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Response of onion to soil and foliar application of iron on entisols

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ABSTRACT : An investigation was carried out on Typic Ustorthent (Entisol) to study the effect of soil and foliar application of iron on nutrient uptake and iron availability in soil and yield of bulb onion (cv. Basawant 780). The highest total uptake of total nitrogen (128.13 kg ha^{-1}) and iron (4.45 kg ha^{-1}) by onion was found in treatment of soil application of RDF + FYM + $FeSO_4$ @ 20 kg ha^{-1} followed by treatment of RDF + FYM + $FeSO_4$ @ 20 kg ha^{-1} + 0.5 % $FeSO_4$ at 30 and 45 days after transplanting. The iron availability in soil 20.12 and 21.43 mg kg^{-1} was also increased in soil after harvest of onion in aforesaid two treatments, respectively. The same trend of increased in microbial count in soil after harvest of onion was recorded in above mentioned two treatments. The highest onion bulb yield (28.11 Mg ha^{-1}) was obtained under the treatment soil application of RDF + FYM + $FeSO_4$ @ 20 kg ha^{-1} on entisol.

KEY WORDS : Ferrous sulphate, Uptake, Microbial count, Residual Fe in soil, Onion bulb yield, Entisol

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Onion the "queen of the kitchen" is one of the most commercially valuable vegetables grown in India. Among fresh vegetables, onion is pride item of agricultural exports earning valuable foreign exchange to the country and account for about 70 % of the total foreign exchange earnings of fresh vegetables (Sirohi and Behra, 2003). In India, it is grown over an area of 8.06 lakh ha. with production of 133.72 lakh MT and productivity 16.6 t ha^{-1} (FAO website, 2010). In Maharashtra it occupies an area of 415000 ha with the production of 4904 MT productivity and 11.82 t ha^{-1} (Anonymous, 2010). Onion is one of the few versatile vegetable crops that can be stored for fairly long period.

A global review of area and production of major vegetables showed that onion ranks second in area and third in production of the total vegetable in the world. China is the first in area and production while, India occupied second position in the production. The big onion is produced in Maharashtra, Karnataka, Andra Pradesh and Tamil Nadu. Soil application of zinc and boron and foliar sprays of iron and manganese are found more economical. Hence, their application is widely practiced by the farmers. Micronutrient toxicities through fertilizations are not reported except of boron. Use of manures and IPNS reduced the micronutrient fertilizer requirements of crops and enhances residual effect. The problems of micronutrients after the green revolution are quite different. GIS based mapping information is important to know micronutrient deficient areas and multi micronutrients are emerging fast in areas brought under intensive cropping, farmers are very much needed to cure micronutrient deficiencies, improve yield and quality produce and sustain soil environment.

Continues use of high analysis fertilizer under intensified cropping and negligence of organic manures manifest the occurrence of widespread micronutrients deficiencies of Fe and Zn in light textured soils of India (Singh, 2006). In Western Maharashtra, 35 % soil are deficient in Zn followed by 31 % in Fe (Dhage *et al*., 2005). Onion productivity is very low 11.82 t ha^{-1} against 4.15 lakh ha. area, this might be due to onion crop grown on light textured soil with low organic matter content in soil, deficiency of micronutrient *viz*., Fe and Zn and imbalance use of nutrients. Therefore, a field investigation was undertaken to study the response of onion to application of ferrous sulphate on entisol.

RESEARCH METHODS

The field experiment was conducted at STCRC Farm of Dept. of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Kharif* 2006-09 for study of response of onion for soil and foliar application of Iron. The soil was shallow, Typic Ustorthent with available N: 240 kg ha^{-1}, P_2O_5: 19.0 kg ha^{-1}, K_2O : 258 kg ha^{-1}, DTPA Fe : 4.10 mg kg^{-1}. The experiment was carried out in a Randomized Block Design with 10 treatments, replicated thrice. Treatments comprises : T_1 = RDF, T_2 = RDF + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT), T_3 = RDF + $FeSO_4$ soil application @ 20 kg ha^{-1}, T_4 = RDF + $FeSO_4$ soil application @ 20 kg ha^{-1} + 0.5 % $FeSO_4$ spray (30 and 45 DAT), T_5 = RDF + FYM + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT), T_6 = RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$, T_7 = RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$ + 0.5 % spray (30 and 45 DAT), T_8 = RDF + FYM + chelated Fe spray (30 and 45 DAT), T_9 = RDF + FYM + Jivamrut 500 l ha^{-1} after (30 and 45 DAT), T_{10} = RDF + FYM + Jivamrut + soil application of $FeSO_4$, 20 kg ha^{-1}.

The NPK dose without FYM was applied (100 :50 :50 kg ha^{-1}) to T_1 to T_4 treatment and FYM @ 10 t ha^{-1} was applied to T_5 to T_{10} treatment. Analysis of DTPA Fe in soil was carried out by using standard methods as described by Lindsay and Norvell (1978) and N, P and K concentration in onion leaves and bulb estimated as per procedure outlined by Jackson (1973).

