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Effect of integrated nitrogen management on quality and economics of sweet sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract
A field experiment was conducted during the *kharif* season 2018 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) to study the effect of integrated nitrogen management on quality and economics of Sweet sorghum [*Sorghum bicolor* (L.) Moench] crop. The soil of thes experimental field was sandy loam with organic carbon (0.45%) and a soil pH of 7.2. The experiment was laid out in a randomized block design consisting of 13 treatments replicated thrice. Treatments consisted of control, 3 levels of inorganic sources of nitrogen *viz.*, N_1 (80%), N_2 (60%) and N_3 (40%) and 4 organic sources of nitrogen viz., Poultry Manure, Vermicompost, Poultry Manure + *Azospirilum* (Seed Inoculation) and Vermicompost + *Azospirilum* (Seed Inoculation) with their levels *viz*., Poultry Manure (20% N, 40% N and 60% N) and Vermicompost (20% N, 40% N and 60% N). The result revealed that treatment T_4-[80% RDN through inorganic source + 20% N through V.C + *Azospirillum* (Seed inoculation)] recorded higher crude protein content (9.19%), crude protein yield (1.61 t ha^{-1}), crude fibre content (28.56%), Ash content (8.67%) and Net returns (□80,546.00 ha^{-1}) whereas B : C ratio (2.88) was found higher in treatment T_3.

Keywords: Integrated nitrogen management, quality, economics, vermicompost, poultry manure, *azospirillum*

Introduction
Sweet sorghum (*Sorghum bicolor* L. Moench) is a C_4 annual grass which can produce high forage biomass yield per unit of land (Fribourg 1995, Rooney *et al*. 2007) [4, 14] and ranks fifth among world cereals after wheat, rice, maize and barley (Sato *et al*., 2004; Khalil, 2008; Namoobe *et al*. 2014) [15, 9, 12]. The crop is adapted to the arid and semi-arid tropics and dry-temperate areas of the world (Kidambi *et al*., 1990; Blum, 2004) [10, 2]. The crop is grown primarily in thewarm dry climates of Africa, India, Pakistan, China and the Southern United States, to be used as food and fodder (Alagarswamy and Chandra, 1998) [1]. It is predominantly grown for grain as wells as fodder in different parts of the country and is one of the widely grown forage crop with good nutritive value for animals. It is fast growing, adaptive to vast environmental conditions and provides palatable nutritious fodder to the animals. India has the largest livestock population, which accounts for 17 per cent of the world's livestock population. However, livestock productivity is constrained by an acute shortage of feed and fodder. Sorghum is an important forage crop in India. As forage it is fast growing, palatable, nutritious and utilized as silage and hay besides fresh feeding. Sorghum crop is adaptive to vast environmental conditions and in India it provides green fodder to the animals for a considerable length of period i.e. from May to November (Kumar *et al*., 2013) [17]. Limited supply with poor quality of fodder is considered as major limiting factor for the livestock industry in India. The mainstay of animal health and their production depends on availability of fodder (Somashekar *et al*., 2015) [16]. Importance of increasing the milk yield per animal through better health care and balanced feed and fodder supply has been relished by the farmers who have so far been growing fodder crops with traditional systems resulting in low productivity of fodder.

Nitrogen is the most important nutrient element, while sorghum is known to respond well to nitrogen fertilization. There are a number of studies reporting on positive effect of nitrogen application on the yields of grain and forage of sorghum. In contrast, relatively few studies have been made regarding the effects of nitrogen on sweet sorghum productivity**,** Buah and Mwinkara (2009) [3] and hugar *et al*. (2010) [6].

