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Effect of Fertilizer Levels, Biocompost and Biofertilizer on Content and Uptake of Nutrients of Fodder Sorghum (*Sorghum bicolor* (L.) Moench)

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A field experiment was conducted at College Farm, Navsari Agricultural University, Navsari (Gujarat) during rabi season of the year 2017-18 to study the "Effect of fertilizer levels, biocompost and biofertilizer effect on yield and yield attributes of fodder sorghum. Twelve treatment combinations consisting of three levels of fertilizer, two levels of biocompost and two levels of biofertilizer were tried in factorial randomized block design with three replications. The result showed that among different treatment combinations, application of 100% RDF with biocompost and biofertilizer significantly registered maximum content and uptake of macro (N, P_2O_5 and K_2O) and micronutrients (Fe, Mn, Zn and Cu). Among the different interaction, content of N and P_2O_5 found significant in biocompost and biofertilizer interaction. While, uptake of N, P_2O_5 and micronutrients (Fe, Mn, Zn and Cu) found significant in interaction of inorganic fertilizer with biofertilizer.

Introduction

Among the forage crops, sorghum (*Sorghum bicolour* (L.) Moench) is very popular in semi-arid zones particularly more in drought-prone regions of the world (Wenzel and Van Rooyen, 2001) due to its short duration, fast growing nature, high productivity and wider adaptability to varied agro-climatic conditions. Sorghum is highly nutrient exhaustive crop, therefore, to achieve sustainable higher productivity maintenance of native soil fertility and health is necessary. The balanced and conjugated use of inorganic fertilizer, biocompost and biofertilizer in order to maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop productivity (Rakshit *et al.*, 2008). Independent use of neither the chemical fertilizer nor an organic source can sustain the fertility of soil and productivity of crop in high input production system, whereas integrated nutrient management maintains soil and plant health and increase fertilizer use efficiency, content and uptake of macro and micro nutrients and ensures high crop production. This may cause a significant reduction in use of fertilizers. The inorganic fertilizer could supply only one, two or three nutrients but integrated use of inorganic fertilizers, biocompost and biofertilizer would provide macro and micronutrient to plant, soil and resist occurrence of multiple deficiencies.

In presence of organic manures, chemical fertilizers play better role with slow release of nutrients after decomposition. Organic manures have favorable influence on soil physio-chemical and biological properties which enhance crop growth and yield as well as content and uptake of nutrients (Ghuman and Sur, 2006). Use of organic manure and biofertilizers can have a greater importance in increasing availability of nutrients, fertilizer use efficiency and microbial biomass. Among several bio-agents, *Azospirillum* alone and in combination with PSB increases the yield of sorghum (Patidar and Mali, 2004). Therefore, introduction of efficient strain of "*Azospirillium* and PSB" may be helpful in boosting up production and consequently more nitrogen fixation and content and uptake of macro and micro nutrients.

Organic manure and biofertilizers are less expensive, easily available and eco-friendly expected to improve soil fertility, crop yield and content and uptake of nutrients. The introduction of efficient strains of biofertilizers in soils may help in boosting up production through increased microbial population and consequently fixation of more atmospheric nitrogen and more solubilization of insoluble phosphorus from the soil. Hence present study was undertaken to know the effect of inorganic fertilizer levels, biocompost and biofertilizer effect on content and uptake of macro and micronutrients of fodder sorghum crop.

Materials and Methods

A field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari during the year 2017-18. The soil of the experimental field was clayey in texture and showed low, medium and high rating for available nitrogen (255.58 kg ha^{-1}), phosphorus (30.96 kg ha^{-1}) and potassium (592.82 kg ha^{-1}), respectively. The soil was found slightly alkaline (pH 7.85) with normal electric conductivity (0.45 dsm^{-1}). The biocompost analysis found pH (7.41), EC (1.51 dS m^{-1}), N (1.02 %), P_2O_5 (1.09 %), K_2O (0.61 %), Fe (17.91 mg kg^{-1}), Mn (1.81 mg kg^{-1}), Zn (0.83 mg kg^{-1}) and Cu (1.72 mg kg^{-1}) content (Table 1).

The treatment combination consisted of integrated nutrient management *viz*., 100% RDF (80:40:0 kg NPK/ha) without biocompost and biofertilizer (T_1), 100 % RDF + without biocompost + with biofertilizer (T_2), 100 % RDF + with biocompost + without biofertilizer (T_3), 100 % RDF + with biocompost + with biofertilizer (T_4), 75 % RDF (60:30:0 kg NPK/ha) without biocompost and biofertilizer (T_5), 75 % RDF + without biocompost + with biofertilizer (T_6), 75 % RDF + with biocompost + without biofertilizer (T_7), 75 % RDF + with biocompost + with biofertilizer (T_8), 50 % RDF (40:20:0 kg NPK/ha) without biocompost and biofertilizer (T_9), 50 % RDF + without biocompost + with biofertilizer (T_{10}), 50 % RDF + with biocompost + without biofertilizer (T_{11}), 50 % RDF + with biocompost + with biofertilizer (T_{12}) to fodder sorghum in *rabi* season. The treatments were evaluated in randomized block design (factorial) with three replications.

