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Response of fodder sorghum (*Sorghum bicolor* L. Moench) varieties to biofertilizer and nitrogen levels

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Abstract
A field trial was conducted during *rabi* season of 2015-16 to 2017-18 at Instructional Farm, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari, to study the "Response of fodder sorghum (*Sorghum bicolor* L. Moench) varieties to biofertilizer and nitrogen levels". The experiment consists of two varieties, *viz*.,GFS-5 and CSV-21F, two biofertilizer levels *viz*., No bio-fertilizer and *Azospirillum* + PSB @ 10 ml each per kg seed and three nitrogen levels *viz*., 40 kg/ha, 60 kg/ha and 80 kg/ha. The experiment was laid out in a factorial randomized block design with three replications. The result showed that between the two varieties, GFS-5 recorded significantly higher green and dry fodder yields. Inoculation of seed with *Azospirillum* + PSB recorded significantly highest plant height, number of internodes per plant, number of leaves per plant, green fodder (282.40 q/ha) and dry fodder (112.01 q/ha) yields. Application of 80 kg N/ha recorded significantly highest plant height (184.62 cm), number of leaves per plant (8.58), number of internodes per plant(6.65), green fodder yield(292.24 q/ha) and dry fodder yield (117.33 q/ha) over rest of the level. Application of *Azospirillum* + PSB and 80 kg N /ha also rewarded significantly higher protein content and lower fibre content in the fodder sorghum. From the three years experiment, fodder sorghum Variety GFS-5, fertilize with 80 kg N/ha and seed treatment with *Azospirillum* + PSB (10 ml per kg seed each) recorded higher yield and net return.

Keywords: Sorghum, Fodder, Nitrogen, Biofertilizer, Economics.

Introduction
Live stock is very important part of our rural economy. India has the largest livestock population in the world, but productivity is low. The low productivity of Indian livestock is mainly due to chronic shortage of feed and fodder coupled with poor quality. At present, the country faces a net deficit of 61.1 per cent green fodder and 21.9 per cent dry fodder. This situation indicates green forage supply has to grow at 3.2 per cent to meet the deficit" (Kumar and Faruqui, 2010) [6]. In Gujarat, total animal population is 18.44 milloin heads and the area under forage crops is only 0.8 mh i.e. 6.4% of the total cultivated area. The total annual production of forage is only 20 mt against requirement of 49.2 mt. Thus, the state is not only had a shortage of fodder, but its quality is also poor. As a result, livestock suffers from malnutrition resulting in a decline in production even though they have the capacity. Therefore, to increase milk production in the country, we have to increase the fodder production by increasing the area and productivity of the crop.
Fodder sorghum is an exhaustive nutrient crop which needs judiciously proper application of fertilizer for enhancing the productivity and quality of fodder. Judicious use of fertilizer is a crucialagronomical management practice to increase single cut sorghum forage production. Nitrogen is the most important plant nutrients required for crop production and is required in large quantities (Balasubramanian *et al*., 2010, Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [1, 11, 12, 13, 14, 15, 16, 17]. It is the main constituent of amino acid, which is directly related to crude protein yield. Protein supply is one of the major factors that influence the productivity of animals which is useful to build assets and increase livestock productivity in term of yield and quality both. Biofertilizers play a vital role in the increasing

availability of nitrogen and phosphorus. They increase the biological fixation of atmospheric nitrogen and enhance the accessibility to crop. *Azospirillum* inoculation increases the green and dry fodder yield varied from 7.8 to 11.3 per cent (Kumar and Sharma, 2002) [7].

