Available online at
http://agrospheresmagazine.vitalbiotech.org/

ISSN (E): 2582 – 7022

Agrospheres:e- Newsletter, (2024) 5(10), 29-32

Article ID: 787

Foxtail Millet- A golden ticket to food security in the regime of climate change

Kumari Anjani[*1]

[1]Department of Agricultural Biotechnology and Molecular Biology
College of Basic Sciences and Humanities
Dr. Rajendra Prasad Central Agricultural University, Pusa

Article History
Received: 23. 09.2024
Revised: 27. 09.2024
Accepted: 1. 10.2024

INTRODUCTION

Foxtail Millet also known as Italian Millet, is an annual grass belonging to the Poaceae family. It is the second most widely cultivated millet species, and the most commonly grown millet species in Asia. Among all the small millets, it is considered as the second most widely grown species and the most cultivated small millet species in Asia. It is one of the six major cereals in the world and is consumed by one-third of the world's population. Foxtail millet has a similar carbohydrate content as rice but is higher in other nutrients such as protein, calcium, phosphorus, iron, and vitamin B1, giving it special value (Kamatar et al., 2015; Setyowati et al., 2020). In addition to being gluten-free, it also contains plenty of lysine, thiamine, and niacin and essential amino acids. It contains compounds called nitrilosides that have anti-cancer role and reduce the risk of heart diseases (Verma et al., 2015). Protein makes up the majority of foxtail millet's composition, while a good amount of fat and fiber come second. This millet contains 3.73 mg of the minerals iron and 30.10 mg of magnesium per 100 g (Verma et al., 2015). The consumption of foxtail millet is believed to suppress cancer cell formation and risk of heart disease including arteriosclerosis, heart attack, stroke, and hypertension (Verma et al., 2015). These nutraceutical properties combined with its climate resilient nature makes foxtail millet a crop of choice for cultivation in adverse climatic conditions.

Foxtail millet is well recognized as a short duration and drought tolerant crop. In India, it is cultivated in an area of 0.87 lakh hectares with a total production of about 0.66 lakh tonnes and a productivity of 762 kg/ha during 2015-16. It is mostly grown as a Kharif crop, with sowing starting from mid-June to July. India is considered the largest producer of this crop (Sahoo et al. 2020). It is grown in states like Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh and Bihar. It is an important crop in arid and semi-arid areas of the region.

ISSN (E): 2582 – 7022

However, climate change, which has emerged as a major challenge in recent years is affecting the production and productivity of this crop in many countries including India. The global climate change is causing changes in rainfall pattern leading to unpredictable, uneven and untimely flooding and drought events. This has led to an increase in erratic altered climatic events. As a result, the crops are exposed to many stresses at a time, disrupting not only the production but also quality of the crop. Hence, the crops like foxtail millet, which can survive in diverse climatic conditions, can solve the problem of food security.

Foxtail millet as climate smart crop

The millets have served as a safety net for impoverished farmers facing the unpredictable Indian monsoon, providing a form of insurance against climate change for generations to come since time immemorial. These resilient crops thrive in harsh condition, enduring droughts and high temperatures, and flourishing in the driest and most challenging environments. Unlike water-intensive cereals such as rice and wheat, millets require substantially less water, positioning them ideally for a future shaped by climate change and global warming. Due to their resilience against drought, temperature variations, and pests, millets thrive under challenging condition, offering farmers and the agriculture sector a safeguard against potential losses. Moreover, their ability to flourish in dry soils enables farmers to minimize tillage and reduce cultivation time. In arid regions of Karnataka, many farmers have already adapted to climate change by transitioning from water-intensive crops like rice, sugarcane, and maize to diverse varieties of drought-resistant millets (Bose, 2018). Foxtail millet is one such crop, which due to its C4 metabolism and high nutrient content is emerging as a climate smart crop. Foxtail millet possesses climate-smart and resilient properties, making it well-suited for a variety of ecological condition. It thrives with less irrigation, performs well under low nutrient input, requires minimal chemical fertilizers, and is less susceptible to drought stresses (Balsamano *et al*., 2006). The crop possesses many remarkable advantages which makes it a climate smart crop.