Fodder sorghum cv. CSV-21F was sown with spacing of 30 cm in the second week of November and harvested in fourth week of January during the year 2017-18. Biocompost @ 5 t ha^{-1} was applied as per treatment before sowing and mixed well in soil. Biofertilizers i.e. seed treatment of *Azospirillum*+ PSB containing 1 x 10^8cfu ml^{-1}@ 10 ml kg^{-1} seed each and 2 L ha^{-1} each as soil application at the time of sowing.

To determine the content and uptake of macro and micronutrients, representative green fodder samples were drawn from each plot at flowering stage. The samples were shade dried for three days, subsequently oven dried for 24 hours at 60˚C then the samples were powdered by Willey grinder for further estimation. Dry plants were ground and composite sample was used for the determination of N, P, K, Fe, Mn, Zn and Cu content in the plants using standard procedures (Table 2).

The uptakes of N, P and K, Fe, Zn by plants were calculated using the following formula:

$$\textbf{Uptake of macronutrient (kg ha}^{-1}\textbf{)} = \frac{\textbf{Nutrient content (\%)} \times \textbf{Yield (kg ha}^{-1}\textbf{)}}{\textbf{100}}$$

$$\textbf{Uptake of micronutrient (g ha}^{-1}\textbf{)} = \frac{\textbf{Nutrient content (mg kg}^{-1}\textbf{)} \times \textbf{Yield (kgha}^{-1}\textbf{)}}{\textbf{1000}}$$

Results and Discussion

Nutrient content

Data furnished in (Table 2) indicated that the application of 100% RDF with biocompost and biofertilizer found maximum significant for content of N, P_2O_5 content in plants. Among different interactions, biocompost and biofertilizer interaction found significant for N and P_2O_5 content of fodder sorghum (Table 3).

The N content of the plant showed significant increase with the increasing levels of N, biocompost and biofertilizer, *Azospirillium* because N of these treatments increases the vegetative growth which leads to absorption of more N from soil and accumulation of N into plant. Similar results were revealed by other researchers (Singh and Kang, 2005; Kumar *et al.*, 2010 and Patel *et al.*, 2018). Increasing content of P_2O_5 in plant might be resulted due to release of growth promoting substances by *Azospirillum* + PSB with application of biocompost, increase in vegetative growth by N and healthy root development by P_2O_5. The similar results were founded by other researchers (Shekara *et al.*, 2009; Duhan, 2013 and jat *et al*, 2013). While, K_2O content was found non-significant.

In the case of micronutrient content, the same treatment found significantly higher for micro nutrient content but micronutrient contents found non-significant in case of different interactions (Table 2). Higher content of these micro nutrients in plants might be due to the better and healthy growth of the crop by higher application of N as well as biofertilizer which facilitates nutrient absorption from the soil. Micronutrients status of soil in organically treated plots might be due to release of chelating agents from organic matter decomposition which might have prevented micronutrients from precipitation, oxidation and leaching. The similar results were reported by Bhoya *et al.* (2013) and Singh and Sharma (2015).

Table.1 Methods used for the determination of nutrients of plant samples

Nutrient	Method	Reference
Nitrogen (%)	Modified Kjeldahl's method	Jackson (1973)
Phosphorus (%)	VanadomolybdoPhosphoric acid yellow colour method	Jackson (1973)
Potassium (%)	Flame photometer method	Jackson (1973)
Micronutrients Fe, Mn, Zn, Cu(ppm)	Atomicabsorption spectrophotometer (AAS)	Lindsay and Norwell (1978)

Table.2 Effect of fertilizer levels, biocompost and biofertilizer on content of macro and micronutrients

Treatment	Macronutrient content (%)			Micronutrient content (mg kg^{-1})			
	N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
(A) Fertilizer levels							
A_1: 100 % RDF	1.32	0.96	2.01	754.52	24.05	11.18	9.36
A_2: 75 % RDF	1.28	0.86	2.00	748.41	23.00	10.49	8.69
A_3: 50 % RDF	1.20	0.70	1.95	730.34	20.85	8.90	7.10
S.Em. ±	0.01	0.01	0.02	2.28	0.13	0.08	0.07
C.D. at 5%	0.02	0.03	NS	6.68	0.37	0.25	0.22
(B) Biocompost (5 t ha^{-1})							
B_1: Without BC	1.26	0.82	1.98	741.52	22.20	9.82	8.01
B_2: With BC	1.27	0.86	2.00	747.33	23.07	10.55	8.75
S.Em. ±	0.005	0.01	0.02	1.86	0.10	0.07	0.06
C.D. at 5%	0.01	0.02	NS	5.46	0.31	0.20	0.18
(C) Biofertilizer (*Azospirillium* and PSB) (10 ml kg^{-1} seed + 2 l ha^{-1})							
C_1: Without BF	1.25	0.81	1.99	741.26	22.06	9.79	7.98
C_2: With BF	1.28	0.87	1.98	747.59	23.21	10.58	8.78
S.Em. ±	0.005	0.01	0.02	1.86	0.10	0.07	0.06
C.D. at 5%	0.01	0.02	NS	5.46	0.31	0.20	0.18
CV %	1.56	3.81	3.29	1.06	1.95	2.88	3.04
Significant interaction	B x C	B x C	-	-	-	-	-

