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EFFECT OF MICRONUTRIENTS ON YIELD ATTRIBUTES AND YIELD OF SORGHUM

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ABSTRACT

A field experiment was conducted during kharif season of 2010 and 2011 to assess the effect of micronutrients on yield attributes and yield of sorghum (Sorghum bicolor)at Udaipur, Rajasthan. The experiment consisted of 24 treatment combinations and replicated three times in split plot design. The results revealed that application through soil + foliar spray significantly increased plant height, weight of panicle, grain weight of panicle and 1000 grain weight, grain, stover and biological yield over soil application. Combined application of micronutrient (Fe+ Zn+ B) increased significantly the mean plant height, weight of panicle, grain weight of panicle and 1000 grain weight, grain, stover and biological yields by11.4, 20.5, 32.7, 13.4, 25.4, 15.5 and 17.4 % over control, respectively.

Keywords: Sorghum, zinc, iron and boron, growth, yield attributes, yield.

INTERODUCTION

Sorghum (*Sorghum bicolour* 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 11.13 million hectares with an annual production of about 11.62 million tonnes and an average productivity of 1040 kg ha^{-1}. The balanced fertilization has shown positive effects on various aspects of growth, development and biological yield of the crop in comparison to nutrient use in single or in combination. Micronutrient fertilization includes combined use of all essential plant nutrients in optimum quantities, proportion and their application at appropriate time through suitable source and methods under specific cropping system and agro climatic zones. Micronutrients are important for maintaining soil health and also for increasing productivity of crops. These are needed in very small amounts. The soil must supply micronutrients for desired growth and development of plants. Increased removal of micronutrients as a consequence of adoption of HYVs and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil to below normal at which productivity of crops cannot be sustained. The role of zinc and iron in crop nutrition is well recognized as it is used for bio-synthesis of plant auxins, nitrogen metabolism, oxidation-reduction reactions, which are considered to be necessary for plant growth and development, chlorophyll formation, photosynthesis, important enzyme system and respiration in plants. Boron also plays a very important role in vital functions of the plant, including meristem, sugar and hydrocarbon metabolism and their transfer, RNA and cytokinin production and transfer, pollen building and seed formation (Dakshinamurthy and Rao 2008). Application of micronutrient fertilizers through soil application is the most efficient and economical method of getting these nutrients into the crops. The amount of nutrient required is much higher compared to foliar application. Foliar application is widely used to apply micronutrients for many crops. Soluble salts are generally effective in foliar sprays. Deficiency symptoms are usually corrected within the few days and after there the entire field could be sprayed with the appropriate micronutrients source. So far, no systematic study has been conducted on the effect of micronutrients on sorghum in Udaipur region of Rajasthan. Hence the study was initiated to study the effect of micronutrients on sorghum.

MATERIALS AND METHODS

A field experiment was conducted during during the rainy (*kharif)* seasons of 2010 and 2011 at Rajasthan College of Agriculture, Udaipur. The site is situated at 24°.35' N latitude, 74°.42' E longitude and an altitude of 579.5m above mean sea level. The region falls under agro-climatic zone IVA of Rajasthan. The soil was clay loam, having 7.0 g ha^{-1} organic carbon, 206 kg ha^{-1} available N, 22.2 kg ha^{-1} available P, 130 kg ha^{-1} available K, iron 4.68 mg kg^{-1}, zinc 0.87 mg kg^{-1} and boron 0.323 mg kg^{-1} with pH 8.10. The experiment consisted of 24 treatment combinations and replicated three times in split plot design with three method of application (soil application, foliar spray and soil + foliar application) in main plots and eight micronutrient treatments (control – Fe, Zn, B, Fe + Zn, Fe + B, Zn + B and Fe + Zn + B) in sub plot. Sorghum variety CSV-23 was sown in furrows at 45 cm row spacing using a seed rate of 10 kg ha^{-1}. Fertilizer application was made as per treatments. Ferrous sulphate, zinc sulphate and borax (25, 25 and 20 kg ha^{-1}.) as soil application were added to soil at sowing. Foliar application (0.5, 0.2 and 0.2 %) of Zn, Fe and boron was made at15 and 30 days after

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sowing. Half dose of N and full dose of phosphorus and potassium (80, 40 and 40 kg ha^{-1}) was applied as basal at the time of sowing and remaining half dose of N at 30 days after sowing. Total amount of rainfall during the crop growth period was 580 and 630 mm in 2010 and 2011, respectively. The treatments were evaluated on the basis of observations and five plants were selected for recording plant height, weight of panicle, grain weight of panicle and 1000 grain weight. The grain, stover and biological yields were recorded at harvest.

