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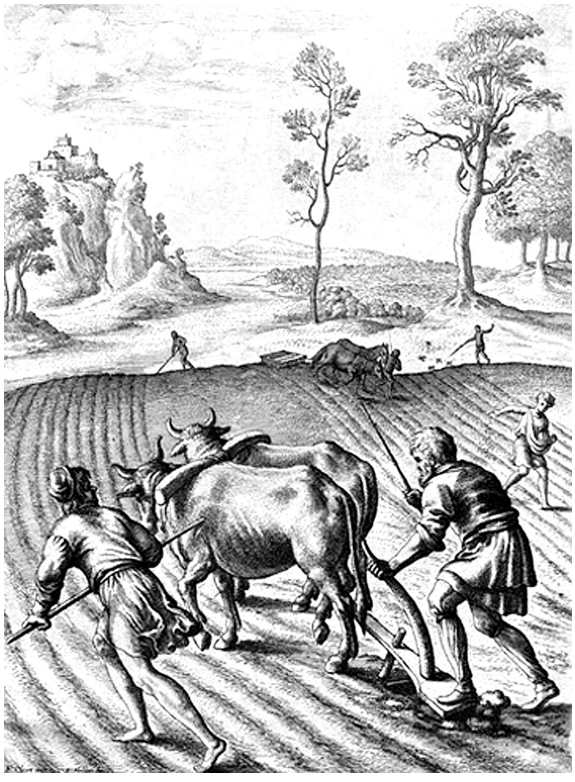

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Influence of Iron and AM Inoculation on Metabolically Active Iron, Chlorophyll Content and Yield of Hybrid Maize in Calcareous Soil

[1]M. Mohamed Amanullah, [1]J. Archana, [1]S. Manoharan and [2]K.S. Subramanian
[1]Department of Agronomy,
[2]Department of Nano Science and Technology,
Tamil Nadu Agricultural University, Coimbatore-641003, India

Abstract: Iron deficiencies are commonly seen in calcareous soils which often reduce the yield of the crops. Iron application in conjunction with Arbuscular mycorrhizae may help to increase the metabolically active iron content in the plants and hence the yields. The objective of this experiment was to study the influence of iron and arbuscular mycorrhizae inoculation on metabolically active iron, chlorophyll content and yield of hybrid maize in calcareous soil. Hence, field experiment was conducted at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during Kharif 2010. The results revealed that the iron treatments, AM inoculation and their combination positively influenced the metabolically active iron, chlorophyll content and yield of hybrid maize. In case of iron treatments, 50 kg $FeSO_4$ ha^{-1}+0.5% $FeSO_4$ foliar spray recorded higher MAI, chlorophyll content and yield. Regarding arbuscular mycorrhizae inoculation, AM inoculated plants recorded the highest value and considering their combination, 25 kg $FeSO_4$ ha^{-1}+0.5% $FeSO_4$ foliar spray along with AM inoculation recorded the highest MAI, chlorophyll content and yield.

Key words: Hybrid maize, ferrous sulphate, soil, foliar, arbuscular mycorrhizae, metabolically active iron, yield

INTRODUCTION

Iron activates several enzymes, involves in oxidation reduction reactions and is responsible for formation of chlorophyll. Iron involves key role in chlorophyll formation and activation of enzymes. Hellal *et al*. (2006) confirmed that the total chlorophyll markedly differed due to iron and nitrogen application. Amanullah *et al*. (2007) stated that the metabolically active iron concentration is significantly influenced with the application of iron in sorghum either as foliar spray or basal supplemented with foliar spray. Iron deficiencies are found mainly on calcareous (high pH) soils which reduces iron uptake by plants causing iron chlorosis. Higher rate of photosynthesis are often displayed by arbuscular mycorrhizal plants than non mycorrhizal counterparts. Auge (2001) stated that the units of photosynthesis were increased by arbuscular mycorrhizal symbiosis. This also increased the rates of photosynthetic storage and export at the same time. It has been proved (Gemma *et al*., 1997) that arbuscular mycorrhizae plants had higher concentration of chlorophyll than their control non mycorrhizal plants and higher concentration of chlorophyll was associated with higher photosynthesis rate (Davies *et al*., 1993). Hence, the present study was proposed to find out the influence of iron treatments and AM inoculation on metabolically active iron, chlorophyll content and yield of hybrid maize in calcareous soil.

