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Effect of Organically Complexed Iron on the Yield of CSH 5 Sorghum

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Effect of organically complexed iron on yield of CSH 5 sorghum was studied in pots with two soils, one a black calcareous soil and a red soil. The soils were treated with $FeSO_4$ and complexed iron material (got by composting cotton leaves with different levels of $FeSO_4$). Increased plant growth and yield due to application of iron both as $FeSO_4$ and as complexed with cotton leaf was highly evident at all stages of crop growth studied viz., 30th day, 60th day and at maturity. The combination of iron with cotton leaf showed progressive increase in grain yield with increase in iron and cotton leaf added to soil.

The investigations conducted by many workers (Olsen, 1950; Mathers, 1970) have revealed that the problem of iron nutrition is very complex and that no complete cure of iron chlorosis is possible in very many cases. Review of Hodgson (1963) and Manskaya and Drozdova(1966)showed that in the majority of the cases micronutrient content of soils was related to the organic matter. While conducting the investigation reported in this paper, it was thought that if chelates generated in the soil by the decomposition of leaves are made tocombine with iron salts added to it, it would be possible to generate some sort of iron chelate which might be cheap and at the same time as effective as any other synthetic chelate. Cotton leaves, which contain citrate and another chelating ions and which are available in plenty in cotton growing black soil areas, were thought to be ideally suited for this purpose. The present investigations were aimed at examining the effect of organically complexed iron on the yield of grain sorghum (CSH 5).

MATERIALS AND METHODS

A pot experiment was conducted using two soils, one in a black calcareous soil containing 4.5 per cent $CaCO_3$, available Fe 3.00 ppm and of pH 8.3 and another in a red soil containing only 0.55 per cent $CaCO_3$ available Fe 4.70 ppm and of pH 6.8. For the experiment, 6 kg of soil was weighed and transferred to each pot, the sides of which were coated with wax inside and it was further covered with a polythene sheet to prevent leaching. A uniform basal application of fertilizers at 90, 45 kg/ha of N, P_2O_5 and K_2O was done. Then the calculated quantities of organic amendment prepared by mixing fresh cotton leaves with soil and the calculated quantity of $FeSO_4$ to get the desired iron concentration and composting for two months and iron were added to the

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respective pots as per the treatments given below and mixed thoroughly.

Control	F_0 M_0
Organic amendment 5 tonnes/ha	F_0 M_1
Organic amendment 10 tonnes/ha	F_0 M_2
Organic amendment 20 tonnes/ha	F_0 M_3
Fe 15 ppm + without organic amendment	F_1 M_0
Fe 15 ppm + organic amendment 5 tonnes/ha	F_1 M_1
Fe 15 ppm + organic amendment 10 tonnes/ha	F_1 M_2
Fe 15 ppm + organic amendment 20 tonnes/ha	F_1 M_3
Fe 30 ppm + without organic amendment	F_2 M_0
Fe 30 ppm + organic amendment 5 tonnes/ha	F_2 M_1
Fe 30 ppm + organic amendment 10 tonnes/ha	F_2 M_2
Fe 30 ppm + organic amendment 20 tonnes/ha	F_2 M_3
Fe 45 ppm + without organic amendment	F_3 M_0
Fe 45 ppm + organic amendment 5 tonnes/ha	F_2 M_1
Fe 45 ppm + organic amendment 10 tonnes/ha	F_3 M_2
Fe 45 ppm + organic amendment 20 tonnes/ha	F_2 M_3

Six seeds were sown in each pot. The yield of drymatter, grain and straw was recorded separately for each pot at three stages (30 and 60 days after sowing and at harvest). The results are presented in Table I.

