The Pharma Innovation Journal 2023; 12(8): 2731-2734

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 2731-2734

www.thepharmajournal.com
Received: 01-05-2023
Accepted: 05-06-2023

Devanand T Kusumbe
Department of Agronomy, College of Agriculture, Nagpur, Maharashtra, India

Nagrare IM
Department of Agronomy, College of Agriculture, Nagpur, Maharashtra, India

Mohini R Punse
Department of Agronomy, College of Agriculture, Nagpur, Maharashtra, India

Aakash D Lewade
Department of Agronomy, College of Agriculture, Nagpur, Maharashtra, India

Corresponding Author:
Devanand T Kusumbe
Department of Agronomy, College of Agriculture, Nagpur, Maharashtra, India

Effect of integrated nitrogen management and biofertilizer inoculation on growth and yield of *kharif* sorghum

Devanand Kusumbe T, Nagrare IM, Mohini R, Punse and Aakash D Lewade

Abstract
A field experiment was conducted at Agronomy farm, College of Agriculture, Nagpur during *kharif* season of 2016-17 on sorghum to study the effect of various integrated Nitrogen doses with biofertilizer inoculation. By considering 80:40:40 kg NPK ha^{-1} as recommended dose, the experiment was laid out in total 30 plots with spilt plot design having five integrated nitrogen management treatments as main factor *viz.*, T_1- Control, T_2- 100% RDN through urea, T_3- 75% RDN through urea + 25% RDN through FYM, T_4- 50% RDN through urea + 50% RDN through FYM, T_5- 5 t FYM ha^{-1} and two biofertilizer inoculation as sub factor *viz.*, B_1- *Azotobacter* seed treatment and B_2- *Azospirillum* seed treatment which was replicated thrice. All the cultural operations were carried out as per recommendation. Treatment T_4 (50% RDN through urea + 50% RDN through FYM) was found significantly superior over all the treatments in respect of growth characters *viz.*, plant height, number of functional leaves, leaf area, leaf area index, dry matter accumulation and also in respect of yield contributing character *viz.*, length of earhead and higher grain yield plant^{-1} consequently produced at harvest. In biofertilizer inoculation, treatment B_2 (*Azospirillum* seed treatment) was found significantly higher at all stages of crop growth in respect of growth characters *viz.*, plant height, number of functional leaves, leaf area, leaf area index and dry matter accumulation over *Azotobacter* seed treatment and also in respect of yield contributing characters *viz.*, length of earhead, grain yield plant^{-1} and consequently produced higher grain yield. The results indicate that the interaction effect was not statistically significant.

Keywords: Sorghum, integrated nitrogen management, biofertilizers, *Azospirillum*

Introduction

Sorghum (*Sorghum bicolor* L.) holds significant importance as a cereal crop in India. Its cultivation is primarily for food, feed, and fodder, and more recently, it has gained attention for bio-fuel and sugar production. Before the green revolution, Sorghum was the second-largest grain crop in India, and presently, it stands as the third-largest in terms of both acreage and production (Anonymous, 2010) [1]. Sorghum is extensively cultivated in different regions of India, such as Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh, and Punjab. In Maharashtra, sorghum is grown during *kharif* season in Vidharbha and some part of Marathwada. It is also grown in *rabi* season in Western Maharashtra and Marathwada region. Grains of sorghum possess roughly 10.4% protein, 72.6% carbohydrates, and 1.9% fat, alongside a starch content between 5 to 7%, and about 1.65% mineral components. Nitrogen stands out as a crucial nutrient that's often deficient in the soils of India, having a significant influence on the growth and evolution of plants due to its physiological and metabolic necessities. Cereals have higher demand of Nitrogen as compared to pulse and oilseeds and they also respond very well to applications of Nitrogen through various sources. Biofertilizers play a crucial role in improving nutrient availability and productivity in a sustainable manner. In India, Maharashtra stands out as the largest producer and consumer of sorghum. However, in rainfed regions, farmers tend to apply limited amounts of FYM, organic manure, and chemical fertilizers, leading to suboptimal sorghum productivity. This deficiency in fertilization stands as one of the primary reasons behind the lower yields in sorghum cultivation. To enhance productivity, there is a need to address this issue and promote the use of appropriate biofertilizers and balanced fertilization practices. Nitrogen, being a crucial nutrient, plays a significant role in the growth and development of crops, serving as the primary component of the plant's body. Kulekci *et al*. (2009) [5] suggested that optimal crop yield and superior quality, an ample supply of nitrogen is crucial. Biofertilizers, enriched with advantageous organisms, provide a cost-efficient, environmentally-friendly, and continuously sustainable nutrient source for plants. This makes them perfect collaborators and indispensable additions to conventional fertilizers. The combination of various sources of Nitrogen viz. Urea, FYM and Biofertilizer would be an ideal option to meet the higher Nitrogen demands of crop and thus considering above points, the experiment entitled "Effect of integrated nitrogen management and biofertilizer inoculation on growth and yield of *kharif* sorghum" was conducted to know the result of various Nitrogen doses and biofertilizers.

