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Evaluation of Foliar Nutrition for Yield Maximization in Foxtail Millet (*Setaria italica*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was carried out in foxtail millet regarding the effect of various foliar treatments in combination with recommended dose of fertilizer on the growth and yield of the crop at Tamil Nadu Agricultural University, Coimbatore during the summer of 2021. Eight treatments in combinations with 100% of the Recommended Dose of Fertilizer (RDF) were arranged in a randomized block design with three replications. Foliar treatments applied were *viz.*, 3% panchagavya along with recommended dose of fertilizer (T1), 3% vermiwash along with recommended dose of fertilizer (T2), 0.6% TNAU maize maxim along with recommended dose of fertilizer (T3), 1% urea along with recommended dose of fertilizer (T4), 1% KCl along with recommended dose of fertilizer (T5), 0.5% zinc sulphate along with recommended dose of fertilizer (T6), 0.5% iron sulphate along with recommended dose of fertilizer (T7) and recommended dose of fertilizers alone (T8). Each treatment was applied at the active vegetative growth stage and panicle initiation stage of the crop.

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The application of full dose of fertilizer along with a foliar spray of 0.6% maize maxim resulted in higher plant height (132.38 cm), number of tillers (2.37), leaf area index (1.37), dry matter production (5937.74 kg/ha), productive tillers per plant (1.95), panicle length (23.59 cm), panicle weight (15.29 g), grain yield (2130.20 kg/ha) and straw yield (4108.14 kg/ha). The plots treated with recommended fertilizer alone had the lowest level of all parameters. Treatments with foliar spray of 3% panchagavya and 3% vermiwash were statistically on par with maize maxim application. The result of the experiment implies that foliar treatment of 0.6% TNAU maize maxim had a significant effect on growth and yield attributes of foxtail millet.

Keywords: Foxtail millet; foliar treatment; maize maxim; crop boosters; growth; yield.

1. INTRODUCTION

Global agriculture is highly oriented towards certain industrially valued crops like rice, wheat and maize. This resulted in micronutrient deficiencies in a large part of the population. In this context, the cultivation and utilization of naturally occurring nutrient-fortified crops like millets are gaining importance. Small millets contain more nutrients than fine cereals. They are high in carbohydrates, micronutrients and phytochemicals. Millet protein has a better essential amino acid profile than maize protein. Foxtail millet is widely cultivated in Asian and African countries and is considered the second most important millet in the world [1]. It is an annual, erect growing millet that is said to have originated in China. It is known to have high fibre (8%) and mineral content like phosphorus, potassium, magnesium and iron. It is also a rich source of protein (12.3) and calcium (13 mg/100 g). It is fairly drought tolerant and can be effectively used as a short-term catch crop due to its quick growth.

Foliar nutrition is considered as a quick and easy way of supplying nutrients to plants. It is highly cost effective and caters to the immediate nutrient requirements at critical growth stages of the crop. The nutrients get effectively absorbed and translocated to developing plant parts resulting in higher biomass yield. This method can alleviate the problems like fixation of nutrients in the soil, limited soil moisture, leaching loss and reduced soil temperature [2].

Liquid organic manures can eliminate acute nutrient shortage as it gets easily dispersed in water and is absorbed 20 times faster through leaves. Crop boosters like maize maxim are gaining popularity which is a combination product of essential nutrients and growth regulators which results in improved grain filling and thereby increasing the yield by 20%. The use of nitrogen fertilizer enhances biomass yield and protein density in plant tissue. A sufficient supply of potassium can help plants withstand limited moisture and improve physiological efficiency. Zinc regulates the activity of growth hormones and enzyme systems. Iron is acting as an oxygen carrier and helps in chlorophyll formation. Therefore, this study focuses on the evaluation of all of these foliar treatments on the growth and yield attributes of foxtail millet.