RESULTS AND DISCUSSION

Yield Attributes

Data (Table 1) indicated that micronutrients application through soil + foliar spray produced significantly taller plants over control during both the years while alone application of both was at par with each other. On the basis of pooled analysis the increases were 9.0 and 7.2 % over soil and foliar application, respectively. Among the treatments, application of Fe +Zn + B proved its superiority over rest of the treatments. However, single or combined applications of two micronutrients were at par with one another in respect of plant height.. The mean increase with Fe+ Zn+ B was to the tune of 11.4% over control. Application of nutrient through soil and foliar significantly produced higher weight of panicle and grain weight of panicle over rest of the treatments.The weight of panicle increased (soil + foliar) by 7.9 and 5.4% over alone method of micronutrients application. The combined application of Zn+ Fe+ B produced significantly higher weight of panicle (145.08 g) and grain weight of panicle (102.94 g) over rest of the treatments.

Table: 1 Effect of micronutrient on growth and yield attributes of sorghum

Treatments	Plant height (cm)			Weight of panicle (g)			Grain weight of panicle (g)			1000 grain weight (g)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
Methods (Main plot) of application												
Soil	253.9	255.2	254.6	124.6	127.7	126.2	84.7	88.9	86.8	30.44	30.67	30.55
Foliar	254.8	262.8	258.8	127.0	131.4	129.2	84.9	89.4	87.2	30.64	30.92	30.78
Soil+Foliar	275.6	279.2	277.4	133.8	138.5	136.2	95.7	100.6	98.2	31.81	32.13	31.97
SEm ±	**4.6**	**4.1**	**3.0**	**1.11**	**1.11**	**0.79**	**0.77**	**0.76**	**0.54**	**0.20**	**0.19**	**0.14**
CD (P = 0.05)	**18.1**	**16.1**	**10.07**	**4.38**	**4.39**	**2.57**	**3.03**	**3.01**	**1.77**	**0.80**	**0.75**	**0.45**
Nutrients (Sub plot)												
Control	244.6	250.0	247.3	118.9	121.7	120.3	75.3	79.8	77.5	28.97	29.28	29.13
Fe	260.7	264.5	262.6	123.6	127.8	125.7	83.5	88.0	85.8	30.40	30.68	30.54
Zn	261.1	265.0	263.0	123.7	127.9	125.8	83.9	88.2	86.0	30.47	30.73	30.60
B	260.6	264.4	262.5	123.2	127.2	125.2	82.4	86.9	84.6	30.39	30.61	30.50
Fe + Zn	265.0	268.5	266.7	132.2	136.4	134.3	95.8	99.3	97.5	31.35	31.64	31.50
Fe + B	262.6	267.3	265.0	131.	135.7	133.6	93.1	97.6	95.4	31.88	31.91	31.89
Zn + B	263.9	268.2	266.1	132.0	136.1	134.1	93.6	98.1	95.9	31.42	31.75	31.58
Fe + Zn + B	273.1	278.2	275.6	142.8	147.3	145.0	100.0	105.8	102.9	32.80	33.32	33.06
SEm ±	**2.4**	**2.3**	**1.7**	**1.45**	**1.46**	**1.03**	**1.04**	**1.03**	**0.73**	**0.29**	**0.29**	**0.21**
CD (P = 0.05)	**7.0**	**6.6**	**4.7**	**4.14**	**4.17**	**2.89**	**2.99**	**2.94**	**2.06**	**0.82**	**0.84**	**0.58**

