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Pursuit of Drought Tolerance in Lesser Explored Pulses/ *Vigna* Spp.

Khushwant B. Choudhary
Scientist, ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan

SUMMARY

Despite their importance for marginal land farmers and contribution capacity in nutritional security, minor pulses (Moth bean, Rice bean, Adzuki bean, Lima bean) are shrinking in terms of their area of cultivation owing to many factors, including a major factor termed as drought stress, which become inevitable in this climate change era. To combat this abiotic factor, especially in these lesser explored pulses, researchers needs to overthink about the use of strategies demonstrating worthy results in other major crops. In this article we are presenting the accessible, yet unexplored approaches for pursuance of drought tolerance in these dwindling legumes.

INTRODUCTION

Legumes are one of the most promising components of the Climate Smart Agriculture Concept (CSAC by FAO, 2013) owing to several attributes including its nutritional intrinsic values propounding the dietary needs of the human being, its symbiosis based biological nitrogen fixing properties, act as valuable cover crops, part of desertification control programs in the arid zone areas suggesting them as the alternative to the protein and micronutrient malnutrition, from which major part of global population is suffering (Godfray et al. 2010). Categorization of legumes by FAO defined the 'drybeans' as collective term including mungbean, urdbean, common bean, mothbean, ricebean, adzukibean and limabean. (http://www.fao.org/waicent/faoinfo/economic/faodef/fdef04e.htm#4.02).

All these drybeans except common bean are of regional importance, cultivated in specific areas as well as restricted market or trade mechanism often considered as forgotten, neglected or underutilized or orphan crops.

Despite the importance of these minor pulses, stance for the global crop production in future doesn't look impressive indicating the dwindled increase in crop production irrespective of the mounting global population (Bohra et al. 2020).There are several abiotic factors likewise depleting ground water table, scarcity of arable land (many factors behind it), unavoidable emergence of new races of insect pests (partly due to frequent climatic alteration) marginalized the increase in crop production further highlights the need for development of such varieties having tolerance to altering environmental conditions in combination with yield stability and increased quality parameters. These multi- aspects breeding programme represents the unprecedented challenge and need of the hour for current researches and agricultural scientist community. Moreover, These factors have vice versa impact on the research negligence in terms of technological investments with compare to the overflow of research invested in major crops mainly cereals and model legumes despite their intrinsic nutritive values (Naylor et al. 2004; Maass et al. 2010; VazPatto and Rubiales, 2014).

Moreover, the irregular rainfall in the rainfed conditions (having major cultivation of these minor pulses) has been denoted as a most significant climatic factor affecting pulse production in the arid and semi-arid regions among the numerous abiotic stresses. Pulses yield in rainfed areas has been limited by the drought stress. Seed yield and other growth parameters have been severely affected depending on crop growth stage when it was exposed to drought, drought intensity and drought duration. This article focuses the different explorative, genetic, molecular, physiological and omics approaches used to improve our understanding of the biology of the complex responses.

Trait Distinctionsbased on morpho-physiology

Drought stress witnessed during any of these critical stages leads to severe yield reduction. Therefore, the selection of genotypes at targeted crop growth stage(s) would be an important measure of drought tolerance. Exploring natural variations in germination-related traits under drought stress will offer the chance to select stress-tolerant genotypes. Drought tolerance poses variability towards the morpho-physiological trait variations in these minor pulses. There are many traits which contribute towards drought tolerance in various manner like early vigour, relative water content (RWC), seedling biomass, stress tolerance index, photosynthesis rate, stomatal conductance, transpiration rate, relative leaf water content (RLWC), leaf temperature, biomass, harvest index, RLWC, root length, number of floral buds, shoot dry weight, number of lateral roots, root length, number of root nodules, dry matter weight of root system, shoot length, root length, root shoot ratio, stem diameter, shoot weight, dead leaf percent, emergence percent,energy of emergence, early flowering, specific leaf area, yield components, wilt index, , stress index leaf area, stomata size, net photosynthesis, osmotic stress injury,chlorophyll stability index (CSI), specific leaf area (SLA), chlorophyll content, germination percent, membrane stability index (MSI) Germination percentage etc.

Exploration approaches

Exploration is the foremost primary crop improvement strategy including these ‘drybeans’ counting the exploration of wild accessions having drought tolerance from outer world owing to their shrinking genetic base crafted by continuous selection pressure for achieving high yield.

Genetic enhancement

Realizing the fact that the narrow genetic base is one of the major constraints for breaking the yield plateaus, a systematic wide hybridization programme involving mungbean, urdbean and other *Vigna* species such as *V.sublobata*and *V. trilobata*was initiated in 1998. The selection criteria have been short duration, photo-thermo-insensitivity, resistance to MYMV and synchronous maturity. Despite this very old practice, yet there is lack of enough diverse material for accessions having drought tolerance. This narrowness can be countered by classical breeding approaches like intra and interspecific purposeful hybridization, wide hybridization and mutation breeding etc.Byaccessing the exploitable natural variation available in the crop gene pool for the abiotic stresses resistance discovering the genotypes that might act as potential donors in the downstream breeding schemes.

Molecular breeding

To this end, marker assisted selection (MAS)-enabled breeding has recently emerged as a promising approach to answer the questions relating to stagnated crop productivity (Varshney et al., 2012).In general, the availability of breeder-friendly DNA markers in unexplored pulse crops is creating new possibilities for introducing MAS in crop improvement schemes.

Omics Approaches to Understanding Drought Tolerance

Targeting the stage-specific drought stress-related traits for improving drought tolerance is the need of the time in these orphan pulses. It includes very modern approaches likewise,

- Linkage mapping for QTL detection: Very few reports are available on this aspect to our best knowledge, indicating the lack of QTL information for drought tolerance in these pulses.
- QTL-hotspot detection, association mapping, nested association mapping, AB-QTL approach have been evolved, the studies on gene mapping for targeted traits for drought tolerance in these pulses are still meagre. Exploring “QTL-hotspot” for drought tolerance could be a milestone for introgression of associated QTLs.
- Genotyping by sequencing (GBS)
- Phenomics: Modern plant phenotyping methods, Many next-generation and high throughput plant phenotyping platforms (HTPPs)

CONCLUSION

Notwithstanding advancement in breeding strategies for different cereal crops and major pulses, few minor pulses are lagged behind in the research work towards drought tolerance in these crops. Drought stress affects these legumes at different growth stages with varying severity, which leads to moderate to severe yield loss. A rise in drought incidence and severity is expected in the coming years due to the changing global climate. Hence, there is a need to develop climate-smart minor pulses cultivars, which perform better in drought environments. The above discussion clearly stated the involvement of different mechanisms towards drought tolerance at different crop growth stages. Therefore, specific breeding strategies need to be focused upon for improving drought tolerance, while identification and deployment of stage-specific drought-tolerant potential donors are required. There is also an urgent need to identify and validate the QTLs from potential intra- and inter-specific donors. Like the QTL mapping approach through linkage and association mapping, classical and omics-based breeding approaches have shed light on the inheritance of complex traits like drought. Furthermore, rising "omics" interventions could substantially improve our present knowledge of the underlying mechanism of drought-tolerance, assisting in development and deploying drought-tolerant mungbean genotypes. Simultaneously, there is a need to enhance the efficiency of the various high-throughput genotyping platforms like GBS, DArT, etc., which might pave the way to discovering high-throughput markers to look for novel genomic variants related to drought tolerance. These approaches will facilitate deeper understanding and could effectively accelerate the development of drought-tolerant minor pulses cultivars.

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