Eco. Env. & Cons. 30 (May Suppl. Issue) : 2024; pp. (S259-S264)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i03s.045

Evaluation of foliar application of bio-stimulants and nutrients on the seed yield of transplanted finger millet (*Eleusine coracana*)

S. Seemansethupathi[1] and A. Kamaraj[2]*

[1,2]Department of Genetics and Plant Breeding, Annamalai University, Chidambaram, Tamil Nadu, India

(Received 28 August, 2023; Accepted 1 November, 2023)

ABSTRACT

Foliar application of bio-stimulants and nutrients is a rapid and promising strategy to enhance the availability of nutrients at a critical stage of crop growth. This favoured the nutrient balance in improving crop growth and yield potential. Therefore, this field study was conducted during 2021 at a farmer's field in Srivilliputhur block, Tamil Nadu to assess the effect of foliar application of bio-stimulants and nutrients on transplanted finger millet CO15. The experiment was laid out in Randomized Block Design (RBD) with three replications and eight treatments *viz.*, Control, GA_3 @ 50 ppm, Panchagava @ 3%, Seaweed extract (*Sargassum wightii*) @ 5%, Humic acid @ 5%, Boron @ 0.3%, $ZnSO_4$ @ 0.5% and $FeSO_4$ @ 0.5% sprayed twice at 20 DAT and 45 DAT. Ten characters namely plant height, number of tillers/hill, Leaf area index, dry matter production, number of ear heads/hill, number of fingers/ear head, finger length, test weight, seed yield and straw yield were studied. Among the different foliar treatments, NPK along with the foliar application of $ZnSO_4$ @ 0.5% (T_6) significantly enhance the growth and yield parameters compared to the other treatments. Hence, foliar application of $ZnSO_4$ @ 0.5% (T_6) could be adopted to get a higher seed yield.

Key words: *$ZnSO_4$, GA_3, Seaweed extract, Foliage application, Seed yield*

Introduction

Finger millet (*Eleusine coracana*) is a prominent minor millet crop known as ragi, African millet, and bird's foot millet. Finger millet being a C_4 crop, meets all the requirements for being highly suitable for both irrigated and rain-fed marginal soils with high nutritional value (Mohanabharathi *et al.*, 2019). Finger millet is one of the important millet crops grown in India next to sorghum and pearl millet (Dass *et al.*, 2013). It has a pride in having higher productivity among millets. In India, finger millet constitutes an area of 8.91 million ha with an annual production of 1.23 million tones and productivity of 1390 kg/ha (Ministry of Agriculture & Farmers Welfare, Govt. of India, 2019).

Finger millet has substantial health advantages because of its high levels of dietary fibre, phenolic compounds, and other useful component. The seed contain 9.2% proteins, 1.29% fats, 76.32% carbohydrates, 2.2% mineral, 3.90 % ash and 0.33% calcium (Gowthami *et al.*, 2022). Finger millet's decreased output can be related to a myriad of situations, including its cultivation in marginal and poor soils, insufficient irrigation, and poor management techniques. One of the main causes of finger millet's low

([1]Ph.D. Scholar, [2]Assistant Professor)
ORCID ID: https://orcid.org/0000-0003-2706-113X

yield among these variables is its fertilization component (Sathishkumar *et al.*, 2018). The seed is the most crucial component for maximizing agricultural yield. The effectiveness of numerous agricultural inputs, such as fertilizers, pesticides, and irrigation, in enhancing productivity and production is largely determined by seed quality. For agronomic and horticultural crops to be produced, high-quality seeds are essential. Twenty to twenty five percent of productivity is attributed to seed quality.

In recent years the area and average productivity under finger millet are in decreasing trend in Tamil Nadu (Ministry of Agriculture & Farmers Welfare, Govt. of India, 2019). The low yield is mainly attributed to the inadequate and imbalanced application of nutrients. The prominent effect of foliar application of bio-stimulants and nutrients at the pre-flowering and flowering stage was to reduce the flower drop percentage. Foliar application is a method of plant nutrition that involves directly applying nutrients to the leaves than the soil. Foliar nutrients make it easier and faster for cells to absorb nutrients since they often pass through the leaf cuticle or stomata and into the cells (Latha and Nandanasababady, 2003). Many studies have reported that the foliar application of bio-stimulants and nutrients caused an enhancement in plant growth, seed yield and its component on Kodo millet (Sujatha *et al.*, 2016); maize (Humtsoe *et al*., 2018); rice (Ramesh *et al.*, 2019); Foxtail Millet (Biswas *et al*., 2019); finger millet (Chowdary and Patra, 2019), Kumar *et al*., (2020), Naveen and Krishnamoorthy (2021) and Groundnut (Prakash *et al.*, 2022). Keeping the above background, the present investigation was taken up on the growth and seed yield of finger millet as influenced by foliar application of bio-stimulants and nutrients.

