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Response of soybean to soil and foliar application of iron fertilizers grown on vertisol

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Abstract
A pot culture experiment entitled "Studies on improvement in fertilizer use efficiency of iron fertilizers in Vertisol" was conducted during *Kharif* 2015 at Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani. The objective of experiment was to evaluate the response of Soybean to different iron fertilizer combinations and application methods. The experiment was conducted with eight treatments viz., T_1 - control, T_2 - only RDF, T_3 - $FeSO_4$ foliar 3 sprays @ 0.5%, T_4 - $FeSO_4$ @20kg ha^{-1}+ Vermicompost @40kg ha^{-1}, T_5 -Fe-EDTA (Soil application @2.5 kg ha^{-1}), T_6 - $FeSO_4$ @20kg ha^{-1}+ DAP @40kg ha^{-1}, T_7 - $FeSO_4$ @20kg ha^{-1}+ 10:26:26 @40kg ha^{-1} and T_8- $FeSO_4$ @20kg ha^{-1} + Urea @40kg ha^{-1}. The experiment was laid out in complete randomized design with three replications. The results emerged out indicated that there was significant increase in grain yield (14.27 gm/pot), number of nodules per plant (14.33 and 16.60 at 40, 80 DAS, respectively), number of pods per plant (16.32) were found in treatment T_8 ($FeSO_4$ @20kg ha^{-1}+ Urea @40kg ha^{-1}) followed by treatment T_7 ($FeSO_4$ @20kg ha^{-1} + 10:26:26 @40kgha^{-1}) which was found to be at par with each other. Plant micronutrients concentration (Fe, Zn, Cu and Mn) were found to be higher with treatment T_3 - $FeSO_4$ foliar 3 sprays @ 0.5%.

Keywords: Fertilizer use efficiency, iron fertilizers, soybean

Introduction
All living things including plants need food for growth. Soil is the supplier of the majority of nutrients needed by plants. Iron is the first rare element recognized as necessary for plants and animals, playing an important role in biochemical and physiological processes. It works as a key enzymes co-factor that plays a role in plant hormone synthesis and is engaged in many electron transportation reactions (Kerkeb and Connolly, 2006). As iron enters root cells, it must be transported to the leaves. Huda *et al*. (2009) [5] reported that the optimal $FeSO_4$ concentration in a medium culture should be sufficient to satisfy the basic energy requirements for cell division and differentiation indication that $FeSO_4$ is one of the factors controlling the induction and growth of shoots. In xylem, iron is transported as Fe (III) and probably makes complexes with citrate. Transportation of iron in apoplast is necessary for its absorption processes by root cells (Zhang *et al*., 1991). It has been suggested that reduction in iron and its transportation allover mesophyll cells plasma membrane is a very important step that can disturb iron shortage through increasing apoplastpH. Iron shortage mostly causes the young leaves to turn yellow, a condition which is usually called ironchlorosis.

Material and Methods
A pot culture experiment was conducted in *Kharif* 2015 at Department of Soil Science and Agricultural Chemistry, College of Agriculture, VNMKV, Parbhani. The experimental soil is characterized by deep black color (Malewar, 1976) [9] dominated by montmorilonite clay with high coefficient of expansion and shrinkage in summer which leads to deep cracking. This pot culture experiment was laid out by using completely randomized design (CRD) with three replications and eight treatments. The experimental soil is of pH 8.14, EC 0.32 dS m^{-1}, Organic Carbon 0.44%, $CaCO_3$ 5.12%, Fe (3.55mg kg^{-1}), Mn (4.14 mg kg^{-1}), Zn 0.28(mg kg^{-1}) and Cu (1.32 mg kg^{-1}). Iron fractions *viz*., Exchangeable iron (1.11 mg kg^{-1}), Dilute acid soluble iron (2.10 mg kg^{-1}), Water soluble iron (0.13 mg kg^{-1}) and Reducible iron (1.25 mg kg^{-1}). The treatments T_1 - control, T_2 - only RDF, T_3 - $FeSO_4$ foliar 3 sprays @ 0.5%, T_4 - $FeSO_4$ @20kg ha^{-1}+ Vermicompost @40kg ha^{-1}, T_5 -Fe-EDTA (Soil application @2.5 kg ha^{-1}), T_6 - $FeSO_4$ @20kg ha^{-1}+ DAP @40kg ha^{-1}, T_7 - $FeSO_4$ @20kg ha^{-1}+ 10:26:26 @40kg ha^{-1} and

