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Potentials of liquid biofertilizers in enhancing growth and yield of fodder sorghum

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Abstract
The present experiment entitled "Potentials of liquid biofertilizers in enhancing growth and yield of fodder sorghum" was done at wetland farm of S.V. Agricultural College, ANGRAU, Tirupati during *rabi*, 2022-23. Three replications were used in the randomised block design of the experiment. The results revealed that the treatment involving 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application) exhibited superior performance across all growth parameters such as plant height, leaf area index, leaf to stem ratio and dry matter production at 30 DAS and at harvest. Furthermore, compared to all other treatments, this one produced a significantly higher green and dry fodder yield.

Keywords: Liquid biofertilizers, green fodder yield, fodder sorghum, growth parameters

Introduction
The livestock population in India plays a crucial role in the agricultural sector, contributing significantly to the GDP. However, the livestock industry faces challenges due to the scarcity and low quality of fodder. On average, there is a 40 percent gap in the dry and green fodder supply; by 2025, this deficit might rise to 45 percent. To meet the high quality forage demand of India's large animal population, there is a need to increase the production and productivity of forage crops while maintaining soil health and environmental sustainability.

Crops used as cereal fodder contain a high concentration of digestible starch, water soluble carbohydrates, and fibre, making them a source of high energy for animals. As a fodder crop, Sorghum (*Sorghum bicolor* (L.) Moench) is a vital fodder crop in India, because this is the most significant, versatile, and widely cultivated and supplies 60 percent of India's livestock needs. Unlike other fodder crops, it can endure heat, drought and waterlogging better but its yield is relatively modest and requires proper nutrient management (Singh *et al*., 2016) [7].

Chemical fertilizers alone are not sustainable and the use of biofertilizers can be a practical solution to improve soil health and nutrient availability for higher crop productivity. The use of biofertilizers can potentially enhance agricultural productivity, improve soil health and offer a sustainable alternative to chemical fertilizers. Liquid biofertilizers, in particular, have shown promise due to their longer shelf life, better seed survival, and cost-effectiveness.

In this study, the impact of applying liquid biofertilizers containing beneficial microorganisms on fodder sorghum growth and yield was investigated.

Materials and Methods
The present investigation entitled "Potentials of liquid biofertilizers in enhancing growth and yield of fodder sorghum" was done at wetland farm of S.V. Agricultural College, ANGRAU, Tirupati during *rabi*, 2022-23. The soil was neutral in reaction (6.9 pH) low in available nitrogen (115 kg ha^{-1}) and medium in available phosphorus (29 kg ha^{-1}) and low in available potassium (156 kg ha^{-1}) status. Three replications of the experiment were done using a randomised block design. Treatments includes T_1: Absolute control, T_2: 100% RDF, T_3: 75% RDF + *Azospirillum* + PSB + KSB (Seed treatment@10 ml kg^{-1}), T_4: 75% RDF + *Azospirillum* + PSB + KSB (Soil application@1.25 l ha^{-1}), T_5: 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application), T_6: 50% RDF + *Azospirillum* + PSB + KSB (Seed treatment@10 ml kg^{-1}), T_7: 50% RDF + *Azospirillum* + PSB + KSB (Soil application@1.25 l ha^{-1}), T_8: 50% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application). The crop was shown at 30 × 10 cm spacing with a seed rate of 25 kg ha^{-1}. Recommended dose of fertilizer was 60 - 40 - 30 N, P_2O_5, K_2O kg ha^{-1}. Soil application of biofertilizers was done by mixing 1.25 l ha^{-1} of each bio inoculant in 500 kg of well decomposed FYM and applied as basal dose

(applied 24 hrs before sowing). Seed treatment of biofertilizers was done by mixing 10 ml of each bio inoculant with 1 kg of seed and dry for 10-15 minutes under shade before sowing. The data collected on various crop parameters were statistically evaluated using the randomised block design method recommended by Panse and Sukhatme (1985) [3].

Results and Discussion

Growth Parameters

All the growth parameters of fodder sorghum *viz.*, plant height, leaf area index, leaf to stem ratio and dry matter production significantly recorded higher values with the application of 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application) (T_5) but it was found to be on par with 100% RDF (T_2) both at 30 DAS and at harvest. The lowest values were recorded with absolute control (T_1) (Table 1). The nutrients that are made available through the administration of liquid biofertilizers through soil application and seed treatment, as well as the provision of inorganic fertilizers, speed up cell division and cell elongation and impact on metabolic processes in plant organs thus increasing the size and fresh weight of leaves which improves plant height, leaf area index, leaf to stem ratio and dry matter production of fodder sorghum. These findings are similar to Avinash Gupta and Mayuri Deshmukh (2022) [1], Rani *et al*. (2019) [6] and Patil *et al*. (2020) [5].