2. MATERIALS AND METHODS

The Field experiment was conducted during the summer of 2021 in Eastern Block Farm under the Department of Agronomy at Tamil Nadu Agricultural University, Coimbatore. The geographical location of the experimental site is 427 m above MSL and located in the western agro-climatic zone of Tamil Nadu. The field soil is sandy clay loam with a slightly alkaline reaction (pH 7.6) and low soluble salt concentration (EC 1.26 d Sm^{-1}). The soil test results showed high organic carbon (0.69%), low available nitrogen (270 kg/ha), medium phosphorous (16.5 kg/ha) and high potassium content (713 kg/ha). In the field, the experimental design followed was a randomized block design with three replication and eight treatment *viz*., foliar application of 3% panchagavya along with recommended dose of fertilizer (T1), foliar application of 3% vermiwash along with recommended dose of fertilizer (T2), foliar application of 0.6% TNAU maize maxim along with recommended dose of fertilizer (T3), foliar application of 1% urea along with recommended dose of fertilizer (T4), foliar application of 1% KCl along with recommended dose of fertilizer (T5), foliar application of 0.5% zinc sulphate along with recommended dose of fertilizer (T6), foliar application of 0.5% iron sulphate along with recommended dose of fertilizer (T7) and recommended dose of fertilizers alone (T8). Foxtail millet variety ATL 1 was sown in a spacing of 22.5 cm x 10 cm after application of basal dose of fertilizers (44:22 kg/ha N and P respectively). All other

intercultural operations were followed as and when required as per the crop production guide. Foliar treatments were given at the active vegetative growth stage (25 DAS) and panicle initiation stage (45 DAS) of the crop. Various parameters were recorded at 30 DAS, 60 DAS and at harvest stage from tagged plants in each plot to assess the growth and yield of the crop. Growth parameters like plant height, number of tillers per m^2, leaf area index and dry matter production and yield parameters like productive tillers per m^2, panicle length and panicle weight, number of grains per panicle, 1000 grain weight and grain and straw yield were recorded by following standard procedure. The collected data from each plot was analyzed statistically. Whenever the result showed significant, the critical difference was worked out at a 5% level of significance. Otherwise, it was denoted as non-significant (NS).

3. RESULT AND DISCUSSION

Nutrient management is an integral part of any crop production system. The application of the right quantity of nutrients at the right time has a significant influence on the growth and yield of any crop. From the given study, it can be derived that foliar treatments of nutrients at critical growth stages have resulted in improved growth attributes and higher yield. This can be attributed to the efficient absorption of nutrients from foliar treatment and immediate recovery from nutrient deficiency. This is in agreement with the findings of Karthika and Maheswari (2017), Rajasekhar et al. (2017) and Yassen [3]. The growth parameters like plant height, number of tillers per plant, leaf area index and dry matter production showed a significant variation due to different treatments (Table 1). Among all of the treatments, the application of RDF + TNAU maize maxim (0.6%) showed higher plant height (132.38 cm) and leaf area index (1.37). The maximum number of tillers per plant (2.37) and highest dry matter production (5937.74 kg/ha) were recorded from plots treated with RDF + TNAU maize maxim (0.6%). The treatment with RDF + 3% panchagavya recorded a mean number of tillers per plant of 2.26, LAI of 1.35 and dry matter production of 5647.84 kg/ha followed by treatment with 3% vermiwash (2.19, 1.26, 5327.59 kg/ha respectively) and was at par with maize maxim application. Increased growth parameters by application of crop boosters can be due to the combined effect of macronutrients, micronutrients and growth regulators present in the right proportion. According to Suresh et al. [4], the dry matter accumulation in the plant was attributed to higher supplementation of essential nutrients and phytohormones which results in increased specific leaf weight and improved photosynthesis. Similar results were obtained by Sathishkumar et al. [5] by application of TNAU maize maxim which resulted in improvements in growth-related characteristics such as plant height, dry matter production, and the number of tillers m^{-2}, as well as yield-related characteristics such as the number of productive tillers m^{-2}, ear head weight, and nutrient uptake by finger millet in comparison with control.