Table.3 Interaction effect of biocompost and biofertilizer on N content (%) and P_2O_5 content (%) of fodder sorghum

Treatment interaction	N content (%)	P_2O_5 content (%)
B_1 x C_1	1.25	0.80
B_1 x C_2	1.26	0.84
B_2 x C_1	1.25	0.81
B_2 x C_2	1.29	0.91
S.Em. ±	0.01	0.01
C.D. at 5%	0.02	0.03

Table.4 Effect of fertilizer levels, biocompost and biofertilizer on uptake of macro and micronutrients

Treatment	Macronutrient uptake (kg ha^{-1})			Micronutrient uptake (g ha^{-1})			
	N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
(A) Fertilizer levels							
A_1: 100 % RDF	132.10	96.08	201.95	7578.01	241.69	112.36	94.12
A_2: 75 % RDF	115.75	78.62	181.30	6782.22	209.20	95.66	79.35
A_3: 50 % RDF	75.77	44.30	122.60	4588.39	131.21	55.93	44.63
S.Em. ±	3.00	1.92	4.84	164.22	5.21	2.41	1.98
C.D. at 5%	8.81	5.63	14.20	481.63	15.27	7.07	5.80
(B) Biocompost (5 t ha^{-1})							
B_1: Without BC	103.66	69.02	162.42	6080.54	183.75	81.87	67.07
B_2: With BC	112.09	76.98	174.81	6551.88	204.32	94.09	78.33
S.Em. ±	2.45	1.57	3.95	134.08	4.25	1.97	1.61
C.D. at 5%	7.19	4.59	11.59	393.25	12.47	5.77	4.74
(C) Biofertilizer (*Azospirillium* and PSB) (10 ml kg^{-1} seed + 2 l ha^{-1})							
C_1: Without BF	101.93	66.78	161.54	6011.69	180.40	80.54	65.92
C_2: With BF	113.82	79.23	175.69	6620.72	207.66	95.42	79.48
S.Em. ±	2.45	1.57	3.95	134.08	4.25	1.97	1.61
C.D. at 5%	7.19	4.59	11.59	393.25	12.47	5.77	4.74
CV %	9.64	9.10	9.95	9.01	9.30	9.49	9.42
Significant interaction	A x C	A x C	-	A x C	A x C	A x C	A x C

Table.5 Interaction effect of fertilizer levels and biofertilizer macro and micronutrient uptake of fodder sorghum

Treatment interaction	Macronutrient (kg ha^{-1})		Micronutrient (g ha^{-1})			
	N	P_2O_5	Fe	Mn	Zn	Cu
A_1 x C_1	128.79	91.91	7425.61	231.59	106.03	88.27
A_1 x C_2	135.42	100.25	7730.41	251.80	118.68	99.97
A_2 x C_1	102.62	66.07	6087.86	181.94	81.60	66.87
A_2 x C_2	128.88	91.17	7476.59	236.45	109.71	91.83
A_3 x C_1	74.37	42.35	4521.61	127.68	53.98	42.61
A_3 x C_2	77.17	46.26	4655.18	134.74	57.87	46.65
S.Em. ±	4.25	2.71	232.24	7.36	3.41	2.80
C.D. at 5%	12.45	7.96	681.13	21.60	10.00	8.20

Nutrient uptake

The application of 100% RDF with biocompost and biofertilizer found significantly maximum in case of macro nutrient (N, P_2O_5, K_2O) and micro nutrient (Fe, Mn, Zn and Cu) uptake (Table 4). Among the interactions, fertilizer levels and biofertilizer found significant for N, P_2O_5, Fe, Mn, Zn and Cu uptake (Table 5). The increased nitrogen uptake with nitrogen fertilization was due to the fact that, soil was unable to supply required quantities of nitrogen for optimum growth therefore application of nitrogen fertilizers made up this deficiency which was ultimately reflected in improvement of nitrogen status of the plant. The increased nitrogen uptake was also due to combined application of inorganic fertilizer, biocompost and biofertilizer could be attributed to the favourable effect of biocompost and biofertilizer on microbial activity and root proliferation in soil caused solubilisation effect on native nutrients, which ultimately results in increased nitrogen availability and its concentration in fodder sorghum, thus favouring its higher uptake. The similar results were found by other researchers (Jat *et al*., 2013; Somashekhar *et al*., 2014; Chaudhary *et al*., 2018 and Patel *et al*., 2018).

From one year experiment, it can be concluded that the application of 100% RDF with biocompost and biofrtilizer significantly increased macro and micro nutrient content and uptake over the rest of treatments.

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