World Journal of Agricultural Sciences 1 (1): 98-100, 2005
ISSN 1817-3047

Screening of Sorghum (*Sorghum bicolor*) Genotypes for Their Iron Efficiency

R. Krishnasamy, D. Jegadeeswari, U. Surendran and C. Sudhalakshmi

Department of Soil Science and Agricultural Chemistry,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, India

Abstract: The role of plant factors on micronutrient uptake and utilization has been a highly neglected field. The root-soil interface (rhizosphere) plays an important role for iron acquisition. In the present study an attempt was made to screen sorghum genotypes for their tolerance to iron stress. A suitable methodology was developed for the initial screening with modified Hoagland's solution. Varieties like K 1, K 8, K 10, K 11, Co 26 and CSV 15 exhibited no or less severe symptoms of iron chlorosis and are highly tolerant to iron deficiency hence classified as resistant. Genotypes / cultures like VMS 98001, Co 21, Co 25 and DMS 652 exhibited chlorosis within few days in all the treatments till the end of the study and rated as susceptible. Varieties like APK 1, TNS 340, TNS 587, Co 18 and TNS 334 exhibited chlorosis in control and lower iron levels and they reclaimed green, when Fe was applied and hence they were classified under moderately tolerant group. These Fe resistant genotypes can be grown in Fe deficient soils without incurring any additional cost on Fe containing fertilizers.

Key words: Genotypes · iron stress · resistant · susceptible

INTRODUCTION

Iron is the fourth abundant element in lithosphere and constitutes about 5% of the earth crust. Since iron may concentrate or depleted during the soil development its normal concentration in soil varies widely from 0.7 to 55%. Iron is an essential micronutrient for almost all living organisms because of tits critical role in processes such as DNA synthesis, respiration and photosynthesis. Many metabolic processes are activated by iron and iron itself is a prosthetic group constituent of many enzymes.

Discrepancies between the solubility of iron in the soil and the demand for iron by the plant are the primary causes of iron chlorosis. Iron deficiency chlorosis is a common disorder for plants grown on many soils in India [1, 2]. Although abundant in most well aerated soils, its biological activity is low because it's primarily forms highly insoluble ferric compounds at neutral pH. Investigations conducted by many workers 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. Also iron fertilization is not helpful as soil applied iron is fixed in soil due to various chemical reactions. Irrigation water is another contributing factor for carbonates, bicarbonates and sometimes for calcium to the rhizosphere, which immobilize iron in soil. Since it is very difficult to bring about drastic alterations in pH values and calcium levels of soils, one has to look into other factors, which can be considered to alleviate iron deficiency in plants.

In order to overcome this discrepancy, higher plants have developed different mechanisms to increase the solubility of iron in the rhizosphere and the uptake of iron. The role of plant factors on micronutrient uptake and utilization has been a highly neglected field. The root-soil interface (rhizosphere) plays an important role for iron acquisition. Plants adapted to iron stress condition have evolved various iron deficiency induced adaptation mechanisms that are genetically controlled. The inherent ability of crop varieties to produce such compounds differs widely. Some crop varieties respond remarkably to iron application while the response is poor in others. However, there is a paucity of information on the response of different varieties to iron application. Therefore, identification of varieties highly susceptible / tolerant to iron deficiency will be of great practical significance. The present investigation was framed with the objective of screening sorghum genotypes for their tolerance to iron stress.

MATERIALS AND METHODS

Plastic trays of 3.5 L capacity were used for conducting hydroponic culture. Plastic plates with

Corresponding Author: Dr. U. Surendran, Department of Soil Science and Agricultural Chemistry, Center for Soil and Crop Management Studies (SCMS), Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India Tel: + 9443791090

Table 1: Screening of sorghum genotypes for their Iron efficiency

No.	Index	Scoring	K 1	K 7	K 8	K 11	Co 18	Co 21	Co 25	Co 26	APK 1	TNS 334	TNS 340	TNS 587	CSV 15	VMS 98001	DMS 652
1	Visual score	a: best d: worst	a	a	a	a	c	d	d	a	c	b	b	d	a	d	d
2	Leaves with deficiency symptoms	a: least d: most	a	b	a	a	c	d	d	a	c	b	b	d	a	d	d
3	Shoot length	a: highest c: lowest	a	a	a	a	b	c	c	a	b	b	b	c	a	c	c
4	Root length	a: highest c: lowest	a	a	a	a	b	c	c	a	b	b	b	c	a	c	c
5	Shoot dry weight	a: highest d: lowest	a	a	a	a	b	d	d	a	c	b	b	d	a	d	d
6	Root dry weight	a: highest d: lowest	a	a	a	a	b	d	d	a	c	b	b	d	a	d	d
7	Shoot Fe content	a: highest d: lowest	a	a	a	a	b	d	d	a	c	b	b	d	a	d	d
8	Root Fe content	a: highest d: lowest	a	a	a	a	b	d	d	a	c	b	b	d	a	d	d

