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PP Chaudhary
Department of Soil Science and Agril. Chemistry, NMCA, NAU, Navsari, Gujarat, India

KH Patel
Department of Soil Science and Agril. Chemistry, College of Agriculture, NAU, Bharuch, Gujarat, India

AP Italia
Department of Soil Science and Agril. Chemistry, College of Agriculture, NAU, Bharuch, Gujarat, India

NH Garaniya
Department of Soil Science and Agril. Chemistry, College of Agriculture, NAU, Bharuch, Gujarat, India

DD Patel
Department of Agronomy, College of Agriculture, NAU, Bharuch, Gujarat, India

Correspondence
KH Patel
Department of Soil Science and Agril. Chemistry, College of Agriculture, NAU, Bharuch, Gujarat, India

Effect of sulphur and zinc with organics on yield and quality of fodder sorghum under south Gujarat condition

PP Chaudhary, KH Patel, AP Italia, NH Garaniya and DD Patel

Abstract
A field experiment was conducted during 2017 to study the effect of soil application of S and Zn in combination with organics on yield and quality of fodder sorghum. There were twelve treatments comprising of three organics treatments [Control(M_1), FYM @10t ha^{-1}(O_2) and bio-compost @ 5t ha^{-1}(O_3)] combined with four S-Zn nutrient treatments [control(M_1), 20kg S ha^{-1} (M_2), 5kg Zn ha^{-1}(M_3), and 20kg S ha^{-1} + 5kg Zn ha^{-1} (M_4)]. S and Zn were applied in the form of S granules and $ZnSO_4$ respectively. The experiment was laid out in factorial RBD with three replications. The recommended dose of N and P were applied uniformly to all the treatments. Green fodder yield (GFY) and dry fodder yield (DFY) of sorghum were significantly increased by the organics and S-Zn nutrient treatments. The per cent increased in GFY due to O_2 and O_3 over O_1 was 15.1 and 11.3 respectively. The treatments M_2 and M_4 increased the GFY by 15.4 and 17.5 per cent, respectively over M_1 (228.3 q ha^{-1}). Similar trend in DFY was noted by organics and S-Zn nutrient treatments. The interaction effect of O x M was found significant on GFY and DFY showed nutrient use efficiency of S and Zn was higher when they were applied along with FYM and bio compost. Quality parameters viz. crude protein content, crude fiber content and HCN content were studied. Application of organics O_2 and O_3, as well as S-Zn treatments favourably influenced quality parameters in comparison to their respective control. A synergistic interaction of O x M on crude protein content indicates improvement in quality of forage sorghum.

Keywords: Green fodder yield, crude protein content, crude fiber content, HCN content

1. Introduction
India is the largest livestock holding country in the world and its present livestock inventories exceed 450 million based on an annual growth rate of 1.3 per cent per annum from the last official livestock census in 2009. The low productivity of Indian livestock is mainly due to chronic shortage of feed and fodder coupled with poor quality. The dairy farming has developed as a subsidiary occupation in India and Gujarat as well. Availability of green forage to the animals is the key to success of dairy enterprise and it is difficult to maintain the health and milk production of livestock without supply of green fodder. Micronutrient deficiencies in Indian soils and crop have been increased since the adoption of high analysis NPK fertilizers generally free from micronutrients, intensive cultivation with high yielding varieties, limited use of organic matter and restricted recycling of crop residues. Sulphur is now recognized as the 4^{th} major plant nutrient along with nitrogen, phosphorus and potassium. Therefore, it is now very much a part of balanced fertilization because in sulphur deficient areas, applying NPK fertilizer only cannot ensure high yields unless sulphur is applied. Sulphur performs important functions in the plant. Zinc deficiency appears to be the most widespread and frequent micronutrient deficiency in crops and pasture of the crops lands were observed, resulting in severe losses in yield and nutritional quality. The application of micronutrients in combination with organic manure like FYM and Bio-compost may serve as a source of micronutrients and complexion with chelating agents. Therefore, integrated use of not only macro nutrients but also secondary and micronutrients with organic manures can lead to higher and sustainable crop production.