T_8- $FeSO_4$ @20kg ha^{-1} + Urea @40kg ha^{-1}. The soybean was sown by dibbling method with five to six seed per pot. Nutrients *viz*, N, P, K and S @ 30:60:30:20 kg ha^{-1} were applied through urea (46%), Diammonium phosphate (18 %), Muriate of potash (60%), Elemental Sulpher (20%) and $FeSO_4$ @20kg/ha, Fe-EDTA @2.5 kg ha^{-1} and Vermicompost @40kg ha^{-1} as per treatment. Observations on the crop characteristics indicating growth of the crop i.e. plant height at interval of 30, 60 and 90 DAS, number of branches per plant, pod per plant and nodules per plant were recorded. The soil samples were collected at the time of harvest and analyzed for pH, EC, organic carbon, calcium carbonate, DTPA extractable micronutrients (Fe, Zn, Mn, and Cu) and iron fractions.

Result and Discussion

Growth attributing characters

The pooled data on growth attributing characters viz., plant height, number of branches per plant, number of pods per plant and number of nodules per plant were significantly influenced by different iron fertilizer combination (Table 1 and 2). the maximum plant height (28.66, 33.29, 34.66 and 37.30 cm at 30, 60, 90 and at harvest, respectively), number of branches per plant (4.33), number of pods per plant (16.32) and number of nodules per plant (14.33 and 16.60 at 40, 80 DAS, respectively) was recorded in treatment T_8- $FeSO_4$ @20kg/ha +Urea @40kg ha^{-1} which was at par with treatment T_7- $FeSO_4$ @20kg/ha + 10:26:26 @40kg ha^{-1}. The increase in plant height, number of branches per plant, number of pods per plant and number of nodules per plant of soybean with soil application of $FeSO_4$ may be due to the greater role of Fe in chlorophyll synthesis and other metabolic activities of the plant thereby increased vegetative growth of plant. Similar results were in conformity with Rajamani and Shanmugasundaram (2014) [10] in black gram. Abdelmajid and Chedly (2003) explained that in nodules, iron is necessary for leghemoglobin biosynthesis as it regulates oxygen contents within cells. Reported that using $FeSO_4$ and iron citrate increased pod formation. Bhatt *et al*. (2004) [8] in their experiment on the effect of micronutrients on growth and performance of Tomatoes found that applying $FeSO_4$ (100 ppm) through leaf led to the maximum number of branches per plant, leaf number, leaf area, wet plant weight, and dry stem weight. Bhat and Jandial (1996) [1] 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.

Table 1: Effect of application of iron fertilizer combinations on number of nodules per plant of Soybean

Treatments	Nodules plant^{-1}		Pods plant^{-1}	Branches plant^{-1}
	40	80		
T_1- Control	10.41	12.46	13.15	3.11
T_2- Only RDF	11.09	13.70	13.21	3.20
T_3- RDF + $FeSO_4$ foliar 0.5% (50 gm 10 lit water).	12.44	14.50	15.22	3.58
T_4- RDF + $FeSO_4$ @20kg/ha+ Vermicompost @40kg ha^{-1}	12.56	14.66	15.68	3.66
T_5- RDF + Fe-EDTA (Soil application @2.5 kg ha^{-1})	13.19	15.11	15.43	3.73
T_6- RDF + $FeSO_4$ @20kg/ha + DAP @40kg ha^{-1}	11.15	13.81	14.27	3.20
T_7- RDF + $FeSO_4$ @20kg/ha + 10:26:26 @40kg ha^{-1}	13.56	15.39	15.88	4.12
T_8- RDF + $FeSO_4$ @20kg/ha + Urea @40kg ha^{-1}	14.33	16.60	16.32	4.33
SE(m)	11.29	0.74	0.42	0.28
CD (0.01)	0.81	2.23	1.27	0.86

