Impact of Integrated Nitrogen Management on Growth Parameters of Sorghum

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Abstract

An experimental trail entitled "Integrated Nitrogen Management in Sorghum [*Sorghum bicolor* (L.) Moench] and its Residual Effect on Chickpea" was caried out during 2013-14 and 2014-15 at Rajasthan College of Agriculture, MPUAT, Udaipur. The soil of the experimental site was clay loam in texture and were low in available nitrogen (271.40 and 275.70 kg ha^{-1}), medium phosphorus (19.60 and 20.20 kg ha^{-1}), available potassium (286.52 and 292.80 kg ha^{-1}) was high and slightly alkaline in reaction with pH 8.15 and 7.07, respectively during the year 2013-14 and 2014-15.

The findings of the present study on integrated nitrogen management showed that the highest values of growth traits *viz*., plant height, dry matter accumulation plant^{-1} (at 40, 60, 80 DAS and harvest), leaves plant^{-1}, stem grith, leaf area index (LAI) and minimum days to 50% flowering under the combine application of 75 % N through chemical fertilizer + 25% N through vermicompost + seed treated with *Azotobactar* & PSB over all the other treatments but it was remained at par with application of 75 % N through chemical fertilizer + 25% N through FYM + seed treated with *Azotobactar* & PSB.

Key words – Integrated Nitrogen Management, Sorghum, FYM, PSB, Azotobactar, Yield

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench], is popularly known as "king of millets" which used for food, fodder and feed for human, cattle and poultry. In India, it is also called as "Jowar". Its seeds contain about 70 % carbohydrate, 10-12 % protein and 3% fat. Amongst cereals, sorghum is the 4th most important crop after rice, wheat, and corn. It is extensively grown over an area of 4355 thousand ha in India with 4632 thousand t production and 1064 kg ha^{-1} productivity (Bhatt et al., 2023).

In the state of Rajasthan, sorghum occupies an area of about 559686 ha with annual production of 590340 MT and productivity of 1055 kg ha^{-1} (APEDA, 2023). In the recent years, the preference of sorghum seeds as staple food has great reduction on an account of shift in food habit and economic status of rural population. On the other hand, because of higher potential, wide adaptation of environmental condition and higher nutritional quality, its used for feed and fodder of cattle gaining motion.

Among the different agronomical practices determining crop production, proper and prudent use of fertilizers is considered as the most common factor on to achieving potential and targeted crop yield. However, ill effects of chemical fertilizers on soil health, energy crisis, high input cost of fertilizers and poor economic condition of small and marginal farmers restrict the use of this vital input. Therefore, it is time to develop a strategy for integrated use of organic materials with fertilizer to the maximum possible extent with proper technology to boost the crop productivity. Among the essential nutrients, nitrogen is universally deficient in Indian soils. Nitrogen is essential component of chlorophyll and implies dark green colour to the plants and also an integral part of amino acids. It contributes to the buildup units of protein and growth of plants. It tillering and regeneration after defoliation, promotes shoot length and governs to considerable degree and enhanced the utilization of phosphorus, potassium, and other nutrients in the plant. The sorghum is more nutrients exhausts than other fodder crops and as a cereal, it needs in high amount of nutrients for better production.

The organic matters are natural sources of slow-release nutrients and inclusion of the organic manures like FYM, poultry manure and vermicompost in nutrient management has become necessity to increase the soil fertility status and sustainable productivity. Addition of organic matter increases soil microbial activities and plays vital role in transformation, recycling, and available form of nutrients to the particular crop. It also enhances the physical aspects like soil structure, porosity, reduces crusting and compaction and increase water intake capacity of the soil. Amongst organic manures, FYM is a traditional method, widely available and most likely used by the Indian farmers since a longer time. Vermicompost is now become very popular and the use of vermicompost has an important input in the integrated plant nutrient management (Singh and Ganguly, 2005). Earthworms are ploughing and recycling agent of the soil and organic matter. The presence of earthworms in soil is an indication to other soil fauna occurrence in soil with contributing soil fertility. Decomposition of organic matter by earthworms is one of the most important developments in biological science (Graff, 1981). Very limited research work on vermicompost showed that earthworms increase macro pores and enhanced water air relationship. The use of vermicompost had favourable effects on soil pH, microbial population, and soil enzyme activities (Maneswarippa *et al.*, 1999). Animal oriented manures have a salutary effect on soil productivity besides increasing the soil condition and plant growth. Poultry manure in this regard occupies a pride of place as it is rich nutrient than other manures (Amanullah *et al*., 2007). Poultry litter provide a major source of nitrogen, phosphorus and trace elements for crop production and is effective in improve physical and biological fertility, indicating that land application remains as the main option of utilization of the valuable resource (Bolar *et al*., 2010).

