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Influence of Mode and Source of Applied Iron on Fenugreek (*Trigonella corniculata* L.) in a Typic Ustochrept in Punjab, India

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ABSTRACT

An investigation was carried out to assess the effect of applied Fe on yield and Fe enrichment of fenugreek (*Trigonella corniculata* L.) grown in an Fe-deficient alkaline field. Both the green and seed yield increased significantly indicating a need to fertilize the crop with Fe in the Fe deficient soils to realize the full yield potential and to improve the Fe content of the crop. Though the crop responded significantly to soil as well as the foliar application of Fe, yet the foliar mode proved significantly superior to soil application as reflected by the magnitude of increase in crop yield and the Fe concentration in plants. When applied to the foliage at equivalent concentration, ferrous sulphate ($FeSO_4.7H_2O$) and the micronutrient mixture (consisting of 5% Zn & 7.5% Fe) were at par in increasing the crop yield but ferrous sulphate ($FeSO_4.7H_2O$) proved significantly better than the micronutrient mixture in improving the Fe content of the crop plants.

Key Words: Fenugreek; Ferrous sulphate; Micronutrient mixture; Soil and foliar application

INTRODUCTION

Fenugreek, locally known as *Methi*, is cultivated in India as well as other parts of the world not only as a leafy vegetable but also for medicinal purposes (Som & Maity, 1993). Besides India, the fenugreek growing counties include Argentina, Egypt, Southern France, Morocco and Lebanon. In India, it is commonly grown in the states of Rajsthan, Madhya Pradesh Gujrat, Uttar Pradesh and Punjab. Green methi is a good source of iron (Fe) as well as other minerals for human beings (Chhibba *et al*., 2000). Adish *et al*. (1999) have identified fenugreek as one of the dietary factors associated with anemia in children. Fenugreek seeds are mainly used for the preparation of tasty dishes. It has also high medicinal and industrial importance (Som & Maity, 1993). Some studies have been conducted to evaluate the mineral composition of this crop and its varieties with a purpose of assessing their contribution towards the daily human requirement. Nevertheless, the efforts relating to the improvement in the yield and mineral composition are scanty. Little information exists concerning the response of this crop to applied nutrients, particularly, the micronutrients. In the state of Punjab, *Methi* is very commonly grown as a leafy vegetable. Since the soils of this state are prone to Fe deficiency (Takkar *et al*., 1989), because of being alkaline, fenugreek raised on them may suffer from a short supply of this nutrient. The present investigation was, therefore, carried out to assess the effect of soil and foliar application of Fe on yield and Fe content of this crop under field conditions.

MATERIALS AND METHODS

A field experiment was carried out at the research farm of Punjab Agricultural University, Ludhiana. The experimental soil (Typic Ustochrept) was alkaline loamy-sand with low content of soluble salts, medium content of organic carbon and deficient status of available Fe (Table I). Analysis of the soil for important basic characteristics was carried out by using the standard methods described by (Page *et al*., 1982). Available Zn and Fe in the soil samples were extracted with DTPA methods of Lindsay and Norvell (1978) and estimated in the soil extract with atomic absorption spectrophotometer (Issac & Kerber, 1971).

Fenugreek, cv. Kasuri methi, was raised by using general recommended basal doses of N (87.5 kg ha^{-1}) and P (30 kg P_2O_5 ha^{-1}) at seeding through calcium ammonium nitrate (nitrogenous fertilizer containing 25% N) and single super phosphate (phosphatic fertilizer containing 16% P_2O_5), respectively. The treatments comprised soil application of commercial grade ferrous sulphate ($FeSO_4.7H_2O$), containing 20.5% Fe, @ 0, 10, 20 and 40 kg ha^{-1} and three sprays with 0.5% solution of $FeSO_4.7H_2O$ and a micronutrient mixture (MM) containing 5% Zn and 7.5 Fe%. One spray was carried out 15 days before each cutting. All the treatments were replicated thrice in Randomized Block Design. In half of the portion of every plot, the crop was allowed to mature and in the remaining half three cuttings of the crop were taken.

After recording the dry matter yield, the plant samples from the third cutting were washed sequentially with tap water, acidulated water containing 0.01 N HCl, distilled water and deionised water. They were then air-dried followed by oven drying at 60 - 65^{0}C to a constant weight. The dried sample were ground in a Wiley mill with stainless steel blades to pass through a 40 mesh sieve and then digested in di-acid mixture of nitric acid (HNO_3) and

perchloric acid ($HClO_4$) in 3:1 ratio (Piper, 1950). Total Fe content in the plant digests was determined by using the atomic absorption spectrophotometer (Issac & Kerber, 1971).

RESULTS

Green yield. Green yield of fenugreek (total of 3 cuttings) increased significantly with Fe application, irrespective of the source and method used for applying (Table II). The increase was, however, of smaller magnitude i.e., 14.2 to 19.5% with the soil application than that 29.0 to 31.1% with the foliar application. Of the different rates of the soil applied Fe, 10 kg $FeSO_4$ ha^{-1} produced maximum yield. The two sources i.e. $FeSO_4.7H_2O$ and MM, used for foliar application were at par with each other in increasing the green yield.

