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

www.agronomyjournals.com
2024; 7(4): 97-100
Received: 09-02-2024
Accepted: 16-03-2024

Hrishabh Rai
M.Sc. Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Ankur Tripathi
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Hariom Mishra
Subject Matter Specialist, Agronomy, Krishi Vigyan Kendra, Basti, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Atish Yadav
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Shivam Kaushik
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Mayank Singh
M.Sc. Scholar, College of Fisheries, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Rajesh Kumar
Associate Professor, Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Ankur Tripathi
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Effect of Plant growth regulators and micro-nutrient on growth and herbage yield of forage sorghum (*Sorghum bicolor* L.)

Hrishabh Rai, Ankur Tripathi, Hariom Mishra, Atish Yadav, Shivam Kaushik, Mayank Singh and Rajesh Kumar

DOI: https://doi.org/10.33545/2618060X.2024.v7.i4b.531

Abstract
The present investigation entitled "Effect of plant growth regulators and micro-nutrient on growth and herbage yield of forage sorghum (*Sorghum bicolor* L.)" was carried out during the Kharif season of 2022, at the G.P.B. Research Farm of the Acharya Narendra Deva University of Agriculture and Technology in Kumarganj, Ayodhya (U.P.). The experiment was laid out in randomized block design with twelve treatments *viz.* Triacontanol 10 ppm at 30 DAS (foliar spray), Salicylic acid 100 ppm at 30 DAS (foliar spray), 5 Kg Zn /ha soil application, 2 Kg B /ha soil application, 5 Kg Zn /ha +2 Kg B /ha soil application, 5 Kg Zn /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray, 5 Kg Zn soil application + Salicylic acid 100 ppm at 30 DAS foliar spray, 2 Kg B /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray, 2 Kg B /ha soil application + Salicylic acid 100 ppm at 30 DAS foliar spray, 5 Kg Zn /ha + 2 Kg B /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray, 5 Kg Zn /ha + 2 Kg B /ha soil application + Salicylic acid 100 ppm at 30 DAS foliar spray and water spray at the time of PGR application. Results revealed that application of 5 Kg Zn /ha + 2 Kg B /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray was found more effective to enhance the growth and herbage yield of forage sorghum.

Keywords: Plant growth regulators, micro-nutrients, forage sorghum

Introduction
Sorghum (*Sorghum bicolor* L.) is a C4 cereal fodder crop with excellent photosynthetic productivity. It has beneficial traits like high biomass yield, resistance to salinity, tolerance of a pH range of 5.0 to 8.5, and resistance to drought and poor drainage, among others. The fodder and stover are also used as industrial raw materials for biofuel production, sugar refining, paper production, and feeding animals for milk (Koeppen *et al.*, 2009) [8]. According to Yuan *et al.* (2008) [15], it is the fifth most widely farmed cereal in the world and is grown for ethanol production, fodder, sugar, grain, and fibre. Sorghum that has reached the soft dough stage of growth when harvested and kept as silage has a dry matter digestibility of 52 to 65%, 8 to 12% crude protein, 60 to 75% crude fat, 34 to 40% acid detergent fibre and the rest neutral detergent fibre. The digestibility increases as the grain content increases. Grain that has been ensiled is 90% digestible.
Plant growth regulators (PGRs) can be applied to produce crops of the necessary quality for fodder, among other uses, in addition to the technological quality that the ethanol sector seeks (Almodares *et al.*, 2013) [1]. PGRs are substances that have the power to alter the morphology and physiology of plants. They can be applied at various times depending on the crop's grower's objectives. The naturally occurring plant hormone salicylic acid functions as a key signaling molecule that increases tolerance to abiotic conditions such as heat, cold, heavy metal toxicity, drought and osmotic stress. It is essential for ion uptake, transport and plant growth. This benefit of salicylic acid may be explained by the stressed plant's improved mineral intake as well as higher CO_2 assimilation and photosynthetic rate. Triacontanol (TRIA) cannot be categorized as a phytohormones because it is a secondary plant growth agent.

Such growth regulators significantly increase the physiological effectiveness of the cells and so fully use the genetic potential of the plant (Mandava, 1979) [10]. Earlier studies have given sound evidences regarding distribution of TRIA in the epicuticular waxes in widely diverse genera, such as California Croton (*Croton californicus*), blueberry (*Vaccinium ashei*), Brazilian palm (*Copernicia cerifera*), runner bean (*Phaseolus multiflorus*), white clover (*Trifolium repens*), alfalfa (*Medicago sativa*) and in physic nut (*Jatropha curcas*) (Hufford and Oguntimein 1978; Luzbetak *et al.* 1978; Freeman 1979) [7, 9, 5]. Chandra and Choudhary (2020) [3] also reported that the Triacontanol (TRIA) plays important role in increasing yield, growth, and quality of many important crops.

