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Effect of Various Levels of Iron on Yield and Quality of Parching Sorghum

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FeSO4, Parching Sorghum, Hurda, Yield, Crude Fiber and Protein

A B S T R A C T

The present investigation was conducted during 2018-19 to study the effect of various levels of iron on yield, nutrient uptake and quality of parching sorghum at Research Farm, Dept. of Soil Science and Agricultural Chemistry Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Factorial Randomized block design with twelve (12) treatments combination in three replications. The parching grain samples were analyzed for various quality parameters. The results of the present experiment indicated that the significantly highest parching grain (hurda) yield, grain yield and fodder yield were recorded significantly highest with soil application of 30 kg $FeSO_4$ ha^{-1} and which was found to be at par with treatment of 20 kg $FeSO_4$ ha^{-1}. The various treatments among foliar application parching grain (hurda) yield, grain yield and fodder yield were recorded significantly highest with foliar application of 1.0 % $FeSO_4$ at flowering stage and which was found to be at par with treatment 0.5% $FeSO_4$ at flowering stage. The reducing sugar was recorded maximum with the soil application of 30 kg $FeSO_4$ ha^{-1}, non-reducing sugar and total sugar of parching grain was recorded maximum with the soil application of 10 kg $FeSO_4$ ha^{-1}.Whereas, the foliar application of 1.0% $FeSO_4$ at flowering stage observed higher reducing sugar and total sugar. The non reducing sugar was maximum with the foliar application of 0.5 % FeSO4 at flowering stage of parching grain. The crude fiber and protein were recorded higher with the soil application of 30 kg $FeSO_4$ ha^{-1}. The ash and fat content of parching sorghum recorded maximum with the soil application of 20 kg $FeSO_4$ ha^{-1}. The foliar spray of $FeSO_4$ @ 1.0% at flowering stage recorded maximum crude fiber, ash, protein and fat in parching grain.

Introduction

Sorghum [*Sorghum bicolor* (L) Munch] is the king of millets and third important crop in the country after rice and wheat. In India, it is most popularly known as "Jowar". It is an important food, feed, fodder and ration for human, cattle and poultry. Its grains have about 10-12 % protein, 3% fat and 70 % carbohydrate. In India, the area under sorghum is approximately 4.9 million hectares with an annual production of about 4.7 million tonnes The main sorghum growing states in India are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat, Tamil Nadu, Rajasthan and Uttar Pradesh. In Rajasthan, the area under sorghum cultivation is 0.73 million hectares, production is 0.51 million tonnes and productivity is 700 kg ha^{-1} (Anonymous, 2011). Ajmer, Pali, Nagaur, Kota and Jhalawar are the major sorghum growing districts in Rajasthan. It is being considered more stable and adaptable crop compared to maize. However, the productivity of sorghum in the state is deplorably low as compared to realizable yield potential of hybrids and improved cultivars (20-30 q ha^{-1}) under average management practices. The low productivity of sorghum is primarily because it is often grown on marginal lands with low fertility by resource poor farmers. Sorghum is an important cereal crop in India. Sorghum ranks 5 th among the world cereal food crops after Rice, Wheat, Maize and Barley. Sorghum is grown extensively in almost all the countries in Africa, America, Brazil, China, Russia and Peru and grown substantially by marginal farmers. In India, sorghum stood third place among the food grains after rice and wheat. The states of India where the sorghum is mainly cultivated are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Rajasthan. Due to erratic and uneven distribution of rainfall, excessive rains and untimely rains and water stress during grain filling stage (mid-season drought) during last three-four years mid-season drought. Sorghum crop is widely grown especially in tropical and sub tropical regions of India. As sorghum is generally cultivated in nutrient-poor soils in frequently drought-prone areas, it offers food and fodder security through risk aversion on sustainable basis. In view of decreasing demand for sorghum [rainy season (*kharif*) sorghum] as a food crop, it is increasingly diverted for various alternative uses such as animal feed, poultry feed, wax, starch, dextrose, syrup, edible oil, exportable alcohol and several by-products from grain. Sweet sorghum with juicy stalks and high sugar content is emerging as a potential alternative feedstock and for ethanol production to meet the increased demand for ethanol. Parching sorghum is eaten in milk stage of grain and it gives 2-3 times more rates as compare to the grain sorghum. Sorghum is gaining importance as ‘health food’ now a days, because of its higher dietary fibre (7.6% to 9.2%). It contains 72.6 per cent carbohydrate, 10 to12 per cent protein, 1.6 per cent mineral matter and 1.9 per cent fat. It is rich source of amino acids mainly lysine, thiamine, riboflavin and folic acid along with vitamin-B complex specially niacin (vitamin B6). It contains nitrogen (212 mg), starch (5.6 % to 7.3 %) in high quantity along with copper, zinc and molybdenum. Its protein in bran, germ fractions contains four times the lysine and two times argentine and lysine than endosperm protein. Parching sorghum is harvested in the milk stage after pollination but before starch has formed. Parching sorghum is a very popular and is a good source of minerals and carbohydrates. Enrichment of iron in parching sorghum used during pregnancy reduces the risk of birth defects. Enrichment of iron in parching sorghum promotes the antioxidant activity. Antioxidant activity which helps to protect body from cancer and heart disease. Parching sorghum is beneficial for good for digestion, prevent anaemia, prevent diabetes, anticancer properties. The cultivars most suitable for roasting have a sweet endosperm that is dimpled at maturity. Vani sorghum (durra group) of India is especially popular in this respect. Iron is the fourth most abundant element in earth’s lithosphere following O, Si and Al, which mostly occurs as ferromagnesian silicates. 3 Most of the Fe release by weathering is precipitated as oxides or hydroxides; only a small part of iron is incorporated into the secondary silicate minerals or complex by soil organic matter. Being one of the major constituents of the lithosphere, various Fe oxides not only govern the solubility of Fe in soil but these oxides are also capable of controlling the solubility of other major (e.g. P) and trace elements (e.g. Zn and Cu). Iron (Fe) and zinc (Zn) deficiencies constitute a major public health problem in many African countries. They mostly affect infants and pregnant women and may have serious consequences. Chronic micronutrient deficiencies, particularly of Fe, Zn, and vitamin A, cause child mortality, impaired mental and physical development and decreased work output and contribute to morbidity from infections. In view of the above, the present experiment was conducted to study the effect of various levels of Iron on Yield and Quality of parching Sorghum during 2018-19.

