Original Research Article

Effect of plant growth regulator on growth, physiology and yield of direct sown finger millet (*Eleusine coracana* L.)

ABSTRACT

Aims: To determine the "Effect of plant growth regulators with direct sown finger millet".

Place and Duration of Study: The field experiment was conducted during rabi 2022 at South Farm, Division of Agronomy, Karunya Institute of Technology and Sciences, Coimbatore.The soil of the experimental field was sandy clay loam in texture, nearly neutral in soil reaction (pH 5.36), level of organic carbon (1.03%), available N (289 kg/ha), P (115 kg/ha) and K (437 kg/ha)

Study design: Completely randomized block design.

Methodology: T_1 (RDF + Water spray - Control), T_2 (100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm), T_3 (100% RDF + Foliar spraying of Gibberellic acid @10 ppm), T_4 (100% RDF + Foliar spraying of Salicylic acid @100 ppm), T_5 (50% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm), T_6 (50% RDF + Foliar spraying of Gibberellic acid @10 ppm), T_7 (50% RDF + Foliar spraying of Salicylic acid @100 ppm), T_8 (Foliar spraying of Brassinosteroid @ 0.5 ppm), T_9 (Foliar spraying of Gibberellic acid @10 ppm), T_{10} (Foliar spraying of Salicylic acid @100 ppm).

Results: The experiment was laid out in RBD and showed that 100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm (T_2) significantly enhanced No. of tillers/hill, Dry matter production, leaf area index, grain yield, straw yield, harvest index, post-harvest NPK uptake of finger millet.

Conclusion: From this study, it was concluded that PGR along with nutrients application increases the nutrient uptake and yield.

Keywords: Finger millet; nutrient uptake; plant growth regulator; yield.

1. INTRODUCTION

Finger millet, scientifically known as *Eleusine coracana* L., is a crucial small millet crop in India. It boasts the highest productivity among all millets. Millets, collectively referred to as small-seeded grains, belong to various varieties of annual grasses. These grains are primarily cultivated as crops on marginal lands in dry areas found in temperate, subtropical, and tropical regions. Millets are regarded as the most important cereals in semi-arid zones worldwide and serve as a staple food for millions of people in Africa and Asia (Thippeswamy *et al*., 2016).

Millets are recognized as one of the most significant cereal grains and are consumed by over one-third of the global population. They rank as the sixth largest cereal crop in terms of agricultural production worldwide. In India, finger millet is cultivated across a total area of 12.11 lakh hectares, with an average yield of 1401 kg/ha, resulting in a production of 16.96 lakh tonnes (AICRP 2020 - 2021). The nutritional content of all millets is three to five times higher compared to commonly used rice and wheat, making them a highly nutritious food option. The prevalence of malnutrition and undernourishment is a significant challenge faced by the Indian population, prompting the exploration of millets as an alternative source of human food both globally and in India. Millets offer several nutritional advantages. They have higher calcium content compared to other cereals and possess the highest iodine content among all food grains. Ragi, in particular, stands out for its excellent protein quality, containing essential amino acids, vitamin A, vitamin B, and phosphorus (Directorate of Millets Development, 2020-2021).

Plant growth regulators (PGRs) are organic compounds that play a role in modifying various physiological processes in plants, apart from providing essential nutrients. PGRs, also known as bio-stimulants or bio-inhibitors, function within plant cells to stimulate or inhibit specific enzymes or enzyme systems, thereby assisting in the regulation of plant metabolism. These regulators typically exhibit their effects at very low concentrations within plants. Growth regulating chemicals that demonstrate positive impacts on major agronomic crops can hold significant value. However, the ultimate measure of success for PGRs lies in their ability to increase harvested yields or enhance crop quality, thereby ensuring their profitability. In recent years, foliar application of plant growth regulators (PGRs) and nutrients, one of the management options, is being employed increasingly to overcome physiological constraints leading to rapid change in the phenotype of the plant within the season to achieve enhanced production in crops (Esmaeil and Abed, 2012). With this basis, the present investigation was focused on growth, physiological, and yield attributes in finger millet by foliar nutrients and PGRs under irrigated conditions.