Sorghum requires good nutrient management because of its extremely exhaustible nature. Micronutrients, particularly zinc (Zn) and boron (B) among other elements, are crucial for producing high-quality fodder. The most effective way to provide these nutrients to crops is through soil application of micronutrient fertilizers. According to Murthy *et al.* (2006) [11], boron is crucial for the meristem, sugar and hydrocarbon metabolism and their transfer, RNA and cytokinin generation and transfer, pollen formation, and seed development. Bhoya *et al.* (2013) [2] reported beneficial effect of zinc application on green forage, dry matter yield and crude protein content of fodder sorghum. Keeping the above fact in view the present investigation was undertaken to study the effect of plant growth regulators and micro-nutrient on growth and herbage yield of forage sorghum (*Sorghum bicolor* L.).

Materials and Methods

The experiment was conducted during the *kharif* season of 2022 at GPB Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.). Geographically, the experimental site falls under humid, sub-tropical climate and is located at 26°47' N latitude, 82°12' E longitude on an elevation of about 113 meter above mean sea level in the Indo-Gangetic alluvial soil belt of Eastern Uttar Pradesh. Ayodhya region receives a mean annual precipitation of about 120 cm. Maximum rainfall in this area is received from mid-June to end of September. However, occasional showers are very common in the month of January and February. The winter months are cold whereas, summer months are extremely hot, the western hot winds locally known as Loo, starts from April and continued till the onset of monsoon in the month of June. The experiment was conducted in Randomize Block Design (RBD) having three replications and 12 treatments. Treatments consisted of Triacontanol 10 ppm at 30 DAS (Foliar spray), Salicylic acid 100 ppm at 30 DAS (foliar spray), 5 Kg Zn /ha soil application, 2 Kg B /ha soil application, 5 Kg Zn /ha + 2 Kg B /ha soil application, 5 Kg Zn /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray, 5 Kg Zn /ha soil application + Salicylic acid 100 ppm at 30 DAS foliar spray, 2 Kg B /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray, 2 Kg B /ha soil application + Salicylic acid, 100 ppm at 30 DAS foliar spray, 5 Kg Zn /ha + 2 Kg B /ha soil application +Triacontanol 10 ppm at 30 DAS foliar spray, 5 Kg Zn /ha + 2 Kg B /ha soil application +Salicylic acid 100 ppm at 30 DAS foliar spray and Water spray at the time of PGR application. The sorghum was hand sown on 14 July, 2022 with a seed rate of 40 Kg /ha. Sowing was done in rows 30 cm apart and 3-4 cm deep in furrows opened by Kudali. The field was fertilized with N: P_2O_5: K_2O @ 120:60:40 Kg ha^{-1} in the form of urea, di-ammonium phosphate and muriate of potash, respectively. Full dose of phosphorus and potassium and half dose of nitrogen was applied at the time of sowing and rest half dose of nitrogen was applied after first irrigation. The allocation of treatment in the plots was done randomly. The crop was grown with recommended package of practices. The crop was harvested at 50% flowering stage. The data recorded on different growth parameters, yield attributes and yield during the course of investigation were subjected to statistical analysis using analysis of variance (ANOVA) technique suggested by Fisher (1958) [4]. The treatment differences were tested by "F" test of significance at 5% level of significance; critical differences were calculated to compare the significant differences between the treatments.

Results and Discussions

Initial Plant population

The data pertaining to initial plant population at 15 days after sowing clearly indicate that PGRs and micronutrients application could not influenced initial plant population significantly (Table1). However, maximum plant population (22 m^{-1} row length) was recorded in 5 Kg Zn /ha + 2 Kg B /ha soil application + Triacontanol 10 ppm 30 DAS foliar spray and minimum (19 m^{-1} row length) in water spray at the time of PGR application and Salicylic acid 100 ppm at 30 DAS foliar spray**.**

Plant height

Significant variations were observed on plant height due to application of PGRs and Micronutrients (Table1). Data clearly revealed that highest plant height at 60 DAS (144.80 cm) and at harvest (210 cm) was recorded under the effect of 5 Kg Zn /ha + 2 Kg B/ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray being on par with T_{11}, T_6, T_5 and T_7 while significantly higher than rest of the treatments at both the stages of crop growth. The increase in plant height might be due to the combine effect of PGRs and micronutrients which promotes the mobilization and translocation of nutrients in plants, resulting into enhance cell division and cell elongation which increased the growth of plant. Similar results were also reported by Gunes *et al.* (2007) [6].

