E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(11): 98-101
Received: 25-08-2024
Accepted: 30-09-2024

Niranjani V Sawane
PG Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Gajanan D Gadade
Extension Agronomist & Manager, ATIC, VNMKV, Parbhani, Maharashtra, India

Pritam O Bhutada
Sorghum Agronomist, Sorghum Research Station, VNMKV, Parbhani, Maharashtra, India

Apeksha B Thombre
Ph. D. Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Sachin G Pawar
PG Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Niranjani V Sawane
PG Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Effect of foliar application of major plant nutrients on yield and economics of *rabi* sorghum (*Sorghum bicolor* L.)

Niranjani V Sawane, Gajanan D Gadade, Pritam O Bhutada, Apeksha B Thombre and Sachin G Pawar

DOI: https://doi.org/10.33545/2618060X.2024.v7.i11b.1948

Abstract
A field experiment entitled "Effect of foliar application of major plant nutrients on growth of *rabi* sorghum (*Sorghum bicolor* L.)" was conducted during the *rabi* season of 2023-24 at the experimental farm of Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, with a view to find out the effect of foliar application of major plant nutrients on growth and yield of *rabi* sorghum and work out the economics of different treatments. The experiment was laid out in randomized block design with seven treatments in three replications each *viz.*, T_1: RDF (40:20:20 NPK kg ha^{-1}), T_2: RDF + Nano urea @ 4 ml liter^{-1} of water spray at panicle initiation stage, T_3: RDF + 2% spray of DAP at panicle initiation stage, T_4: RDF + 2% spray of KCL at panicle initiation stage, T_5: RDF + spray of nano urea @ 4 ml liter^{-1} of water + 2% spray of DAP at panicle initiation stage, T_6: RDF + spray of nano urea @ 4 ml liter^{-1} of water + 2% spray of KCL at panicle initiation stage and T_7: Control. The result of the experiment revealed that soil application of 40:20:20 NPK kg ha^{-1} (RDF) + spray of nano urea @ 4 ml liter^{-1} of water + 2% spray of DAP at panicle initiation stage (T_5) recorded significantly higher grain yield plant^{-1} (28.94 g), number of grains earhead^{-1} (1120), grain yield (2486 kg ha^{-1}), fodder yield (7052 kg ha^{-1}), biological yield (9538 kg ha^{-1}), gross monetary returns (114318 ₹ ha^{-1}), net monetary returns (78989 ₹ ha^{-1}) and B:C ratio (3.24 ₹ ha^{-1}), however, it was comparable with RDF + spray of nano urea @ 4 ml liter^{-1} of water at panicle initiation stage + 2% spray of KCL at panicle initiation stage (T_6), RDF + 2% spray of DAP at panicle initiation stage (T_3) and RDF + 2% spray of KCL at panicle initiation stage (T_4). Test weight (g) and harvest index of *Rabi* sorghum were not influenced by foliar application of major nutrients.

Keywords: *Rabi* sorghum, nano urea, DAP, KCL, foliar application, yield and economics

Introduction
Sorghum is one of the most important crops cultivated in India and is eaten everyday by most Indians. It is popularly known as *Jowar* in Hindi, *Jawari* in Marathi, King of Millets, Great millet, Camel crop and drought resistant crop. It is a staple crop for millions of people living in semi-arid regions. It stands at fifth position in the production of cereals after wheat, maize, rice and barley.

The major sorghum producing countries worldwide are USA (14%), Nigeria (11%), India (8%), Brazil (8%) and Mexico (7%). All these five countries accounts for 48 % of total world production (USDA, 2023). In India *Rabi* sorghum is produced in the states of Maharashtra (2.29 m ha), Karnataka (0.82 m ha) and Andhra Pradesh (0.15 m ha) and is a notable dryland crop in the Deccan plateau (Anonymous, 2021) [2]. Maharashtra is the leading producer of the sorghum and makes a significant contribution to the overall production of sorghum and it has largest area under cultivation both in *kharif* and *Rabi* seasons and in that Marathwada region of Maharashtra contribute major share in production of sorghum.