Same letters indicate that they did not differ significantly at p = 0.01 by Duncan's Multiple Range Test (DMRT) mean comparison analysis

Susceptible	Moderately tolerant	Resistant
VMS 98001, DMS 652, TNS 587, Co 21, Co 25	APK 1, TNS 340, Co 18, TNS 334	K 1, K 8, K 10, K 11, CSV 15, Co 26

Plate 1: Growth of sorghum genotypes in nutrients solution

depression were covered at the bottom with a nylon mesh of approximately 5 mm diameter. The plate with the nylon mesh was gently sunk into the tray containing modified Hoagland solution. The plates were constantly in touch of the solution (Plate 1). This set up provides 30 holes of 2.5 cm diameter and 3 cm depth. Seeds of sorghum genotypes treated with 'Captan' were germinated in moist paper towels for 4 days in the dark. The four-day-old uniform sized seedlings of twelve varieties were inserted through the nylon mesh so that the roots make contact with the nutrient solution. The size of the seeds was large enough to retain the shoot above the nylon mesh. Each tray contained 30 seedlings of five varieties each replicated six times. As hydroponics culture requires aeration, the seedlings were artificially aerated employing simple fabricated aerators supplying constant inflow of air. Iron was supplied as ferrous sulphate in 4 levels viz., 0, 5, 10 and 20 mg L^{-1}. The initial pH of the nutrient solution was 6.9. The solution in the trays was replaced at weekly intervals in order to supplement the nutrient demand of the crop. This experiment was maintained for 40 days from sowing. Visual iron deficiency rating was made on recently emerged, fully expanded leaves of plants. Ratings for the degree of iron deficiency / tolerance were made adopting 0-5 scale: 0 (No iron deficiency / highly tolerant); 5 (Severe iron deficiency). Intermediate values of 1, 2, 3 and 4 indicated 30, 45, 60 and 75% intervienal chlorosis, respectively [3].

RESULTS AND DISCUSSION

A suitable methodology was developed for the initial screening with modified Hoagland's solution. Genotypes / cultures like VMS 98001, Co 21, Co 25 and DMS 652 exhibited chlorosis within few days in all the treatments till the end of the study and rated as susceptible. Varieties like APK 1, TNS 340, TNS 587, Co 18 and TNS 334 exhibited chlorosis in control and lower iron levels and they reclaimed green when Fe was applied and hence they were classified under moderately tolerant group. Varieties like K 1, K 8, K 10, K 11, Co 26 and CSV 15 exhibited no or less severe symptoms of iron chlorosis and are highly tolerant to iron deficiency (indices 1, 2 and 7 remaining low) hence classified as resistant types (Table 1). The internal efficiency of these genotypes remains high owing to the higher shoot and root dry weight and higher shoot Fe content. For a genotype to be Fe efficient it should not only be able to absorb more Fe from deficient soils but should also produce more dry matter and grain yield [4, 5]. The decline in shoot growth of VMS 98001, Co 21, Co 25

and DMS 652 is in compliance with the above finding. Enhanced Fe content per shoot, efficient transport of Zn from root to shoot all proves K 1, K 8, K 10, Co 26, CSV 15 and K 11 to be Fe efficient genotypes.

CONCLUSIONS

Iron deficient crops show lower water use efficiencies, as they transpire at rates similar to green crops while fixing much less C, under limited water availability / dry land conditions such a waste of water is not affordable. This preliminary study paved the way for selecting genotypes to be grown in such areas. In the Fe deficient soils, K 1, K 8, K 10, Co 26, CSV 15 and K 11 can be cultivated without any additional cost of iron fertilization or they can be included in the plant breeding programme for the development of genotypes tolerant to Fe stress. The Fe efficiency of tolerant genotypes portrays the functioning of an unidentified mechanism in them allowing them to more effectively utilize low levels of cytoplasmic Fe for biochemical processes and physiological mechanisms.

ACKNOWLEDGEMENT

The funding for this study provided by Council of Scientific and Industrial Research (CSIR) is greatly acknowledged.

REFERENCES

1. Kannan, S., 1980. Iron Correlative influence of pH reduction on recovery from iron chlorosis. J. Plant Nutr., 2: 507-518.
2. Patel, G.J., B.U. Ramakrishna and B.K. Patel, 1977. Effect of soil and foliar application of ferrous sulphate and of acidulation of soil on iron chlorosis of paddy seedlings in Goradu soils, Nuca series in India. Plant and Soil, 46: 209-219.
3. Loeppert, R.H., S.C. Geiger, R.C. Hartwig and D.E. Morris, 1988. A comparison of indigenous soil factors influencing the Fe-deficiency chlorosis of sorghum and soybean in the calcareous soils. J. Plant Nutr., 11: 1481-1482.
4. Mortvedt, J.J., 1991. Correcting Iron deficiencies in annual and perennial plants. Present technologies and future prospects. Plant and Soil, 130: 273-279.
5. Romheld, V., 1987. Different strategies for Iron acquisition in higher plants. Physiol. Planatrum, 70: 231-234.