Materials and Methods

A field experiment was conducted during 2021 at Srivilliputhur block, Tamil Nadu, India (9.4393890 Latitude and 77.6664830 Longitude, with a height of 137.2 meters above the mean sea level (MSL). The experimental soil at 0"30 cm depth was assessed for various physico-chemical properties of soil. The field's soil is a sandy clay loam in nature with 0.54 % of organic matter. The soil texture is 54.23% of sand, 23.53% of silt and 26.24% of clay. The pH of the soil was 7.1 and the electrical conductivity of the soil was 0.42. The maximum temperature during the cropping period ranges from 30.4°C to 35.7 °C with a mean temperature of 32.8 ^{0}C and the minimum temperature fluctuates between 20.7°C to 25.5°C with a mean temperature of 22.7 ^{0}C. The relative humidity ranged from 61.0% to 76.0% with an average of 67.9%. During the crop period, 435.7 mm of rainfall was recorded. The experiment comprised of eight treatments *viz.*,

T_0 – Control, T_1 – GA_3 @ 50 ppm (25 gm/ha), T_2 – Panchagava @ 3% (15 Lit/ha), T_3 –Seaweed extract (*Sargassum wightii*) @ 5% (25 Lit/ha), T_4 – Humic acid @ 5% (25 Lit/ha) , T_5 – Boron @ 0.3% (1.5 kg/ha), T_6 – $ZnSO_4$@ 0.5% (2.5 kg/ha) and T_7 – $FeSO_4$ @ 0.5% (2.5 kg/ha) with finger millet 'CO15'crop having a plot size 5 × 4 m. The experiment was laid out in Randomized Block Design (RBD) with three replications. The recommended dose of 60: 30: 30 kg N, P_2O_5 and K_2O/ha was applied in the form of Urea (46% N), Single super phosphate (16% P_2O_5) and Muriate of potash (60 % K_2O). As per the recommendation, basal application of 30: 30: 30 kg N, P_2O_5 and K_2O_5/ha was applied uniformly to all plots at the time of transplanting and the remaining dose of 30 kg N/ha was applied 45 days after transplanting. Foliar application of bio-stimulants and nutrients was applied twice at 20 DAT and 45 DAT of crop growth according to the above treatments replication wise in their respective plots.

At the vegetative stage (30 DAT), active tillering stage (60 DAT) and harvest stage of the crop, the observations were noted. The five tagged plants in each plot were marked randomly to collect data on growth characters *viz.*, plant height, number of tillers/hill, Leaf area index, dry matter production at harvest stage and yield attributes *viz.*, number of ear heads/hill, number of fingers/ear head, finger length, test weight, seed yield and straw yield. The samples were air dried first, then oven-dried at 70^{0}C until they attained a uniform dry weight. The mean dry weight was calculated in kg/ha. From the net plot area, the seed and straw yield was calculated and expressed in kg/ha. Data were analyzed using OPSTAT for analysis of variance (ANOVA) as described by Gomez and Gomez (1984) and the treatment difference was calculated using the critical difference (CD) at a 5% level of probability.

Results and Discussion

Growth characters

The impact of different foliar applications has a substantial influence on the plant height, the number of tillers/hill, leaf area index, and dry matter production. Among the treatments foliar application of $ZnSO_4$ @ 0.5% (T_6) showed a remarkable increase in plant height (43.7 cm, 104.5 cm, and 120.3 cm at 30, 60 DAT and harvest stage respectively). The shortest plant height (35.0 cm, 84.6 cm, and 96.2 cm at 30, 60 DAT and harvest stage respectively) was recorded in (T_1) control. An increase in plant height might be due to the role of zinc in the formation of IAA, carbonic anhydrase and various enzymes that enhanced the physiological and metabolic activity of plants. Formation of IAA (by tryptophan synthesis) due to foliar application of $ZnSO_4$ induces rapid cell multiplication and cell elongation in the meristematic region, which in turn improved the length of internodes length thereby, increasing the plant height. In addition, Zinc plays a role in nitrogen uptake and sulphur in the transfer of high-energy molecules which favors better crop growth (Pandey and Sinha, 2021). These outcomes were similar to those reported earlier by Shehla and Atif (2019). The recorded data on plant height was presented in Fig 1.