2. MATERIALS AND METHODS

The experiment was conducted during the rabi season of 2022 at South Farm, Division of Agronomy, Karunya Institute of Technology and Sciences, Coimbatore. The experimental site is geographically located in the western agro-climatic zone of Tamil Nadu at 10^0 56’N latitude and 76^0 44’E longitude at an elevation of 474 m above mean sea level. The soil of the experimental field was sandy clay loam in texture, nearly neutral in soil reaction (pH 5.36), level of organic carbon (1.03%), available N (289 kg/ha), P (115 kg/ha) and K (437 kg/ha). Treatments comprised of T_1 (RDF + Water spray - Control), T_2 (100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm), T_3 (100% RDF + Foliar spraying of Gibberellic acid @10 ppm), T_4 (100% RDF + Foliar spraying of Salicylic acid @100 ppm), T_5 (50% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm), T_6 (50% RDF + Foliar spraying of Gibberellic acid @10 ppm), T_7 (50% RDF + Foliar spraying of Salicylic acid @100 ppm), T_8 (Foliar spraying of Brassinosteroid @ 0.5 ppm), T_9 (Foliar spraying of Gibberellic acid @10 ppm), T_{10} (Foliar spraying of Salicylic acid @100 ppm). These had been replicated thrice in RBD (Randomized Block Design). The recommended dose of fertilizer at the time of sowing is applied in the form of urea, DAP, and MOP and data were subjected to statistical analysis of variance method (Gomez and Gomez, 1984).

3. RESULT AND DISCUSSION

3.1 No. of tillers/hill

The results showed that there is no significant differences at all three stages of observation as shown in Figure 1. The higher no. of tillers was recorded in T_2 (100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm) at 45, 60 DAS and at harvest of 8.5, 8.6 and 9.0, respectively. Golada and Debbarma (2023) reported that the dissimilarity in growth attributes signifies that each rice variety responds uniquely to the applied nutrient in terms of uptake and utilization efficiency. Further, increase in tiller/hill may be due to its application of PGR which controls the growth of the plant as reported by Singh *et al*. (2020). The lowest value was recorded in control (T_1) of 4.9, 5.0 and 8.0, respectively.

3.2 Dry matter production

The data on the dry matter production of finger millet as influenced by the nutrients and plant growth regulators at various growth stages are presented in Table 1. Among different treatments compared 100% RDF + Brassinosteriod @ 0.5ppm (T_2) registered the highest dry matter production of 4902 kg ha^{-1} and 6021 kg ha^{-1} at 60 DAS and at harvest. At 45, 60 DAS and harvest 100% RDF + Brassinosteriod @ 0.5ppm (T_2) is statistically on par with T_3 (100% RDF + Foliar spraying of Gibberellic acid @10 ppm), T_4 (100% RDF + Foliar spraying of Salicylic acid @100 ppm). Suresh *et al*. (2018) reported that increased nutrient application, particularly NPK, played a significant role in enhancing dry matter production. The presence of NPK nutrients influenced the efficiency with which sunlight was utilized by promoting increased biomass. It was also noted that any inadequacy of nitrogen adversely affected the efficiency of utilizing sunlight for photosynthesis. Similar, results were also supported by Pradhan *et al*. (2011). The lowest value was recorded in the control (T_1) with values of 4902 kg ha^{-1} and 6324 kg ha^{-1}.

3.3 Leaf area index

The effect of plant growth regulator on leaf area index was presented in Table 2. LAI was significantly influenced by the treatments as compared to control. Application of 100% RDF + Brassinosteriod @ 0.5ppm (T_2) recorded higher LAI at 30 DAS (2.95), 60 DAS (3.23) and at harvest (4.05). It was statistically on par with application of 100% RDF + Foliar spraying of Gibberellic acid @10 ppm (T_3) and 100% RDF + Foliar spraying of Salicylic acid @100 ppm (T_4). The observed phenomenon could be attributed to an increase in leaf numbers, leaf length, width, and the presence of tillers. These findings align with a previous study reported by Kumar *et al*. (2018). Sengupta *et al*. (2011), it was reported that the biomass of the crop increased as the crop aged. Additionally, the application of a growth regulator had a clear and significant impact on the accumulation of dry matter. The lower leaf area index was recorded with values of 1.57, 1.09 and 2.34, respectively.

3.4 Yield

3.4.1. Grain yield

Spraying of foliar nutrients and growth regulators had significant influence on grain yield of finger millet (Table 3). The plant sprayed with plant growth regulators at 100% RDF + Brassinosteriod @ 0.5ppm (T_2) produced significantly higher grain yield of 4791 kg ha^{-1} . This was followed by foliar application of 100% RDF + Foliar spraying of Gibberellic acid @10 ppm (T_3) and this was on par with 100% RDF + Foliar spraying of Salicylic acid @100 ppm

(T_4) with grain yield of 4450 and 4422 kg ha^{-1}, respectively. The observed increase in biomass could be attributed to the enhancement of growth-related characteristics such as leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), and net assimilation rate (NAR). Dawood *et al*. (2012) was noted that the application of plant growth regulators (PGR) resulted in an increase in kernel yield and yield components of sunflower. This increase was attributed to the impact of physiological and biochemical processes that improved vegetative growth, active assimilation, and efficient translocation of nutrients from source to sink. Sengupta *et al*. (2011), it was found that brassinolide exerted a significant influence on the growth and seed yield of the crop. The lowest value was recorded in control (T_1) of 3871 kg ha^{-1}.

