake by onion bulbs was noted at 20 kg Fe ha^{-1}. Kumar *et al.* (2006) reported similar results.The uptake of K by onion bulb was significantly increased with increasing levels of Zn up to 5 kg Zn ha^{-1}. The magnitude of increase in K uptake with 5 kg Zn ha^{-1} was 20.2 % in onion bulbs over control. This increase in K uptake may be ascribed to greater dry matter production with zinc application (Singh *et al.* 2015).

The S uptake by onion bulbs increased significantly with increasing levels of Fe over control (Table 2) which may be due to increased availability of S in soil. In onion bulbs, S uptake ranged from 9.6 kg ha^{-1} (control) to 13.6 g ha^{-1} (10 kg Fe ha^{-1}). There was a significant increase in S uptake by onion bulb with the application of Zn up to 5 kg Zn ha^{-1} over the control. Thereafter, a reduction in S uptake was noted at higher level of zinc (10 kg ha^{-1}) over 5 kg Zn ha^{-1} (Singh *et al.* 2015). Application of Fe progressively increased its uptake by onion bulb, i.e. at 5,10 and 20 kg Fe ha^{-1}, it was 14.0,36.7and 39.6% higher over control, respectively. This increase may be due to increased availability of iron in soil (Chandel *et al.,* 2013). The Fe application had significant adverse effect on Zn uptake by the onion bulb. The highest level of Fe (20 kg ha^{-1}) reduced the Zn uptake compared with its lower levels as a result of lower content of Zn in bulbs. The Zn uptake by onion bulbs increased with its addition and the highest value of Zn uptake 121.7 g ha^{-1} was recorded at 5 kg Zn ha^{-1}. It was due to combined effect of higher yield along with higher Zn content. Zinc application increased the Fe uptake by onion bulb significantly over the control. However, higher level of Zn slightly reduced the Fe uptake in onion bulbs over control.

From the results, it can be concluded that application of iron and zinc was found to be effective for sustainable production, quality and uptake of nutrients in onion bulbs. Application of 10 kg Fe ha^{-1} and 5 kg Zn ha^{-1} had significant effect on yield, quality and uptake of nutrients by inion bulbs under the agro-climatic conditions of Agra.

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