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Effect of fertilizer levels, biocompost and biofertilizer on growth and yield attributes of fodder sorghum (*Sorghum bicolor* (L.) Moench)

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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 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 green and dry fodder yield, plant height and stem girth. While, in interaction maximumplant height, green and dry fodder yield was recorded in 100% RDF with biofertilizer which was statistically at par with 75% RDF with biofertilizer.

Keywords: Yield, yield attributes, fertilizer levels, biocompost and biofertilizer

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) due to its short duration, fast growing nature, high productivity and wider adaptability to varied agro-climatic conditions. Sorghum (*Sorghum bicolor* (L.) Moench) locally known as 'juvar' or 'chari' is under cultivation since ancient times for grain, feed and fodder in tropical countries and it is the most important, widely adaptable and extensively grown as a fodder crop. It can withstand heat, drought and also tolerate water logging better than other forage crops. The yield potential of sorghum is much higher than other forage crops but the production is low (Singh *et al.,* 2016) [23]. 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) [20].
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) [8]. Among several bio-agents, *Azospirillum* alone and in combination with PSB increases the yield of sorghum (Patidar and Mali, 2004) [19]. 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 crop yield and yield attributes. 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. Hence present study was undertaken to know the effect of inorganic fertilizer levels, biocompost and biofertilizer effect on yield and yield attributes 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 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 $tha^{-1}$was applied as per treatment before sowing and mixed well in soil. Biofertilizers i.e. seed treatment of *Azospirillum* + PSB containing 1 x 10^8 cfu ml^{-1}@ 10 ml kg^{-1} seed each and 2 L ha^{-1} each as soil application at the time of sowing.

Five plants from each net plot area were selected randomly from respective treatments and tagged for recording periodical observations till harvest.Green and dry yield measured after harvesting of crop. Statistically analysis was done using standard methodology of randomize block design as per the method described by Panse and Sukhatme (1967).

Result and discussion

Growth and yield attributes

The table data showed that the statistical analysis on plant stand did not point out any significant differences among different treatments and the combined application of fertilizer levels, biocompost and biofertilizer. The germination of seeds depends on the quality and the viability of seeds, soil moisture and prevailing temperature at the time of seeding, which was observed to be normal. Thus, uniform plant population maintained in all of the plots did not cause significant variation under different treatments. The similar result was reported by Mistry (2013) [15]. Application of 100% RDF with biocompost and biofertilizer revealed significantly higher plant height and stem girth (Table 1). Among different interactions, interaction of fertilizer levels and biofertilizer found significant in case of plant height except stem girth. which was statistically at par with 75% RDF and biofertilizer (Table 2). It is very well theorized that nitrogen application boosts plant growth, being one of the most important nutrients with its role in plant metabolism and development. The increase in the plant height due to nitrogen fertilizer may be caused by increase in number of nodes or inter nodes elongation or both. The taller plants in higher nitrogen applied treatments either alone or in combination with biofertilizer might be due to the responsive nature of the sorghum crop, which normally require higher doses of nitrogen. Thus, it is said that N is responsible for the vegetative growth of fodder sorghum plants. The changes in growth of fodder sorghum due to N were also recorded by the different researchers. Similar results were also reported by Trivedi (2010) and Bhatt (2012) [3] and Afzal *et al.* (2012) [1] and Chaudhry *et al.* (2018).

Plants are profoundly affected by phosphorus deficiency because P is an indispensable constituent of nucleic acids and membrane phospholipids. Moreover, P plays a pivotal role in energy transfer, as a regulator of enzyme activity and signal transduction. So, it can be said that application of P found significantly beneficial for the growth of fodder sorghum crop. It also promotes root growth which leads to the better absorption of nutrients from soil which might be a reason for better growth of the crop. The similar result was reported by Abida *et al*. (2007).

The improvement in morphological as well as photosynthetic parameter like stem girth might have resulted in better interception and utilization of radiant energy leading towards higher photosynthesis and finally more accumulation of dry matter of individual plants due to application of inorganic fertilizer with biocompost and biofertilizer. The results of present investigation are in close conformity with findings of several researchers (Singh 2007; Trivedi, 2010 and Singh *et al*., 2016) [24, 23]. The interaction of different treatments found non-significant in case of stem girth during all the period of crop.