As compare to chemical fertilizers, bio-fertilizers are very cheap, non-pollutant and renewable source of nutrients supply. Bio-fertilizers provide nutrients to particular crop and also adds organic matter into the field to protect it from degradation. *Azotobacter* is a biotic, free living soil micro-organism which plays vital role for the nitrogen cycling in environment, binding environmental nitrogen which is impervious to crop plants. Inoculation with *Azotobacter* has been found to reduce the requirement of chemical fertilizer upto 50 per cent (Soleimanzadeh and Gooshchi, 2013). Phosphorus solubilizing bacteria (PSB) play an important role in converting insoluble phosphate chemically fixed soil phosphorus into available form, resulting in higher crop yields (Gull *et al.*, 2004). Among the whole microbial population in soil, PSB constitute 1 to 50 per cent in P solubilization potential (Chen *et al.*, 2006).

MATERIALS AND METHODS

The field study was caried out at the Instructional Farm (Agronomy) E-1, RCA, MPUAT, Udaipur located at south-eastern part of Rajasthan at 24° 35′ N latitude and 74° 42′ E longitude and altitude of 579.5 metre above mean sea level. The experiments consisted of fourteen treatments and replicated three times with Randomised Block Design and the treatments were 100% RDN through chemical fertilizer, 50% RDN through chemical fertilizer + 50% RDN through FYM, 75% RDN through chemical fertilizer + 25% RDN through FYM, 50% RDN through chemical fertilizer + 50% RDN through vermicompost, 75% RDN through chemical fertilizer + 25% RDN through vermicompost, 50% RDN through chemical fertilizer + 50% RDN through poultry manure, 75% RDN through chemical fertilizer + 25% RDN through poultry manure, 50% RDN through chemical fertilizer + 25% FDN through FYM + 25% RDN through vermicompost, 50% RDN through chemical fertilizer + 25% RDN through FYM + 25% RDN through poultry manure, 50% RDN through chemical fertilizer + 25% RDN through vermicompost + 25% RDN through poultry manure, 75% RDN through chemical fertilizer + 25% RDN through FYM + seed treated with PSB + *Azotobacter,* 75% RDN through chemical fertilizer + 25% RDN through vermicompost + seed treated with PSB + *Azotobacter,* 75% RDN through chemical fertilizer + 25% RDN through poultry manure + seed treated with PSB + *Azotobacter* and 75% RDN through chemical fertilizer + seed treated with PSB + *Azotobacter*. The region comes under agro-climatic zone IV a (Sub- humid Southern Plain and Aravalli Hills) of Rajasthan. The highest and lowest temperature during sorghum crop growing season 2013-14 period ranged between 28.7ºC to 37.4ºC and 17.1ºC to 25.6 ºC, respectively and during year 2014-15 ranged between 27.8ºC to 31.9ºC and 15.2ºC to 25.1ºC, respectively. The total rainfall received during the crop season was 777.5 mm and 870.1 mm during 2013-14 and 2014-15, respectively.

The texture of soil was clay loam and reaction of the soil was slightly alkaline (pH 8.15 to 7.07), low in available nitrogen (271.40 and 275.70 kg ha^{-1}), medium in available phosphorus (19.60 and 20.20 kg ha^{-1}) and high in available potassium (286.52 and 292.80 kg ha^{-1})

RESULTS AND DISCUSSION

The plant height, dry matter accumulation $plant^{-1}$ (at 40, 60, 80 DAS and harvest), leaves $plant^{-1}$, stem grith, leaf area index (LAI) and minimum days to 50% flowering was significantly influenced due to integrated nitrogen management practices during both the years (Table 4.1.2).

