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Different Nutrient Ratios and Their Effect on Drymatter Accumulation in Sorghum Crop Due to Application of Organically Complexed Iron

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The results of a pot experimant to study the effect of organically complexed iron on different nutrient ratios in sorghum crop revealed that there were significant negative relationships between Ca/Fe ratios as well as P/Fe ratio and drymatter yield of 30 and 60 day old plants, grain and straw. There were significant positive relationships between Fe/Mn, Fe/Zn and Fe/Cu and drymatter yields of 30 and 60 day old plants, grain and straw. There was no significant relationship between K/Ca ratio and drymatter yield of 30 and 60 day old plants, grain and straw.

Balanced fertilization is advocated to obtain maximum yield as well as to maintain the soil fertility. It is necessary to include the secondary and micronutrients also, along with the macronutrients, to have balanced nutrition. In the present paper an attempt has been made to elucidate the effect of organically complexed iron on nutrient ratios in sorghum crop under two different soil conditions at successive growth stages.

MATERIAL AND METHODS

Preparation of complex of organic matter and iron: Three kg. of green cotton leaves and 3 kg of soil were mixed well and transferred to a glazed pot. One gram ammonimum phosphate was added, moistened with water and incubated for a month. The partially decomposed organic material was divided into four portions. One portion was kept as such as and to the three portions, calculated quantities of $FeSO_4$ at the rates of 15, 30 and 45 ppm Fe were added and put in different pots, mixed well, and allowed to remain for a month. The organic amendment and the complex were then applied to the soils in the different treatments as detailed below,

Pot experiment

F_0M_0 — Control (Soil without addition of organic matter or iron but mixed with NPK as per soil test recommendations)

F_0M_1 — Soil as above + organic matter (Cotton leaves) at 5 tonnes/ha.

F_0M_2 — Soil as in (1) + organic matter at 10 tonnes/ha

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F_0M_3 — Soil as in (1) + organic matter at 20 tonnes/ha

F_1M_0 — Soil as in (1) + 15 ppm Fe without organic amendment.

F_1M_1 — Soil as in (1)+ 15 ppm Fe with organic amendment at 5 tonnes/ ha.

F_1M_2 — Soil as in (1) + 15 ppm Fe with 10 tonnes/ha organic amendment

F_1M_3 — Soil as in (1) + 15 ppm Fe with 20 tonnes / ha organic amendment

F_2M_0 — Soil as in (1)+ 30 ppm Fe with out organic amendment

F_2M_1 — Soil as in (1) + 30 ppm Fe with 5 tonnes organic amendment per hectare.

F_2M_2 + Soil as in (1) + 30 ppm Fe with 10 tonnes/ha organic amendment.

F_2M_3 — Soil as in (1) + 30 ppm Fe with 20 tonnes / ha organic amendment.

F_3M_0 — Soil as in (1) + 45 ppm Fe without organic amendment.

F_3M_1 — Soil as in (1) 45 ppm Fe with 5 tonnes/ha organic amendment

F_3M_2 — Soil as in (1) + 45 ppm Fe with 10 tonnes/ha organic amendment.

F_3M_3 + Soil as in (1) + 45 ppm Fe with 20 tonnes / ha organic amendment.

The experiment was replicated twice and simultaneously conducted on two soils, red and black. Six seeds of sorghum CSH5, were sown in each pot. Watering was done using demineralised water. Plant samples were collected after 30 days, 60 doys of growth and at maturity and analysed for P, K, Ca and Mg using the standard procedures (Jackson 1967). Plant micronutrients were estimated in the triacid-digested extract using Varian Techtran AA. 120 atomic absorption spectrophotometer. From the nutrient content of sorghum plant at three stages nutrient ratio was worked out. The relationships between different nutrient ratios and dry matter yield at the above three sages were worked out.

RESULTS AND DISCUSSION

The relationships between the different nutrient ratios and drymatter yield at 30 and 60 days old plants and grain and straw yields are given in Table I.

Ca/Fe ratio : The Ca/Fe ratio determined in the plants under different treatments varied from 8.0 to 50.0 with a mean of 20.08 and from 7.16 to 36.32 with a mean of 18.43 in 30 day old plants and 60 day old plants respectively in the black calcareous soil. For plants in the red soil the variation in the ratios were 8.50 to 55.45 and 11.27 to 49.52 for 30 day plants and 60 day plants respectively. The mean values were 25.58 and 24.26 respectively. Ca/Fe ratio was negatively correlated with grain yield, in both the soils. The ratio decreased with increase in the nutrient level of treatment in both the soils. A perusal of the data indicating that the increase in Ca/Fe ratio resulted in decreased yield thereby indicating that the suppresion of Fe by Ca has lead to decreased drymatter production and adversely affected the yield. Similar observations were also made by Anter *et al.* (1973) and Mahendra Singh and Dahiya

TABLE I. Relationship between the different nutrient ratio and drymatter yield at 30 and 60 day old plants and grain and straw yields (n=32)