The foliar application of major plant nutrients such as nitrogen, phosphorus and potassium have a substantial impact on sorghum growth and output. Foliar applied nano-fertilizers considered as the smart delivery system because of their large surface area, absorption capacity and controlled-release kinetics to specific areas (Rameshaiah *et al.*, 2015; Solanki *et al.*, 2015) [11, 16]. The application of nano-fertilizer is promising due to efficient translocation of nutrients to the

desired parts of plant (Deepa *et al.*, 2015) [6]. Nano fertilizers enhance growth parameters, dry matter production, chlorophyll production and rate of the photosynthesis which result in more production and translocation of photosynthesis to different parts of the plant as compared to traditional fertilizers (Ali and Juthery 2017; Singh *et al.*, 2017) [1, 15].

Nitrogen is a major input in sorghum production, affecting both yield and quality (Wondimu, 2004) [18]. Nano urea contains 4% N as encapsulated nitrogen analogues or forms embedded in an organic matrix. A bottle of nano urea (500 ml) equals to 45 kg of urea fertilizer and is 10% less than a bag of conventional urea (Sahu *et al.*, 2022) [13]. According to IFFCO foliar application of nano-urea improves grain yield, fruit quality, physiological growth and nitrogen absorption efficiency. Nano urea particles measure around 30 nm (1 nm is one billionth of a meter) and have 10,000 times more surface area than ordinary urea. Nano urea has a small size and surface qualities make it easily absorbed by plants when sprayed on their leaves. Nanoparticles penetrate plant sections and release nitrogen in a controlled manner (Anonymous, 2021) [2]. In field trials conducted across the country over 94 crops, the nano urea has increased the average crop yield to the tune of 8% (Kiran and Samal, 2021) [8]. Thus, nano urea in an agriculture offers a more effective way to provide nitrogen to plant.

Phosphorus is important for root development and blooming. DAP is a productive source of readily available nitrogen (N) and phosphorus (P_2O_5) for all crops. It also aids in addressing nitrogen and phosphorus deficits in standing crops and boosts crop growth and production. For photosynthesis, cell division, synthesis of glucose *i.e.,* sugar (Carbohydrate production), protein synthesis, root development, early growth winter hardiness and nitrogen fixation in case of legume, forage needs phosphorus (Dongarwar, 2014) [7].

In plant tissue levels, potassium is second to nitrogen with range of 1- 3% by weight. KCl is a major source of potassium for all crops. For translocation of sugar from source to sink, potassium is important. Potassium can also transport water and nutrients in the xylem through the plant. It plays a crucial role in the protein and starch synthesis. The physical quality, disease resistance, feeding value of grain, stress tolerance, forage crops and overall plant health are improved by availability of sufficient amount of potassium. It also helps in drought and lodging resistance. It also regulates photosynthesis, stomatal activity and enzyme activation processes are also regulated by potassium (Prajapati and Modi, 2012) [10]. Its application through foliar spray is beneficial in sodic soil.

The macronutrients are taken by the plants in comparatively large quantities, however available nitrogen and phosphorus are usually deficient in most soils. In rainfed areas the availability of soil moisture is a main constraint for split application of plant nutrients during *Rabi* season. Under such circumstances foliar application of NPK may get easily available to the plants and in turn increase the yield and quality of crop.

Keeping in view the above points, the present study was under taken during *rabi*-2023 at Sorghum Research Station, VNMKV, Parbhani to study the effect of foliar application of major plant nutrients on yield and economics of *rabi* sorghum (*Sorghum bicolor* L.).

Materials and Methods

An experiment was conducted during the *Rabi* season of 2023-24 in sorghum crop at the experimental farm of Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The soil of the experimental plot was medium deep black, low in organic carbon, medium in available nitrogen and phosphorous, but high in available potassium.

The experiment was laid out in randomized block design with seven treatment combination in three replications each *viz.,* T_1: RDF (40:20:20 NPK kg ha^{-1}), T_2: RDF + Nano urea @ 4 ml $liter^{-1}$ of water spray at panicle initiation stage, T_3: RDF + 2% spray of DAP at panicle initiation stage, T_4: RDF + 2% spray of KCL at panicle initiation stage, T_5: RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of DAP at panicle initiation stage, T_6: RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of KCL at panicle initiation stage and T_7: Control. The experimental gross plot size was 4.50 m x 5.40 m and net plot size was 3.90 m x 4.50 m. Sowing was done by dibbling seeds @ 10 kg ha-1 on 17th October, 2023. The harvest took place on 20th February, 2024.