Materials and Methods

A field experiment was conducted during the *Kharif* season of 2018 on fodder sweet sorghum at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.), which is located at 25^0 57' N latitude, $87^0$50' E longitude and at an altitude of 98 m above the mean sea level. The soil of experimental field was sandy loam having pH of 7.2 with 0.45% organic carbon, available nitrogen 225 kg ha^{-1}, available phosphorus 19.50 kg ha^{-1} and available potassium 92.00 kg ha^{-1}. The experiment was laid out in randomized block design with thirteen treatments replicated thrice. Treatments consisted of control, 3 levels of inorganic sources of nitrogen *viz*., N_1 (80%), N_2 (60%) and N_3 (40%) and 4 organic sources of nitrogen viz., Poultry Manure, Vermicompost, Poultry Manure + *Azospirilum* (Seed Inoculation) and Vermicompost + *Azospirilum* (Seed Inoculation) with their levels *viz*., Poultry Manure (20% N, 40% N and 60% N) and Vermicompost (20% N, 40% N and 60% N). *Azospirillum spp* was used as biofertilizer for seed inoculation in sweet sorghum crop. The recommended dose of N, P, K for sweet sorghum was 120:50:50 kg/ha. The required amount of vermi compost, poultry manure was calculated and applied with respect to the treatments. Urea, Single Super Phosphate and Murate of Potash were used as inorganic sources for nitrogen, phosphorus and potassium respectively.

Results and Discussion

Crude protein content

The data pertaining to Crude protein content is presented in Table 1,which revealed that the crude protein content (9.19%) was found significantly higher in treatment T_4 [80% RDN through inorganic source + 20% N through V.C+ *Azospirillum* (Seed inoculation)] whereas treatment T_3[80% RDN through inorganic source + 20%N through P.M+ *Azospirillum* (Seed inoculation)] and T_8 [60% RDN through inorganic source+ 40%N through V.C+ *Azospirillum* (Seed inoculation)] were found to be statistically at par with treatment T_4. Higher protein yield might be as a result of increased crude protein content and higher dry matter accumulation by crops as the protein yield is a function of dry matter yield and protein content in dry matter. This is in close conformity with the findings of Gill *et al*. (1988) [5] and Perejra *et al*. (1989).

Crude protein yield

The data pertaining Crude protein yield is presented in table 1, which revealed that the crude protein yield (1.91 t/ha) was found significantly higher in treatment T_4 [80% RDN through inorganic source + 20% N through V.C + *Azospirillum* (Seed inoculation)] whereas treatment T_3 [80% RDN through inorganic source + 20% N through P.M + *Azospirillum* (Seed inoculation)] and T_8 [60% RDN through inorganic source + 40% N through V.C + *Azospirillum* (Seed inoculation)] were found to be statistically at par with treatment T_4. The increase in dry matter yield under integration of nutrients compared to inorganic sources might be the reason for high crude protein yield under this treatment might also be due to production of higher metabolizable energy (Kalra and Khokhar, 1979: Krishna *et al*., 1988) [8, 11].

Crude fibre content

The data pertaining to Crude fibre content is presented Table 1,which revealed that the crude fibre content (28.56%) was found significantly higher in treatment T_4 [80% RDN through inorganic source + 20% N through V.C+ *Azospirillum* (Seed inoculation)] whereas treatment T_3 [80% RDN through inorganic source + 20% N through P.M + *Azospirillum* (Seed inoculation)] and T_8 [60% RDN through inorganic source + 40% N through V.C + *Azospirillum* (Seed inoculation)] were found to be statistically at par with treatment T_4. This can be attributed to the fact that sweet sorghum is a rapid growing crop and contains more fibre needing higher amount of nitrogen for meeting its demand (Kar *et al.*, 2017)

Ash content

The data represented in Table l, represented that the highest ash content was recorded in treatment T_4 [80% RDN through inorganic source+20%N through V.C + *Azospirillum* (Seed inoculation)] (8.67%) whereas treatment T_3 [80% RDN through inorganic source+20%N through P.M + *Azospirillum* (Seed inoculation)] and T_8 [60% RDN through inorganic source + 40% N through V.C + *Azospirillum* (Seed inoculation)] were found to be statistically at par with treatment T_4.