Leaf Area Index

Data related to leaf area index computed at 60 days after sowing and at harvest indicated significant effect of PGRs and Micronutrients application. Data revealed that maximum leaf area index (3.03) at 60 days after sowing and (4.49) at harvest was recorded under the influence of 5 Kg Zn /ha + 2 Kg B /ha soil application + Triacontanol 10 ppm at 30 DAS foliar spray being at par with T_{11}, T_6, T_5 and T_7 while significantly higher than rest of the treatments. The higher leaf area index might be resultant of the Zn, B and Triacontanol application which help in the biosynthesis of auxin that promotes the growth of plant and also increase the leaf area index. The results corroborate the findings of Youssef *et al.* (2017) [14]. Pal *et al.* (2009) [12] also found positive effect of Triacontanol application on leaf area index and dry matter accumulation of the crop.

Leaf stem ratio

The leaf stem ratio did not influenced significantly by due to various combination of PGRs and Micronutrients application. However, maximum leaf stem ratio (0.75) was found with the application of 5 Kg Zn /ha + 2 Kg B /ha + Triacontanol 10 ppm foliar spray at 30 DAS.

Yield

Green fodder yield

Yield is the resultant of coordinated interplay of growth and yield contributing characters whereas, yield attributes are the function of vegetative development. A perusal of data summarized in table 1 indicate that green fodder yield of sorghum was influenced significantly due to application of plant growth regulators and micronutrients. Data further revealed that maximum green fodder yield (573.22 q /ha) was recorded with the application of 5 Kg Zn/ha + 2 Kg B /ha + Triacontanol 10 ppm foliar spray at 30 days after sowing which was at par with T_6, T_{11}, T_5, T_7, T_1 and T_3 which produced 555.31, 554.70, 546.48, 537.59, 536.86 and 531.76, q /ha respectively while significantly higher than rest of the treatments. Verma *et al*. (2021) [13] also reported that application zinc and boron coupled with foliar spray of Triacontanol enhanced the growth and herbage yield and quality attributes of fodder sorghum.

Dry fodder yield: The effect of plant growth regulators and micronutrients on dry fodder yield was also studied (Table 1). The dry fodder yield was significantly influenced due to the application of plant growth regulators and micronutrients. The maximum dry fodder yield (158.63 q /ha) was recorded under the effect of 5 Kg Zn/ha + 2 Kg B/ha + Triacontanol 10 ppm foliar spray at 30 days after sowing being at par with T_6, T_{11}, T_5, T_7, T_1, and T_3 which produced 153.66, 153.50, 151.23, 148.75, 148.56 and 147.15, q /ha respectively while rest of the treatments were significantly low. The higher yield under the effect of plant growth regulators coupled with zinc and boron might be attributed to better nutrient mobilization and translocation in the plant resulting into increase in photosynthates that increase the yield of plant by cell division, cell elongation and converting more food from source to sink that maximize the yield of crop. Similar findings have been also reported by Pal *et al.* (2009) [12].

Table 1: Effect of Plant growth regulators and micro-nutrient on initial plant population, plant height, LAI, leaf stem ratio and fodder yield of forage sorghum (*Sorghum bicolor* L.)

Symbol	Treatments	Initial Plant population	Plant height (cm)		LAI		Leaf stem ratio	Fodder Yield (Q/ha)	
			60 DAS	At harvest	60 DAS	At harvest		Green	Dry
T_1	Triacontano l10 ppmat 30 DAS (Foliar spray)	20	130.40	189.00	2.50	3.95	0.71	536.86	148.56
T_2	Salicylic acid 100 ppmat 30 DAS (foliar spray)	19	127.40	184.70	2.36	3.86	0.70	508.72	140.76
T_3	5 KgZn/hostel application	21	128.80	186.80	2.19	3.90	0.72	531.76	147.15
T_4	2 KgB/hostel application	20	123.10	173.50	2.55	3.72	0.70	507.05	140.32
T_5	5Kg Zn/ha +2 KgB/hostel application	20	137.20	199.00	2.53	4.17	0.73	546.48	151.23
T_6	5 Kg Zn/ha soil application + Triacontanol 10 ppmat 30 DAS foliar Spray	20	138.60	201.00	2.53	4.23	0.74	555.31	153.66
T_7	5 Kg Zn soil application + Salicylic acid 100 ppmat 30 DAS foliar spray	19	135.80	196.80	2.79	4.10	0.72	537.59	148.75
T_8	2KgB/ha soil application + Triacontanol 10 ppmat 30 DA Sfoliar Spray	20	128.90	186.80	2.68	3.90	0.71	518.63	143.52
T_9	2KgB/hostel application + Salicylic acid 100 ppmat s30 DAS foliar Spray	21	128.10	185.80	3.02	3.88	0.70	511.99	141.68
T_{10}	5 KgZn/ha + 2 KgB/hostel application + Triacontanol 10 ppmat 30 DAS foliar spray	22	144.80	210.00	3.03	4.49	0.75	573.22	158.63
T_{11}	5 KgZn/ha+2 KgB/ha soil application + Salicylic acid 100 ppmat 30 DAS foliar spray	20	139.90	202.90	2.73	4.34	0.74	554.70	153.50
T_{12}	Waters pray at the time of PGR application	19	115.10	161.90	2.07	3.49	0.70	472.58	130.30
S.Em±		0.88	4.68	6.93	0.12	0.15	0.01	15.28	4.42
CDaT5%		NS	13.74	20.34	0.35	0.45	NS	44.81	12.96