Results and Discussion

Yield

The data presented in Table 1 revealed that yield parameter of *Rabi* sorghum were significantly influenced by different treatments. Soil application of RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of DAP at panicle initiation stage (T_5) recorded significantly higher grain yield $plant^{-1}$ (28.94 g), number of grains $earhead^{-1}$ (1120), grain yield (2486 kg ha^{-1}), fodder yield (7052 kg ha^{-1}) and biological yield (9538 kg ha^{-1}) however, it was at par with RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of KCL at panicle initiation stage (T_6), RDF + 2% spray of DAP at panicle initiation stage (T_3) and RDF + 2% spray of KCL at panicle initiation stage (T_4). Test weight (g) and harvest index of *rabi* sorghum were not influenced by foliar application of major nutrients. These findings are in conformity with the earlier findings reported by Rani (2019) [12], Satish and Sudharani (2021) [14], Chavan *et al.* (2023) [4], Chinnappa *et al.* (2023) [5], Rundan *et al.* (2023) [19], Balachandar *et al.* (2023) [3].

Economics

The data presented in Table 2 revealed that economics of *Rabi* sorghum were significantly influenced by different treatments. Soil application of RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of DAP at panicle initiation stage (T_5) recorded significantly higher gross monetary returns (114318 ₹ ha^{-1}), net monetary returns (78989 ₹ ha^{-1}) and B:C ratio (3.24 ₹ ha^{-1}) however, it was comparable with RDF + spray of nano urea @ 4 ml $liter^{-1}$ of water + 2% spray of KCL at panicle initiation stage (T_6), RDF + 2% spray of DAP at panicle initiation stage (T_3) and RDF + 2% spray of KCL at panicle initiation stage (T_4). These findings are in conformity with the earlier findings reported by Lagad *et al.* (2020) [9], Chavan *et al.* (2023) [4], Chinnappa *et al.* (2023) [5].

Table 1: Effect of different treatments on yield of *Rabi* sorghum

Treatments	Number of grains earhead^{-1}	Test weight (g)	Grain yield Plant^{-1} (g)	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index
T_1: RDF (40:20:20 NPK kg ha^{-1})	855	28.03	19.97	1798	5885	7683	23.41
T_2: RDF + Spray of Nano urea @ 4 ml liter^{-1} of water at panicle initiation stage (PI)	872	30.79	20.63	1890	6097	7987	23.91
T_3: RDF + 2% spray of DAP at panicle initiation stage (PI)	916	31.84	22.11	2294	6880	9174	24.99
T_4: RDF + 2% spray of KCL at panicle initiation stage (PI)	891	31.50	21.03	2126	6443	8569	24.79
T_5: T_2+ 2% spray of DAP at panicle initiation stage (PI)	1120	31.94	28.94	2486	7052	9538	26.05
T_6: T_2 + 2% spray of KCL at panicle initiation stage (PI)	1065	31.90	22.28	2370	6947	9317	25.4
T_7: Control (No fertilizer and no spray)	742	27.36	11.86	1296	4700	5996	22.23
S.E. m±	79.95	1.56	1.9	124.97	488.82	512.59	1.74
C.D. @ 5%	246.36	NS	5.85	385.07	1506	1579	5.37
G.M.	923.19	30.48	20.97	2037	6286	8323	24.4

Table 2: Effect of different treatments on economics of *Rabi* sorghum

Treatments	Gross monetary returns (₹ ha^{-1})	Cost of Cultivation (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	Benefit: Cost ratio
T_1: RDF (40:20:20 NPK kg ha^{-1})	86594	33709	52885	2.57
T_2: RDF + Spray of Nano urea @ 4 ml liter^{-1} of water at panicle initiation stage (PI)	90582	35059	55523	2.58
T_3: RDF + 2% spray of DAP at panicle initiation stage (PI)	107346	34579	72767	3.10
T_4: RDF + 2% spray of KCL at panicle initiation stage (PI)	99820	34649	65171	2.88
T_5: T_2+ 2% spray of DAP at panicle initiation stage (PI)	114318	35329	78989	3.24
T_6: T_2 + 2% spray of KCL at panicle initiation stage (PI)	110110	35399	74711	3.11
T_7: Control (No fertilizer and no spray)	64717	31150	33567	2.08
S.E. m±	4803	-	4803	-
C.D. @ 5%	14799	-	14799	-
G.M.	96212	34268	61945	2.79

Conclusion

The application of 40:20:20 NPK kg ha^{-1} (RDF) + spray of nano urea @ 4 ml liter^{-1} of water + 2% spray of DAP at panicle initiation stage or RDF + spray of nano urea @ 4 ml liter^{-1} of water at panicle initiation stage + 2% spray of KCL at panicle initiation stage or RDF + 2% spray of DAP at panicle initiation stage or RDF + 2% spray of KCL at panicle initiation stage were found equally effective in achieving higher yield and economics of *rabi* sorghum.