Table 2: Effect of application of iron fertilizer combinations on plant height of Soybean

Treatments	Plant height (cm)			
	30	60	90	At Harvest
T_1- Control	22.29	29.31	31.89	33.28
T_2- Only RDF	23.22	29.81	31.56	33.48
T_3- RDF + $FeSO_4$ foliar 0.5% (50 gm 10 lit water)	26.60	31.33	33.44	35.66
T_4- RDF + $FeSO_4$ @20kg/ha + Vermicompost @40kg ha^{-1}	26.55	31.20	33.56	34.51
T_5- RDF + Fe-EDTA (Soil application @2.5 kg ha^{-1})	26.68	30.98	33.11	35.19
T_6- RDF + $FeSO_4$ @20kg/ha+ DAP @40kg ha^{-1}	25.21	30.11	32.18	33.60
T_7- RDF + $FeSO_4$ @20kg/ha + 10:26:26 @40kg ha^{-1}	27.66	32.31	34.55	36.55
T_8- RDF + $FeSO_4$ @20kg/ha + Urea @40kg ha^{-1}	28.66	33.29	34.66	37.30
SE(m)	0.82	0.97	0.67	1.07
CD (0.01)	2.46	2.93	2.02	3.21

Plant micronutrient content in soybean

The plant micronutrients Zn, Fe, Cu, and Mn status after harvest of soybean as influenced by various treatments is presented in Table 3. The plant Fe, Zn, Cu, and Mn in soil were significantly increased (312, 36.54, 23.33 and 38.60 µg g^{-1}, respectively) in treatment T_3- RDF + $FeSO_4$ foliar 0.5% (50 gm 10 lit water) which was at par with treatment T_8- RDF + $FeSO_4$ @20kg/ha + Urea @40kg ha^{-1}. This may be due to application of foliar $FeSO_4$ increasing the effect of photosynthesis and demand for the increase of essential element, causes to enhancing both absorption and transportation of elements. The similar results were also reported by Hamid and Yases (2012) [4] and Aciksoz *et al.* (2011) [2] in durum wheat in clay loam texture soil.

Table 3: Effect of application of iron fertilizer combinations on plant micronutrient content (µg g^{-1} dry matter) of Soybean

Treatments	Plant micronutrient (µg g^{-1})			
	Fe	Zn	Cu	Mn
T_1- Control	214	31.38	17.55	32.48
T_2- Only RDF	254	32.44	18.44	33.32
T_3- RDF + $FeSO_4$ foliar 0.5% (50 gm 10 lit water).	312	36.54	23.33	38.60
T_4- RDF + $FeSO_4$ @20kg/ha + Vermicompost @40kg ha^{-1}	288	34.45	20.41	36.98
T_5- RDF + Fe-EDTA (Soil application @2.5 kg ha^{-1})	292	34.69	20.98	36.48
T_6- RDF + $FeSO_4$ @20kg/ha+ DAP @40kg ha^{-1}	285	32.09	18.51	35.04
T_7- RDF + $FeSO_4$ @20kg/ha + 10:26:26 @40kg ha^{-1}	286	34.11	20.18	36.11
T_8- RDF + $FeSO_4$ @20kg/ha + Urea @40kg ha^{-1}	298	35.88	22.58	37.51
SE(m)	9.19	0.90	1.14	1.09
CD (0.01)	27.53	2.7	3.42	3.29

Soybean yield as influenced by of iron fertilizers

Data reported in Table 4 indicated that, the influence of iron fertilizer combinations on yield of soybean was significantly influenced due to variation in fertilizer combinations. The significantly highest grain yield (14.27gm pot^{-1}) was recorded in treatment T_8- RDF + $FeSO_4$ @20kg/ha + Urea @40kg $ha^{-1}$and the significantly highest fertilizer use efficiency (19.92%) was recorded in treatment T_5- Fe-EDTA (Soil application @2.5 kg ha^{-1}). Similar resultswere close conformity with chibba *et al*. (2007) [3] reported that the foliar and soil application of Fe significantly increased yield of Fenugreek. Kumbhar and Deshmukh (1993) [7] also reported the response of Tomato cv. Rupali to soil application of $FeSO_4$ @ 80 kg ha^{-1} for increasing the yield of Tomato.