2. Materials and Methods
A field experiment on fodder sorghum crop (variety CSV - 21F) was conducted at College farm, N.M.C.A., Navsari Agricultural University, Navsari during *summer* 2017 to study the efficacy of soil application of S and Zn in combination with organics (FYM and Bio compost) on yield and quality parameters like crude protein content, crude fiber content and HCN content in fodder sorghum. There were three organic treatments [no organics (O_1), FYM @ 10 t ha^{-1} (O_2), bio compost @ 5 t ha^{-1} (O_3)] combined with four S-Zn nutrient supplementation

Treatments [control (M_1), 20 kg S ha^{-1} (M_2), 5 kg Zn ha^{-1} (M_3) and 20 kg S ha^{-1} + 5 kg Zn ha^{-1} (M_4)]. Thus there were twelve treatment combinations. S and Zn were applied @ 20 kg and 5 kg ha^{-1} in the form of S granules and zinc sulphate respectively. The experiment was laid out in factorial randomized block design with three replications. The soil was clayey in texture, low in available nitrogen (158 kg ha^{-1}), medium in phosphorus (30.70 kg ha^{-1}) and fairly rich in available potassium (368 kg ha^{-1}). The soil was slightly alkaline in reaction (pH 8.00) with normal electrical conductivity (0.39 dSm^{-1}).

3. Result and Discussion

3.1. Effect of Organics

GFY of the sorghum was significantly influenced by organic treatments (Table 1). GFY significantly increased with application of FYM @ 10 t ha^{-1} and bio compost @ 5 t ha^{-1}over control. The highest GFY (264.4 q ha^{-1}) was recorded by O_2. The GFY recorded by O_2 and O_3 were at par. The percentage increase in GFY due to O_2 and O_3 over O_1 was 15.1 and 11.3 respectively. In the present investigation significant increase in crude protein content was observed due to organic treatments. Organic application generally improves physical, chemical and biological properties of soil and thereby increases productivity. Further application of organics helps in increasing availability of major and micro nutrient. The results of present study were similar to the earlier reports by Meena and Meena (2005) [6], Ahmad *et al.*, (2007) [1], Patel *et al.*, (2010) [8] and Badole *et al.*, (2011) [2].

The data presented in Table 1 revealed that DFY of sorghum found significantly influenced by organics. Significantly higher DFY was recorded under application of FYM @10 t ha^{-1} (O_2) (75.1 q ha^{-1}) over control (O_1) (65.1 q ha^{-1}) but was at par with application of Bio compost @ 5 t ha^{-1} (O_3). The results for DFY are similar to those on GFY. The reasoning and discussion given for GFY earlier hold true for DFY also.

The data presented in Table 1 showed that crude protein content was significantly influenced by organics treatments in fodder sorghum. Treatment O_2 recorded significantly higher crude protein content (7.97%) over that recorded by O_1 (control) but statistically at par with treatment O_3.

Perusal of the data in Table 1 revealed that the effect of organics on crude fiber content in fodder sorghum was found non-significant. However, maximum crude fiber content obtained under treatment O_1 (31.73%) while in case of treatment O_3 recorded lowest crude fiber content (31.41%) which showed improvement in quality over control.

An appraisal of data in Table 1 revealed that the effect of organics on HCN content in fodder sorghum was found non-significant. However, in case of organics, there was a decreasing trend observed in HCN content of fodder sorghum. Maximum HCN content obtained under treatment O_1 (81.05%) were as treatment O_3 recorded lowest HCN content (79.47%) which showed improvement in quality over control.