Materials and Methods

A field experiment was carried out at the Instructional Farm, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during *rabi* season of 2015-16 to 2017-18.The soil of experimental site was heavy black soil with pH 7.8, 0.33% organic carbon, 0.37dS/m, 219.0 kg/ha available N, 52.0 kg/ha P_2O5 and high K_2O of 305.0kg/ha. Twelve treatment combinations are comprising two varieties (V) viz. V_1,GFS-5 and V_2, CSV-21F, two biofertilizer levels (B) *viz*., B_1,No biofertilizer and B_2, *Azospirillum* + PSB @ 10 ml each per kg seed and three nitrogen levels (F) viz., F_1, 40 kg/ha, F_2, 60 kg/ha and F_3, 80 kg/ha. Recommended dose of P_2O_5 @ 40 kg/ha in the form of single superphosphate and FYM @ 5 tonne/ha was applied as basal at the time of sowing of fodder sorghum crop. The experiment was laid out in a factorial randomized block design with 3 replications.

The crop was harvested after 50 per cent flowering stage and recorded green fodder yield. Dry fodder yield was recorded after 15 days of sun drying. To determine the content and uptake of nutrient, a representative green fodder sample were drawn from each plot at harvest stage. The sample were dried for three days; subsequently, oven-dried for24 hours at 60 °C then sample were powdered by Willey grinder for further estimation. This grinded and a composite sample was used for the determination of N, P, crude protein and crude fibre content in the plant using standard procedure.

Result and Discussion

Growth parameter and yield

The significant difference was observed in the growth parameter and yields between the varieties. Fodder sorghum variety GFS-5 recorded significantly highest plant height (176.4 cm), number of leaves per plant (8.07), number of internodes per plant (6.42), green fodder yield (279.7 q/ha) and dry fodder yield (111.72 q/ha) then CSV-21 F (Table.1).

In case of biofertilizer, all the growth and yield parameter significantly influence by the biofertilizers (*Azospirillum* + PSB) inoculation. They recorded significantly highest plant height (175.7 cm), number of internodes per plant(8.29), number of leaves per plant (6.36), green fodder yield (282.40 q/ha) and dry fodder yield (112.01 q/ha) (Table.1). The magnitude of increase in green fodder and dry fodder yield of fodder sorghum was to the extent of 13.15 and 12.89 per cent with the dual inoculation of biofertilizers (*Azospirillum* + PSB) over no inoculation. Biofertilizers, the microbial inoculants which bring about fixation of atmospheric nitrogen either in free-living N_2 fixer in the rhizosphere (*Azospirillum*) and transform native unavailable phosphorus into plant utilizable (PSB) or improving plant growth, plant stands and vegetative growth of plant, are low cost eco friendly input for farmers. Biofertilizer has been identified as a good supplement to chemical fertilizer to increase soil fertility and crop production in sustainable farming. The use of bio-fertilizer results in the highest biomass and increased the nutrient uptake by plants (Singh *et al*., 2011) [20]

Nitrogen level increased from 40 kg/ha to 80 kg/ha were marked increased the plant height, number of leaves per plant, number of internodes per plant. Application of 80 kg N /ha revealed significantly highest plant height (184.62cm), number of leaves per plant (8.58), number of internodes per plant (6.65) (Table.1). The increase in plant height is responsible for the positive effect of nitrogen element on plant growth that leads to a progressive increase in number of internodes, internodal length and consequently plant height. The changes in the growth of fodder sorghum due to N was also recorded by the different researchers. Similar results were also reported by Chaudhry *et al*. (2018) and Chauhan *et al*., (2019) [3, 4]. Application of 80 kg N /ha recorded significantly higher green fodder (292.24 q/ha) and dry fodder yield (117.33 q/ha) over the rest of the treatment. The treatment 80 kg nitrogen /ha recorded (19.27 and 9.90) per cent and (21.15 and 10.94) per cent higher green fodder and dry fodder yield than 40 kg/ha, 60 kg/ha, respectively.

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 an increase in a number of nodes or internodes 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 generally requires higher doses of nitrogen. Thus, it is said that N is responsible for the vegetative growth of fodder sorghum plants. The changes in the growth of fodder sorghum due to N was also recorded by the different researchers. Similar results were also reported by Chaudhry *et al*., (2018).