Materials and Methods

During the kharif season of 2016-17, a field experiment took place at Agronomy farm, College of Agriculture, Nagpur. on a well-drained black cotton soil belonging to vertisol, It has a slightly alkaline nature with a pH of 7.60. It contains low levels of available nitrogen and phosphorus but is abundant in available potassium and medium organic carbon. 80:40:40 kg NPK $ha^{-1}$was considered as the recommended dose of nutrients. The experiment was laid out in total 30 experimental plots with split plot design having five integrated nitrogen management treatments as main factor *viz.*, T_1- Control, T_2- 100% RDN through urea, T_3- 75% RDN through urea + 25% RDN through FYM, T_4- 50% RDN through urea + 50% RDN through FYM, T_5- 5 t FYM ha^{-1} and two biofertilizer inoculation as sub factor *viz.*, B_1- *Azotobacter* seed treatment and B_2- *Azospirillum* seed treatment which was replicated thrice. The sorghum variety CSH-9 was used with gross plot size of 5.4 m × 4.8 m and net plot size of 4.5 m × 4.5 m. To depict the treatment effect, a random selection of five sorghum plants was made from each net plot. These plants were properly labeled, and observations were recorded at 30-day intervals.

Results and Discussion

The findings derived from the recent study are detailed below, cantered on the experimental data gathered in the period of 2016-2017.

Growth Parameter

A) Effect of integrated nitrogen management

The experimental findings indicated that Effect of integrated nitrogen management were significantly influenced the growth parameter (Table 1).

The data revealed that, application of 50% RDN through urea + 50% RDN through FYM recorded significantly higher plant height (222.83 cm), number of functional leaves $plant^{-1}$ (2.83), leaf area $plant^{-1}$ (33.50 dm^2), leaf area index (4.96) and higher dry matter accumulation $plant^{-1}$ (132.50 g) over 100% RDN through urea, 5 t FYM ha^{-1} and control treatments but was at par with 75% RDN through urea + 25% RDN through FYM at 60, 90 DAS and at harvest. Control plot recorded least plant height (201.00 cm), number of functional leaves $plant^{-1}$ (2.45), leaf area $plant^{-1}$ (28.42 dm^2), leaf area index (4.21) and higher dry matter accumulation $plant^{-1}$ (127.17 g).

The increase in plant height through integrated nitrogen management Singh *et al*. (2006) [14], Singh *et al*. (2013) [18], Patel *et al*. (2015) [11] and Nemade *et al*. (2017) [8] reported that the enhanced nitrogen availability to plants was initially facilitated by inorganic fertilizers, followed by FYM (Farm Yard Manure). Number of functional leaves $plant^{-1}$ might be due to better availability of sufficient amounts of plant nutrient throughout the growth period. The investigation's results align closely with those of Singh and Sumeriya (2010) [17] as well as Trivedi *et al*. (2010) [19]. Leaf area $plant^{-1}$ possibly, the rise in nitrogen supply to plants was facilitated by inorganic fertilizers at first and later by FYM, catering to the crop's requirements throughout the entire cropping season. The outcomes of the study closely align with the discoveries made by Singh *et al*. in 2015 [15]. The reasons for better growth under fertilizer and manure combination increase in leaf area and constant ground area. The results obtained during the investigation are in close accordance with the findings of Singh *et al.* (2015) [15]. The accumulation of dry matter in plants might be linked to heightened nitrogen activity, which augments the constituents of protoplasm and boosts cell division and expansion processes. This could result in robust vegetative growth, promoting a higher quantity of dry matter. These observations align closely with the insights drawn from previous research, specifically those conducted by Singh *et al.* (2013) [18] and Singh *et al.* (2015) [15]. The reasons for better length of earhead under fertilizer and manure combination The enhanced accessibility of nitrogen to plants, resulting from the use of inorganic fertilizer and Farm Yard Manure (FYM), aligns closely with the outcomes of this research. This correlation is consistent with the studies conducted by Dhonde *et al.* (2004) [3], Patel *et al.* (2015) [11] and Nemade *et al.* (2017) [8]. *Azospirillum* seed treatment (B_2) recorded significantly higher length of the earhead $plant^{-1}$ over *Azotobacter* seed treatment (B_1) at harvest. The outcomes closely align with the discoveries made by Siddiqui *et al*. (2005) [13] in their research.

