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Insights Into Finger Millet Breeding Using the Wild

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Abstract

Finger millet is a highly nutritious, drought-tolerant crop which need to get the research and public attention it deserves. Crop wild relatives of finger millet are a one stop solution to the improvement of yield, nutritional factors, biotic and abiotic stresses. Though there are challenges associated with the inclusion of them in finger crop improvement program which are thoroughly discussed in this paper. Collection, evaluation of crop wild relatives and Pre-breeding programs are being taken up by Crop Trust (non-profit organization) under Crop Wild Relatives Project.

Introduction

Finger millet [*Eleusine coracana* (L.)] is a C4, annual cereal crop native to Eastern Africa and also widely cultivated in Asia, especially in India. This crop withstands drought, thrives well in low fertile soils and resistant to a wide range of pests and diseases, including in storage. It is one of the important small millets which contain high calcium, zinc, iron, dietary fiber, phytates and protein in its grain. This gluten free grain is used for producing beer, porridge, soups, bread, cakes and pudding.

Crop wild relatives

Global climate change impacts compounding negative affects to crop growth and productivity by making the crops vulnerable to various abiotic and biotic stresses. Therefore, developing improved varieties and designing newer approaches for crop improvement against stress tolerance have become a priority now-a-days (Gupta *et al*., 2017). Crop wild relatives (CWRs) are the rich source of trait specific genetic diversity which means CWRs provide valuable reservoir of genetic traits that can be used to improve crop yields, enhance disease and pest resistance, increase resistance to environmental stresses (drought, heat, cold etc.), upgrade nutritional content and develop climate resilient crops. CWRs are wild species closely related to domesticated crops offering novel genes, allelic diversity and genetic variation.

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Conserving and utilizing CWRs helps ensure food security, promote sustainable agriculture and protect biodiversity.

CWRs of finger millet

Finger millet (*Eleusine coracana*) has several crop wild relatives (CWRs) that are valuable sources of genetic diversity. Some of the prominent CWRs of finger millet include:

1. *Eleusine africana* (African finger millet)
2. *Eleusine indica* (Indian goosegrass or wiregrass)
3. *Eleusine tristachya* (Three-branched finger millet)
4. *Eleusine floccifolia* (Woolly finger millet)
5. *Eleusine intermedia* (Intermediate finger millet)
6. *Eleusine kigeziensis* (Kigezi finger millet)
7. *Eleusine jaegeri* (Jaeger's finger millet)
8. *Eleusine multiculmis* (Many-stemmed finger millet)
9. *Eleusine pilosa* (Hairy finger millet)

Challenges with CWRs

Crop breeders face several challenges when incorporating finger millet wild relatives into crop improvement programs. The biological challenges include (i) Incompatibility: difficulty in crossing wild species with cultivated ragi due to reproductive barriers. (ii) Sterility: Hybrid progenies may be sterile or have reduced fertility. (iii) Genetic complexity: Wild relatives may have complex genetic makeup, making it hard to identify desirable traits and (iv) Linkage drag: Unwanted traits linked to desirable genes. The technical challenges include (i) Limited genetic diversity: Insufficient characterization and conservation of wild relatives. (ii) Difficulty in trait identification: Identifying beneficial traits in wild relatives. (iii) Backcrossing: Transferring desirable traits to cultivated ragi without losing existing traits and (iv) Embryo rescue: Overcoming reproductive barriers. The logistical challenges include (i) Accessibility: Wild relatives may be difficult to access due to geographical or political constraints. (ii) Conservation: Limited resources for conserving and maintaining wild relative collections. (iii) Funding: Insufficient funding for research and breeding programs and (iv) Regulatory framework: Complex regulations surrounding genetic resource utilization. The breeding challenges include (i) Trait integration: Combining desirable traits from wild relatives with existing cultivated varieties. (ii) Stability: Ensuring trait expression stability across

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environments. (iii) Yield penalty: Potential yield reduction when introducing new traits and (iv) Seed quality: Maintaining seed quality during breeding. The genomic challenges (i) Genome complexity: Large, complex genomes in finger millet and its wild relatives. (ii) Genetic mapping: Developing accurate genetic maps. (iii) Marker-assisted selection: Identifying reliable molecular markers and (iv) Genomic diversity: Capturing genomic diversity in breeding programs.

To overcome these challenges, breeders employ advanced techniques like Genomic selection, Marker-assisted breeding, Double haploidy, Embryo rescue, In vitro culture, Genetic diversity analysis and Collaborative research in the umbrella term of Pre-breeding.

Pre-breeding

Pre-breeding provides a unique opportunity, through the introgression of desirable genes from wild germplasm into genetic backgrounds readily used by the breeders with minimum linkage drag, to overcome this (Sharma *et al*., 2013). Pre-breeding and evaluation work is being done by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India as a lead institute partnering with Maseno University, Kenya and Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya. The largest finger millet collection is conserved at the R.S. Paroda Genebank, ICRISAT. 136 seed samples of nine species of crop wild relatives collected from nine countries: Brazil, Chile, Ethiopia, Ghana, Kenya, Nepal, Nigeria, Pakistan and Uganda.

Pre-breeding and evaluation (source: https://www.croptrust.org/work/projects/crop-wild-relatives/)

- 24 promising crop wild relative (CWR)-derived pre-bred materials were tested in adaptation trials in six sites across Kenya.
- 3 CWR-derived varieties showing earliness, resistance to lodging and tolerance/resistance to blast disease, Striga and drought have been released in Kenya.
- 28 finger millet lines including four CWR-derived pre-breeding lines have been prepared for submission to the genebank of the International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India.
- 12 promising blast resistant materials have been identified, most of which were wild accessions.

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- Candidate genes involved in response to *Striga hermonthica* identified and their expression patterns established within 6 days of *Striga* infestation.

Conclusion

The narrow genetic base of the existing varieties in the crop can be broadened by inclusion of the developed pre-bred lines in the finger millet crop improvement program. Hence, the solution lies in the nature which gifted us with crop wild relatives which were once considered as weeds are now the valuable asset which are being systematically tamed by the breeders to make them used for the good.

References

Gupta, S.M., Arora, S., Mirza, N., Pande, A., Lata, C., Puranik, S., Kumar, J and Kumar, A .2017. Finger Millet: A "Certain" Crop for an "Uncertain" Future and a Solution to Food Insecurity and Hidden Hunger under Stressful Environments. *Frontiers in Plant Science*. 8:643.

Sharma, S., Upadyaya, H.D., Varshney, R.K and Gowda, C.L.L. 2013. Pre-breeding for diversification of primary gene pool and genetic enhancement of grain legumes. *Frontiers in Plant Science.* 4:309.