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Impact of integrated nutrient management practices on yield, juice quality and nutrient uptake in sweet sorghum [*Sorghum biocolor* (L.) Moench] grown on vertisol

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A field experiment was conducted on Typic Haplustert at Research Farm, Marathwada Agricultural University, Parbhani (M.S.), India in rainy season of 2005-06. The soil was slightly alkaline (pH 8.2) and low in available N (231 kg ha^{-1}) and moderate in availability of P_2O_5 (15 kg ha^{-1}) and high in K_2O (472 kg ha^{-1}) having DTPA extractable Zn and Fe 0.79 and 4.29 mg kg^{-1}, respectively. The experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated thrice. The sweet sorghum variety used was HES-04. Inorganic fertilizers were applied as per recommended dose of fertilizer and micronutrients as per treatment through chemical fertilizers. However, Azotobacter and phosphorus solubilizing bacteria (PSB) were used for seed treatment before sowing. Vermicompost was applied @ 2.5 Mg ha^{-1} as per treatment at the time of sowing. Green stalk and grain yield ,chemical analysis , Juice extraction, total soluble solid (^{o}Brix), reducing and non-reducing sugars were determined at physiological maturity using standard procedures. The grain and green stalk yield of sorghum was significantly improved by application of inorganic fertilizers @ 50% RDF + vermicompost and micronutrients (Zn and Fe) along with seed treatment of biofertlizers. Similarly, addition of micronutrients also has contributed in increasing yield of crop. Quality of sweet sorghum in terms of juice extraction (%), ^{o}brix, reducing and non-reducing sugar was also found to increase with different integrated management practices particularly with application of 50% RDF + vermicompost + biofertilizer along with micronutrients. Comparatively higher nutrient concentration of NPK in grain and stover was found in 50% RDF along with micronutrients and Fe and Zn in stover was found higher in same treatment.

Key words : Sweet sorghum, Vermicompost, Biofertilizers, Micronutrients

INTRODUCTION

Sorghum is notable for its most efficient dry matter production among cereal crop plants. Sorghum has C_4 photosynthetic pathway and demonstrated an ability to produce dry matter at an average of 50g m^{-2} day^{-1}. This unique carbon assimilation capability in conjunction with its yet another ability to accumulate high levels of sugars in the stalk make this species a very promising for bioenergy production. Sweet sorghum is a special type of sorghum that accumulates sugars (sucrose, glucose and fructose) in stalk. Green juicy cane contributes 70-80 per cent of total biomass. It is used for grain and stem sweet juice can be used for ethanol, jaggery, syrup etc. production. Yield and soil properties were significantly improved by combined application of organic, inorganics and biofertilizers than the inorganics alone (Gawai and Pawar, 2005). The poor fertility status of the soil is one of major constraints for higher productivity. The importance and usefulness of organic manures in soil sustainability has been emphasized by Katyal (2000) and judicious use of inorganic fertilizer along with organic sources have been suggested. To sustain the crop yield and increase land productivity, combination of organic manures fertilizers not only increase the crop yield of sorghum but also improves physical and biological properties of soil (Bagade *et al.*, 2003). This is an attempt to study the impact of inorganic fertilizer, vermicompost, biofertilizer and soil test based micronutrients (Fe and Zn) on yield and nutrient uptake of sweet sorghum.

MATERIALS AND METHODS

A field experiment was conducted on Vertisol (Typic Haplustert) at Research Farm of Marathwada Agricultural University, Parbhani (M.S.) India, in rainy season of 2005-06. The soil was slightly alkaline (pH 8.2) and low in available N (231 kg ha^{-1}) and moderate in availability of P_2O_5 (15 kg ha^{-1}) and high in K_2O (472 kg ha^{-1}) having DTPA extractable Zn and Fe 0.79 and 4.29 mg kg^{-1}, respectively. The experiment was laid out in randomized block design with seven treatments replicated thrice. The sweet sorghum variety used was HES-04. Inorganic fertilizers were applied as per recommended dose of