B) Effect of biofertilizer

The experimental findings indicated that Effect of biofertilizer was significantly influenced the growth parameter (Table 1).

The effect of biofertilizer applied to sorghum on growth parameter was found significant at all the crop growth stages except 30 DAS. *Azospirillum* seed treatment recorded significantly higher plant height (212.67 cm), number of functional leaves $plant^{-1}$ (2.65), leaf area $plant^{-1}$ (31.27 dm^2), leaf area index (4.63) and higher dry matter accumulation $plant^{-1}$ (130.07 g) over *Azotobacter* seed treatment at 60, 90 DAS and at harvest. The plant height might be due to microbial inoculant *Azospirillum* bring about more improvement in the nutrient availability by fixation of atmospheric nitrogen in the *rhizosphere*. After analyzing the data, the obtained results align closely with the discoveries made by Gupta *et al*. (2007) [4] in their study conducted in 2007. The plant growth character like plant height was increased due to same treatment, which might be due to increase in internodes and nodes which ultimately increased the number of functional leaves due to *Azospirillum*. The outcomes of the research closely mirror those discovered by Gupta *et al.* (2007) [4] and Oosterom *et al.* (2010) [9]. Leaf area $plant^{-1}$ might be due to microbial activity in the *rhizosphere* with the application of *Azospirillum* enhanced the number of leaves which might have reflected in leaf area. The results so obtained during the investigation are in close accordance with the findings Siddiqui *et al.* (2005) [13] and Oosterom *et al.* (2010) [9]. Leaf area index might be due to increase in leaf area and constant ground area. The results obtained during the course of experimentation are in close accordance with the findings of Oosterom *et al.* (2010) [9]. Higher dry matter accumulation $plant^{-1}$ obtained during the experimentation are in close conformity with the findings of Siddiqui *et al.* (2005) [13].

Interaction effects

The interaction effects due to integrated nitrogen management and biofertilizer inoculation on plant height, number of functional leaves plant^{-1}, Leaf area plant^{-1}, leaf area index, dry matter accumulation plant^{-1}, length of earhead at harvest was found to be non-significant at all growth stages of the crop.

Yield Parameters

The data regarding grain yield plant^{-1} and was significantly influenced by integrated nitrogen management and biofertilizer inoculation treatments.

A) Effect of integrated nitrogen management

The data revealed that, among all the treatments, application of 50% RDN through urea + 50% RDN through FYM recorded significantly higher length of the earhead plant $^{-1}$ (29.00) and grain yield plant^{-1} (40.00 and 49.55 q ha^{-1}) over 100% RDN through urea, 5 t FYM ha^{-1} and control treatments but was at par with 75% RDN through urea + 25% RDN through FYM at harvest. Control plot recorded least length of the earhead plant^{-1} (24.00) and grain yield plant^{-1} (34.17 and 33.92 q ha^{-1}). A potential explanation for the improved production of yield components and overall yield could be the provision of nutrients in an equilibrated quantity and accessible form. Manure supplying all the essential nutrients and improve physical condition of soil. The continuous supply of nutrients throughout the growing season is the key factor contributing to this phenomenon. The effectiveness of organic fertilizer becomes more evident when used in conjunction with organic manure (FYM). This combination leads to enhanced vegetative growth and a balanced C: N ratio, ultimately stimulating carbohydrate synthesis and promoting higher yields. The investigation's findings closely align with the results reported by Singh *et al.* (2009) [16], Patel *et al.* (2015) [11], and Nemade *et al.* (2017) [8].