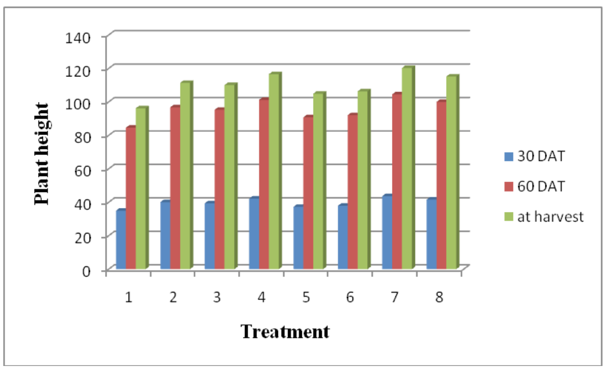

Fig. 1. Effect of foliar application on plant height at different growth stages (DAT – Days after transplanting)

During plant growth, it was observed that tillering expanded progressively more as the plant growth advanced. During 30 DAT, a maximum number of tillers/hill (2.8) was observed under foliar application of $ZnSO_4$ @ 0.5% (T_6). Foliar application twice during the vegetative and flowering stage of crop growth has revealed a similar trend at 60 DAT (5.7) and harvest stage (6.8) respectively. The minimum number of tillers/hill (2.3, 4.6, and 5.6 tillers at 30, 60 DAT and harvest stage respectively) was recorded in (T_1) control (Fig. 2). As a result of foliar spraying of Zinc sulphate, the crops grew taller and their enzyme activity was higher due to the positive role of zinc, inefficient photosynthesis as well as sulphur ions is readily available to plants for effective physiological activity, which in turn encouraged the growth of more tillers plant. Similar findings have been reported earlier by Chowdary and Patra, (2019).

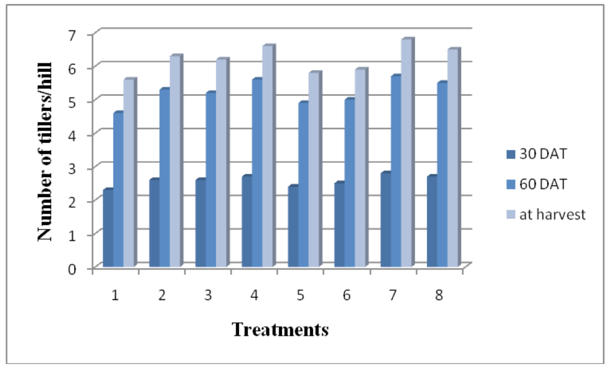

Fig. 2. Effect of foliar application on the number of tillers/hill at different growth stages (DAT – Days after transplanting)

The Leaf area index (LAI) was (2.0, 3.3 and 2.9 at 30, 60 DAT and harvest stage respectively) recorded significantly higher and positive expansion under foliar application of $ZnSO_4$ @ 0.5% (T_6). The minimum number of LAI was (1.6, 2.8 and 2.3 at 30, 60 DAT and harvest stage respectively) recorded (T_1) control. The positive impact of zinc foliar application on LAI could be due to the increased synthesis of growth hormone auxin coupled with nutrient uptake especially nitrogen which favored leaf area expansion by enhanced cell division and cell elongation. Similar findings have been reported earlier by

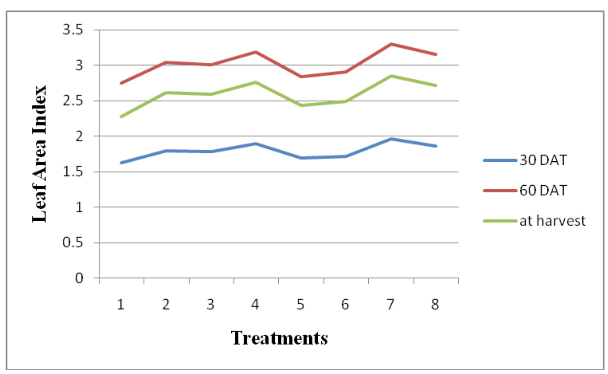

Fig. 3. Effect of foliar application on leaf area index at different growth stages (DAT – Days after transplanting)

Nadergholi *et al.,* (2011) and Yadav *et al.* (2021). The recorded data on the leaf area index was presented in Fig. 3.