3.2. Effect of S-Zn nutrient supplementation

The effect of S-Zn nutrient supplementation on GFY was found significant. Treatment M_2 and M_4 produced significantly higher GFY (263.4 and 268.5 q ha^{-1} respectively) over M_1 control (228.3 q ha^{-1}). Treatment M_4 (combined application of S and Zn) gave the highest total GFY which was significantly higher over the GFY produced by treatment M_3 (*i.e.* that is their individual application alone) thus comparison of the effect of M_3 and M_4 showed synergistic effect in the present investigation. The experimental sites were deficient in available S, so supplementation of S-Zn resulted in crop response resulting in significant increasing GFY. Treatment M_4 (S + Zn) showed significant effect over that of M_3. These result could be explained by Liebig's low of minimum i.e. if two factors are limiting or nearly so, addition of one have little effect or less effect on growth, whereas provision of both together will have a much greater influence (Tisdale *et al.*, 2003) [10]. Further efficacy of M_4 (S + Zn) treatment could be attributed to higher S content since Zn was added as sulphates. The result could be attributed to significant increase in crude protein content due to S-Zn nutrient treatments. The result of present investigation are confirmed with the earlier reported by Dadhich and Gupta (2003) [3] and Verma *et al*., (2005) [11].

An appraisal of data in Table 1 indicated that effect of S-Zn nutrient supplementation on dry fodder yield was found significant. Treatment M4 (S+ Zn) recorded significantly higher DFY (76.3 q ha^{-1}) of sorghum over treatment M_1 (Control) (64.4 q ha^{-1}) and treatment M_3 (67.1 q ha^{-1}) but statistically remain at par with treatment M_2 (75.1 q ha^{-1}). The results for DFY are similar to those on GFY. The reasoning and discussion given for GFY earlier hold true for DFY also.

Perusal of data in Table 1 indicated that effect of S-Zn nutrient supplementation on crude protein content of fodder sorghum was found significant. Significantly highest crude protein content obtained by treatment M_4 (8.40%) over control M_1 treatment but statistically it remain at par with treatment M_2 (7.74%) and treatment M_3 (7.74%).

Decreasing trend was observed in case of S-Zn nutrient supplementation for crude fiber content in fodder sorghum. Maximum crude fiber content produced under treatment M_1 (31.71%) while lowest crude fiber content observed under treatment M_4 (31.50%) shows improvement in fodder quality. Thus the results suggest that application S and Zn help in imparting better quality to the fodder sorghum.

Similarly decreasing trend observed in case of S-Zn nutrient supplementation for HCN content in fodder sorghum. Maximum HCN content produced under treatment M_1 (80.70%) while lowest HCN content observed under treatment M_4 (79.25%), suggested that improvement in fodder quality due to S-Zn nutrient supplementation.

Table 1: Green fodder yield, Dry fodder yield, Crude protein, crude fiber and HCN content, as influenced by organics and S-Zn nutrient supplementation

Treatments	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})	Crude protein content (%)	Crude fiber content (%)	HCN content (%)
Organics (O)					
O_1	230.1	65.1	7.00	31.73	81.05
O_2	264.4	75.1	8.14	31.67	80.20
O_3	256.4	73.1	8.08	31.41	79.47
S.Em. ±	6.7	2.1	0.15	0.41	1.17
C.D. at 5%	19.7	6.3	0.46	NS	NS
S-Zn nutrient supplementation (M)					
M_1	228.3	64.4	7.09	31.71	80.70
M_2	263.4	75.1	7.74	31.64	80.60
M_3	241.3	67.1	7.74	31.56	80.42
M_4	268.5	76.3	8.40	31.50	79.25
S.Em. ±	7.7	2.5	0.18	0.47	1.35
C.D. at 5%	22.7	7.3	0.53	NS	NS
Interaction					
S.Em. ±	13.4	4.3	0.31	0.82	2.35
C.D. at 5%	39.4	12.6	0.92	NS	NS
C.V. %	9.3	10.5	7.02	4.51	5.08

3.3. Interaction effect of organics and S-Zn nutrient supplementation

The data presented in Table 2 showed that O_2M_4 recorded significantly higher GFY than that of O_2M_1 and O_2M_3. Treatment M_4 in combination with O_2 recorded 37.0 and 25.2 percent higher GFY than that recorded in combination with M_3 and M_1 respectively. In the present investigation, the effect of these nutrients significantly increased in the presence of organic FYM. These result revealed a distinct synergistic interaction between FYM and S and Zn nutrient supplementation.