B) Effect of biofertilizer

The grain yield was influenced significantly by biofertilizer application. *Azospirillum* seed treatment recorded significantly higher length of the earhead plant^{-1} (27.27) and grain yield plant^{-1} (37.87 and 44.05 q ha^{-1}) over *Azotobacter* seed treatment at harvest. The increased productivity observed from treating seeds with *Azospirillum* could likely be due to the bacterium's ability to produce and secrete Indole-3-Acetic Acid (IAA). This observation aligns closely with the research outcomes presented by Siddiqui *et al.* (2005) [13] as well as Patil's study in 2014. Higher grain yield (q ha^{-1}) might be due to *Azospirillum* enhances plant growth by producing phytohormones, which promote better plant development and increased photosynthate production. This leads to improved translocation of nutrients to reproductive parts. The research findings align closely with those of Bhonde *et al.* (2002) [2], Kumar *et al.* (2002) [6], Nayak *et al.* (2002) [7], and Patil (2014) [12].

C) Interaction effects

Interaction effect of integrated nitrogen management and biofertilizer inoculation was found non-significant in respect of grain yield plant^{-1} and grain yield q ha^{-1}.

Table 1: Effect of Integrated Nitrogen Management and Biofertilizer inoculation on growth and yield of *Kharif* Sorghum.

	Growth parameter												**Yield Parameter**					
Treatments	**Plant height (cm)**			**Number of functional leaves**			**Leaf area plant^{-1} (dm^2)**			**Leaf area index**			**Dry matter accumulation plant^{-1} (g)**			**Length of earhead at harvest**	**Grain yield plant^{-1} (g)**	**Grain yield plant$_{-1}$ (q ha^{-1})**
	60 DAS	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**			
Integrated nitrogen management																		
T_1 – Control	145.82	197.83	201.00	7.90	9.98	2.45	27.22	29.32	28.42	4.03	4.34	4.21	59.05	113.88	127.17	24.00	34.17	33.92
T_2- 100% RDN through urea	150.55	206.00	212.50	8.24	10.85	2.64	29.48	33.13	30.77	4.37	4.90	4.56	62.29	116.17	128.87	26.17	36.67	41.33
T_3- 75% RDN through urea + 25% RDN through FYM	153.93	209.83	217.00	8.86	11.20	2.72	31.39	34.67	32.23	4.65	5.13	4.78	63.30	119.76	131.13	27.67	37.33	45.33
T_4- 50% RDN through urea + 50% RDN through FYM	157.67	216.33	222.83	9.48	11.77	2.83	32.06	36.02	33.50	4.75	5.33	4.96	64.28	120.97	132.50	29.00	40.00	49.55
T_5- 5 t FYM ha^{-1}	147.33	200.17	206.17	7.98	10.37	2.55	29.25	31.67	30.00	4.33	4.69	4.44	60.34	115.07	127.83	25.83	35.17	40.62
SE (m) ±	1.16	2.15	1.85	0.31	0.25	0.05	0.76	0.80	0.57	0.11	0.12	0.08	0.38	0.50	0.84	0.83	0.93	1.32
CD at 5%	3.77	7.03	6.04	1.00	0.82	0.16	2.48	2.59	1.84	0.37	0.38	0.27	1.23	1.64	2.75	2.70	3.05	4.31
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Biofertilizer inoculation																		
B_1- *Azotobacter* seed treatment	150.05	204.80	211.13	8.27	10.73	2.62	27.99	32.54	30.74	4.15	4.82	4.55	61.54	116.78	128.93	25.80	35.47	40.25
B_2- *Azospirillum* seed treatment	152.07	207.27	212.67	8.71	10.94	2.65	31.77	33.58	31.27	4.71	4.94	4.63	62.16	117.55	130.07	27.27	37.87	44.05
SE (m) ±	0.49	0.77	0.27	0.11	0.06	0.01	1.19	0.23	0.13	0.18	0.03	0.02	0.07	0.11	0.23	0.44	0.72	0.91
CD at 5%	1.53	2.41	0.85	0.36	0.18	0.02	3.75	0.71	0.41	0.56	0.11	0.06	0.21	0.36	0.72	1.39	2.27	2.86
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Interaction																		
SE (m) ±	1.09	1.71	0.61	0.26	0.13	0.24	2.66	0.50	0.29	0.39	0.08	0.04	0.15	0.25	0.51	0.98	1.61	2.03
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Acknowledgement
Authors would like to acknowledge to all the staff and friends from Department of Agronomy, College of Agriculture, and Nagpur for their help during this investigation.

