

Commentary

## Genome Editing in Pulses

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With 20 years of research experience in genetic engineering of crop plants for stress tolerance and weed biology, current interests of Dr. Meenal Rathore include improving legumes for stress tolerance using advanced biotechnological tools. A doctorate in Molecular Biology and Genetic Engineering from GBPUA&T, Pantnagar, she served DRDO for more than 9 years and was recipient of DRDO Technology Day Award and DRDO Technology Group Award. She also served as Head, Division of Plant Biotechnology, ICAR-IIPR, Kanpur for more than six years and is the

Rich in vegetarian protein and fibre, low in fat, pulses add to the dietary diversity and are a good component to address hunger and malnutrition. Capable of growing in marginal environments, an affordable source of nutrients and minerals, having a low food wastage footprint and minimal carbon footprints, pulses are also capable of symbiotically fixing nitrogen and releasing high-quality organic matter into the soil. Yet, their cultivation is affected by low yields due to stress factors and there is need to accelerate genetic gain in terms of yield, stress tolerance and nutrition.

The major constraints that limit the realization of potential yield of pulses include biotic and abiotic stresses prevalent in the pulses-growing areas besides socio-economic factors. Among biotic stresses, *Fusarium* wilt coupled with root rot complex is probably the most widespread disease causing substantial losses to chickpea, besides dry root rot and collar rot. While *Fusarium* wilt, sterility mosaic and *Phytophthora* blight cause substantial losses in pigeonpea, yellow mosaic, *Cercospora* leaf spot, powdery mildew and leaf crinkle and leaf curl cause considerable damage in *Vigna* crops (mungbean and urdbean). Among key insect-pests, gram pod borer (*Helicoverpa armigera*) in chickpea and pigeonpea, pod fly in pigeonpea, whitefly, jassids and thrips in urdbean and mungbean cause severe damage to the respective crops. Bruchids are the most serious pest of the stored pulse grains and require topmost priority in management. Weeds also cause substantial loss to pulses. Recently, nematodes have emerged as potential threat to the successful cultivation of pulses in many areas.

While drought and heat are concerns in the regime of climate change, waterlogging and lodging in pigeonpea, earliness in lentil, thermo insensitivity in blackgram, salinity and nutritional enhancement are few traits demanding attention in near future.

Though genetic improvement in pulses has been largely accomplished by pedigree and selection based breeding, higher genetic gain is now achievable by using novel genomics techniques and high-throughput phenotyping. For efficient and precision breeding, advanced tools like genomic selection and genome editing are now being used. With increased access to information on genome sequences, genes and haplotypes that contribute to significantly important and desirable traits, genome editing has made it plausible to modify SNPs without altering the original phenotype. Also, the genetic drag associated with recombination during conventional breeding is not a problem as modifications are done for single or multiplex SNPs.

Of all the techniques known for genome editing, the RNA-based CRISPR/Cas9 system is more amenable as it addresses specific genomic DNA sequences while TALENs and zinc finger nuclease (ZFNs) systems are protein-based methods. The CRISPR method is a feasible, cost effective, versatile and efficient tool permitting precise editing of plant genomes including knockouts, making precise base edits or altering multiplex nucleotides. As a result, many genome-edited crops have been developed, and their numbers are increasing rapidly compared to those developed by other methods such as conventional breeding, mutation breeding, hybrids or GM technology.

Though gene-editing methodologies have been successfully established in soybean, cowpea, chickpea and other legumes such as *Medicago truncatula* and *Lotus japonica*; recalcitrance of other legumes to *in vitro* gene transfer and regeneration still poses a serious challenge to application of gene editing. Also, thorough contemplation is advised for choice of crop, variety, target niche area and trait; associated characterized genes and available allelic variations; availability of efficient *in vitro* regeneration and genetic transformation systems; skilled manpower and infrastructure to support round the year associated activities.

For harnessing the potential of genome edited

crops with appraisal of biosafety concerns, the Department of Biotechnology has already released and notified Guidelines for Safety Assessment of Genome edited crops 2022, wherein genome edited crops falling under the category of SDN 1 and SDN-2 are free from prior DBT guidelines rules 7-11 and rule 20 (recent guidelines may be accessed from DBT website: [www.dbtindia.nic.in](http://www.dbtindia.nic.in)). The exemption of GEd crops from certain biosafety concerns has eased the procedure for on-field phenotyping and release of these crops. Evolution of the modern tools and related biosafety guidelines has opened new avenues to develop improved lines and achieve higher genetic gain in pulses.