It was found that high dry matter production (4235 kg/ha, 7034 kg/ha and 9105 kg/ha at 30, 60 DAT and harvest stage respectively) was recorded under the foliar application of $ZnSO_4$ @ 0.5% (T_6). The lowest dry matter production (3284 kg/ha, 5853 kg/ha and 6937 kg/ha at 30, 60 DAT and harvest stage respectively) was recorded in (T_1) control. Higher dry matter production induced by foliar application of $ZnSO_4$ would possibly be due to the role of zinc and sulphur in preventing the chloroplast injury and involvement in the synthesis of more chlorophyll, which promotes vigorous vegetative growth (photosynthetic area and tiller count), that ultimately boosted dry matter yield (translocation of assimilates to the sink). Similar findings have been reported earlier by Arshewar *et al.* (2018). The recorded data on dry matter production was presented in Fig 4.

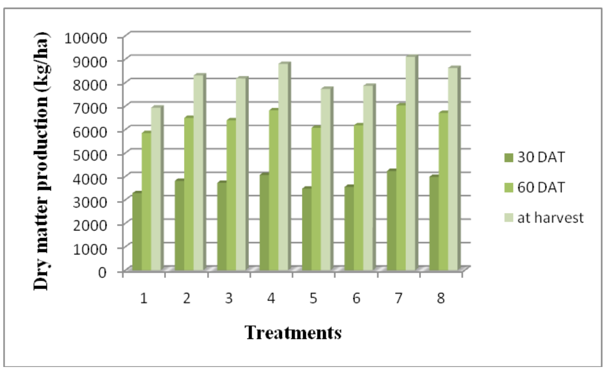

Fig. 4. Effect of foliar application on the dry matter production at different growth stages (DAT – Days after transplanting).

Yield attributes

The trend continued in the same line as that of growth parameters. Foliar is applied twice which converts crop tillers into effective tillers. The maximum number of ear heads/hill (4.5) at the harvest stage was observed in the foliar application of $ZnSO_4$ @ 0.5% (T_6). This was due to a more assimilatory surface and effective photosynthesis favored by better vegetative growth in T_6 compared to others. The minimum number of ear heads/hill (3.4) was observed in (T_1) control.

Similarly, the maximum number of fingers/ear head (7.3) was recorded under the foliar application of $ZnSO_4$@ 0.5% (T_6). Which were considerably better than all other treatments? The minimum number of fingers (4.5) obtained from (T_1) control. Foliar application of $ZnSO_4$@ 0.5% has a striking influence on the number of fingers/ear head and finger length. The finger length was longer (9.3 cm) under the foliar application of $ZnSO_4$ @ 0.5% (T_6). While shortest finger length (6.7cm) was observed in (T_1) control. The recorded data on the number of ear heads/hill, the number of fingers/ear head and finger length was presented in Fig. 5.

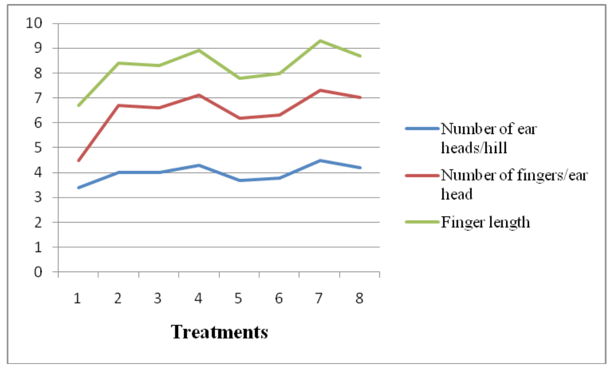

Fig. 5. Effect of foliar application on of yield attributes (DAT – Days after transplanting)

However, foliar application of bio-stimulants and nutrients does not have any significant influence on the test weight of finger millet. The highest test (3.23 g) weight was recorded in T_6 and the lowest test (3.21 g) weight was observed in (T_1) control. This might be due to the role of zinc in the transfer of photo-assimilates from source (leaf) to sink (Seed). Similar findings have been reported earlier by Gokul and Senthilkumar (2019). The recorded data on the seed test weight was presented in Fig. 6.