Materials and Methods

The experiment was sown at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in *Kharif* season 2018-19. The application of fertilizer as per recommendations the basal nitrogen (half), phosphorus and potassium were applied at the time of sowing. Iron was applied through Ferrous sulphate. In treatments the application of iron involves various levels through soil and foliar application. Levels of $FeSO_4$ for soil application, S_0Control (No manures and fertilizer), $S_1$10 kg $FeSO_4$ ha $^{-1}$, S_2 20 kg $FeSO_4$ ha $^{-1}$, $S_3$30 kg $FeSO_4$ ha $^{-1}$ and Levels of $FeSO_4$ for foliar application$F_{0,}$0.0 % $FeSO_4$ha $^{-1}$, at flowering stage, F_1, 0.5 % $FeSO_4$ ha $^{-1}$ at flowering stage, $F_2$1.0 % $FeSO_4$ ha $^{-1}$ at flowering stage. To determine the nutrient content and quality parameters in plants, the plant samples were washed with tap water and in detergent solution followed by distilled water. After cleaning, plants were dried in shade and subsequently in hot air oven at 64°C till constant weight. The oven dried samples were ground in electrically operated grinder. The powdered samples were stored in polythene bags with proper labeling and used for nutrient analysis. The crude fiber content was determined by the Loss on ignition method described by Maynard (1970). The percentage of this ingredient was calculated as under. It was determined by multiplying the total nitrogen per cent in grain sample by constant factor 6.25.The mineral matter content was determined by using Muffle furnace by the method loss on ignition as described by AOAC (1965). Crude fat was determined according to the Soxhlet extraction method as described by AOAC (1965).Reducing Sugar was determined according to the DNS method using spectrophotometer by Miller G.L (1972).Total Sugar was determined according to the anthrone method Using spectrophotometer described by Hodge J.E and B.T. Hofreiter (1962).