The increase in yield with soil applied Fe might have been the result of increase in the content of available Fe in the soil. The increase in yield with foliar application of Fe could be attributed to the direct absorption of the element by the foliage sprayed with Fe solution. Significantly greater yields obtained with foliar application than those produced with soil application of Fe indicated the superiority of foliar application over soil application. This may be attributed to relatively less availability of soil applied Fe to plants, because of its conversion to un-available forms (Takkar & Nayyar, 1979).

Seed yield. Notwithstanding the source and mode of application, the seed yield of *methi* registered an increase with the applied Fe (Table III). The magnitude of the increase in the seed yield varied between 10.0 and 28.8% with soil applied Fe and between 53.1 and 57.4% with the foliage applied Fe. Obviously, these results also confirmed that foliar application of Fe was certainly superior to soil application in respect of enhancing the seed yield of fenugreek. Ferrous sulphate ($FeSO_4.7H_2O$) and the micronutrient mixture were at par with each other when applied to the foliage.

Iron content of fenugreek plants. The application of Fe through soil as well as foliar application caused a marked increase in the total content of Fe in the fenugreek plants (Table IV). While the soil application caused 1.6 to 2.1 times increase compared to that in the control plots, the foliar application of Fe was able to bring about 2.7 to 3.4 times increase. The Fe content of the plants in the control plots was less than that (17.2 mg 100 g^{-1}) suggested by (Som & Maity, 1993). As in case of green and seed yield of the crop, the maximum content of Fe was observed in plants receiving Fe through foliar application. Nevertheless, the foliar application of $FeSO_4.7H_2O$ solution raised the plant Fe content to a significantly higher level (470.5 µg g^{-1}) than that (371.5 µg g^{-1}) effected by that of the MM. As such, of the two sources used for foliar application, $FeSO_4.7H_2O$ solution was significantly superior to the micronutrient mixture in respect of increasing the total Fe content of the plants indicating thereby, that the enrichment of the fenugreek plants can be accomplished more effectively with $FeSO_4.7H_2O_4$ solution than with the micronutrient mixture.

Table I. Important characteristics of experimental soil

Characteristic	Value
Texture	Loamy sand
pH (1:2)	8.2
EC (1:2)	0.20 dS m^{-1}
Organic Carbon	0.40 %
Available-Fe	3.66 mg kg^{-1}
Available-Zn	1.06 mg kg^{-1}

Table II. Green yield of fenugreek as influenced by iron application

Treatments		Green Yield (q ha^{-1})	Percent Response
Dose	Mode of application		
Control		18.40	-
10 kg $FeSO_4$ ha^{-1}	Soil	22.00	19.5
20 kg $FeSO_4$ ha^{-1}	Soil	21.00	14.2
40 kg $FeSO_4$ ha^{-1}	Soil	21.75	18.2
0.5% $FeSO_4$ (Solution)	Foliar	23.75	29.0
0.5% MM (Solution)	Foliar	24.12	31.1
LSD (p=0.05)		0.79	

$FeSO_4$-$FeSO_4.7H_2O$; MM-Micronutrient mixture with 5% Zn and 7.5% Fe

Table III. Effect of iron application on seed yield of fenugreek

Treatment		Seed yield (q ha^{-1})	Percent Response
Dose	Mode of application		
Control	-	5.11	-
10 kg $FeSO_4$ ha^{-1}	Soil	5.75	11.5
20 kg $FeSO_4$ ha^{-1}	Soil	5.67	10.0
40 kg $FeSO_4$ ha^{-1}	Soil	6.75	28.8
0.5% $FeSO_4$ (Solution)	Foliar	8.17	53.1
0.5% MM (Solution)	Foliar	8.42	57.4
LSD (p=0.05)		0.89	

$FeSO_4$-$FeSO_4.7H_2O$; Solution; MM-Micronutrient mixture with 5% Zn and 7.5% Fe

Table IV. Iron content of fenugreek plants as influenced by Fe application

Treatment		Fe Content (µg g^{-1})
Dose	Mode of application	
Control	-	137.2
10 kg $FeSO_4$ ha^{-1}	Soil	220.9
20 kg $FeSO_4$ ha^{-1}	Soil	272.0
40 kg $FeSO_4$ ha^{-1}	Soil	286.3
0.5% $FeSO_4$ (S)	Foliar	470.5
0.5% MM (S)	Foliar	371.5
LSD (p=0.05)		37.2

$FeSO_4$-$FeSO_4.7H_2O$; S-Solution; MM-Micronutrient mixture with 5% Zn and 7.5% Fe

CONCLUSION

While showing the significant response of fenugreek to Fe application in Fe-deficient fields, the results of the investigation have revealed the superiority of foliar

application to soil application. Besides, they have brought out that the enrichment of the edible portion of the fenugreek with Fe can be accomplished more effectively with the foliar application of either $FeSO_4.7H_2O$ or the micronutrient mixture used in this investigation.

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