Foliar application of $ZnSO_4$ can be expanded the yield attributes characters through photosynthesis of green plants. All growth and yield attributing char-

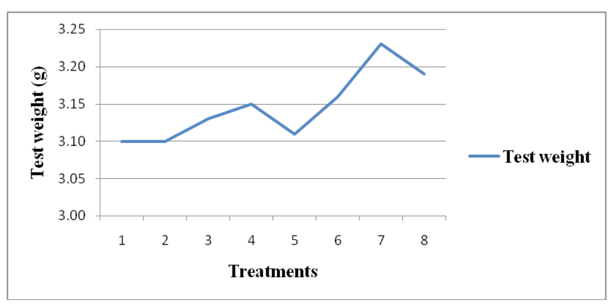

Fig. 6. Effect of foliar application on test weight (DAT – Days after transplanting)

acteristics combined to have an impact on seed yield. Foliar spray of $ZnSO_4$ @ 0.5% (T_6) recorded the most seed yield (2896 kg/ha) that was considered superior over all treatments. The treatments T_3 (Seaweed extract (*Sargassum wightii*) @ 5%) and T_7 ($FeSO_4$ @ 0.5%) ranked second in the order of magnitude. The above two treatment was statistically on par with each other. The lowest seed yield (2153 kg/ha) was obtained from NPK alone (T_1) control. The increase in yields from the foliar application through the leaves may have led to a better nutritional balance, which increase the nitrogen uptake, protein synthesis and plant photosynthetic efficiency resulting ultimately improved growth and yield attributes (Shekhawat and Kumawat, 2017 and Shehla Noreen and Atif Kamran, 2019).

The significantly higher straw yield (7109 kg/ha) was recorded in the foliar spray of $ZnSO_4$ @ 0.5% (T_6). The lowest straw yield (5684 kg/ha) was recorded in (T_1) control. The foliar application $ZnSO_4$ may have improved assimilatory surface, which in turn increased photosynthetic, and growth hormone production, following internodes elongation and subsequent luxurious growth, which ultimately contributed to the increased dry matter production. These outcomes were similar to the report Jain *et al.*, (2018). The recorded data on seed yield and straw yield was presented in Fig. 7.

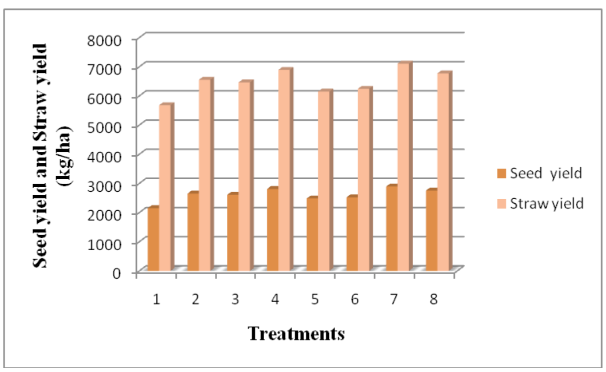

Fig. 7. Effect of foliar application on seed and straw yield (DAT – Days after transplanting)

Conclusion

Finger millet was an underrated crop and its usage has increased recently due to its significant nutritional health benefits. Additionally in Tamil Nadu, the production of finger millet is decreasing. From this study, it could be concluded that foliar application of $ZnSO_4$ @ 0.5% sprayed twice at vegetative (20 DAT) and flowering stage (45 DAT) of crop growth, brings about an improvement in growth and yield attributes of finger millet. For future studies, there is a need to intensify the study of the combined effect of foliar spray on plant growth regulators, organics and nutrients in varying ecosystems to increase the seed yield related attributes.

Conflict of Interest: None

References

Arshewar, S.P., Karanjikar, P.N., Dambale, A.S. and Kawde, M.B. 2018. Effect of nitrogen and zinc levels on growth, yield and economics of pearl millet. *Int. J. Bio-Resour. Stress Manag.* 9(6): 729-732. https://doi.org/10.37273/chesci.cs20520509

Biswas, D., Mannan, M.A., Karim, M.A. and Miah, M.Y. 2019. Amelioration of salinity tolerance in foxtail millet by applying plant growth regulators. *Bangladesh Agron. J.* 22 (2): 25-39.

Chowdary, K.A. and Patra, B.C. 2019. Effect of micronutrient application with different sources of NPK on growth and yield of finger millet crop in red laterite zone. *J. Agric. Sci Tech.* B. 9 : 403-416. https://doi.org/10.17265/2161-6264/2019.06.004

Dass, A., Sudhishri, S. and Lenka, N.K. 2013. Integrated nutrient management to improve finger millet productivity and soil conditions in hilly region of Eastern India. *J. Crop. Improv.* 27(5): 528546. https://doi.org/10.1080/15427528.2013.800828

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research.