fertilizer and micronutrients as per treatment through chemical fertilizers. However, Azotobacter and Phosphorus Solubilizing Bacteria (PSB) were used for seed treatment before sowing. Vermicompost was applied @ 2.5 Mg ha^{-1} as per treatment at the time of sowing. Other cultural operations and plant protection measures were followed as per recommendations. Green stalk and grain yield was recorded at physiological maturity. Before harvest, five plants were harvested and used for chemical analysis after oven drying. Nitrogen (N), phosphorus (P), potassium (K) and micronutrient concentrations in plant samples were determined as per standard procedures. Juice extraction, total soluble solid (°Brix), reducing and non-reducing sugars were determined at physiological maturity using standard procedure.

RESULTS AND DISCUSSION

Effect of integrated nutrient management practices on grain yield, green stalk yield, juice extraction (%), °brix, reducing and non-reducing sugars of sweet sorghum:

The grain and green stalk yield of sorghum was significantly improved by application of inorganic fertilizers @ 50% RDF + vermicompost and micronutrients (Zn and Fe) along with seed treatment of biofertlizers (Table 1). This increase might be a result of improvement in soil properties in terms of fertility, microbial abundance and other physical properties of soil which reflected on increasing biological yield as reported by Kachapur *et al*. (2001). Similarly, addition of micronutrients also has contributed in increasing yield of crop as reported by Naphade *et al*. (1990). Raghuwanshi *et al*. (1998) also reported higher sorghum production with biofertlizer inoculation to the seed. Quality of sweet sorghum in terms of juice extraction (%), °brix, reducing and non-reducing sugar was also found to increase with different integrated management practices particularly with application of 50% RDF + vermicompost + biofertilizer along with micronutrients showing desirable effect of organic biofertilizers and micronutrients. Bagade *et al*. (2003) found similar impact of chemical fertilizers + FYM and biofertilizers on juice extraction, °brix, reducing and non-reducing content of juice.

Content and uptake of nutrients:

Contrary to the comparable performance of RDF and 50% of RDF + vermicompost + biofertilizers along with micronutrients in respect to grain and dry matter the sweet sorghum removed significantly higher amount of N, P, K, Fe and Zn when compared with other treatments (Table 2). Comparatively higher nutrient concentration of NPK in grain and stover was found in 50% RDF along with micronutrients and Fe and Zn in stover was found higher in same treatment (Table 3). Jadhav *et al*. (2002) also reported that the application of organic manures in combination with NPK fertilizer has highest total N, P, K, S and Zn uptake in sorghum.

Conclusion:

Present research suggests that integrated use of inorganic fertilizers, organics, biofertilizers and micronutrients based on soil test values were better to increase grain yield, green stalk yield, juice extraction percentage, ° brix and non-reducing sugars, concentration of nutrients in stover and grain as well as their uptake by sweet sorghum crop was also more in integrated nutrient supply system as compared to inorganic fertilizer alone.

Table 1 : Grain, green stalk yield, juice extraction (%), ^{0}brix, reducing sugar and non-reducing sugar as influenced by nutrient management in sweet sorghum

Treat. Code	Treatments	Grain yield (t ha^{-1})	Green stalk yield (t ha^{-1})	Juice extraction (%)	Brix reading (°brix)	Reducing sugar (%)	Non-reducing sugar (%)
T_1	RDF[1]	10.12	238.9	31	14	2.6	12.48
T_2	50% RDF + Vermicompost[2]	10.33	240.2	32	16	2.9	13.12
T_3	50% RDF + Micronutrients[3]	9.74	235.1	29	14	2.8	12.97
T_4	50% RDF + Biofertilizers[4]	9.68	226.4	31	15	2.9	12.76
T_5	T_2 + Micronutrients	11.58	248.6	33	16	3.1	13.54
T_6	T_2 + Biofertilizers	10.68	242.5	34	15	2.9	13.32
T_7	T_5 + Biofertilizers	12.28	253.0	35	17	3.0	13.61
	S.E. ±	16.61	5.3	0.89	0.47	0.11	0.10
	C.D. (P=0.05)	51.12	16.5	2.74	1.47	NS	0.33

1- Recommended dose of fertilizer (80:60:40 kg ha^{-1} as N, P_2O_5 and K_2O, respectively), 2-Vermicompost @ 2.5 Mg ha^{-1}., 3-Micronutrient $FeSO_4$ and $ZnSO_4$ @ 25 and 20 kg ha^{-1}, respectively, 4- Biofertilizers (*Azotobacter* + PSB).