The experimental data collected during the course of investigation were statistical analyses with factorial randomized block design programmed on computer by adopting standard statistical techniques of analysis of variance (Gomez and Gomez, 1984). Whenever, the results were significant, critical differences at P=0.05 level were calculated for comparison of treatment means. The data on interaction effects are presented whenever found significant.

Results and Discussion

Yield

The effect of soil application of $FeSO_4$ on parching grain (hurda) and oven dry grain yield of parching sorghum was found significant. The parching grain (hurda) and oven dry grain yield of parching sorghum were recorded significantly highest with soil application of 30 kg $FeSO_4$ ha^{-1} i.e. 39.57 and 32.54 q ha^{-1} respectively which was at par with the soil application of 20 kg FeSO4 ha^{-1} and superior over control. The fodder yield of parching sorghum was recorded significantly highest with soil application of 30 kg FeSO4 ha^{-1} (62.52 q ha^{-1}) which was at par with the soil application of 20 kg $FeSO_4$ ha^{-1} and superior over control. The lowest fodder yield of parching sorghum was recorded in control. Wankhade *et al.,* (1996) at Akola (Maharashtra) observed that application of 10 kg $FeSO_4$ along with RDF significantly increased the grain and fodder dry matter yields of sorghum by 18.0 and 18.2 per cent and of wheat by 8.3 and 6.8 per cent over RDF alone, respectively. Field experiment was conducted at Akola and results revealed that application of RDF along with 20 kg Fe ha^{-1} significantly higher fodder and grain yield (Wanjari *et al.,* 2003). Effect of Foliar application: The effect of foliar application of ferrous sulphate on parching grain (hurda) and oven dry grain yield of parching sorghum was found significant. The parching grain (hurda) and oven dry grain yield of parching sorghum was recorded significantly highest with foliar application of 1.0 % $FeSO_4$ at flowering stage (38.80 q ha^{-1}) and (31.84 q ha^{-1}) which was at par with foliar application of 0.5 % FeSO4 at flowering stage (35.87 q ha^{-1}) and (29.05 q ha^{-1}) and significantly superior over the control. The lowest yield was recorded with no foliar application of $FeSO_4$. The fodder yield of parching sorghum was recorded significantly highest with foliar application of 1.0 % $FeSO_4$ at flowering stage (60.92 q ha^{-1}) which was at par with the foliar application of 0.5 % $FeSO_4$ at flowering stage and superior over control. Amanullah *et al.,* (2007) conducted experiment at Tamil Nadu to study the influence of Fe on growth and yield of sorghum. Results revealed that the application of 25 kg ha-1 FeSO4 + 2 % FeSO4 foliar spray recorded the highest grain yield of sorghum 4.41 t ha^{-1}.

Quality parameters

The quality parameters in parching grain i.e. reducing sugar 2.16% were recorded maximum with the soil application of 30 kg $FeSO_4$ ha^{-1}. The non-reducing sugar 7.0% and total sugar 8.93% were significantly highest with the soil application of 10 kg $FeSO_4$ ha^{-1} (Table 2).

The reducing sugar 2.20 % and total sugar 8.99 % significantly highest with foliar application of 1.0 % $FeSO_4$ at flowering stage whereas non-reducing sugar 7.1% with the application of 0.5 % $FeSO_4$ at flowering stage the numerically higher value of sugar are in close confirm of the findings of Romheld and Marschner, (1991) observed that Iron has many important functions in plant growth and development, such as involvement in the biosynthesis of chlorophyll, respiration, chloroplast development and improves the performance of photosystems. It is an essential part of many enzymes. Iron also participates in the oxidation process that releases energy from sugars and starches and in responses that convert nitrate to ammonium in plant. It plays an essential role in nucleic acid metabolism.

Biochemical properties of parching grain

The data in relation crude fiber, ash protein and fat content in parching grain as influenced by various levels of $FeSO_4$ is depicted in Table 3. The crude fiber were recorded higher (2.32%) with the soil application of 30 kg $FeSO_4$ ha^{-1} whereas the ash (4.27%), protein (10.7%) and fat (1.73%) were recorded higher with the soil application of 20 kg $FeSO_4$ ha^{-1}. The lowest fiber, ash, protein and fat content was found with the soil application of 0 kg $FeSO_4$ ha^{-1}. The data indicated that, the crude fiber (2.20%), ash (4.25%), protein (10.7%) and fat (1.71%) in parching grain were recorded higher with foliar application of 1.0% $FeSO_4$ at flowering stage. Interaction among the soil and foliar application of $FeSO_4$ on crude fiber, ash, protein in parching grain were found non-significant.