RESULTS AND DISCUSSION

Wide differences in the drymatter production by the 30 and 60 day old plants were registered due to the treatments. Plants in the red soil recorded higher dry matter yield compared to those in the black soil. This may be to the betterionic environment existing in the red soil as a result of the lower level of calcium present in it. Among iron levels, F_3 (45 ppm) recorded higher dry matter yields than the other levels in both the soils, at the two stages studied. Among the organic amendment applied M_3 level (20 tonnes/ha), recorded higher yield than the other levels at both the stages. In the interaction between iron and organic amendment, at all levels of organic amendment F_3 level of iron (45 ppm) recorded higher yield at both the stages. At all levels of iron, M_3 level (20 tonnes/ha) of organic amendment registered higher yield than at the other levels of organic amendments applied, at both the stages.

Grain yield expressed in g pot varied from 6.5 to 47.0 and 6.9 to 48.3 in the black and red soils respectively. The grain yield increased progressively with increasing iron levels. An exactly similar trend was obtained with the application of organic amendment. The combination of the highest level of organic amendment and $FeSO_4$ registered the highest grain yield in both the soils

The yield of straw expressed in g/pot ranged from 28.5 to 129.1 in black soil and from 29.2 to 138.9 in red soil. The straw yield data given in Table I indicated a similar trend for the different treatments in both the soils, as in the case of grain yield. The beneficial effect of $FeSO_4$ on straw yield was quite conspicuous. There was also significant differences in straw yield due to the organic amendment treatments and the interaction between organic amendment and iron was highly significant in the case of treatments in both the soils. The highest level of treatment combination, F_3M_3 record-

TABLE I Influence of treatments on the mean drymatter yield of 30 and 60 day old plants and grain and straw (g/pot)

Treatments	Black calcareous soil				Red soil			
	30-day old plants	60-day old plants	Grain	Straw	30-day old plants	60-day old plants	Grain	Straw
$F_0 M_0$	1.70	9.70	6.75	30.85	2.50	9.75	7.10	29.56
M_1	1.70	10.30	8.70	32.10	2.50	11.20	9.00	33.50
M_2	1.70	11.75	10.50	35.15	2.10	12.10	11.15	35.55
M_3	2.00	12.35	13.05	37.15	2.90	13.10	13.45	39.00
$F_1 M_0$	2.20	12.10	14.25	39.30	3.30	12.85	15.35	41.00
M_1	2.50	13.30	17.60	51.75	3.50	13.55	17.85	52.85
M_2	2.80	14.20	19.95	58.00	4.10	14.20	19.75	60.50
M_3	2.95	15.40	25.00	64.75	4.10	15.05	26.05	67.75
$F_2 M_0$	2.90	13.80	26.95	69.85	4.10	15.90	27.60	74.05
M_1	3.75	15.00	27.35	73.45	4.20	16.70	28.40	84.50
M_2	3.50	15.35	29.10	88.30	4.60	16.70	29.55	88.90
M_3	4.00	16.50	36.00	96.00	5.10	18.05	38.00	94.05
$F_3 M_0$	4.10	17.15	39.50	108.80	5.30	18.30	40.50	97.70
M_1	4.60	17.60	42.25	111.90	6.20	18.90	42.05	117.05
M_2	5.70	18.15	44.45	115.90	7.25	19.45	44.15	121.25
M_3	6.10	19.05	46.40	129.00	7.50	21.00	48.10	136.80
0.5% spray	3.60	15.25	21.55	62.45	5.50	17.25	25.40	73.15

ed the maximum straw yield in both the soils.

The necessity for increased iron (than is available in the soil) is also revealed by the effect produced by the foliar application of iron sulphate (neutral $FeSO_4$ along with the wetting agent TEEPOL). This application was done at 15 days' interval during the whole period of crop growth. However, the yield increase never came up to the highest level of organic amendment (20 tonnes/ha) of cotton leaves applied to soil along with $FeSO_4$ at 45 ppm. Even-though the foliar application was equivalent to 5000 ppm (0.5 per cent) of iron, the efficiency of this application was far less than that of organically complexed iron at the rate of 45 ppm iron and 20 tonnes/ha organic amendment. This is in close agreement with the results obtained by Datta and Bains (1960), Koraddi *et al.* (1969) and Mortvedt and Giordano (1971).