Green and dry fodder yield

The application of 100% RDF with biocompost and with biofertilizer resulted in significantly higher green and dry fodder yield of fodder sorghum over rest of the treatments. (Table 1). The treatments 100% RDF with biocompost and with biofertilizer recorded 59.68, 7.04 and 9.13 per cent higher yield of green fodder while, 59.80, 7.00 and 9.17 per cent higher yield of dry fodder than 50% RDF without biocompost and biofertilizer treatments. Integration of 100% RDF and biofertilizer treatments observed 63.92 and 64.14 per cent higher yield of green and dry fodder over the interactions of 50% RDF without biofertilizer, respectively, but it was statistically at par with 75% RDF with biofertilizer (Table 2).

The possible reason for higher green fodder yield might be due to the fact that nitrogen is an integral part of chlorophyll and also an essential component of amino acids and related proteins which are critical not only as building blocks for plant tissue but also in cell nuclei and protoplasm and accelerating the process of cell division and elongation which in terms give luxuriant vegetative growth for higher productivity. This element encourages above ground vegetative growth and this favorable impact giving taller plants, a greater number of leaves higher total chlorophyll content, more plant stand, plant height and stem girth might have reflected in terms of higher fodder yields. The similar result was revealed by other researchers (Ahmad and Mahmood 2007; Trivedi 2010; Bhatt *et al.*, 2012 and Sardrood *et al*., 2013) [3, 2].

Biocompost might have played a key role in enhancing the native as well as added fertilizers when it was combined with application of chemical fertilizers to fodder sorghum, there by created the favorable environment in rhizosphere for better expression of the physiological growth parameter like better plant stand, plant height, stem girth and increased dry matter production which ultimately reflected in terms of higher green fodder yield. The similar results were reported by other several researchers (Kumar *et al.*, 2004; Yadav *et al*., 2007; Abusuwar and Zilal, 2010 and Jat *et al*., 2013) [13]. It is also interesting to know that *Azospirillium* application promoted root growth and thereby more nitrogen fixation in soil for luxuriant crop growth were also in the same view that inoculation with *Azospirillium* increased the yield significantly. More or less same results were also reported by (Patidar and Mali, 2004; Ponnusway *et al*. 2002 and Gautam *et al*., 2003) [19].

Table 1: Effect of fertilizer levels, biocompost and biofertilizer on growth and yield attributes of fodder sorghum (*Sorghum bicolor* (L.) Moench)

Treatment	Fodder yield (q ha^{-1})		Plant height (cm)	Stem girth (mm)
	Green	Dry		
A) Fertilizer levels				
A_1	279.01	100.45	249.92	31.53
A_2	251.62	90.58	224.79	30.15
A_3	174.73	62.86	155.27	26.11
S.Em. ±	6.58	2.36	6.06	0.51
C.D. at 5%	19.30	6.93	17.76	1.50
B) Biocompost (5 t ha^{-1})				
B_1	227.12	81.77	202.65	28.02
B_2	243.11	87.49	217.34	30.51
S.Em. ±	5.37	1.93	4.95	0.42
C.D. at 5%	15.75	5.66	14.50	1.22
C) Biofertilizer(*Azospirillium* and PSB) (10 ml kg^{-1} seed + 2 L ha^{-1})				
C_1	224.86	80.92	200.64	28.17
C_2	245.38	88.34	219.34	30.36
S.Em. ±	5.37	1.93	4.95	0.42
C.D. at 5%	15.75	5.66	14.50	1.22
CV%	9.69	9.68	9.99	6.04
Interaction	A x C	A x C	A x C	-

Table 2: Interaction effect of fertilizer levels and biofertilizer on growth and yield attributes of fodder sorghum (*Sorghum bicolor* (L.) Moench)

Treatment interaction	Plant height (cm)	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})
A_1 x C_1	245.47	274.12	98.68
A_1 x C_2	254.38	283.91	102.21
A_2 x C_1	202.43	227.27	81.82
A_2 x C_2	247.15	275.96	99.35
A_3 x C_1	154.03	173.20	62.27
A_3 x C_2	156.50	176.25	63.45
S.Em. ±	8.57	9.30	3.34
C.D. at 5%	25.12	27.29	9.81

Conclusion
From one year experiment, it can be concluded that 100% RDF with biocompost and biofertilizer increased growth and yield of fodder sorghum over the rest of treatments.

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