Pooled results indicated that application of 75% N through CF + 25% N through VC + seed treatment with *Azotobacter* & PSB registered significantly improvement in plant height by dry matter accumulation $plant^{-1}$ and stem grith at harvest 21.93, 20.45, and 14.54, per cent as compare to the application of 75% RDN through chemical fertilizer + seed treated with PSB + *Azotobacter*. While the magnitude of increase with 75% through CF + 25% through FYM + seed treatment with *Azotobacter* & PSB was 19.16, 19.98 and 13.91 per cent, respectively. In general, overall improvement in crop growth under optimum nutrition involving combination of chemical fertilizer, organic manure and biofertilizer seems to be on account of their potential role in modifying soil and plant environment conducive for better development of morphological and biochemical components of plant growth. The similar results were also reported by Mishra *et al*. (2014)

Further, the application of 75 % N through chemical fertilizer + 25% N through vermicompost + seed treated with *Azotobactar* & PSB and 75 % N through chemical fertilizer + 25% N through FYM + seed treated with *Azotobactar* & PSB increased leaves $plant^{-1}$, leaf area index (LAI) at 50% flowering and minimum days to 50% flowering of 30.02, 27.61, 12.62, 9.30 and 6.74, 6.45 per cent on pooled basis as compare to the application of 75% RDN through chemical fertilizer + seed treated with PSB + *Azotobacter*.

The beneficial effect of nitrogen application through chemical fertilizer, organic manures and biofertilizer on plant height, stem grith, leaves $plant^{-1}$ and DMA by sorghum plants was also observed by several researchers (Yadav *et al*., 2007 and Singh *et al*., 2015).

REFERENCES

APEDA. 2023. Agricultural & Processed Food Products Export Development Authority, E-Catalogue for Export of Millets and Value-Added Products, Rajasthan.

Amanullah, M.M., Somasundaram, E., Vaiyapuri, K. and Sathyamoorthi, K. 2007. Poultry manure to crops: A review. *Agricultural Review*, **28**: 216-222.

Bhat, B.V., Hariprasanna, K., Sooganna and Ratnavathi C.V. (2023). Global and Indian scenario of millets. *Indian Farming* **73** (01): 16-18.

Bolar, N.S. Szogi, A.A., Chuasavthe, T., Sehadri, B., JR Rothrock, M.J. and Panneerselvam, P. 2010. Uses and management of poultry litter. *Would Poultry Science Journal*, **66:** 673-698.

Chen, Y.P., Rekha, P.D., Arunshen, A.B., Lai, W.A. and Young, C.C. 2006. Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. *Applied Soil and Ecology*, **34:** 33-41.

Graff, O. 1981. Preliminary experiment of vermicomposting of different waste materials using *Eudrilus eugeniae* (Kingberg). In: *Proceedings of First International Workshop on Role of Earthworms in Stabilization of Organic Residues,* held at Western Machigan University, Kalamazoo, Machigan pp. 179-181 (Appelhaf M. Ed.).

Gull, M., Hafeez, F.Y., Saleem, M. and Malik, K.A. 2004. Phosphorus uptake and growth promotion of chickpea by co-inoculation of mineral phosphate solubilizing bacteria and a mixed rhizobial culture. *Australian Journal of Experimental Agriculture*, **44:** 623-628.

Maneswarippa, H.P., Nanjappa, H.V. and Hedge, M.R. 1999. Influence of organic manure on yield of arrowroot soil physico-chemical and biological properties when grown as intercrop in coconut garden. *Annals of Agricultural Research,* **20**: 318-323.

Mishra, J.S., Thakur, N.S., Singh, P., Kubsad, V.S., Kalpana, R., Alse, U.N. and Nemade, S.M. 2014. Tillage and integrated nutrient management in rainy-season grain sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy,* **59**(4): 619-623.

Singh, A.B. and Ganguly, T.K. 2005. Quality comparison of conventional compost, vermicompost and chemically-enriched compost. *Journal of Indian Society of Soil Science,* **53**: 352-355.

Singh, K., Joshi, Y.P., Hem Chandra, Singh, D.K., Singh, R. and Kumar, M. 2015. Effect of integrated nutrient management on growth, productivity and quality of sweet sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy,* **60**(2): 291-296.

