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Cisgenesis:A SUSTAINABLE APPROACH OF CROP IMPROVEMENT

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Inroduction

Genetic modification of crop plants involves the transfer of foreign desirable genes into the plant genomic background through genetic engineering technology. At presnt, Genetically modified plants give a promising impact to various crop improvement programmes in many countries throughout the world. The foremost outcome is the development of resistance varieties against various biotic and abiotic stresses. Transgenesis is the genetic modification of a recipient plant with one or more genes from any non-plant organism or from a donor plant that is sexually in-compatible with the recipient plant. Despite, genetically engineered traits comprise priceless alternatives from the conventional breeding, but, there arise a public issue on consumption of genetically modified foods. This unlocks a new vista for engineering crop plants using the DNA from a sexually compatible donor plant. Cisgenesis, sometimes called intragenesis, is a type of genetic engineering involving artificially transferring genes between organisms from the same species or between closely related organisms that could otherwise be conventionally bred.

What is cisgenesis ?

Cisgenesis refers to genetic modification using one of the techniques of recombinant DNA technology, but using no “foreign” DNA; in other words, the manipulation is done using DNA entirely from the same species as the host plant, or a species that is closely related enough to be sexually compatible. Schouten *et al.* (2006) introduced the term cisgenesis and defined cisgenesis as the modification in the genetic background of a recipient plant by a naturally derived gene from a cross compatible species including it’s introns and it’s native promoter and terminator flanked in the normal sense orientation.

The gene used in cisgenic approach is similar compared with classical breeding and cisgenic plant should be treated equally as classically bred plant and differently from transgenic plants. This approach combines traditional breeding techniques with modern biotechnology and dramatically speeds up the breeding process. This allows plant genomes to be modified while remaining plants within the gene pool. Therefore, cisgenic plants should not be assessed as transgenics for environmental impacts as well as ethical issues.

Need of Cisgenesis ?

Traditional plant breeding and Cisgenesis approach

Traditional plant breeding approaches are associated with several problems like requirement of longer time for development of varieties. Over the time of development, there is change of general vigour and suitability of economic parts. Most important problem related to linkage drag i.e. tendency of linked deletorious gene with desire gene of interest to transfer into genetic back-ground of recipient genotype through the process of introgression. These

problems are overcome by cisgenesis approach by various means like to minimize effect of linkage drag, to preserve genetic make-up of the original cultivar, to add only one or few genes, enhance breeding speed, less time requirement for varietal development, single step process for disease/ insect resistance.

Transgenic Technology and Cisgenesis approach

Development of transgenic cultivars are often associated with several problems related to safety concerns, environmental risks as escape of foreign genes via pollen flow to natural vegetation known as pollen drift, creation of super weed, insect-diseases resistance and health issues due to the presence of foreign DNA.

These problems could be overcome by cisgenesis approach by various means like no change in fitness of target plant, no risk on non-targeted organism and ecosystem, no alteration of gene pool of recipient genotype, no addition trait in gene pool of recipient species.

Induced translocation or mutation breeding and Cisgenesis approach

Majority of translocations causes by radiation treatments concern with safety problems related to radioactivity. It also reduces agronomic performance ex. Radiation induced translocation in *Agrostophyllum elongatum* causes a reduction of yield upto 10%. These Problems are overcome by cisgenesis approach by varios means like no use of radioactive radiations, no effect on performance specially yield and quality. Thus, Cisgenesis furnishes no unnecessary hazard compared to induced translocation or mutation breeding.

Achievements

The first scientific statement of bringing forth a true plant obtained by cisgenic approach was reported in apple through the insertion of the internal scab resistance gene HcrVf2 influenced by their own regulatory genes into the cultivar Gala, a scab susceptible cultivar (Vanblaere *et al.*, 2011). Barley with improved phytase activity was produced successfully by Holme *et al.* 2011, through cisgenic approach. Late blight resistant potatoes have developed by cisgene stacking of R- gene taken from their wild species.

Challenges and limitations of Cisgenesis and Transgenesis

Although cisgenics technology is exhibiting considerable advantages over the transgenic and conventional plant breeding, but still there are a few limitations associated with this technology. Which are as following,

1. Only those of traits in sexually compatible gene pool can be transferred to a crop species. Characters outside the sexually compatible gene pool cannot be introduced.
2. Sequence information of the plants are needed because the gene of interest or fragments of gene may not be readily available but need to be isolated from sexually compatible gene pool.
3. The Development of marker and vector backbone free plants usually requires the development of innovative protocols, since such protocols may not be readily available for the crop.
4. Positional effect.
5. Low transformation efficiencies to create large number of transformants.

Conclusion

In cisgenesis, only the desired genes are introduced without the undesirable genes. Knowledge of traditional breeding remains critical for selection of cisgenic plants in breeding

by cisgenesis. New biotechnology is making cisgenesis increasingly feasible in use of gene resources and precisely obtaining new agricultural traits without insertion of foreign genes or gene fragments. Cisgenesis furnishes no unnecessary hazard compared to induced translocation or mutation breeding. Therefore, cisgenesis excludes linkage drag, and hence, prevents hazards from unidentified hitch hiking genes. Due to this reason, cisgenesis is normally safe than traditional breeding programmes and various biotic and abiotic stress resistance genes can be pyramided to provide wider and long lasting forms of resistance. Thus, if we expand our area of research towards cisgenic approach and if it has been exempted from the regulatory framework of GM technology it is anticipated that cisgenesis may wipe out the likely uncertain outcomes and the social beliefs that public have in their mind regarding GM technology. Therefore, cisgenesis will be playing an important role in sustainable crop improvement

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