Relationship between (1)	Correlation coefficient 'r' (2)	Regression equation (3)
30 day old plants		
Ca/Fe ratio Vs Drymatter yield		
a) Black calcareous soil	−0.630**	Y : 4.450 — 0.060 X
b) Red soil	−0.420*	Y : 5.445 — 0.047 X
P/Fe ratio Vs Drymatter yield		
a) Black calcareous soil	−0.420**	Y : 4.244 — 0.339 X
b) Red soil	−0.460**	Y : 5.859 — 0.578 X
K/Ca ratio Vs Dry matter yield		
a) Black calcareous soil	0.240 N.S.	
b) Red Soil	0.160 N.S.	—
Fe/Mn ratio Vs Drymatter yield		
a) Black calcareous soil	0.640**	Y : 0.985 + 0.322 X
b) Red Soil	0.640**	Y : 2.083 + 0.364 X
Fe/Zn ratio Vs Dry matter yield		
a) Black calcareous soil	0.610**	Y : 2.130 + 0.040 X
b) Red soil	0.610**	Y : 2.678 + 0.071 X
Fe/Cu ratio Vs Dry matter yield		
a) Black calcareous soil	0.430*	Y : 1.760 + 0.140 X
b) Red Soil	0.740**	Y : 1.270 + 0.230 X
60 day old plants		
Ca/Fe ratio Vs Drymatter yield		
a) Black calcareous soil	—0.74**	Y : 18.930 — 2.240 X
b) Red Soil	—0.82**	Y : 19.980 — 0.190 X
P/Fe ratio Vs Drymatter yield		
a) Black calcareous soil	—0.51**	Y : 17.270 — 1.090 X
b) Red soil	—0.54**	Y : 18.450 — 1.530 X
K/Ca ratio Vs Drymatter yield		
a) Black calcareous soil	—0.33 N.S.	—
b) Red soil	0.32 N.S	—
Fe/Mn ratio Vs Drymatter yield		
a) Black calcareous soil	0.890**	Y : 6.920+ 1.160 X
b) Red soil	0.630**	Y : 12.040+0.580 X
Fe/Zn ratio Vs Drymatter yield		
a) Black calcareous soil	0.570**	Y : 11.976+0.124 X
b) Red Soil	0.590**	Y : 12.117+0.178 X
Fe/Cu ratio Vs Drymatter yield		
a) Black calcareous soil	0.710**	Y : 11.080+0.060 X
b) Red soil	0.590**	Y : 13.290+0.050 X

[Contd.

(1)	(2)	(3)
Sorghum Grain		
Ca/Fe ratio Vs Grain yield		
a) Black calcareous soil	—0.600**	Y : 42.100 — 0.518 X
b) Red soil	—0.590**	Y : 42.915 — 0.612 X
P/Fe ratio Vs Grain yield		
a) Black calcareous soil	—0.884**	Y : 57.112 — 3.586 X
b) Red soil	—0.768**	Y : 54.448 — 3.506 X
K/Ca ratio Vs Grain yield		
a) Black calcareous soil	0.014 N.S	—
b) Red soil	—0.107 N.S	—
Fe/Mn ratio Vs Grain yield		
Black calcareous soil	0.514**	Y : 15.994 + 0.458 X
Red soil	0.396*	Y : 18.189 + 0.323 X
Fe/Zn ratio Vs Grain yield		
a) Black calcareous soil	0.580**	Y : 6.486 + 4.818 X
b) Red soil	0.690**	Y : 8.293 X — 0.618
Fe/Cu ratio Vs Grain		
a) Black calcareous soil	0.580**	Y : 13 020 + 0.830 X
b) Red soil	0.200 N.S.	—
Sorghum straw		
a) Black calcareous soil	—0.740**	Y : 119.688—0.447 X
b) Red soil	—0.850**	Y : 154.616—3.893 X
P/Fe ratio Vs Straw yield		
a) Black calcareous soil	—0.862**	Y: 140.136—28 344 X
b) Red Soil	—0.342*	Y : 99.598—25.538 X
K/Ca ratio Vs Straw yield		
a) Black calcareous soil	—0.042 N.S.	—
b) Red soil	0.060 N.S.	—
Fe/Mn ratio Vs Straw yield		
a) Black calcareous soil	0.534**	Y : 29.566 + 5.271 X
b) Red soil	0.904**	Y : 12.328 X — 3.455
Fe/Zn Vs Straw yield		
a) Black calcareous soil	0.940**	Y : 10.702 X — 9.722
b) Red soil	0.850**	Y : 0.346 + 7.120 X
Fe/Cu ratio Vs Straw yield		
a) Black calcareous soil	0.570**	Y : 29.810 + 2.680 X
b) Red soil	0.750**	Y : 23.110 + 2.650 X

(1975) who observed that increase in the level of Ca appeared to depress the accumulation by the leaves of both Fe and Mn.

