Opinion

Perspectives of genome editing in plant breeding

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Genome or gene editing technologies include several new techniques to help scientists modify precisely specific genome sequences. The gene editing technologies can also allow the regulation of gene expression patterns in a pre-determined region and probably in a pre-determined manner, thus facilitating the discovery of novel insights into the functional genomics of an organism. The advent of genome editing resulted increased enthusiasm in the scientific community. Especially in the agricultural sector scientists and plant breeders are extremely overwhelmed by its simplicity, precision and power as it offers new prospects to develop improved crop varieties with straightforward addition of valuable traits or removal of disadvantageous traits. Research and implication of genome and gene editing technologies has already started in order to improve crop varieties for traits like increased yields, enhanced stress tolerance, disease and pest resistance, decrease input costs, and increase nutritional value.

Genome editing includes a wide array of tools which use either a site-specific recombinase (SSR) or a site-specific nuclease (SSN) system; however it is important for both systems to recognize a well-known sequence. The SSN system causes single or double strand DNA breaks, breaks activate the endogenous DNA repair pathways which result the changes in the original DNA sequence. There are 4 main classes of SSN systems which have the ability to cleave genomic sequence and these are:

i. zinc finger nucleases (ZFNs),

ii. mega-nucleases (homing endonuclease),

iii. transcriptional activator-like effector nucleases (TALENs), and

iv. the new entrance in the field, the CRISPR/Cas nuclease system (or the clustered regularly interspaced short palindromic repeat/CRISPR-associated protein).

On the other hand SSR technology, includes systems such as Cre/loxP and Flp/FRT used to carry out deletions, insertions, translocations and inversions at high efficiency at specific sites in the DNA of cells and organisms which can, among others, cause knockdown or knock-in genes in the genome of eukaryotes, depending on the orientation of the specific sites (loxP, FLP, etc.) which flank the targeted site.

Genome and gene editing techniques offer many option in improving crop, these techniques can change from a specific single nucleotide to a full allele or by inserting a specific sequence (a gene for example) in a specific region or place in the vast genome of an organism. The precision which these techniques offer is what will eventually make them the method of choice for the scientific community in understanding molecular mechanisms and also for the breeding community for the improvement of new varieties over conventional breeding or genetic engineering methods. This technology shows enhanced potential and maybe for the first time in the field the excitement caused in the begging might continue until these techniques will eventually find their niece.

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The problems we as humans face in terms of agricultural production is the supply of food, raw materials for the industry, climate change resilient plants and abiotic and biotic stress tolerant plants. Conventional plant breeding requires a long term project with doubtful results and genetic engineering is suitable usually for single or low gene number traits. On the other hand editing technologies seem to overcome the disadvantages above yet their disadvantage is the information. The increase in sequencing technologies and bioinformatics and the accumulation of data probably secure the successful and long term usage of editing technologies. Thus editing technologies could offer novel genome-editing perceptions for plants in order to improve crops for better nutrition and food security. However, as the ability to generate mutated plant increases, their screening and identification of the mutations become a major issue. Many techniques can be used to screening and identify mutations High Resolution Melting analysis seems to be the most promising and efficient method for the detection of InDels in the locus of interest while at the same time they are relative cheaper.

Finally, editing technologies have recently entered in the field generating high expectations, like every other technique in the beginning. Although, this excitement will decrease in time, at the end, the advantages and the power these techniques have will probably render them the methods of choice to secure the world's food and raw materials supply by improving the nutritional value of crops, their yield and their tolerance to biotic and abiotic stresses.

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Conflict of interest

The author declares no conflict of interest.