Singh, K., Joshi, Y.P., Hem Chandra, Singh, D.K., Singh, R. and Kumar, M. 2015. Effect of integrated nutrient management on growth, productivity and quality of sweet sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy,* **60**(2): 291-296.

Soleimanzadeh, H. and Gooshchi, F. 2013. Effect of *Azotobacter* and nitrogen chemical fertilizer on yield and yield component wheat (*Triticum aestivum*). *World Applied Science Journal*, **21:** 1180-2013.

Yadav, P.C., Sadhu, A.C., Swarnkar, P.K. 2007. Yield and quality of multi-cut forage sorghum (*Sorghum sudanense*) as influenced by integrated nitrogen. *Indian Journal of Agronomy*, **52**: 330-334.

Table 1. Effect of integrated nitrogen management on plant height (cm) of sorghum

Treatment	40 DAS			60 DAS			80 DAS			At harvest		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
100 RDF CF	53.54	56.09	54.82	178.95	177.06	178.00	190.44	197.31	193.88	213.78	226.45	220.11
50 CF + 50 FYM	51.48	53.69	52.59	167.61	174.36	170.99	183.11	191.66	187.39	207.52	223.92	215.72
75 CF + 25 FYM	52.63	54.32	53.47	176.45	175.43	175.94	184.09	196.31	190.20	209.27	224.00	216.63
50 CF + 50 VC	53.29	55.18	54.24	178.68	176.46	177.57	187.21	197.64	192.43	210.45	225.16	217.81
75 CF + 25 VC	53.71	56.19	54.95	179.43	178.01	178.72	191.78	198.65	195.22	216.63	226.84	221.73
50 CF + 50 PM	49.33	50.66	50.00	173.13	170.48	171.80	180.22	191.69	185.96	192.45	213.52	202.99
75 CF + 25 PM	48.67	49.53	49.10	177.67	168.49	173.08	178.57	189.59	184.08	200.17	215.10	207.64
50 CF + 25 FYM + 25 VC	54.20	56.33	55.27	180.45	178.51	179.48	193.59	200.63	197.11	217.04	228.90	222.97
50 CF + 25 FYM + 25 PM	49.48	52.00	50.74	174.62	172.03	173.33	181.78	192.47	187.12	204.53	220.32	212.43
50 CF + 25 VC + 25 PM	50.33	52.67	51.50	176.15	172.88	174.52	182.59	194.67	188.63	204.83	221.28	213.06
75 CF + 25 FYM + BF	58.33	60.45	59.39	187.53	189.59	188.56	211.45	214.88	213.17	233.47	241.56	237.51
75 CF + 25 VC + BF	58.41	61.18	59.80	187.64	190.19	188.91	213.15	216.40	214.78	242.01	244.07	243.04
75 CF + 25 PM + BF	50.69	51.38	51.04	169.75	171.51	170.63	188.92	188.27	188.60	201.81	217.67	209.74
75 CF + BF	47.95	48.39	48.17	160.10	162.51	161.31	168.93	169.09	169.01	187.97	210.67	199.32
SEm±	1.316	1.160	0.760	2.692	3.333	1.855	5.545	4.698	3.147	5.513	4.209	3.003
CD 5%	3.826	3.371	2.156	7.825	9.688	5.264	16.118	13.658	8.931	16.026	12.236	8.523

Table 2 Effect of integrated nitrogen management on dry matter accumulation (g plant^{-1}) of sorghum

Treatment	40 DAS			60 DAS			80 DAS			At harvest		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
100 RDF F	5.53	6.19	5.86	57.75	64.97	61.36	66.73	73.66	70.19	202.66	210.38	206.52
50 F + 50 FYM	5.37	6.10	5.73	56.04	62.89	59.47	64.77	71.94	68.35	200.01	204.09	202.05