Yield improvement is the ultimate aim of any treatment followed. Foliar supplementing of nutrients at the reproductive stages of a crop helps in effective absorption and translocation to the developing reproductive parts which result in the improved productivity and quality of the seeds (Fouly et al. (2001)) [6,7]. The yield contributing factors like productive tillers per plant, panicle length, panicle weight, grain yield and straw yield had a commendable response due to various foliar treatments. The number of productive tillers produced per plant (1.95) was more with the treatment of RDF + TNAU

Table 1. Effect of foliar treatments on growth parameters in foxtail millet

Treatments	Plant height (cm)	No of tillers per plant	LAI	Dry matter production (kg/ha)
T1- RDF +Panchagavya (3%)	130.80	2.26	1.35	5647.84
T2- RDF +Vermiwash (3%)	128.93	2.19	1.26	5327.59
T3- RDF + Maize maxim (0.6%)	132.38	2.37	1.37	5937.74
T4- RDF +Urea (1%)	123.37	1.96	1.20	5161.24
T5- RDF +KCl (1%)	121.69	1.86	1.152	5064.04
T6- RDF +Zinc sulphate (0.5%)	123.06	1.69	1.16	4670.71
T7- RDF +Iron sulphate (0.5%)	120.92	1.67	1.04	4323.58
T8- RDF alone (control)	118.15	1.61	0.96	3948.87
SEd	10.066	0.11	0.069	339.53
CD (p=0.05)	NS	0.241	0.148	728.23

Table 2. Effect of foliar treatments on yield parameters in foxtail millet

Treatments	Productive tiller per plant	Panicle length (cm)	Panicle weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T1- RDF +Panchagavya (3%)	1.85	20.98	13.35	2055.45	3993.05
T2- RDF +Vermiwash (3%)	1.758	19.50	12.94	2015.61	3915.07
T3- RDF + Maize maxim (0.6%)	1.95	23.59	15.29	2130.20	4108.14
T4- RDF +Urea (1%)	1.71	18.67	11.19	1861.33	3772.21
T5- RDF +KCl (1%)	1.72	18.08	10.59	1800.64	3614.84
T6- RDF +Zinc sulphate (0.5%)	1.67	16.31	9.05	1690.74	3588.24
T7- RDF +Iron sulphate (0.5%)	1.63	15.66	8.65	1619.56	3528.36
T8- RDF alone (control)	1.51	13.89	6.60	1523.67	3198.04
SEd	0.11	1.39	0.91	112.20	143.72
CD (p=0.05)	0.24	2.98	1.96	240.65	308.25

maize maxim (0.6%). Panicle length (23.59 cm) and panicle weight (15.29 g) were found to be highest in plants supplied with RDF + TNAU maize maxim (0.6%). The grain yield (2130.20 kg/ha) and straw yield (4108.14 kg/ha) showed a significant rise due to treatment with RDF + TNAU maize maxim (3%). The productive tiller per plant, grain yield and straw yield recorded from treatments *viz*., RDF + panchagavya (1.85, 2055.45 kg/ha, 3993.05 kg/ha respectively) and RDF+ vermiwash (1.75, 2015.61 kg/ha, 3915.07 kg/ha respectively) were on par with TNAU maize maxim. The balanced nutrient application at the appropriate crop growth stage along with necessary growth regulators present in crop boosters resulted in the enhanced allocation of nutrients to the reproductive parts and improved grain filling. Devaraju and Senthivel [8] found that applying crop booster (pulse wonder @ 5 kg/ha spray) in black gram at flowering and 15 days after spray produced significantly more pods per plant, the highest yield and the highest net return than other foliar spray treatments, which can be attributed to a higher supply of all nutrients during the flowering and pod formation stages of crop growth. This resulted in efficient nutrient translocation from source to sink. These results fall similar to the findings of Kunjammal and Sukumar [9], Kiruthika et al. [10] and Rajeshkumar et al*.* [11], who could find improved yield attributes due to the application of crop boosters [12-14].

4. CONCLUSION

From the study conducted, it is concluded that treatment with 0.6% TNAU maize maxim at active vegetative growth stage and panicle initiation stage of foxtail millet in addition to the recommended dose of fertilizer resulted in higher growth attributes and yield advantage compared to control. It was followed by treatments with 3% panchagavya and 3% vermiwash and was statistically at par with maize maxim.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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