P/Fe ratio : In the plants grown in black calcareous soil this ratio in different treatments varied from 1.19 to 6.08 with a mean of 2.92 and 1.25 to

5.77 with a mean of 2.55 respectively for the 30 day and 60 day plants. In the grain and straw samples from the same soil, the ratios varied from 3.28 to 13.00 with a mean value of 8.8 and 1.18 to 4.12 with a mean of 2.46 respectively. In the red soil the ratios were 1.4 to 5.90 and 0.79 to 3.65 in the case of 30 day and 60 day plants respectively and 3.90 to 12.33 and 0.61 to 1.47 respectively for grain and straw. Generally the grain samples recorded higher ratios in both the soils. With increase in the level of iron treatments there was decrease in the ratios. It is suggested that with an increase in the relative P content of the tissues more Fe is tied up in phosphate combination and consequently less Fe is available for synthesis reactions leading to chlorophyll formations. With increase of P/Fe ratio there was reduction in the yield because of less synthesis of starch through photo-synthesis thus, accounting for negative relationship. This is in accordance with the findings of De Kock *et al*. (1960), Odurukwe and Maynard (1969) and Adriano *et al*. (1971) who obsarved that high Fe decreased the P/Fe ratio in the shoot.

K/Ca ratio : K/Ca ratio for the 30 day plants and 60 day plants in the black calcareous soil was from 1.26 to 2.97 with a mean value of 1.93 and 1.30 to 3.60 with a mean of 2.00 respectively. In the case of grain and straw the ratio varied from 0.58 to 1.90 and 1.94 to 3.36 respectively. With regard to red soil the ration varied from 0.45 to 2.18 and 1.47 to 3.00 respectively in the case of 30 day and 60 day plants. In the grain and straw the ratio varied from 0.88 to 1.66 and 1.90 to 2.47 respectively. The mean values were 1.28 and 2.46 respectively. There was no marked difference in this ratio between the soils in the various treatments. No consistent difference was observed between K/Ca ratio and iron level thereby indicating that this ratio cannot be taken as a criterion for predicting Fe deficiency in plants. This is contrary to the findings of Dekock *et al*. (1960) who reported that increases in the iron level decreases the value of K/Ca ratio. It is evident that the K/Ca ratio in the present study has not been disturbed much under the conditions existing in the soil,

Fe/Mn ratio : Fe and Mn are interrelated in their metabolic functions with the effectiveness of one determined by the proportionate presence of the other (Olson, 1972). The efficiency of Fe utilization by plants is a function of the ratio of the two cations. A positive significant correlation was recorded between Fe/Mn ratios and drymatter yield and yield of grain and straw in all the three stages of sorghum in both the soils studied. A perusal of the data for Fe/Mn ratio indicates that it varied from 3.75 to as high as 60 and showed that this ratio alone could not be taken as a criterion for Mn deficiency. Similar findings were also reported by Agarwala and Sharma(1961)and Baser and Saxena (1970) who observed this ratio alone could not be taken as criterion for optimum growth.

Fe/Zn ratio : In the case of Maize, Prabhakaran Nair and Babu (1975) reported a Fe to Zn ratio of 6 to 16 in the shoot. The investigations conducted

under the present studies, showed with sorghum the ratio raged from 10.66 to 53.93, 6.34 to 45.46, 2.35 to 6.78 and 4.08 to 12.3 in black calcareous and 7.51 to 52.84, 4.37 to 31.75, 2.0 to 4.44 and 5.12 to 19.29 in red soil for 30 day 60 day old plants, grain and straw samples respectively. The mean values were 29,12, 20.27, 3.97, 7.55 in black caleareous and 22.41, 15.04, 3.23 and 10.44 in red soil for 30 day, 60 day old plants, grain and straw samples respectively. In the present study the dry matter yield increased as the ratio of Fe/Zn increased in both the soils. This is also evident both in the plant as well as in the grain.

Fe/Cu ratio: This ratio ranged from 3.75 to 15.58 with a mean of 10.88 and 16.52 to 94.44 with a mean of 57.71 respectively in the 30 day plants and 60 day plants raised in the black calcareous soil. It varied from 4.79 to 26.87 with a mean of 15.10 and 7.37 to 25.77 with a mean value of 15.70 respectively in the grain and straw samples from the black calcareous soil. For red soil the ratios ranged between 4.75 to 24.75 and 10.40 to 80.39 respectively in the 30 day plants and 60 day plants and between 10.0 and 24.37 and 9.09 and 43.83 respectively in the grain and straw samples. The mean values were 12.96 45.08, 16.53 and 19.13 respectively in the 30 day, 60 day plants, grain and straw samples. There was an increase in the ratio with increase in the nutrient level of treatment. Higher copper concentration in the nutrient medium has been shown to produce iron chlorosis (Chapman *et al.*(1945).Spencer(1966)reported that Cu in the soil reduced the Fe content of citrus. In the present studies it is seen that when the Fe/Cu ratio was high, dry matter yield, grain and straw yield have all increased proportionately, thus confirming the results already obtained. In both black calcareous as well as red soil the same trend is observed.

It would be seen that a definite proportion of each nutrient is needed for optimum yields. The present study has shown that some nutrients are antagonistic when they exceed a certain percentage in the plant while others are beneficial in the efficient utilisation of one another at lower concentration. Hence a definite ratio of various macro and micronutrients is essential in increasing the crop yield to the desired level.

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