75 F + 25 FYM	5.40	6.15	5.78	57.35	64.18	60.77	65.83	72.99	69.41	201.04	207.38	204.21
50 F + 50 VC	5.45	6.18	5.81	57.68	64.20	60.94	65.95	73.13	69.54	202.63	210.38	206.50
75 F + 25 VC	5.56	6.22	5.89	57.95	65.02	61.49	67.06	74.00	70.53	203.07	211.51	207.29
50 F + 50 PM	5.20	5.48	5.34	53.82	58.71	56.27	61.32	64.69	63.01	185.60	190.90	188.25
75 F + 25 PM	5.18	5.40	5.29	54.89	58.63	56.76	61.03	64.54	62.78	183.92	192.53	188.23
50 F + 25 FYM + 25 VC	5.80	6.25	6.02	58.05	65.26	61.66	67.13	75.32	71.22	203.10	212.01	207.55
50 F + 25 FYM + 25 PM	5.24	5.66	5.45	54.18	61.17	57.67	63.00	70.50	66.75	190.57	198.35	194.46
50 F + 25 VC + 25 PM	5.33	5.73	5.53	55.74	62.70	59.22	64.47	71.45	67.96	184.52	203.17	193.84
75 F + 25 FYM + BF	6.31	6.78	6.55	62.28	70.15	66.22	72.49	81.18	76.83	217.58	227.32	222.45
75 F + 25 VC + BF	6.59	6.97	6.78	62.67	70.35	66.51	72.80	81.70	77.25	217.70	228.93	223.31
75 F + 25 PM + BF	5.17	5.50	5.34	51.65	58.94	55.29	62.58	68.56	65.57	194.37	194.26	194.32
75 F + BF	5.15	5.24	5.19	51.25	57.86	54.55	59.93	63.14	61.53	180.13	190.67	185.40
SEm±	0.111	0.161	0.085	1.443	1.655	0.951	1.830	1.768	1.102	4.867	4.860	2.978
CD 5%	0.324	0.467	0.240	4.195	4.810	2.698	5.319	5.140	3.127	14.149	14.127	8.452

Table 3. Effect of integrated nitrogen management on growth parameters of sorghum

	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
100 RDF F	67.97	69.02	68.49	3.08	3.16	3.12	10.63	11.02	10.82	25.76	26.10	25.93
50 F + 50 FYM	68.30	69.30	68.80	3.04	3.13	3.08	10.37	10.35	10.36	25.40	24.91	25.16
75 F + 25 FYM	68.29	68.98	68.64	3.07	3.14	3.11	10.41	10.53	10.47	25.54	25.39	25.47
50 F + 50 VC	68.15	69.06	68.61	3.08	3.15	3.12	10.47	10.80	10.63	25.58	25.92	25.75
75 F + 25 VC	68.27	68.97	68.62	3.09	3.17	3.13	10.75	10.99	10.87	25.79	26.22	26.00
50 F + 50 PM	69.77	71.13	70.45	3.01	3.06	3.04	10.17	9.89	10.03	24.44	24.47	24.46
75 F + 25 PM	70.60	71.18	70.89	3.00	3.04	3.02	10.24	10.02	10.13	24.86	24.65	24.76

50 F + 25 FYM + 25 VC	67.93	69.95	68.94	3.10	3.18	3.14	11.00	11.22	11.11	25.95	26.32	26.13
50 F + 25 FYM + 25 PM	68.64	69.77	69.21	3.01	3.11	3.06	10.29	10.17	10.23	24.97	24.83	24.90
50 F + 25 VC + 25 PM	68.47	69.01	68.74	3.02	3.12	3.07	10.31	10.24	10.27	25.12	24.88	25.00
75 F + 25 FYM + BF	65.89	67.50	66.69	3.25	3.34	3.29	12.10	12.29	12.20	26.91	27.62	27.27
75 F + 25 VC + BF	65.67	67.35	66.51	3.36	3.43	3.39	12.33	12.53	12.43	27.18	27.66	27.42
75 F + 25 PM + BF	67.49	71.09	69.29	3.01	3.09	3.05	10.26	10.06	10.16	24.92	25.75	25.33
75 F + BF	70.74	71.24	70.99	3.00	3.02	3.01	9.56	9.57	9.56	24.05	23.83	23.94
SEm±	0.619	0.496	0.343	0.049	0.049	0.030	0.427	0.435	0.264	0.365	0.460	0.254
CD 5%	1.799	1.441	0.975	0.142	0.143	0.085	1.242	1.264	0.749	1.062	1.338	0.722