3.4.2. Staw yield

Application of 100% RDF + Brassinosteriod @ 0.5ppm (T_2) recorded a higher straw yield of 5950 kg ha^{-1}. It was followed by of 100% RDF + Foliar spraying of Gibberellic acid @10 ppm (T_3) which was statistically on par with 100% RDF + Foliar spraying of Salicylic acid @100 ppm (T_4). The straw yield enhancement due to the adoption of different treatments might be due to the continuous supply of nutrients which in turn increased the plant height, dry matter production. This is also attributed due to the higher nutrient uptake throughout the crop growth period. The results of the present study were in confirmation with the finding of Esther and Gautam. (2020). The lowest straw yield (4468 kg ha^{-1}) was recorded with control (T_1).

3.4.3. Harvest index

The harvest index is the best measure of the source and sink relationship indicating efficient uptake and utilization of nutrients to biological and economic yield. In this investigation, the foliar application of 100% RDF + Brassinosteriod @ 0.5 ppm (T_2) recorded a higher harvest index. This might be due to the increased mobilization of metabolites to reproductive sinks. Azizi Kh *et al*. (2012) reported that foliar spray of gibberellic acid increased the harvest index in soybean. The effect of growth regulator enhances the physiological and biochemical process that to increase the yield and yield attributes reported by Ashwini *et al*. (2021).

3.5 Post-harvest NPK uptake

The higher nutrient uptake of NPK at harvest was recorded in 100% RDF + Brassinosteriod @ 0.5 ppm (T_2) with values of 95.1 kg ha^{-1}, 28.7 kg ha^{-1}and 107.1 kg ha^{-1}(Figure). It was followed by 100% RDF + Foliar spraying of Gibberellic acid @10 ppm (T_3) which was statistically on par with 100% RDF + Foliar spraying of Salicylic acid @100 ppm (T_4). Higher nutrient content in the produce and higher biomass production of finger millet might be the pertinent reason for higher uptake of nutrients. These findings were in close agreement with the results reported Sujatha *et al*. (2008) and Singh *et al*. (2011).The lowest NPK uptake was recorded 55.2, 13.1 and 70.6 kg ha^{-1} at all the stages of harvest in control (T_1).

Table 1. Effect of plant growth regulators on dry matter production (kg ha^{-1}) of direct sown finger millet

DMP (Kg ha^{-1})			
Treatment	**45 DAS**	**60 DAS**	**Harvest**
T_1 - RDF + Water spray	182	2806	3072
T_2 - 100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	442	4902	6324
T_3 - 100% RDF + Foliar spraying of Gibberellic acid @10 ppm	406	4575	6021
T_4 - 100% RDF + Foliar spraying of Salicylic acid @100 ppm	398	4455	6002
T_5 - 50% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	328	4006	5548
T_6 - 50% RDF + Foliar spraying of Gibberellic acid @10 ppm	308	3870	5363
T_7 - 50% RDF + Foliar spraying of Salicylic acid @100 ppm	302	3798	5258
T_8 - Foliar spraying of Brassinosteroid @0.5 ppm	238	3377	4304
T_9 - Foliar spraying of Gibberellic acid @10 ppm	232	3285	4090
T_{10} - Foliar spraying of Salicylic acid @100 ppm	214	3208	3977
SEd	29.03	52.67	72
C.D(P= 0.05%)	61.45	111.502	153

Table 2. Effect of plant growth regulators on leaf area index of direct sown finger millet