References

1. Ali NS, Al-Juthery HWA. The application of nanotechnology for micronutrient in agricultural production. The Iraqi Journal of Agricultural Sciences. 2017;48(9):489-441.
2. Anonymous. Production of nano urea IFFCO; c2021. Available at: https://www.iffco.in/. Accessed October 1, 2021.
3. Balachandar N, Sharmili K, Balaganesh B, Manuel RI. Impact of Neem-Coated Urea and Nano Urea on Sorghum (*Sorghum bicolor* (L.) Moench.) Growth and Yield. Biological Forum – An International Journal. 2023;15(10):55-58.
4. Chavan PM, Waghmare YM, Maindale SD, Chaudhari BK. Studies on effect of foliar application of nano N fertilizer on yield and economics of sorghum (*Sorghum bicolor* L). The Pharma Innovation Journal. 2023;12(3):1498-1500.
5. Chinnappa SA, Krishnamurthy D, Ajayakumar MY, Ramesha YM, Ravi S. Response of nano fertilizers on growth, yield and economics of kharif sorghum. The Pharma Innovation Journal. 2023;12(9):761-765.
6. Deepa M, Sudhakar P, Nagamadhuri KV, Reddy KB, Krishna TG, Prasad TNVKV. First evidence on phloem transport of nanoscale calcium oxide in groundnut using solution culture technique. Applied Nanoscience. 2015;5:545-551.
7. Dongarwar SM. Effect of foliar nutrient management on green forage yield of summer Giant bajra. M.Sc. Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.), India; c2014.
8. Kiran K, Samal KC. "Nano urea liquid" - A Boon for Indian Farmers and Mother Earth. Biotic Research Today. 2021;3(6):511-514.
9. Lagad PM, Pathan SH, Damame SV, Sinare BT. Effect of foliar nutrient management on growth, yield and quality of summer forage sorghum. Forage Research. 2020;46(3):271-273.
10. Prajapati K, Modi HA. The importance of potassium in plant growth – A review. Indian Journal of Plant Sciences. 2012;1(23):177-186.
11. Rameshaiah GN, Pallavi J, Shabnam S. Nano fertilizers and nano sensors - an attempt for developing smart agriculture. International Journal of Engineering Research and General Science. 2015;3:314-320.
12. Rani B, Nirali B, Zalawadia NM, Rushang K. Effect of different levels of chemical and nano nitrogenous fertilizers on yield and yield attributes of sorghum crop (*Sorghum bicolor* L.) cv. Gundri. International Journal of Current Microbiology and Applied Sciences. 2019;8(8):2878-2884.
13. Sahu TK, Kumar M, Kumar N, Chandrakar T, Singh DP. Effect of nano urea application on growth and productivity of rice (*Oryza sativa* L.) under midland situation of Bastar region. The Pharma Innovation Journal. 2022;11(6):185-187.
14. Satish P, Sudharani C. Influence of seed priming and foliar spray of nutrients on growth and yield of Rabi sorghum (*Sorghum bicolor* L.). International Journal of Environment and Climate Change. 2021;11(12):180-186.

15. Singh MD, Gautam C, Patidar OP, Meena HM, Prakasha G, Vishwajith. Nano Fertilizers is a new way to increase nutrients use efficiency in crop production. International Journal of Agriculture Sciences. 2017;9(7):3831-3833.
16. Solanki P, Bhargava A, Chhipa H, Jain N, Panwar J. Nanofertilizers and their smart delivery system. In: Rai M, *et al*., editors. Nanotechnologies in Food and Agriculture. Switzerland: Springer International Publishing; c2015. p. 81-101.
17. USDA – Sorghum production. Available at: https://fas.usda.gov/data/production/commodity/0459200. Accessed 2023.
18. Wondimu B. Growth, development and yield responses of sorghum to water deficit stress, nitrogen fertilizer, organic fertilizer and planting density [Doctoral dissertation]. Pretoria: University of Pretoria; c2004.
19. Rundan V, Singh M, Praveen B, Yadav MB, Chethan BR. Proximate Composition Assessment of Fodder Maize with Ricebean Intercropping under Different Nutrient Management Practices. Annals of Plant and Soil Research. 2023;25(4):641-648.