References
1. Anonymous. Monthly Review of the Indian Economy (CMIE), Economic Intelligence Service; c2010.
2. Bhonde NO, Naphade PS, Hadole SS, Kubde KJ, Dangore ST. Yield and nutrient uptake of nutrient by *kharif* sorghum as influenced by integrated nutrient management. Panjabrao Krishi Vidyapeeth Research Journal. 2002;26(1& 2):1-4.
3. Dhonde MB, Andhale RP, Shinde SH. Effect of integrated nutrient management on growth and yield of sorghum (*Sorghum bicolor*). Journal of Maharashtra Agricultural Universities. 2004;29(2):130-132.
4. Gupta K, Rana DS, Sheoran RS. Response of forage sorghum to *Azotobacter* under organic and inorganic fertilizers. Forage Research. 2007;33(3):168-170.
5. Kulekci M, Polat T, Ozturk E. The determination of economically optimum nitrogen dose in safflower production under dry conditions. Bulgaria Journal of Agricultural Sciences. 2009;15:341-346.
6. Kumar S, Sharma BL. Effect of FYM, nitrogen and *Azospirillum* inoculation on yield and quality of fodder sorghum. Forage Research; 2002;28(3):165-168.
7. Nayak S, Gautam VS, Kushwaha BB. Response of sorghum to *Azospirillum* with and without FYM at different levels of nitrogen. Journal of Maharashtra Agricultural Universities. 2002;26:341-343.
8. Nemade Seema M, Ghorade RB, Mohod NB. Integrated nutrient management (INM) in sorghum chickpea cropping system under unirrigated conditons. International Journal of Microbiological Applied Science. 2017;6(2):379-385.
9. Oosterom EJ, Van AK. Borrell, Chapman SC Hammer GL. Functional dynamics of the nitrogen balance of Sorghum: I.N demand of vegetative plant parts. Field Crop Research. 2010;155:19-28.
10. Panse VG, Sukhatme PV. Statistical methods for agricultural workers, ICAR, New Delhi; c1971. p. 54-57.
11. Patel Vanita BM, Patel JM, Patel PM. Patel. Integrated nitrogen management in pearlmillet (*Pennisetum glaucum* (L) R. Br. EmendStuntz) during summer season. Trends in Biosciences. 2015;8(6):1606-1609.
12. Patil SL. *Azosprillium* based integrated nutrient management for conserving soil moisture and increasing sorghum productivity. African Journal of Agricultural Research. 2014;9(23):1761-1769.
13. Siddiqui MZ, Singh F, Dubey RP, Kumar P, Pal S, Katiyar RP. Integrated nutrient management in pearlmillet for sustainable production. Farm Science Journal. 2005;14(2):85-86.
14. Singh JA, Kumar B, Singh. Integrated nutrient management in pearlmillet under rainfed conditions of southern Haryana. Haryana Journal of Agronomy. 2006;22(2):119-121.
15. Singh Kuldeep, Joshi YP, Hem Chandra, Dinesh Kumar Singh, Ragesh Singh and Mukeshkumar. Effect of nutrient management on growth, productivity and quality of sweet sorghum (*Sorghum bicolor*). Indian Journal of Agronomy. 2015;60(2):291-296.
16. Singh MK, Singh RN, Singh SP. Effect of integrated nutrient management on growth, yield and yield attributes of baby corn (*Zea mays*). Vegetable Science. 2009;36(1):77-79.
17. Singh P, Sumeriya HK, Effects of nitrogen levels on fodder and economics of multicut forage sorghum (*Sorghum bicolor* L. Moench) genotypes. Forage Research. 2010;36(1):15-18.
18. Singh R, Gupta AK, RamT, Choudhary GL, Sheoran S. Effect of integrated nitrogen management on transplanted pearlmillet under rainfed condition. Indian Journal of Agronomy. 2013;58(1):81-85.
19. Trivedi J, Mundra SL, Kaushik MK, Singh P. Response of fodder sorghum (*Sorghum bicolor* L. Moench) genotypes to nitrogen fertilization in Southern Rajastan. M.Sc Thesis submitted to Maharana Pratap University of Agriculture & Technology, Udaipur (Rajasthan); c2010.