The soil + foliar application produced higher 1000 grain weight on pooled analysis (31.81, 32.13 & 31.97 g) over rest of the treatments. The increases in test weight with soil + foliar spray were 4.6 and 3.8% over alone soil and foliar application of nutrients, respectively. The maximum 1000 grain weight was observed in the treatment receiving combined application of Fe+ Zn+ B along with RDF (32.80 and 33.32 g) over control (28.97 and 29.28 g) during both years. Though foliar spray is not a substitute to soil application but it is considered as a supplement to soil application. Among the methods of nutrient application, foliar application is recognized as an important method of fertilization, since foliar spray usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients. The combined application of micronutrients along with RDF provided greater availability of nutrients for the development of reproductive structures and increase in the number of grains and grain weight. Since boron and combination of all micronutrients were responsible for the translocation of food materials in plants therefore it played a vital role in grain setting as well as higher number of grain. Micronutrients such as iron and zinc have a structural role in chlorophyll. These elements can be easily sprayed on leaf, thus leaf chlorophyll concentration increased by foliar application of micronutrient which in turn, leads to an increase in plant height. The results of present investigation are in close agreement with the findingsThe results of present investigation are in close agreement with the findings of Uddin *et al.* (2008), Tahir *et al.* (2009), Kuttimani and Velayutham (2011) and Yosefi *et al.* (2011).

Table: 2 Effect of micronutrient fertilization on yields and harvest index of sorghum

Treatments	Grain (t. ha^{-1})			Stover (t. ha^{-1})			Biological (t. ha^{-1})			Harvest index (%)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
Methods (Main plot)												
Soil application	3.20	3.45	3.32	12.49	13.75	13.12	15.69	17.20	16.45	20.4	20.1	20.2
Foliar	3.25	3.50	3.37	12.84	13.90	13.37	16.09	17.41	16.75	20.1	20.0	20.1
Soil+Foliar	3.62	3.95	3.78	13.84	15.20	14.52	17.46	19.16	18.31	20.6	20.6	20.6
SEm ±	0.07	0.05	0.04	0.27	0.27	0.19	0.31	0.24	0.19	0.3	0.5	0.3
CD (P = 0.05)	0.27	0.21	0.14	1.07	1.06	0.63	1.22	0.95	0.64	NS	NS	NS
Nutrients (Sub plot)												
Control	2.92	3.16	3.04	12.04	13.20	12.62	14.96	16.36	15.66	19.5	19.4	19.5
Fe	3.27	3.48	3.38	13.05	14.15	13.60	16.33	17.64	16.98	20.1	19.7	19.9
Zn	3.29	3.50	3.40	13.14	14.23	13.68	16.43	17.74	17.08	20.1	19.7	19.9
B	3.26	3.46	3.36	13.12	14.13	13.62	16.38	17.59	16.99	19.9	19.7	19.8
Fe + Zn	3.48	3.87	3.68	13.09	14.45	13.77	16.58	18.32	17.45	21.0	21.1	21.1
Fe + B	3.47	3.75	3.61	13.13	14.37	13.75	16.61	18.13	17.37	20.9	20.7	20.8
Zn + B	3.48	3.89	3.68	13.05	14.43	13.74	16.53	18.32	17.43	20.9	21.2	21.1
Fe + Zn + B	3.66	3.97	3.81	13.84	15.32	14.58	17.50	19.29	18.40	20.7	20.5	20.6
SEm ±	0.06	0.07	0.04	0.20	0.23	0.15	0.23	0.24	0.16	0.3	0.4	0.2
CD (P = 0.05)	0.18	0.20	0.13	0.58	0.66	0.43	0.65	0.68	0.46	0.9	1.1	0.7

The increases in grain yield were13.8 and 12.1 %, stover yield 10.6 and 8.5 % and biological yield 11.3 and 9.3 %, respectively due to soil and foliar application over control. Application of Fe+ Zn+ B along with RDF proved their superiority over rest of treatments. However, combined application of two micronutrients also produced significantly higher grain yield over alone nutrients application. The mean increases with RDF+ Fe+ Zn+ B were to the tune of 25.4 % in grain, 15.5 % in stover, 17.4 % in biological yield and 5.9 % harvest index over control. Foliar application of iron, zinc and boron at reproductive growth stage increased grain and stover yield. The existence of favourable nutritional environmental below ground and above ground under the influence of zinc had a positive influence on both the phases of crop, which ultimately led to realization of higher yields. Iron is a structural component of porphyrin molecules, Cytochroms, hemes, hematian, ferrichrome and leghemogloben. These substances are involved in oxidation-reduction reactions in respiration and photosynthesis. The increase in yields attributed to the fact that because of favourable nutritional environment in rhizosphere and higher absorption of nutrients by plant leading to the increased photosynthetic efficiency and production of assimilates (Singh 2006, Sareen and Sharma 2010).

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