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Effect of fertilizer levels, Biocompost and biofertilizer on Physioco chemical properties of soil

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Abstract
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 physico chemical properties of soil. 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 revealed that application of different treatments did not affect the pH, EC, available K_2O and micronutrients (Fe, Mn, Zn and Cu). While soil bulk density decreased, micro aggregate and organic carbon significantly improved after harvest of fodder sorghum. Available N of soil after harvest of fodder sorghum was improved significantly due to the integration of inorganic fertilizers with biocompost and biofertilizer. Available P_2O_5 content found non-significant but interaction of biocompost and biofertilizer found significant.

Keywords: Fertilizer levels, biocompost, *Azospirillium*, PSB and soil physico chemical properties

Introduction
Among the forage crops, sorghum (*Sorghum bicolor* (L.) Moench) is very popular in semi-arid zones particularly more in drought-prone regions of the world (Wenzel and Van Rooyen, 2001) [17] 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) [14]. 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 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 (Ghuman and Sur, 2006) [4]. 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) [13]. Therefore, introduction of efficient strain of "*Azospirillium* and PSB" may be helpful in boosting up production and consequently more nitrogen fixation.

Organic manure and biofertilizers are less expensive, easily available and eco-friendly expected to improve soil fertility, crop yield and quality. 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 solubilizati on of insoluble phosphorus from the soil. Hence present study was undertaken to know the effect of inorganic fertilizer levels, biocompost and biofertilizer effect on the physico chemical properties in the rhizosphere soil of fodder sorghum crop.

Material 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.

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 are 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 $tha^{-1}$was applied as per treatment before sowing and mixed well in soil. Biofertilizersi.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.

The soil samples were collected from each plot after harvesting of fodder sorghum at 0 - 15 cm depth and analysed using standard procedures. Statistically analysis was done using standard methodology of randomize block design as per the method described by Panse and Sukhatme (1967) [11].

Soil analysis methods

Table 1: Physico-chemical properties of experimental soil (0-15 cm depth)

S. No.	Particulars	Methods adopted	References
I	**Physical properties**		
1.	Bulk density (Mg m^{-3})	Clod method	(Black, 1965) [1]
2.	Micro aggregate (%)	Wet sieving	(Black, 1965) [1]
	0.5-1.0 mm		
	>1.0 mm		
II	**Chemical properties**		
1.	pH $_{1:2.5}$	pH meter	(Jackson, 1973) [6]
2.	EC $_{2.5}$ at 25º C (dS m^{-1})	EC meter	(Jackson, 1973) [6]
3.	Organic carbon (%)	Walkley and Black Method	(Jackson, 1973) [6]
4.	Available N (kg ha^{-1})	Alkaline $KMnO_4$ method	(Subbiah and Asija, 1956) [16]
5.	Available P_2O_5 (kg ha^{-1})	Olsen's method	(Olsen *et al*. 1954) [10]
6.	Available K_2O (kg ha^{-1})	Flame photometric method	(Jackson, 1973) [6]
7.	Available Fe, Mn, Zn, Cu (mg ka^{-1})	Extraction with DTPA and estimation with AAS	(Lindsay and Norwell, 1978) [9]

Result and Discussion

Soil physical properties

The data presented in Table 2 indicate that the increasing levels of fertilizer application, biocompost and biofertilizer did not show any significant effect on bulk density yet it decreased bulk densitywas might be due to increase inorganiccarbon content in the soil. The results are corroborated with the findings of Dadhich *et al*., (2011) [2].

The data regarding micro aggregate of soil are exhibited in Table 2. The results revealed the significantly highest micro aggregate percentage for 0.5-1.0 mm was registered under the treatment 100% RDF with bio compost and bio-fertilizer as 22.65, 22.09 and 22.22, respectively. The application of 100% RDF was at par with 75% RDF (22.33%) in case of micro aggregate% of soil. The micro aggregate% (>0.1 mm) of soil was significantly influenced by impose of various treatments. The highest micro aggregate% (>0.1 mm) was noted in soil (57.06, 55.03 and 54.85%) by impose of 100% RDF with bio compost and with bio-fertilizer, respectively. The beneficial effect of bio compost and bio-fertilizer on aggregate stability was due to formation of clay-humus complexes (through binding of polyvalent cations adsorbed on clay surface) which would orient the chelating acidic functional group of humic material (carboxylic and phenols) towards the interior of aggregate, leaving aliphatic and aromatic hydrophobic components to face outward. This ultimately leaded to the formation of a water repellent coating with high surface tension, effectively reducing the water infiltration in to the aggregates and thereby improving stability of the aggregates.