Table 1: Effect bio fertilizer and nitrogen levels on green fodder and dry fodder yields of sorghum varieties

Treatment	Plant height(cm)	No. of leaves per plant	No. of internodes per plant	Green fodder (q/ha)	Dry fodder (q/ha)
Variety					
V1: GFS -5	176.4	8.07	6.42	279.70	111.72
V2: CSV-21F	164.0	7.89	5.83	247.94	97.86
S. Em. ±	2.18	0.23	0.08	5.17	2.36
CD (P=0.05)	6.17	0.64	0.24	14.62	6.67
Biofertilizer					
B0:No bio fertilizer	164.7	7.69	5.90	245.24	97.57
B1: *Azospirillum*+ PSB @ 10 ml each per kg seed	175.7	8.29	6.36	282.40	112.01
S. Em. ±	2.18	0.13	0.08	5.17	2.36
CD (P=0.05)	6.17	0.37	0.23	14.62	6.67
Nitrogen levels					
F1: 40 kg/ha	155.54	7.54	5.71	235.91	92.52
F2: 60 kg/ha	170.44	7.83	6.01	263.30	104.49

F3: 80 kg/ha	184.62	8.58	6.65	292.24	117.33
S. Em. ±	2.76	0.15	0.10	6.35	2.89
CD (P=0.05)	7.79	0.44	0.29	17.93	8.18
Interactions					
CD (P=0.05)	NS	NS	NS	NS	NS
CV%	9.57	11.98	10.20	14.50	16.64

Quality Parameter

It was found that progressive increase in crude protein and decrease in crude fibre content with the increase in nitrogen level. Significantly highest CP content (6.31%) and lowest fibre content (31.43 %) were recorded with application of 80 kg N/ha. In case of biofertilizer significantly highest CP content (6.12%) and lowest fibre content (32.10%) were recorded with inoculation of seed with biofertilizer over uninoculated seed (Table.2). Similar result was found by Kushwaha *et al*., 2018 [8].

Nutrient content and uptake

The N content of the plant observed significantly increase with increase the level of nitrogen and inoculation of seed with biofertilizer because nitrogen increase the vegetative growth which draw to absorption of higher nitrogen from the soil and accumulation of N into the plant. The result revealed that significantly highest N content was found with application of nitrogen 80kg/ha while in case of biofertilizer significantly highest N content was found with inoculation of seed with biofertilizer (*Azospirillum* + PSB). Similar result were found by other scientist (Patel *et al.*, 2018) [8]. Similar trend were observed in P_2O_5 content. Increase the content of P_2O_5 in plant might be resulted due to PSB transform native unavailable phosphorus into plant utilizable or plant growth, plant stands and vegetative growth of plant. Similar results were found by other scientist. In case of nutrient uptake, Application of 80 kg N/ha recorded significantly highest NPK (121.5, 12.56 and 64.60 kg/ha) uptake and inoculation of seed with biofertilizer recorded significantly highest NPK (114.2, 12.10 and 59.68 kg/ha) uptake (Table.2). The uptake of N and P increased with a progressive increase N level and application of biofertilizer to the crops. The microorganisms play an essential role in increasing the availability of N and P. because of higher availability of these nutrients resulting in higher biomass yield. The impact of higher uptake of plant nutrients under these treatments has been reflected in the growth and yield performance of the crop (Faujdar, 2011) [5].

Table 2: Effect bio fertilizer and nitrogen levels on nutrient content, uptake and quality of fodder sorghum varieties