Table.1 Effect of soil and foliar application of iron on yield of parching sorghum

Treatments	Green Hurda yield	Oven dry grain yield	Fodder yield
	(q ha^{-1})		
a) Soil application			
S_o - 0 kg $FeSO_4$ ha^{-1}	35.50	28.82	55.51
S_1 - 10 kg $FeSO_4$ ha^{-1}	37.29	30.53	60.11
S_2 - 20 kg $FeSO_4$ ha^{-1}	39.21	32.05	62.44
S_3 - 30 kg $FeSO_4$ ha^{-1}	39.57	32.54	62.52
SE(m)±	0.75	0.79	0.42
CD at 5 %	2.21	2.32	1.24
(b) Foliar application			
F_0 - 0.0 % $FeSO_4$ at flowering stage	34.13	27.94	59.53
F_1 - 0.5 % $FeSO_4$ at flowering stage	35.87	29.05	60.00
F_{2-} 1.0 % $FeSO_4$ at flowering stage	38.80	31.84	60.92
SE(m)±	0.65	0.69	0.37
CD at 5 %	1.91	2.01	1.07
(c) **Interaction**	NS	NS	NS

Table.2 Effect of soil and foliar application of iron on biochemical parameters of parching sorghum grain

Treatments	Reducing sugar (%)	Non Reducing sugar (%)	Total sugar (%)
a) Soil application			
S_o - 0 kg $FeSO_4$ ha^{-1}	2.05	6.7	8.69
S_1 - 10 kg $FeSO_4$ ha^{-1}	2.03	7.0	8.93
S_2 - 20 kg $FeSO_4$ ha^{-1}	2.14	6.9	8.89
S_3 - 30 kg $FeSO_4$ ha^{-1}	2.16	6.8	8.87
SE(m)±	0.06	0.02	0.05
CD at 5 %	NS	NS	0.14
b) Foliar application			
F_0 - 0.0 % $FeSO_4$ at flowering stage	2.06	6.6	8.56
F_1 - 0.5 % $FeSO_4$ at flowering stage	2.02	7.1	8.98
F_{2-} 1.0 % $FeSO_4$ at flowering stage	2.20	6.9	8.99
SE(m)±	0.05	0.04	0.04
CD at 5 %	NS	NS	0.12
c) Interaction	NS	NS	NS

Table.3 Effect of soil and foliar application of iron on crude fiber, ash, protein and fat content in parching grain

Treatments	Crude fiber (%)	Ash (%)	Protein (%)	Fat (%)
a) Soil application				
S_o - 0 kg $FeSO_4$ ha^{-1}	1.82	3.82	10.5	1.61
S_1 - 10 kg $FeSO_4$ ha^{-1}	1.88	4.09	10.6	1.64
S_2 - 20 kg $FeSO_4$ ha^{-1}	2.19	4.27	10.7	1.73
S_3 - 30 kg $FeSO_4$ ha^{-1}	2.32	4.24	10.7	1.70
SE(m)±	0.03	0.13	0.01	0.09
CD at 5 %	NS	NS	NS	NS
b) Foliar application				
F_0 -0.0% $FeSO_4$ at flowering stage	1.92	4.09	10.5	1.66
F_1-0.5% $FeSO_4$ at flowering stage	2.05	3.97	10.6	1.62
F_2-1.0% $FeSO_4$ at flowering stage	2.20	4.25	10.7	1.71
SE(m)±	0.02	0.11	0.01	0.08
CD at 5 %	NS	NS	NS	NS
c) Interaction	NS	NS	NS	NS

The parching hurda yield, oven dry grain yield and fodder yield of parching sorghum were found significantly highest with the soil application of 30 kg $FeSO_4$ ha^{-1} and foliar application of 1.0 % $FeSO_4$ at flowering stage. The soil and foliar application of various levels of $FeSO_4$did not improve the quality parameters of parching sorghum grain, except total sugar which was influenced significantly with the varying levels of $FeSO_4$.

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