Soil chemical properties

It is discernible from Table 2 that application of 100% RDF through inorganic fertilizer + with biocompost + with biofertilizer (*Azospirillum* + PSB) @ 10 $mlkg^{-1}$ seed each and 2 Lha^{-1} each as soil application was found the soil pH slight decreased to the initial value (Table 1) might be due to the formation of organic acids during the decomposition of organic manure and crop residues (Sharma *et al.*, 2013) and soil EC was found0.52 $dSm^{-1}$with application of 100% RDF and non-significant result found due to treatments of biocompost and biofertilizer. The EC of soil increased with increase the dose of fertilizer it may be due to accumulation of soluble salt of fertilizer.

The data indicated in (Table 2) that the organic carbon content (%) of soil was significantly affected by the different treatments of fertilizer levels, bio compost and bio-fertilizer. Significantly the highest organic carbon content of 0.47, 0.47 and 0.47% was observed under the treatment 100% RDF with biocompost and biofertilizer, respectively. The treatment 100% RDF was at par with treatment 75% RDF (0.46%) in case of organic carbon content (%) of soil after harvest of fodder sorghum. The organic carbon did not show much increase after application of bio compost and bio-fertilizer which may be due to oxidation of organic matter owing to prevailing high temperature under semi-arid climate. However, the conjoint use of chemical fertilizers with bio compost and bio-fertilizer was found beneficial for maintaining organic carbon content compared to the use of only chemical fertilizers. These results are also in accordance with the results reported by Singh and Dubey (2007) [15], Dixit *et al.* (2017) [3] and Patel *et al.* (2018) [12].

Table 2: Effect of fertilizer levels, biocompost and biofertilizer on physico-chemical properties of soil of fodder sorghum

Treatment	pH	EC	BD (Mg m^{-3})	Micro aggregate (%)		OC (%)
				0.5-1.0mm	>1.0 mm	
(A) Fertilizer levels						
A_1	7.67	0.52	1.58	22.65	57.06	0.47
A_2	7.72	0.51	1.59	22.33	54.81	0.46
A_3	7.77	0.46	1.60	20.63	49.21	0.43
S.Em. +	0.02	0.004	0.01	0.16	0.50	0.006
C.D. at 5%	NS	0.01	NS	0.47	1.47	0.02
(B) Biocompost (5 t ha^{-1})						
B_1	7.75	0.49	1.60	21.64	52.36	0.44
B_2	7.69	0.50	1.58	22.09	55.03	0.47
S.Em. +	0.02	0.003	0.01	0.13	0.41	0.005
C.D. at 5%	NS	NS	NS	0.39	1.20	0.01
(C) Biofertilizer (*Azospirillium* and PSB) (10 ml kg^{-1} seed + 2 L ha^{-1})						
C_1	7.75	0.49	1.60	21.52	52.53	0.44
C_2	7.69	0.50	1.58	22.22	54.85	0.47
S.Em. +	0.02	0.003	0.01	0.13	0.41	0.005
C.D. at 5%	NS	NS	NS	0.39	1.20	0.01
CV%	1.11	2.46	2.36	2.55	3.23	4.23
Initial value	7.85	0.45	1.60	20.29	49.17	0.41

A_1: 100% RDF (80:40:00 NPK kg ha^{-1}), A_2: 100% RDF (60:30:00 NPK kg ha^{-1}), A_3: 100% RDF (40:20:00 NPK kg ha^{-1}), B_1: without biocompost, B_2: biocompost (5 t ha^{-1}), C_1: without biofertilizer, C_2: biofertilizer (*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).

Available N, P_2O_5, K_2O

The data presented in (Table 3) revealed that available N and K_2O content of soil after harvest of fodder sorghum was not significantly changed due to different treatments of fertilizer levels, bio compost and bio-fertilizer. More or less similar available N and K_2O content in soil was reported due to the various levels of fertilizer, bio compost and bio-fertilizer. The available P_2O_5content in soil after harvest of crop was observed due to impose of different treatments showed non-significant effect on available P_2O_5 of the soil. The P_2O_5 content of ranging from 30.68 to 33.03 kg ha^{-1} under treatment of different level of fertilizer, bio compost and bio-fertilizer. The available P_2O_5 content of soil is found significant with interaction of biocompost and biofertilizer. (Table 4).