Treatment	N Content (%)	P Content (%)	N Uptake (kg/ha)	P Uptake (kg/ha)	CP (%)	CF (%)
Variety						
V1: GFS -5	0.98	0.102	108.9	11.52	5.83	32.75
V2: CSV-21F	0.99	0.104	98.5	10.29	6.06	33.10
S. Em. ±	0.007	0.001	2.51	0.27	0.05	0.22
CD (P=0.05)	NS	NS	7.09	0.77	NS	NS
Biofertilizer						
B0:No bio fertilizer	0.95	0.098	93.3	9.72	5.76	33.76
B1: *Azospirillum*+ PSB @ 10 ml each per kg seed	1.02	0.107	114.2	12.10	6.12	32.10
S. Em. ±	0.007	0.001	2.51	0.28	0.05	0.23
CD (P=0.05)	0.002	0.027	7.09	0.80	0.13	0.64
Nitrogen levels						
F1: 40 kg/ha	0.91	0.097	85.8	9.12	5.55	34.42
F2: 60 kg/ha	0.99	0.105	103.8	11.04	5.98	32.93
F3: 80 kg/ha	1.04	0.106	121.5	12.56	6.31	31.43
S. Em. ±	0.009	0.0012	3.10	0.33	0.06	0.28
CD (P=0.05)	0.003	0.033	8.76	0.95	0.16	0.78
Interactions						
CD (P=0.05)	NS	NS	NS	NS	NS	NS
CV	5.57	6.94	17.94	18.65	5.82	5.15

Economics

The maximum gross monetary returns (Rs 83911/ha), net monetary returns (Rs 60500 /ha) and B:C ratio (3.58) recorded by variety GFS-5.Application of biofertilizer *Azospirillum*+ PSB recorded higher gross monetary returns (Rs 84722/ha), net monetary returns (Rs 61260/ha) and B:C ratio (3.61) over no biofertilizer (Table. 3). Biofertilizer enhances the N and P uptake resulted increased the productivity and quality fodder. From higher productivity, it may be obtained the net return and B:C ratio for the cultivation of forage crops. Application of 80 kg N/ha was recorded maximum gross monetary returns (Rs 87673/ha) and net monetary returns (Rs 64005/ha) over lower levels while the higher B:C ratio was recorded with 60 kg N/ha (3.70) over 80 kg N/ha (Table.3). Similar result was also found by Kushwaha *et al*., 2018 [8] and Singh and Sumeriya 2012. Application of 80 kg N/ha was found to be the optimum dose to increase net return (Rathod *et al.* 2002) [10].

Table 3: Effect bio fertilizer and nitrogen levels on economic of fodder sorghum varieties

Treatment	Green Fodder yield (q/ha)	Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	Benefit :Cost Ratio
Variety					
V1: GFS -5	280	23412	83911	60500	3.58
V2: CSV-21F	248	23412	74382	50971	3.18
Biofertilizer					
B0:No bio fertilizer	245	23362	73572	50211	3.15
B1: *Azospirillum*+ PSB @ 10 ml each per kg seed	282	23462	84722	61260	3.61
Nitrogen levels					
F1: 40 kg/ha	236	23155	70775	47620	3.06
F2: 60 kg/ha	263	23412	78993	55581	3.37
F3: 80 kg/ha	292	23668	87673	64005	3.70

Conclusion

From the three years experiment, fodder sorghum Variety GFS-5, fertilize with 80 kg N/ha and seed treatment with *Azospirillum* + PSB (10 ml per kg seed each) recorded higher yield and net return.