MATERIALS AND METHODS

A field experiment was conducted during the Kharif, 2010 at Tamil Nadu Agricultural University, Coimbatore, in a factorial randomized block design replicated thrice. The experimental soil was sandy clay loam in texture having a pH of 7.58. The fertility status was low in available N (220.4), medium in available P (13.1) and high in available K (457.5). The available Fe (DTPA-extractable) content was 2.24 ppm. The treatments included were AM (M^+) and control (M^-) under factor 'A' and T_1-25 kg $FeSO_4$ ha^{-1}, T_2-50 kg $FeSO_4$ ha^{-1}, T_3-0.5% $FeSO_4$ foliar spray, T_4-25 kg $FeSO_4$ ha^{-1}+0.5% $FeSO_4$ foliar spray, T_5-50 kg $FeSO_4$ ha^{-1}+0.5% $FeSO_4$ foliar spray and T_6-Control, under factor 'B'.

Hybrid maize (CO H(M)5) was used as test crop and it was grown by adopting a spacing of 60×25 cm. Seeds of maize hybrids under arbuscular mycorrhizal inoculated treatments were sown with vermiculite based mycorrhizal inoculum at a depth of 5 cm below the seeds. Uniform fertilizer schedule was followed at the rate of 150:75:75. Nitrogen was applied in three splits viz., 25: 50: 25% as basal, 25 and 45 days after sowing, respectively. The

Corresponding Author: M. Mohamed Amanullah, Department of Agronomy, Tamil Nadu Agriculture University, Coimbatore- 641 003, India

entire dose of phosphorus was applied basally. The potassium was applied in two equal split doses viz., basal and at 45 days after sowing. Iron was applied treatment basally and foliar spray of 0.5% $FeSO_4$. Foliar spray was given twice at 35 and 45 days after sowing.

Estimation of Metabolically active iron and Chlorophyll: Metabolically active iron content was estimated by employing 10 mL of 1.5% 1, 10-Orthophenanthroline (Katyal and Sharma, 1980) in freshly collected leaf sample at 45 and 60 DAS. For chlorophyll estimation, 250 mg of finely macerated leaf tissues was ground in a glass mortar with enough 80% acetone after homogenization and the volume made upto 25 mL with 80% acetone and estimated colorimetrically at 663, 665 and 480 nm. During the course of investigation, metabolically active iron, chlorophyll content and yield were recorded.

Statistical analysis: The data collected were statistically analyzed as suggested by Gomez and Gomez (1984). Wherever the treatment differences were found significant, critical difference were worked out at five percent probability level.

RESULTS AND DISCUSSION

Metabolically active iron content in leaves: The highest metabolically active iron content in plants were recorded with application of 50 kg $FeSO_4$+0.5% $FeSO_4$ foliar spray (0.460 mg kg^{-1}) followed by 25 kg $FeSO_4$+0.5% $FeSO_4$ foliar spray and were comparable with each other (Table 1). Orthophenonthoraline Fe content of leaves, considered to the active Fe involved in various physiological activities was more influenced by foliar spray treatment over soil application treatment. The increased availability of iron might have resulted in the increased uptake of nitrogen which in turn might have increased the metabolically active iron of hybrid maize under these treatments. This result is in conformity with the results obtained by Amanullah *et al.* (2007). AM inoculation significantly increased metabolically active iron. This might be due to the increased availability of Fe due to solubilization by the roots of AM inoculated maize and the resultant higher uptake and translocation of iron due to the formation of external mycelium around the roots by AM fungi.

Total chlorophyll content: Chlorophyll content estimated in the maize leaves indicated that application of iron had a positive and significant influence on the increase of chlorophyll content (Table 1). Highest values of total chlorophyll on 45 and 60 DAS viz., (2.501) and (3.017) were recorded under treatment receiving 50 kg $FeSO_4$+0.5% $FeSO_4$ foliar spray followed by 25 kg $FeSO_4$+0.5% $FeSO_4$ foliar spray. It is obvious that foliar spray was found to be better in utilization of iron by direct absorption and strikingly bestowed on the chlorophyll content of the leaves. Soil application might have subjected to fixation in the soil being calcareous and needs to be nourished through foliar as supplemented dose. The results are in accordance with the findings of Amanullah *et al.* (2007). AM inoculation significantly increased the total chlorophyll content viz., (2.630) and (3.184). It may be due to the higher uptake of nutrients especially N and Fe and the resultant enhanced chlorophyll synthesis and is in concordant with the findings of Gemma *et al.* (1997) who observed significantly higher chlorophyll concentration due to inoculation of *Agrostis plastids*. Mycorrhizal plants had higher total chlorophyll and carotenoid contents than the non-mycorrhizal plants as reported by Manoharan *et al.* (2008) and Morte *et al.* (2000).