The phenomenal increase in grain and straw yield at the post harvest stage

TABLE II Effect of treatments on the mean drymatter yield (30-day old plants) (g/pot)

a) Iron X organic amendments levels
Mean

	M_0	M_1	M_2	M_3	S.E.D.	C.D.(0.05)
F_0	2.10	2.10	1.90	2.45	0.244	0.495
F_1	2.75	3.00	3.28	3.53		
F_2	3.50	3.98	4.05	4.55		
F_3	4.70	5.40	6.48	6.80		

b) Comparison of iron levels
Mean

	F_0	F_1	F_2	F_3	S.E.D	C.D. (0.05
Mean	2.14	3.14	4.02	5.84	0.122	0.247

c) Comparison of organic amendment levels
Mean

	M_0	M_1	M_2	M_3	S.E.D	C.D.(0.05)
Mean	3.26	3.62	3.93	4.33	0.112	0.247

(60-day old plants)

d) Comparison of iron levels

	F_0	F_1	F_2	F_3	S.E.D	C.D. (0.05)
Mean	11.28	13.83	16.14	18.70	0.308	0.625

60-day old Plants)

e) Comparison of organic amendment levels

	M_0	M_1	M_2	M_3	S.E.D	C.D.(0.05)
Mean	13.69	14.57	15.38	16.31	0.308	0.625

GRAIN

f) Comparison of iron levels

F_0	F_1	F_2	F_3	S.E.D	C.D.(0.05)
9.96	19.48	30.36	43.42	0.58	1.36

g) Comparison of organic amendment

M_0	M_1	M_2	M_3	S.E.D	C.D.(0.05)
22.25	24.15	26.07	30.75	0.58	1.36

h) Comparison of Iron X organic amendment levels

	M_0	M_1	M_2	M_3	S.E.D	C.D.(0.05)
F_0	6.92	8.85	10.82	13.25	1.17	2.37
F_1	14.80	17.72	19.85	25.52		
F_2	27.27	27.87	29.32	37.00		
F_3	40.00	42.15	44.30	47.20		

[Contd.

STRAW

i) Comparison of iron levels

	F_0	F_1	F_2	F_3	S.E.D	C.D.(0.05)
Mean	34.10	54.36	83.75	117.38	6.05	12.28

ii) Comparison of organic amendment levels

	M_0	M_1	M_2	M_3	S.E.D	C.D.(0.05)
Mean	61.38	69.68	75 35	83.17	6.05	12.28

of growth could be ascribed to the application of iron in the form of cotton leaf organic complex. As iron is required for chlorophyll production, biosynthesis of enzymes, absorption of nutrients and oxygen uptake in plants (Agarwala *et al*. 1961), all of which are directly or indirectly connected with the optimum plant metabolism and drymatter accumulation, the fact that the increased weight of plant was obtained by the F_3 M_3 treatment showed the adequate availability of iron for these functions.

A drymatter increase of over 200 per cent was obtained at the highest level of iron organic complex application in the case of 30-day old plants in the red soil and 259 per cent in the black soil as compared to the control treatment. The corresponding figures for 60 day plants were 115.30 per cent and 96.38 per cent respectively. The grain yield increase at the highest level of organically complexed iron application over the control was 577.46 per cent in the case of red soil and 587.41 per cent in the case of black soil and the corresponding increase in straw yield were 362.94 per cent and 318.15 per cent respectively. The immense benefit of applying iron complexed with cotton leaf manure was thus, quite obvious. Mortvedt and Giordano (1971) working with iron sulphate and Fe EDDHA obtained results closely resembling this. The soil abound in many natural chelating agents, but many of these organic compounds could be easily destroyed by soil microbes. Hence the necessity to augment the chelated iron in the soil with extra amount of this form of iron, for keeping the optimum balance of ions in the soil.

It could be seen that the highest levels of manure and iron combination (F_3 M_3) had given the highest yield of drymatter in both the soils. The act that the plants in the red soil responded significantly better to the treatment indicated the better ionic balance obtained in the soil in the absence of too much calcium.

The great advantage in resorting the organometallic combination of iron to sorghum plants has been convincingly proved by this experiment.

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