Method of preparation of Jivamrut:10 kg cattle dung + 5 l cattle urine + 2 kg Jaggary + 2 kg floor of any pulse + 200 l water - incubated for 8 days.

Chemical composition of Jivamrut:

pH = 5.85	P = 0.02 %
EC = 5.60 dSm^{-1}	Fe = 17 mg L^{-1}
Moisture = 99.25 %	Mn = 12.76 mg L^{-1}
Ash = 0.1 %	Cu = 13.68 mg L^{-1}
N = 0.01 %	Zn = 5 mg L^{-1}
K = 0.2 %.	

RESEARCH FINDINGS AND DISCUSSION

The pooled data (2006-2009) in respect of total chlorophyll content in leaves at 30 and 45 DAT and residual DTPA-Fe in soil are given in Table 1. The pooled mean of total chlorophyll content in leaves at 30 DAT was higher in treatments T_7, T_5 and T_8, however, at 45 DAT, it was higher in treatments of T_7, T_8, T_5 and T_6. All these treatments showed significant increase in total chlorophyll content in leaves over control. Jadhao *et al*. (2002) also reported that, the response of turmeric to soil application of $FeSO_4$ @ 30 kg ha^{-1} which increased the height of plant and number of leaves per plant of turmeric.

The residual available DTPA-Fe in soil was significantly increased 20.12 mg kg^{-1} in treatments of T_6 (RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$) and 21.43 mg kg^{-1} in T_7 (T_6 + 0.5 % spray of $FeSO_4$ at 30 and 45 DAT) over all the treatments under study, however, treatment T_6 and T_7 were at par. The soil was deficient in DTPA-Fe after harvest of onion in the treatments of only RDF and RDF + foliar application of $FeSO_4$ @ 0.5 %.

Total uptake of N, P, K and Fe by onion as influenced by various treatment under study are presented in Table 2. The pooled data revealed that highest total uptake of nitrogen (128.13 kg ha^{-1}) and iron (4.457 kg ha^{-1}) was found in treatment of T_6 (RDF + FYM + soil application of $FeSO_4$ @ 20 kg ha^{-1}) which was at par with treatment of T_7 (RDF + FYM + soil application of $FeSO_4$ @ 20 kg ha^{-1} + 0.5 %spray) at 30 and 45 DAT. Singh *et al*. (1984) reported that application of $FeSO_4$ @ 5, 10, 20 and 40 kg ha^{-1} significantly increased the grain yield and concentration of iron in lentil

Table 1 : Total chlorophyll content at 30 and 45 days after transplanting of onion and residual DTPA Fe in soil after harvest of onion (Pooled mean of 4 years)

Treatments	Total chlorophyll (mg g^{-1} fresh wt.)		Residual Fe in soil (ppm)
	30 days	45 days	
T_1 : RDF	0.305	0.337	4.10
T_2 : RDF + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	0.405	0.435	4.49
T_3 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1}	0.408	0.440	16.15
T_4 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1} + 0.5 % $FeSO_4$ spray (30 and 45 DAT)	0.445	0.475	16.86
T_5 : RDF + FYM + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	0.517	0.537	6.55
T_6 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$	0.478	0.533	20.12
T_7 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$ + 0.5 % spray (30 and 45 DAT)	0.528	0.563	21.43
T_8 : RDF + FYM + chelated Fe spray (30 and 45 DAT)	0.515	0.547	8.52
T_9 : RDF + FYM + Jivamrut 500 L ha^{-1} after (30 and 45 DAT)	0.418	0.435	5.37
T_{10} : RDF + FYM + Jivamrut + soil application of $FeSO_4$ 20 kg ha^{-1}	0.458	0.478	11.56
S.E. ±	0.014	0.016	0.672
C.D. (P=0.05)	0.039	0.047	1.950

Table 2 : Pooled mean of total nutrient uptake as influenced by different soil and foliar application of iron to onion

Treatments	Total nutrient uptake (kg ha^{-1})			
	N	P	K	Fe
T_1 : RDF	71.27	41.9	48.9	1.740
T_2 : RDF + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	85.27	49.6	60.2	2.712
T_3 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1}	93.54	61.2	68.6	3.052
T_4 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1} +0.5 % $FeSO_4$ spray (30 and 45 DAT)	109.15	71.5	77.8	3.863
T_5 : RDF + FYM + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	117.89	73.3	80.6	3.315
T_6 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$	128.13	73.0	92.5	4.457
T_7 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$ + 0.5 % spray (30 and 45 DAT)	122.43	83.8	96.1	4.441
T_8 : RDF + FYM + chelated Fe spray (30 and 45 DAT)	105.76	68.2	63.5	3.315
T_9 : RDF + FYM + Jivamrut 500 L ha^{-1} after (30 and 45 DAT)	75.37	38.6	46.0	1.713
T_{10} : RDF + FYM + Jivamrut + soil application of $FeSO_4$ 20 kg ha^{-1}	95.50	57.9	57.6	2.833
S.E. ±	8.561	5.3	4.54	0.200
C.D. (P=0.05)	24.843	15.5	13.19	0.580

Table 3 : Pooled mean of microbial count in soil after harvest as influenced by different soil and foliar application of iron on onion