LAI			
Treatment	**45DAS**	**60DAS**	**Harvest**
T_1 - RDF + Water spray	1.63	2.09	2.54
T_2 - 100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	2.95	3.23	4.05
T_3 - 100% RDF + Foliar spraying of Gibberellic acid @10 ppm	2.76	2.95	3.74
T_4 - 100% RDF + Foliar spraying of Salicylic acid @100 ppm	2.61	2.75	3.62
T_5 - 50% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	2.33	2.53	3.43
T_6 - 50% RDF + Foliar spraying of Gibberellic acid @10 ppm	2.14	2.26	3.21
T_7 - 50% RDF + Foliar spraying of Salicylic acid @100 ppm	2.03	2.13	3.08
T_8 - Foliar spraying of Brassinosteroid @0.5 ppm	1.97	2.09	2.98
T_9 - Foliar spraying of Gibberellic acid @10 ppm	1.82	1.98	2.82
T_{10} - Foliar spraying of Salicylic acid @100 ppm	1.74	1.84	2.66
SEd	0.085	0.081	0.086
CD (P=0.05%)	0.179	0.171	0.181

Table 3. Effect of plant growth regulators on grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index of direct sown finger millet

Treatment	Grain Yield	Straw Yield	HI
T_1 - RDF + Water spray	3871	4568	0.46
T_2 - 100% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	4491	5840	0.43
T_3 - 100% RDF + Foliar spraying of Gibberellic acid @10 ppm	4450	5768	0.44
T_4 - 100% RDF + Foliar spraying of Salicylic acid @100 ppm	4422	5712	0.44
T_5 - 50% RDF + Foliar spraying of Brassinosteroid @ 0.5 ppm	4298	5473	0.44
T_6 - 50% RDF + Foliar spraying of Gibberellic acid @10 ppm	4273	5264	0.45
T_7 - 50% RDF + Foliar spraying of Salicylic acid @100 ppm	4243	5101	0.45
T_8 - Foliar spraying of Brassinosteroid @0.5 ppm	3991	4844	0.45
T_9 - Foliar spraying of Gibberellic acid @10 ppm	3974	4798	0.45
T_{10} - Foliar spraying of Salicylic acid @100 ppm	3945	4662	0.46
SEd	80.28	82.99	
CD(P=0.05%)	169.9	175.7	

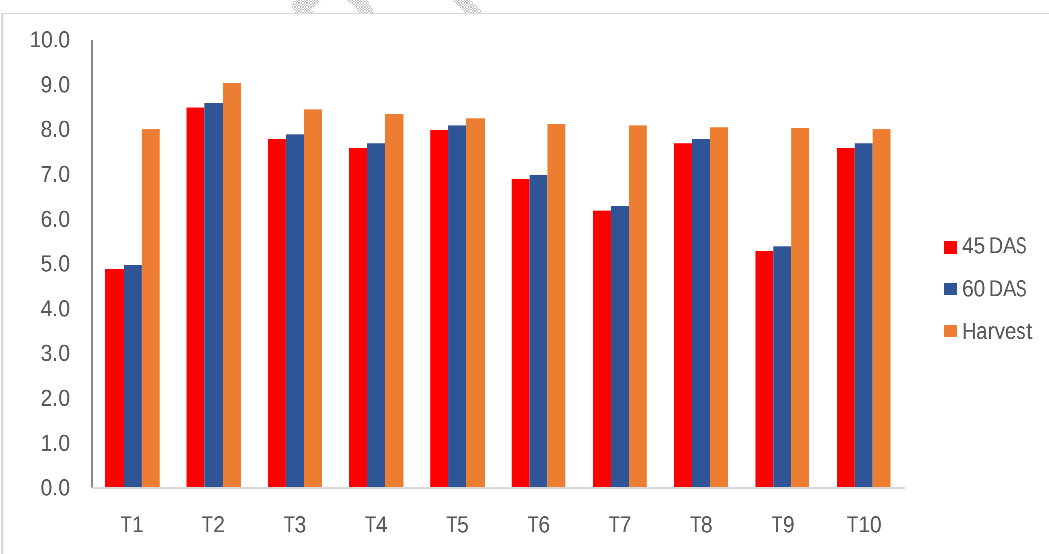
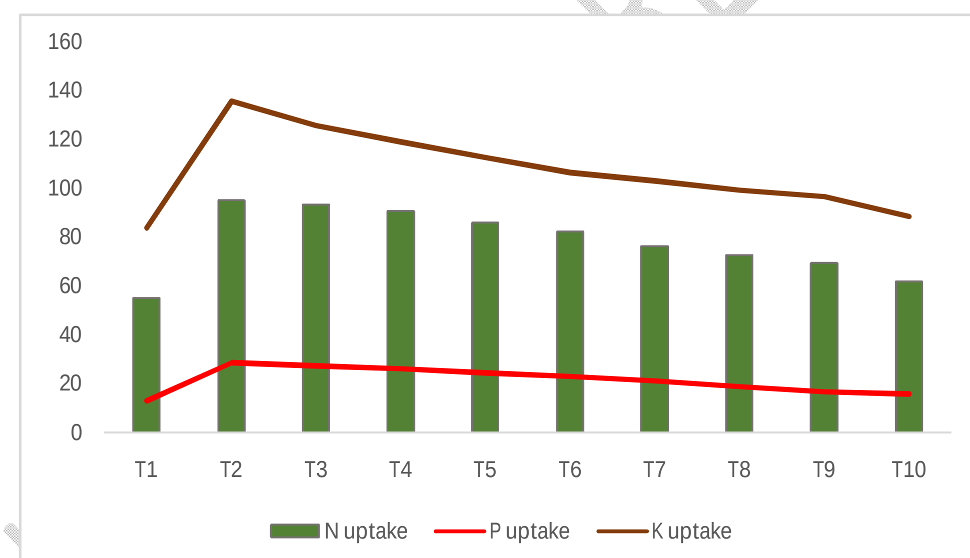