The higher amount of available N in soil is may be due to the favorable soil conditions under addition of organic matter might have helped in mineralization of soil N leading to build-up of higher available N. P-fixation in swell-shrink soils is due to the conjunctive use of organics with chemical fertilizers is beneficial for improving available P. The CO_2 released during decomposition of organic matter forms carbonic acid, solubilizing certain primary minerals. The appreciable build-up in available P may be due to the influence of organic matter in increasing the labile P in soil through complexing of cation like Ca^{2+} which are mainly responsible for fixation of P. The restoration of soil in available K under integrated use of fertilizer, biocompost and biofertilizer is due to the greater capacity of organic colloids to hold K ions on the exchange sites. (Singh and Dubey, 2007; Khan *et al.*, 2014; and Dixit *et al.*, 2017) [15, 7, 3].

Available micronutrients (Fe, Mn, Zn, Cu)

The data on available micronutrient content were represented in (Table 3). The results indicated non-significant difference in available Fe, Mn, Zn, Cu content in soil due to impose of various level of fertilizer, biocompost and biofertilizer.Use of bio compost and bio-fertilizer along with chemical fertilizers was found useful in maintaining available micronutrient status of soil. Addition of organic materials might have enhanced the microbial activity in the soil and consequently the release of complex organic substances like chelating agents could have prevented micronutrients from precipitation, fixation, oxidation and leaching and also addition of micronutrients through organic source. Application of bio compost significantly increased availability of micronutrients over rest of the treatments probably due to decomposition of organic matter and consequent release of micronutrients. These results are also in accordance with the results reported by Gupta *et al.* (2008) [5] and Kharche *et al.* (2013) [8].

Table 3: Effect of fertilizer levels, biocompost and biofertilizer on available macro and micronutrient content of soil of fodder sorghum

Treatment	Available macro nutrient (kg ha^{-1})			Available micro nutrient (mg kg^{-1})			
	N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
(A) Fertilizer levels							
A_1	278.94	33.03	602.73	10.85	26.54	0.54	2.23
A_2	274.60	32.11	599.36	10.81	26.60	0.54	2.20
A_3	253.42	30.68	595.82	10.70	26.25	0.52	2.14
S.Em. +	3.31	0.55	10.33	0.04	0.38	0.01	0.03
C.D. at 5%	9.70	1.60	NS	NS	NS	NS	NS
(B) Biocompost (5 t ha^{-1})							

B_1	264.84	31.60	598.23	10.75	26.11	0.53	2.17
B_2	273.14	32.28	600.38	10.82	26.82	0.54	2.22
S.Em. +	2.70	0.45	8.43	0.03	0.31	0.005	0.02
C.D. at 5%	7.92	NS	NS	NS	NS	NS	NS
(C) Biofertilizer (*Azospirillium* and PSB) (10 ml kg^{-1} seed + 2 L ha^{-1})							
C_1	264.82	31.64	297.53	10.76	26.24	0.53	2.18
C_2	273.15	32.24	601.08	10.81	26.69	0.54	2.20
S.Em. +	2.70	0.45	8.43	0.03	0.31	0.005	0.02
C.D. at 5%	7.92	NS	NS	NS	NS	NS	NS
CV%	4.26	5.93	5.97	1.35	4.94	3.64	4.16

A_1: 100% RDF (80:40:00 NPK kg ha^{-1}), A_2: 100% RDF (60:30:00 NPK kg ha^{-1}), A_3: 100% RDF (40:20:00 NPK kg ha^{-1}), B_1: without biocompost, B_2: biocompost (5 t ha^{-1}), C_1: without biofertilizer, C_2: biofertilizer (*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).

Table 4: Interaction effect of biocompost and biofertilizer on available P_2O_5 content of soil

Treatments	Available P_2O_5 content (kg ha^{-1})	
	C_1	**C_2**
B_1	31.98	31.22
B_2	31.30	33.26
S.Em. ±	0.63	
C.D. at 5%	1.85	

Conclusion

From the results of one-year experimentation, it can be concluded that integration of all the treatment in balance form improve the physico-chemical properties of soil.

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