Table 4: Effect of application of iron fertilizers on yield of soybean.

Treatments	Yield (gm/pot)
T_1- Control	11.32
T_2- Only RDF	11.39
T_3- RDF + $FeSO_4$ foliar 0.5% (50 gm 10 lit water).	13.98
T_4- RDF+ $FeSO_4$ @20kg/ha + Vermicompost @40kg ha^{-1}	13.88
T_5- RDF+ Fe-EDT(Soil application @2.5 kg ha^{-1})	13.91
T_6- RDF+ $FeSO_4$ @20kg/ha + DAP @40kg ha^{-1}	12.88
T_7- RDF+ $FeSO_4$ @20kg/ha + 10:26:26 @40kg ha^{-1}	14.11
T_8- RDF+ $FeSO_4$ @20kg/ha +Urea @40kg ha^{-1}	14.27
SE(m)	0.491
CD (0.01)	1.436

Conclusions

From the above study it can be concluded that combinations of iron fertilizers with organic and inorganic sources enhanced the growth parameters viz., plant height, number of branches per plant, pod per plant and nodules per plant. The highest grain yield andFe, Zn, Cu and Mn content in plant increased significantly with application of three$FeSO_4$ foliar sprays 0.5% (50 gm. in 10 lit water) at different growth stages.

References

1. Abdelmajid KM, Chedly A. Differences in response to iron deficiency among some lines of common bean Journal of Plant Nutrition, 26(10 & 11): 2295- Bhat, K.L. and Jandial, K.C. (1996). A note on levels of zinc and iron on growth and yield of potato. Veg. Sci. 2003; 23(2):207-209.
2. Aciksoz SB, Atilla Y, Ozturk L, Cakmak S. Biofortification of wheat with iron through soil and foliar application of nitrogen and iron fertilizers. Plant Soil. 2011; 349:215-225.
3. Chibba IM, Nayyar VK, Kanwar JS. Influence of mode and source of iron on Fenugreek in a typic Ustocherpt in Punjab. International Journal of agri. and biology. 2007; 9(2):254-256.
4. Hamid SR, Yases HA. Effects of iron on the wheat crop (Triticumaestivum L.) by uptake of nitrogen, phosphorus and potassium. Asian, J. Agric. Sci. 2012; 4(3):229-235.
5. Huda K, Bhuiyan R, Zeba N, Banu A, Mahmud F, Khatun A. Effect of FeSO4 and pH on shoot regeneration from the cotyledonary explants of Tossa Jute. Plant Omics J. 2009; 2(5):190-196.
6. Kerkeb L, Connolly E. Iron transport and metabolism in plants'. Genet. Eng. 1002; 27:119-140.
7. Kumbhar VS, Deshmukh SS. Effect of soil application of ferrous sulphate on the uptake of nutrients, yield and quality of tomato (cv. Rupali South). Indian J. Hort. 1993; 41(3):144-147.
8. Lalit Bhatt B, Srivastava K, Singh MP. Studies on the effect of foliar application of micronutrients on growth, yield and economics of tomato (*Lycopersicon esculentum* Mill.). Progressive Horticulture. 2004; 28(1):222-223.
9. Malewar GU. Placement of black soils of Marathwada in comprehensive system of soil classification. J. Maharashtra agric. Univ. 1976; 1:195-199.
10. Rajamani P, Shanmugasundaram R. Influence of FeEDDHA on Iron–Manganese Interaction in Soybean Genotypes in a Calcareous Soil. Journal of Plant Nutrition. 2014; 26(9):1815-1823.
11. Zhang F, Römheld, Marschner H. Role of the root apoplasm for iron acquisition by wheat plants. Plant Physiology. 2222; 29:2211-2215.