Treatments	Bacterial (x 10^6 g^{-1})	Fungi (x 10^4 g^{-1})	Actinomycetes (x 10^6 g^{-1})
T_1 : RDF	9.87	5.16	7.23
T_2 : RDF + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	10.82	5.91	8.20
T_3 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1}	11.59	6.49	9.82
T_4 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1} + 0.5 % $FeSO_4$ spray (30 and 45 DAT)	11.71	6.45	10.28
T_5 : RDF + FYM + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	12.09	6.74	11.66
T_6 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$	12.22	6.84	12.00
T_7 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$ + 0.5 % spray (30 and 45 DAT)	12.35	6.93	12.07
T_8 : RDF + FYM + chelated Fe spray (30 and 45 DAT)	12.10	6.81	11.80
T_9 : RDF + FYM + Jivamrut 500 L ha^{-1} after (30 and 45 DAT)	11.54	6.42	10.24
T_{10} : RDF + FYM + Jivamrut + soil application of $FeSO_4$ 20 kg ha^{-1}	11.83	6.84	12.45
S.E. ±	0.275	0.123	0.52
C.D. (P=0.05)	0.818	0.366	1.54

Table 4 : Pooled mean of economics of *Kharif* onion as influenced by different soil and foliar application of iron on onion

Treatments	Bulb yield (Mg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
T_1 : RDF	19.04	23130	95200	72070	3.12
T_2 : RDF + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	21.83	23180	109150	85970	3.71
T_3 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1}	23.81	23380	119050	95670	4.09
T_4 : RDF + $FeSO_4$ soil application @ 20 kg ha^{-1} + 0.5 % $FeSO_4$ spray (30 and 45 DAT)	26.24	23430	131200	107770	4.60
T_5 : RDF + FYM + $FeSO_4$ @ 0.5 % spray (30 and 45 DAT)	24.53	31180	122650	91470	4.93
T_6 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$	28.11	31130	140550	109220	3.49
T_7 : RDF + FYM + soil application @ 20 kg ha^{-1} $FeSO_4$ + 0.5 % spray (30 and 45 DAT)	27.80	31380	139000	107620	3.43
T_8 : RDF + FYM + chelated Fe spray (30 and 45 DAT)	24.54	31630	122700	91070	2.88
T_9 : RDF + FYM + Jivamrut 500 L ha^{-1} after (30 and 45 DAT)	18.24	31230	91200	59970	1.92
T_{10} : RDF + FYM + Jivamrut + soil application of $FeSO_4$ 20 kg ha^{-1}	22.54	31430	112700	81270	2.59
S.E. ±	0.815	--	--		0.56
C.D. (P=0.05)	2.365	--	--		1.26

crop over control.

Total uptake of P (83.8 kg ha^{-1}) and K (96.1 kg ha^{-1}) by onion was found significantly higher in treatment T_7 followed by T_6 treatment, however, treatment T_7 and T_6 were at par.

Microbial count in soil after harvest of onion are given in Table 3. The pooled mean of four year data revealed that bacterial count soil was significantly higher (12.35 x 106 g^{-1}) in T_7 which was followed by T_6 treatment (12.22 x 106 g^{-1}) over T_1 and T_2. The same trend in respect of fungi and actinomycetes count in soil was also observed in treatments T_7 and T_6. The lowest microbial count in soil was observed in control and RDF + foliar spray of 0.5 % $FeSO_4$ treatment.

The four year mean pooled data of bulb yield are presented in Table 4, which revealed that the application of $FeSO_4$ @ 20 kg ha^{-1} with RDF and FYM (T_6) showed significant increase in bulb yield (28.11 Mg ha^{-1}) over all the treatments except T_4 and T_7 treatments which were at par (26.24 and 27.80 Mg ha^{-1}), respectively. The lowest bulb yield was recorded in RDF + FYM + Jivamrut 500 ha^{-1} treatment (18.24 Mg ha^{-1}) and RDF control treatment (19.04 Mg ha^{-1}). Kumbhar and Deshmukh (1993) also reported the response of tomato cv. Rupali to soil application of $FeSO_4$ @ 80 kg ha^{-1} for increasing the yield of tomato. Bhat and Jandial (1996) also reported that application of $FeSO_4$ @ 5 kg ha^{-1} increased the plant height, number of shoots per plant, no. of leaves and yield of potato (cv. Kufri Badshah).

The economics of *Kharif* onion as influenced by application of different soil and foliar iron treatments are given Table 4. The four year pooled mean revealed that the highest net monetary returns were recorded in treatment of T_6 (Rs. 1,09,220/-) followed by T_7 (Rs. 1,07,620/-). The B:C ratio was higher in treatment of T_5 but looking to residual increased in available DTPA-Fe in soil was higher in treatments of T_6 and T_7. Hence, it is concluded that soil application of 20 kg ha^{-1} ferrous sulphate along with recommended dose of fertilizer ($N:P_2O_5:K_2O$ 100:50:50 + 10 t ha^{-1} FYM) is recommended for higher yield and profit of onion on iron deficient soils of Western Maharashtra.

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