Gokul, G. and Senthil Kumar, N. 2019. Effect of foliar feeding technique on growth and yield of ragi. *Plant Arch.* 19(2): 2889-2892.

Gowthami, S., Keerthi, B., Gayethri, G., Reddy, S. R. and Singh, S. 2022. Effect of organic manures and zinc levels on growth and yield of finger millet. *J. Pharm. Innov.* 11(4): 1747-1750.

Humtsoe, B.M., Dawson, J. and Rajana, P. 2018. Effect of nitrogen, boron and zinc as basal and foliar application on growth and yield of maize. *J. Pharmacogn. Phytochem*. 7 (6): 01-04.

Jain, A.K., Shrivastava, S. and Arya, V. 2018. Response of organic manure, zinc and iron on soil properties, yield and nutrient uptake by pearl millet crop grown in inceptisol. *Int. J. Pure Appl Biosci*. 6(1): 426-435.

Kumar, E. A., Surekha, K., Rekha, K. B. and Sharma, S. H. K. 2020. Effect of various sources of zinc and iron on grain yield, nutrient uptake and quality parameters of finger millet. *Int. Res. J. Pure Appl Chem*. 21(2): 46-55.

Latha, M.R. and Nadanasababady, T. 2003. Foliar nutrition in crops-A Review. *Agric. Rev.* 24 : 229-234.

Ministry of Agriculture and Farmers Welfare, Govt. of India. 2019. Selected State-wise area, production and productivity of finger millet. http://www.indiastat.com

Mohanabharathi, M., Sritharan, N., Senthil, A. and Ravikesavan, R. 2019. Physiological studies for yield enhancement in finger millet under drought condition. *J. Pharmacogn. Phytochem.* 8: 3308-3312.

Nadergoli, M. S., Yarnia, M. and Khoei, F. R. 2011. Effect of zinc and manganese and their application method on yield and yield components of common bean. *Middle East J. Sci. Res*. 8(5): 859-865.

Naveen, T. and Krishnamoorthy, R. 2021. Studies on impact of organic sources for sustainable yield and soil health in finger millet. cv. CO 9. *Crop Res.* (0970-4884): 56.

Pandey and Sinha, 2021. *Plant Physiology and Biochemistry*. 978-93-90845-78-1

Prakash, S., Raman, R., Krishnamoorthy, R. and Balaji, E. 2022. Effect of organic foliar nutrition on growth and yield of groundnut. *Crop Res.* 57: 249-252. https://doi.org/10.31830/2454-1761.2022.CR.-817

Ramesh, S., Sudhakar, P., Elankavi, S., Suseendran, K. and Jawahar, S. 2019. Effect of gibberellic acid (GA_3) on growth and yield of rice. *Plant Arch*. 19: 1369-1372.

Sathishkumar, A., Sakthivel, N., Subramanian, E., Kalpana, R., Janaki, P. and Rajesh, P. 2018. Foliar application of nutrients and plant growth regulators on growth and yield of finger millet. *J. pharmacogn. Phytochem.* 7: 3, 3032-3035.

Shekhawat, P.S. and Kumawat, N. 2017. Response of zinc fertilization on production and profitability of pearl millet under rainfed condition of rajasthan: zinc fertilization for improving production and profitability of pearl millet. *J. Agri Search*. 4(4): 251-254.

Shehla, N. and Atif, K. 2019. Foliar application of zinc sulphate to improve yield and grain zinc content in wheat (*Triticum aestivum* L.). *Afr. J. Agric. Res.* 14(20): 867-876. https://doi.org/10.5897/AJAR2018.13593

Sujatha, K. Anand, R. Ragupathi, K.P and Sabir Ahamed. A. 2016. Effect of organic foliar nutrition on growth and yield attributes of kodo millet. *AIJRFANS*. 2328-3785. http://www.iasir.net

Yadav, S.K., Dudwal, B.L., Yadav, V.L., Yadav, K.C. and Yadav, J.K. 2021. Effect of Moisture Conservation Practices and Zinc Fertilization on Nutrient Status and Quality of Pearlmillet under Rainfed Condition. *Indian J. Agric. Res.* 55(5): 629-633.