Days to 50% flowering

Application of 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application) (T_5) resulted less number of days to 50% flowering which was on par with 100% RDF (T_2). Significantly more days for 50% flowering of fodder sorghum was observed with absolute control (T_1) (Table 1). Because of the simultaneous use of liquid biofertilizers, fodder sorghum needs fewer days to reach 50% blooming. enhanced microbial activity in the rhizosphere, which led to the solubilization of bound forms of soil minerals and enhanced availability of nutrients in the soil for plant growth and development, was blamed for improved seedling germination, vigour, emergence, and productivity. Similar results were obtained by Rani *et al*. (2019) [9] and Hekmat *et al*. (2019) [2].

Green and dry fodder yield

Higher green and dry fodder yield of fodder sorghum was recorded with 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application) (T_5) which was on par with 100% RDF (T_2). Statistically lower green and dry fodder yields were noticed with absolute control (T_1) (Table 2). Because of the combined effect of increased growth stature and yield structure. Moreover, enhanced mineral and water uptake, root development, and vegetative growth together with the conversion of unavailable plant nutrients into available form by biofertilizers all contribute to higher nutrient uptake, which eventually increases green and dry fodder yield. These results are supported by findings of Yadahalli *et al*. (2022) [9], Patel *et al*. (2018) [4] and Verma *et al*. (2014) [8].

Table 1: Growth parameters and Days to 50% flowering of fodder sorghum as influenced by application of liquid biofertilizers at different levels of recommended dose of fertilizers

Treatments	Plant height (cm)		Leaf area index		Leaf: Stem ratio		Dry matter production (kg ha^{-1})		Days to 50% Flowering
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	
T_1: Absolute control	46.2	124	0.72	2.63	1.01	0.19	2071	5674	75
T_2: 100% RDF	74.2	204	1.45	4.88	1.39	0.27	3536	12207	65
T_3: 75% RDF + *Azospirillum* + PSB + KSB (Seed treatment @ 10 ml kg^{-1})	67.1	182	1.40	4.74	1.26	0.24	3075	10702	68
T_4: 75% RDF + *Azospirillum* + PSB + KSB (Soil application @ 1.25 l ha^{-1})	70.8	197	1.43	4.83	1.32	0.27	3328	10725	65
T_5: 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application)	74.4	207	1.46	4.88	1.48	0.28	3846	12353	65
T_6: 50% RDF + *Azospirillum* + PSB + KSB (Seed treatment @ 10 ml kg^{-1})	67.4	172	1.12	4.06	1.12	0.24	2771	9195	72
T_7: 50% RDF + *Azospirillum* + PSB + KSB (Soil application @ 1.25 l ha^{-1})	69.0	183	1.13	4.12	1.28	0.24	3021	9296	70
T_8: 50% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application)	70.9	195	1.17	4.24	1.32	0.25	3130	10604	70
SEm±	2.56	6.55	0.047	0.160	0.042	0.008	121.2	394.1	1.32
CD(P=0.05)	7.8	20.0	0.15	0.51	0.13	0.02	371	1207	4.0

Table 2: Green and dry fodder yield of fodder sorghum as influenced by application of liquid biofertilizers at different levels of recommended dose of fertilizers

Treatments	Green fodder yield (t ha^{-1})	Dry fodder yield (t ha^{-1})
T_1: Absolute control	13.9	6.0
T_2: 100% RDF	30.6	12.8
T_3: 75% RDF + *Azospirillum* + PSB + KSB (Seed treatment @ 10 ml kg^{-1})	26.5	11.3
T_4: 75% RDF + *Azospirillum* + PSB + KSB (Soil application @ 1.25 l ha^{-1})	27.3	11.3
T_5: 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application)	32.1	13.0
T_6: 50% RDF + *Azospirillum* + PSB + KSB (Seed treatment @ 10 ml kg^{-1})	21.9	9.7
T_7: 50% RDF + *Azospirillum* + PSB + KSB (Soil application @ 1.25 l ha^{-1})	22.2	9.8
T_8: 50% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application)	25.5	11.2
SEm±	1.03	0.41
CD (P=0.05)	3.1	1.3

Conclusion

In conclusion, the present research indicated that combined application of 75% RDF + *Azospirillum* + PSB + KSB (Both seed & soil application) is a viable and sustainable nutrient management practice for achieving enhanced green and dry fodder yields in fodder sorghum in the Southern Agroclimatic Zone of Andhra Pradesh.

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