Fig. 1. Effect of plant growth regulator on no. of tillers hill-1 of direct sown finger millet

Fig. 2. Effect of plant growth regulator on NPK uptake of direct sown finger millet



4. CONCLUSION

Based on above findings it can be concluded that combination of 100% RDF + Brassinosteriod @ 0.5 ppm (T_2) has performed better in growth parameters and yield attributes of finger millet and has also proven profitable.

REFERENCES

1. Azizi K, Moradii J, Heidari S, Khalili A., Feizian M. Effect of different concentrations of gibberellic acid on seed yield and yield components of soybean genotypes in summer intercropping. *Intern. J*. Agric. Sci. 2012;2(4):291-301.
2. Dawood MG, Sadak MS, Hozayen M. Physiological role of salicylic acid in improving performance, yield and some biochemical aspects of sunflower plant grown under newly reclaimed sandy soil. Aust. J. of Basic & Applied Sci. 2012; 6(4):82-89.
3. Esmaeil Y. and Abed V. Impact of urea as nitrogen source and Pix as growth regulator on cotton (*Gossypium hirsutum* L.). Int. J. Biol. 2012; 4 : 3.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research 2nd edition. New York. 1984680.
5. Gautam G. Effect of foliar nutrition and plant growth regulators on growth of Blackgram (Vigna mungo L.). Journal of Pharmacognosy and Phytochemistry. 2020; *9*(3), 1754-1756.
6. Golada S, and Debbarma V. Influence of Varieties and Foliar Application of Zinc on Growth, Yield and Economics of Rice (Oryza sativa L.). International Journal of Plant & Soil Science. 2023; *35*(13), 33-42.
7. Kumar AS, Sakthivel N, Subramanian E, Kalpana R, Janaki P, Rajesh P. Influence of foliar spray of nutrients and plant growth regulators on physiological attributes and yield of finger millet (*Eleusine coracana* (L.) Gaertn.). *Inter J of Chem Studies*. 2018; *6*(3), 2876-2879.
8. Pradhan A, Thakur A, Patel, S, Mishra N. Effect of different nitrogen levels on kodo and finger millet under rainfed conditions. Res. J. Agric. Sci. 2011; *2*, 136-138.
9. Sengupta K, Banik NC, Bhui S, Mitra S. Effect of brassinolide on growth and yield of summer green gram crop. Journal of Crop and Weed. 2011; *7*(2), 152-154.
10. Singh AP, Rai A, Singh V, Dubey AK. Comparative study of growth and yield attributes of different paddy cultivars under Tarai region of Uttar Pradesh. Int J Chem Stud. 2020;8(2):129-32.
11. Singh G, Sharma GL, and Golada SL. Effect of enriched FYM with fertilizers & biofertilizers on yield, harvest index, protein, nitrogen and phosphorous content in grains. Journal of Progressive Agriculture. 2011; 2 (3): 65-67.
12. Sujatha MG, Lingaraju BS, Palled YB, Ashalatha KV. Importance of integrated nutrient management practices in maize under rainfed condition. Karnataka Journal of Agricultural Sciences. 2008;21 (3): 334-338.
13. Suresh G, Guru G, Lokanadan S. Effect of nutrient levels and plant growth regulators on growth parameters of Pearl Millet. International Journal of Pure and Applied Bioscience. 2018; *6*(3), 271-277.

14. Thippeswamy TG, junna L, Shinde M. Proximate composition, resistant starch and other phytochemical constituents of native finger millet cultivar. International journal of food and nutritional science. 2016;3(5): 2320-7876.