Conclusion

On the basis of result obtained during this study it could be concluded that application of 5 Kg Zn /ha + 2 Kg B /ha soil application + Triacontanol 10 ppm foliar spray 30 days after sowing might be effective to enhance the growth and herbage yield of fodder sorghum.

Reference

1. Almodares A, Usofzadeh M, Daneshvar M. Effect of nitrogen and ethephon on growth parameters, carbohydrate contents, and bioethanol production from sweet sorghum. Sugar Tech. 2013;15:300-304.
2. Bhoya M, Chaudhari PP, Raval C, Bhatt PK. Effect of nitrogen and zinc on yield and quality of fodder sorghum [*Sorghum bicolor* (L.) Moench] varieties. Forage Res. 2013;39(1):24-26.
3. Chandra S, Choudhury AR. Penconazole, Paclobutrazol, and Triacontanol in overcoming environmental stress in plants. Available from: https://www.researchgate.net/publication/341839220.
4. Fisher RA. Statistical Methods for Research Workers. New York: Hafner; c1958.
5. Freeman B, Albrigo LC, Biggs RH. Cuticular waxes of developing leaves and fruit blueberry, *Vaccinium ashei* Readecv. Blugreen. J Amer. Soc. Hort. Sci. 1979;104:398-403.
6. Gunes A, Inal A, Alpaslan M, Cicek N, Guneri E, Eraslan F, *et al*. Effects of exogenously applied salicylic acid on the induction of multiple stress tolerance and mineral nutrition in maize (*Zea mays* L.). Arch Agron. Soil. Sci. 2007;51(6):687-695.
7. Hufford CD, Oguntimein BO. Non-polar constituents of *Jatropha curcas*. Lloydia. 1978;41:161-165.
8. Koeppen K, Reinhardt G, Gaertner S. Assessment of energy and greenhouse gas inventories of sweet sorghum for first and second generation bioethanol. FAO Environmental and Natural Resources Service Series; c2009. p. 30.
9. Luzbetak DJ, Torrance SJ, Hoffman JJ, Cole JR. Isolation of levo hardwickiic-acid and 1-triacontanol from *Croton californicus*. J Nat Prod. 1978;42:315-316.

10. Mandava NB. Natural products in plant growth regulation. In: Mandava NB, editor. Plant growth substances. ACS Symposium Series 111. Washington (DC): American Chemical Society; c1979. p. 137-213.
11. Murthy DKM, Rao A, Upendra. Effect of organically bound micronutrients on growth and yield of rice. J Eco-friendlily Agric. 2006;3:86-87.
12. Pal D, Mallick S, Ghosh RK, Pal P, Tzudir L, Barui K, *et al*. Efficacy of Triacontanol on the growth and yield of rice crop in inceptisol of West Bengal. J Crop Weed. 2009;5(2):128-130.
13. Verma D. To assess the effect of PGRs and micronutrients (Zn and B) on herbage yield and quality of produce on fodder sorghum (*Sorghum bicolor* L.). Pharma Innovation J. 2021;10(10):1646-165.
14. Youssef RA, Azab ME, El Mahdy HAA, Essa EM, Mohammed KAS. Effect of salicylic acid on growth, yield, nutritional status, and physiological properties of sunflower plant under salinity stress. Int. J Pharm Phytopharmacol. Res. 2017;7(5):54-58.
15. Yuan JS, Tiller KH, Al-Ahmad H, Stewart NR, Stewart Jr CN. Plants to power: Bioenergy to fuel the future. Trends Plant Sci. 2008;13:421-432.