References

1. Balasubramanian V, Raghauram N, Abrol YP, Sachdev MS, Pathak H, Singh B. Reactive nitrogen: Good, Bad and Ugly. Comprehensive Status Report, SCON-ING, New Delhi, 2010, 52.
2. Chaudhary JD, Pavaya RP, Malav JK, Dipika G, Chaudhary N, Kuniya NK. Effect of nitrogen and potassium on yield, nutrient content and uptake by forage sorghum [Sorghum bicolor (L.) Moench] on loamy sand. International Journal of Chemical Studies. 2018; 6(2):761-765.
3. Chauhan A, Tripathi S, Singh N, Govind, Satdev, Singh N. Effect of fertilizer levels, biocompost and biofertilizer on content and uptake of fodder sorghum (*Sorghum bicolor* (L.) Moench). International journal of current microbiology and applied sciences. 2019; 8(10):1130-1136.
4. Chauhan AC, Tripathi S, Singh N, Saini L. Effect of fertilizer levels, biocompost and biofertilizer on growth and yield attributes of fodder sorghum (*Sorghum bicolor* (L.) Moench). Journal of Pharmacognosy and Phytochemistry. 2019; 8(6):617-620.
5. Faujdar RS. Effect of FYM, biofertilizers and zinc on nutrient transformations, soil properties and yield of maize (*Zea mays* L.) and their residual effect on wheat (*Triticum aestivum* L.) on typic haplustept. Ph.D. Thesis, MPUAT, Udaipur, 2011.
6. Kumar S, Faruqui S. A. Forage production technologies for different agro-ecological regions. (March 2010), 1.
7. Kumar S, Sharma BL. Effect of nitrogen and *Azospirillum*noculation on yield and quality of fodder sorghum. *Forage Res.* 2002; 28(3):65-168.
8. Kushwaha M, Singh M, Pandey AK, Kar S. Role of nitrogen, phosphorus and bio-fertilizer in improving performance of fodder sorghum-A Review. Journal of Hill Agriculture. 2018; 9(1):22-29.
9. Patel KM, Patel DM, Gelot DG, Patel IM. Effect of integrated nutrient management on green forage yield, quality and nutrient uptake of fodder sorghum [*Sorghum bicolor* (L.) Moench]. International Journal of Conservation Science. 2018; 6(1):173-176
10. Rathod ND, Meghani MN, Dudhat MS. Response of forage sorghum (*Sorghum bicolor*) to different levels of nitrogen and phosphorus. Forage Research. 2002; 28(1):16-18.
11. Singh C, Tiwari S, Boudh S, Singh JS. Biochar application in management of paddy crop production and methane mitigation. In: Singh, J.S., Seneviratne, G. (Eds.), Agro-Environmental Sustainability: Managing Environmental Pollution, second ed. Springer, Switzerland, 2017a, 123-146.
12. Singh C, Tiwari S, Singh JS. Impact of Rice Husk Biochar on Nitrogen Mineralization and Methanotrophs Community Dynamics in Paddy Soil. International Journal of Pure and Applied Bioscience. 2017b; 5:428-435.
13. Singh C, Tiwari S, Singh JS.. Application of Biochar in Soil Fertility and Environmental Management: A review, Bulletin of Environment, Pharmacology and Life Sciences. 2017c; 6:07-14
14. Singh C, Tiwari S, Gupta VK, Singh JS. The effect of rice husk biochar on soil nutrient status, microbial biomass and paddy productivity of nutrient poor agriculture soils *Catena* 2018; 171:485-493.
15. Tiwari S, Singh C, Singh JS. Land use changes: a key ecological driver regulating methanotrophs abundance in upland soils. Energy, Ecology, and the Environment. 2018; 3:355-371.
16. Tiwari S, Singh C, Boudh S, Rai PK, Gupta VK, Singh JS. Land use change: A key ecological disturbance declines soil microbial biomass in dry tropical uplands. Journal of Environmental Management. 2019a; 242:1-10.
17. Tiwari S, Singh C, Singh JS. Wetlands: A Major Natural Source Responsible for Methane EmissionA. K. Upadhyay *et al*. (Eds.), Restoration of Wetland Ecosystem: A Trajectory towards a Sustainable Environment, 2019b, 59-74.
18. Kour D, Rana KL, Yadav N, Yadav AN, Rastegari AA, Singh C *et al*. Technologies for Biofuel Production: Current Development, Challenges, and Future Prospects A. A. Rastegari *et al*. (Eds.), Prospects of Renewable Bioprocessing in Future Energy Systems, Biofuel and Biorefinery Technologies. 2019a; 10:1-50.
19. Singh C, Tiwari S, Singh JS. Biochar: A Sustainable Tool in Soil 2 Pollutant Bioremediation R. N. Bharagava, G. Saxena (Eds.), Bioremediation of Industrial Waste for Environmental Safety. 2019b, 475-494.
20. Singh G, Singh S, Prasad K, Singh RK. Effect of manures and inorganic fertilizers on productivity of rice wheat cropping system in lowlands. Annals of Plant Soil Research. 2011; 13:92-97.