Short life cycle: Foxtail millet is a short duration crop and takes only 80-90 days to reach the harvesting stage. Its short life cycle helps it to withstand erratic weather patterns and climate change impacts making it less prone to damage from extreme weather events. The short life cycle also enables multiple cropping seasons within a year (Gandhi et al., 2024).

Survival in wide range of environmental conditions: Foxtail millet can be grown in both tropical and temperate regions with low to moderate rainfall. This plant can grow well in arid and semi-arid areas (Zooleh, 2011). It can grow well in a variety of soils ranging from sandy soil to clay soil, most suitable being loamy soil with good drainage. The crop can also be grown at an altitude of 2000 m and 50-75 cm annual rainfall. This plant is well adapted to low rainfall and can be planted when other crops cannot be grown.

C4 metabolism: The plant exhibits a C4 mechanism and has higher photosynthetic rate as compared to C3 plants. Additionally, the C4 metabolism enhances the water use efficiency of the plant, since C4 plants close their stomata more frequently, reducing water loss through transpiration. This makes the foxtail millet more energy efficient, provides superior growth, and higher rates of carbon fixation and biomass production, which helps in its better adaptation to changing climatic conditions (Singh and Prasad, 2020).

Tolerance to multiple abiotic stresses: Foxtail millet can survive under a wide range of environmental stress conditions, especially drought stress (Dai et al., 2012; Kirankumar et al., 2016), salinity stress (Puranik et al., 2011) and cold stress in addition to various biotic stresses. The plant has the ability to survive many abiotic stresses at a time. The plant is well adapted to low rainfall and can be planted when other crops cannot be planted. The plant is particularly tolerant to drought and many studies have identified key genes regulating the drought tolerance in the plant (Geng et al., 2021; Zhang et al., 2023). In fact, the plant is used as a model pant for the identification of molecular pathway of drought tolerance in millets (Zhang et al., 2023, Gandhi et al., 2024). Similarly, the genes for salinity tolerance have also been identified in the crop, which contribute to adaptations to this stress (Qi et al., 2013; Yang et al., 2019; Zhao et al., 2021). The plant has also been shown to have tolerance to waterlogging (Borah, 2023; Sharma, 2024). Due to its wide range of adaptations, foxtail millet has become an important crop that

can provide food and nutrition security in the current regime of climate change due to its C4 metabolism and high nutrient content.

CONCLUSION

Foxtail millet is the one of the most ancient crops having remarkable nutritional value and climate resilience. They can survive with minimum inputs, without the need of irrigation, fertilizers or pest control agents. They can grow as rainfed crop and can survive erratic weather conditions. These small seeded grains provide higher nutrition than rice, wheat and maize. Therefore, foxtail millet can be a golden ticket to meet the increasing food demand of the growing population and ensure food security for humans and cattle alike.

REFERENCES

Balsamo, R. A., Willigen, C. V., Bauer, A. M., & Farrant, J. (2006). Drought tolerance of selected Eragrostis species correlates with leaf tensile properties. *Annals of botany*, *97*(6), 985-991.

Borah, B. (2023). Morpho-physiological characterization and gene expression profiling of foxtail millet genotypes for waterlogging tolerance at seedling stage., Masters' Thesis, Dr. Rajendra Prasad Central Agricultural University.

Bose, H. K. (2018). Farmers turn to millets as a climate-smart crop. *LEISA India*.

Dai, H. P., Shan, C. J., Wei, A. Z., Yang, T., Sa, W. Q., & Feng, B. L. (2012). Leaf senescence and photosynthesis in foxtail millet ['Setaria italica'(L.) P. Beauv] varieties exposed to drought conditions. *Australian Journal of Crop Science*, *6*(2), 232-237.