Table 1: Effect of Integrated Nitrogen Management on quality parameters of Sweet sorghum

S. No	Treatments	Crude protein content (%)	Crude protein Yield (t/ha)	Crude fibre Content (%)	Ash content (%)
1	80% RDN through inorganic source + 20% N through Poultry Manure	7.90	1.52	23.33	7.50
2	80% RDN through inorganic source + 20% N through Vermi compost	8.84	1.68	26.91	8.13
3	80% RDN through inorganic source + 20% N through P.M + *Azospirillum* (Seed inoculation)	8.90	1.69	27.93	8.53
4	80% RDN through inorganic source + 20% N through V.C + *Azospirillum* (Seed inoculation)	9.19	1.91	28.56	8.67
5	60% RDN through inorganic source + 40% N through Poultry Manure	7.77	1.05	20.83	7.27
6	60% RDN through inorganic source + 40% N through Vermi compost	7.97	1.66	23.47	7.70
7	60% RDN through inorganic source + 40% N through P.M + *Azospirillum* (Seed inoculation)	8.00	1.32	25.17	8.03
8	60% RDN through inorganic source + 40% N through V.C + *Azospirillum* (Seed inoculant)	8.86	1.65	26.95	8.47
9	40% RDN through inorganic source + 60% N through Poultry manure	7.37	0.96	18.67	6.53
10	40% RDN through inorganic source + 60% N through Vermi compost	7.63	0.97	19.70	6.90
11	40% RDN through inorganic source +60%N through P.M +*Azospirillum* (Seed inoculation)	7.73	1.13	20.53	7.03
12	40% RDN through inorganic source +60%N through V. C + *Azospirillum* (Seed inoculation)	7.83	1.19	22.08	7.33
13	100% N through inorganic source (control)	7.03	0.95	18.67	6.10

	F test	S	S	S	S
	SE.m ±	0.12	0.34	0.57	0.07
	CD (P=0.05)	0.35	0.99	1.66	0.22

Table 2: Effect of Integrated Nitrogen Management on Economics of Sweet Sorghum

S.NO	Treatments	Cost of Cultivation (□ ha $^{-1}$)	Gross return (□ ha $^{-1}$)	Net returns (□ ha^{-1})	B:C ratio
1	80% RDN through inorganic source + 20% N through Poultry Manure	42,194.00	103500.00	61,306.00	2.45
2	80% RDN through inorganic source + 20% N through Vermi compost	43,394.00	117210.00	73,816.00	2.70
3	80% RDN through inorganic source + 20% N through P.M + *Azospirillum* (Seed inoculation)	42,244.00	122010.00	79,766.00	2.88
4	80% RDN through inorganic source+ 20% N through V.C + *Azospirillum* (Seed inoculation)	43,444.00	123990.00	80,546.00	2.85
5	60% RDN through inorganic source + 40% N through Poultry Manure	46,473.00	95490.00	49,017.00	2.05
6	60% RDN through inorganic source + 40% N through Vermi compost	48,873.00	103290.00	54,417.00	2.11
7	60% RDN through inorganic source + 40% N through P.M + *Azospirillum* (Seed inoculation)	46,523.00	103800.00	57,277.00	2.23
8	60% RDN through inorganic source + 40% N through V.C + *Azospirillum* (Seed inoculation)	48,923.00	120000.00	71,077.00	2.45
9	40% RDN through inorganic source+60%N through Poultry manure	50,751.00	85890.00	35,139.00	1.69
10	40% RDN through inorganic source+60%N through Vermi compost	54,351.00	88500.00	34,149.00	1.62
11	40% RDN through inorganic source +60%N through P.M +*Azospirillum* (Seed inoculation)	50,801.00	93390.00	42,589.00	1.83
12	40% RDN through inorganic source +60%N through V. C *Azospirillum* (Seed inoculation)	54,401.00	99000.00	44,599.00	1.81
13	100% N through inorganic source (control)	37,916.00	71400.00	33,484.00	1.88

Economics
The highest gross returns (□123990.00 ha^{-1}) and net returns (□ 80,546.00 ha^{-1}) were found in T_4 [80% RDN through inorganic source + 20% N through V.C + *Azospirillum* (Seed inoculation)] and highest benefit cost ratio was found in T_3 [80% RDN through inorganic source + 20% N through P.M + *Azospirillum* (Seed inoculation) *i.e.*, 2.88.

Conclusion
Based on the findings, of this experiment it can be concluded that application of 80% nitrogen through urea and 20% nitrogen through poultry manure with seed inoculation from *azospirilum* was found economically profitable for farmers.

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