In the present investigation significant interaction effect of O X M was observed in crude protein content and these could be contributed in significant interaction between OXM in GFY. Decomposition of FYM is known to supply numerous chelating agents that aid in maintaining the solubility of metallic micronutrients. Chelation can help in increasing the solubility in exchange and slow release of ions to the crop (Elgawhary *et al*., 1970) [5]. The concentration of these nutrients, particularly of S and Zn in solution and quantity transported to the root by mass flow and diffusion could have greatly increased through complexation of Zn with natural organic chelating compounds in the soil (Tisdale *et al*., 2003) [10]. Further, significant quantity of different organic acids could have been added by decomposition of organic matter (FYM) and as a result availability of these nutrients could have increased. Thus, increase in total GFY was obtained probably due to these reasons. Similar result were recorded by Meena (2003) [7], Rahman *et al.*, (2011), Dixit *et al.*, (2014) [4] and Badole *et al.*, (2011) [2].To sum up, a synergistic interaction effect of organics and S and Zn nutrient supplementation was evident suggesting need for combined application of organic, Zn and S as per the treatments to realize the maximum yield potential of fodder sorghum crop.

Data presented in Table 2 showed that O_2M_2 recorded significantly higher DFY than that of O_2M_1 and O_2M_3. Treatment M_2 in combination with O_2 recorded 36.5 and 29.62 percent higher DFY than that recorded in combination with M_1 and M_3 respectively. DFY recorded by O_2M_4 were at par with DFY recorded by O_2M_2, O_3M_4 and O_3M_2. The results of present study were in agreement with earlier finding by Meena (2003) [7] and Dixit *et al.*, (2014) [4]. In the present investigation, the effect of these nutrient significantly increased in the presence of FYM. These result revealed a distinct synergistic interaction between FYM and S and Zn nutrient supplementation.

Data presented in Table 2 revealed the interaction effect of organics with S-Zn nutrient supplementation was found significant for crude protein content of fodder sorghum. Significantly higher crude protein content obtained under treatment O_2M_4 (9.19%) over O_2M_1 (7.33%) and O_2M_3 (7.68%) which remain at par with crude protein content observed under treatment O_2M_2 (8.35%), O_3M_4 (8.87%) and O_3M_3 (8.63%). This result could be attributed by interaction effect of organics with nutrient supplementation. Similar results reported by Patel *et al.*, (2010) [8].

Table 2: O x M interaction effect on Green fodder yield, Dry fodder yield and Crude protein content of fodder sorghum

Treatments	Green fodder yield (q/ha)	Dry fodder yield (q/ha)	Crude protein content (%)
O_1M_1	229.1	65.3	6.85
O_1M_2	223.1	60.1	7.11
O_1M_3	227.1	66.5	6.91
O_1M_4	240.1	66.2	7.13
O_2M_1	219.1	63.1	7.33
O_2M_2	299.2	86.1	8.35
O_2M_3	240.1	66.1	7.68
O_2M_4	300.1	85.6	9.19
O_3M_1	238.1	65.2	7.09
O_3M_2	268.1	79.1	7.75
O_3M_3	258.1	69.1	8.63
O_3M_4	262.5	77.2	8.87
S.Em. ±	13.4	4.3	0.31
C.D. at 5%	39.4	12.6	0.92

4. Conclusion

Application of S @ 20 kg ha^{-1} and Zn @ 5 kg ha^{-1} along with FYM @ 10 t ha^{-1} or Bio compost @ 5 t ha^{-1} advisable to get higher yield of fodder sorghum with better quality under south Gujarat condition.

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