Gandhi, M. K., Anjani, K., Kale, A. N., Paul, P., & Sharma, V. K. (2024). Exploring the Correlation between Yield Components and Nutrient Content in Foxtail Millet [*Setaria italica* (L.) Beauv.] Genotypes Subjected to Drought Stress Condition. Journal of Advances in Biology & Biotechnology, 27(7), 980-987. DOI: 10.9734/jabb/2024/v27i71058

Geng, Z., Liu, J., Li, D., Zhao, G., Liu, X., Dou, H., ... & Wang, Y. (2021). A conserved miR394-targeted F-box gene positively regulates drought resistance in foxtail millet. Journal of Plant Biology, 64, 243-252.

Kamatar, M. Y., Brunda, S. M., Rajaput, S., & Hundekar, R. (2015). Nutritional composition of seventy five, elite germplasm of foxtail millet (Setaria italica). *Inter. J. of Engineering Research & Technology*, *4*(4).

Kirankumar T V, Madhusudhan K V, Nareshkumar A, Kiranmai K, Lokesh U, Venkatesh B and Sudhakar C 2016 Expression analysis of Aldo-Keto Reductase1(AKR1) in foxtail millet (Setaria italica L.) subjected to abiotic stresses Am. J. Plant Sci. 7: 500-509

Mali Ram Sharma (2024). Gene expression profiling of ERF family genes in foxtail millets (Setaria italica) under pre and post-heading waterlogging. Masters' Thesis, Dr. Rajendra Prasad Central Agricultural University.

Puranik, S., Jha, S., Srivastava, P. S., Sreenivasulu, N., & Prasad, M. (2011). Comparative transcriptome analysis of contrasting foxtail millet cultivars in response to short-term salinity stress. *Journal of Plant Physiology*, *168*(3), 280-287.

Sahoo, I., Satish, P., Hussain, S. A., & Sharma, S. H. K. (2020). Growth, yield attributes and yield of foxtail millet as influenced by varieties and integrated nutrient management. *Journal of Pharmacognosy and Phytochemistry*, *9*(4), 3426-3429.

Setyowati, N., Lestari, P., & Wawo, A. H. (2020, November). Tracking optimum temperature for germination and seedling characterization of three millet (Setaria italica) accessions. In *IOP Conference Series: Earth and Environmental Science* (Vol. 591, No. 1, p. 012014). IOP Publishing.

Singh, R. K., & Prasad, M. (2020). Foxtail Millet: A climate-resilient crop species with potential to ensure food and agriculture security amidst global climate change. *International Journal of Plant and Environment*, *6*(03), 165-169.

Verma, S., Srivastava, S., & Tiwari, N. (2015). Comparative study on nutritional and sensory quality of barnyard and foxtail millet food products with traditional rice products. *Journal of food science and technology*, *52*(8), 5147-5155.

Yang, R., Chen, M., Sun, J. C., Yu, Y., Min, D. H., Chen, J., ... & Zhang, X. H. (2019). Genome-wide analysis of LIM family genes in foxtail millet (Setaria italica L.) and characterization of the role of SiWLIM2b in drought tolerance. International Journal of Molecular Sciences, 20(6), 1303.

Zhang, Y., Xiao, T., Yi, F., & Yu, J. (2023). SimiR396d targets SiGRF1 to regulate drought tolerance and root growth in foxtail millet. Plant Science, 326, 111492.

Zhao, W., Zhang, L. L., Xu, Z. S., Fu, L., Pang, H. X., Ma, Y. Z., & Min, D. H. (2021). Genome-wide analysis of MADS-Box genes in foxtail millet (Setaria italica L.) and functional assessment of the role of SiMADS51 in the drought stress response. Frontiers in Plant Science, 12, 659474

Zooleh, H. H., Jahansooz, M. R., Yunusa, I., Hosseini, S. M., Chaichi, M. R., & Jafari, A. A. (2011). Effect of alternate irrigation on root-divided foxtail millet (Setaria italica). *Australian Journal of Crop Science*, *5*(2), 205-213.