Grain yield: Application of 50 kg $FeSO_4$+0.5% $FeSO_4$FS recorded the highest grain yield of 5752 kg ha^{-1} followed by 25 kg $FeSO_4$+0.5% $FeSO_4$ FS and 50 kg $FeSO_4$ and both were comparable with each other (Table 1). This increase in yield was due to effective utilization of applied nutrients. The positive and significant improvement in LAI and DMP noticed at different stages, increased yield attributes and nutrient uptake due to both soil and foliar application of $FeSO_4$ would have resulted in enhanced grain yield. The results are in conformity with the findings of Amanullah *et al.* (2007) in sorghum and Ramu and Reddy (2007) in maize. Inoculation of mycorrhiza significantly influenced grain yield (5820 kg ha^{-1}). This yield increase under treatment might be due to mycorrhizal inoculation cause the intense flow of minerals and metabolites from the leaf to the developing kernel. A higher yield of maize due to mycorrhizal inoculation has been reported previously by Solaiman and Hirata (1998).

Stover yield: The stover yield recorded treatment wise showed that Fe application either through soil or foliar had influenced significantly registering the highest value (Table 1). The treatment 25 kg $FeSO_4$+0.5% $FeSO_4$ FS (8937 kg ha^{-1}) recorded the highest yield followed by 50 kg $FeSO_4$+0.5% $FeSO_4$ FS and 50 kg $FeSO_4$ and both were comparable with each other. Application of $FeSO_4$ either soil or foliar would help to recover the crop from chlorosis and yield well especially in calcareous soil. AM inoculation significantly influenced the stover yield. AM inoculated plants recorded significantly higher (9076 kg ha^{-1}) stover yield. It is due to increase in growth

Table 1:Effect of iron and AM inoculation on metabolically active iron, total chlorophyll content and yield of hybrid maize

	Metabolically active iron (mg kg^{-1})						Total chlorophyll content (mg g^{-1} of tissue)											
	45 DAS			60 DAS			45 DAS			60 DAS			Grain yield (kg ha^{-1})			Stover yield (kg ha^{-1})		
Treatments	M-	M+	Mean	M-	M+	Mean	M-	M+	Mean	M-	M+	Mean	M-	M+	Mean	M-	M+	Mean
T_1-25 kg $FeSO_4$	0.325	0.596	0.460	0.315	0.429	0.372	2.103	2.600	2.352	2.543	3.111	2.827	4501	5407	4954	7581	8705	8143
T_2-50 kg $FeSO_4$	0.367	0.615	0.491	0.360	0.446	0.403	2.275	2.612	2.444	2.693	3.156	2.925	5208	5764	5486	8346	9206	8776
T_3-0.5% $FeSO_4$ FS	0.347	0.641	0.494	0.336	0.466	0.401	2.168	2.652	2.410	2.597	3.187	2.892	4919	5868	5394	7917	9248	8583
T_4-25 kg $FeSO_4$+0.5% $FeSO_4$ FS	0.359	0.673	0.516	0.345	0.532	0.438	2.223	2.721	2.472	2.634	3.276	2.955	5023	6470	5747	8313	9561	8937
T_5-50 kg $FeSO_4$+0.5% $FeSO_4$ FS	0.381	0.650	0.515	0.411	0.510	0.460	2.311	2.692	2.501	2.713	3.222	3.017	5451	6053	5752	8547	9088	8817
T_6-Control	0.310	0.560	0.435	0.308	0.414	0.361	2.028	2.503	2.266	2.509	3.056	2.783	4468	5357	4912	7646	8651	8148
Mean	0.348	0.629		0.346	0.467		2.185	2.630		2.615	3.184		4928	5820		8058	9076	
C.D. (P = 0.05)																		
T	0.014	0.030		0.010	0.021		0.080	0.162		0.061	0.126		164	337		161	323	
M	0.010	0.022		0.006	0.013		0.046	0.095		0.035	0.073		94	196		110	221	
T ×M	0.02	NS		0.02	0.03		0.113	0.234		0.086	0.178		221	467		232	465	

NS: Not Significant

parameters as evidenced in the present investigation. Similar results of increase in stover yield due to mycorrhizal inoculation were also reported earlier by Lauzon and Miller (1997) in maize.

The study revealed that, application of 50 kg $FeSO_4$+0.5% $FeSO_4$ FS among iron treatments and AM inoculation recorded better growth and yield. Among the treatment combination, 25 kg $FeSO_4$+0.5% $FeSO_4$ FS along with AM inoculation recorded better growth and yield attributes and grain yield and it was comparable with 50 kg $FeSO_4$+0.5% $FeSO_4$ FS along with AM inoculation.

CONCLUSION

The study revealed that application of 25 kg $FeSO_4$+0.5% $FeSO_4$ foliar spray along with AM inoculation recorded higher active iron, chlorophyll content and yield of Hybrid maize in calcareous soil.

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