Table 2 : Concentration of N,P,K, Zn, Fe by grain and stover of sweet sorghum as influenced by nutrient management

Treat. Code	Treatments	Nutrient concentration									
		N (%)		P (%)		K (%)		Fe (mg kg^{-1})		Zn (mg kg^{-1})	
		Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T_1	RDF[1]	1.58	0.50	0.246	0.122	1.43	0.68	1.43	33.20	32.44	21.63
T_2	50% RDF + Vermicompost[2]	1.59	0.49	0.244	0.113	1.52	0.70	1.52	36.27	33.99	22.72
T_3	50% RDF + Micronutrients[3]	1.52	0.47	0.235	0.096	1.40	0.65	1.40	50.46	37.64	29.70
T_4	50% RDF + Biofertilizers[4]	1.62	0.52	0.247	0.125	1.35	0.62	1.35	35.48	32.51	23.33
T_5	T_2 + Micronutrients	1.64	0.53	0.251	0.131	1.55	0.75	1.55	47.14	36.77	27.41
T_6	T_2 + Biofertilizers	1.66	0.57	0.256	0.138	1.45	0.71	1.45	38.08	34.73	24.03
T_7	T_5 + Biofertilizers	1.69	0.59	0.260	0.141	1.58	0.78	1.58	48.02	38.07	28.43
	S.E. $\pm$	0.029	0.014	0.004	0.004	0.037	0.023	0.037	1.94	0.70	1.06
	C.D. (P=0.05)	0.089	0.043	0.014	0.013	0.116	0.071	0.116	5.97	2.10	3.27

1- Recommended dose of fertilizer (80:60:40 kg ha^{-1} as N, P_2O_5 and K_2O, respectively), 2-Vermicompost @ 2.5 Mg ha^{-1}., 3-Micronutrient $FeSO_4$ and $ZnSO_4$ @ 25 and 20 kg ha^{-1}, respectively, 4- Biofertilizers (*Azotobacter* + PSB).

Table 3 : Total uptake of NPK, Zn, Fe in sweet sorghum as influenced by nutrient management

Treat. Code	Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	Fe uptake (g ha^{-1})	Zn uptake (g ha^{-1})
T_1	RDF[1]	41.78	8.77	49.55	235.28	144.43
T_2	50% RDF + Vermicompost[2]	41.93	8.40	52.15	262.24	153.34
T_3	50% RDF + Micronutrients[3]	38.43	7.04	46.31	345.48	185.44
T_4	50% RDF + Biofertilizers[4]	41.56	8.62	43.91	240.42	147.83
T_5	T_2 + Micronutrients	48.37	10.12	59.52	378.91	194.53
T_6	T_2 + Biofertilizers	48.02	10.06	53.22	286.27	164.93
T_7	T_5 + Biofertilizers	53.86	11.1	63.17	395.25	206.28
	S.E. $\pm$	0.71	0.33	1.53	11.81	5.39
	C.D. (P=0.005)	2.20	1.01	4.74	36.34	16.58

1- Recommended dose of fertilizer (80:60:40 kg ha^{-1} as N, P_2O_5 and K_2O, respectively), 2-Vermicompost @ 2.5 Mg ha^{-1}., 3-Micronutrient $FeSO_4$ and $ZnSO_4$ @ 25 and 20 kg ha^{-1}, respectively, 4- Biofertilizers (*Azotobacter* + PSB).

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