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Cisgenesis: A New Biotechnological Tool for Crop Improvement

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ABSTRACT:
Cisgenesis is genetic modification to transfer beneficial alleles from crossable species into a recipient plant. The donor genes transferred by cisgenesis are the same as those used in traditional breeding. It can avoid linkage drag, enhance the use of existing gene alleles. 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.
Key Words: Cisgenesis, Transgenesis, GMO, Genetic engineering

INTRODUCTION:

At onset of plant breeding sufficient genetic variation was available and breeders practiced many crosses, selection schemes to obtain new varieties that were more domesticated. Occurrence of biotic and abiotic stresses and the need for quality traits require more genetic variation which opened up new avenues like direct improvement of existing varieties; mutation breeding, crosses with wild species and consecutive backcrosses; introgression breeding.

Biotechnology broaden these approaches by transfer of genes across very wide taxonomic boundaries. Transgenic comprise priceless alternative for conventional breeding, but these arise public issue on consumption of transgenic crops. This unlocks a new vista for engineering crop plants using genes from cross compatible donor plants i.e. cisgenesis

The area under transgenic or genetically modified (GM) crops has been increased at a faster rate and the area being 160 million hectares. But one of the main concerns of the public about transgenic crops is the use of artificial combination of genetic elements which are derived from different organisms that are not crossable by natural means. The full potential of GM crops can be realized only with an increased acceptance by the general public. Moreover, the costly, hectic and lengthy procedures for obtaining approval of these crops and the threat for potential health risks and the spread of new genes into other unrelated crops are the major drawback in the path of implementing these techniques. Keeping in view of the above drawbacks and to ensure an eco- friendly crop improvement techniques, cisgenesis and intragenesis approaches were developed as alternatives to transgenesis.

What is cisgenesis?

Cisgenesis simply refers to genetic modification of crop using one of the technique of recombinant DNA technology, but using no foreign DNA. DNA fragment from the species itself or from closely related species enough to be sexually compatible is inserted in plant genome. Concept of cisgenesis introduced by Dutch researchers Schouten, Krens and Jacobsen in 2006**.** Schouten et al. (2006) defined cisgenesis as "A crop plant that has been genetically modified with one or more genes (containing introns and flanking regions such as native promoter and terminator regions in a sense orientation) isolated from a crossable donor plant". The gene pool available for cisgenesis is accordingly identical to the gene pool available for classical breeding. Transferred gene contain complete copy of a natural gene with its all regulatory sequences.

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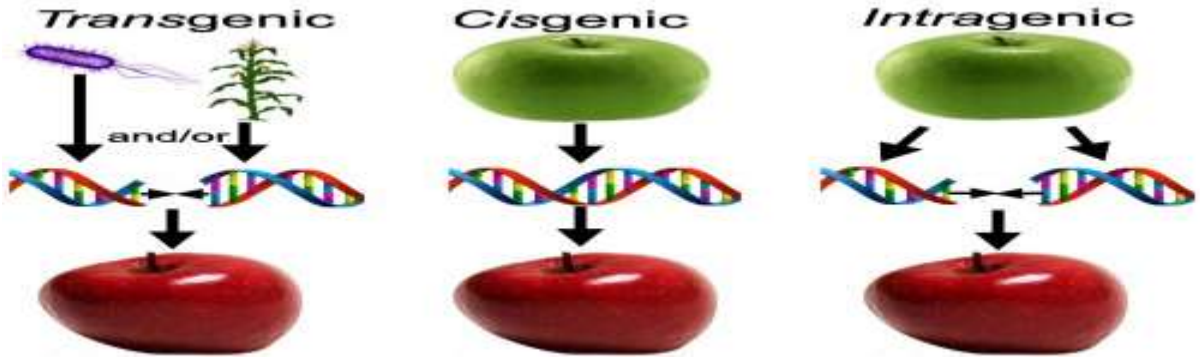
Different GM concepts :



1) Transgenic :

Crop genetic engineering is a technology where the genome of a host crop is engineered with a foreign donor gene regulated by certain gene regulatory sequences (promoter, terminator, etc.). In crop genetic engineering, genes are randomly inserted into a host plant genome.Transgenic Plants have been genetically engineered with foreign gene and could be from any organism i.e. outside the sexual compatible group.

2) Cisgenesis :

If the donor gene and all of transgene's regulatory sequences belong to the same crop species or belong to the host's cross breedable species, the resulting crop is called "cisgenic". In the cisgenic technology, the cisgene must be an identical copy of the host's native gene cassette, including its regulatory sequences integrated in the host plant in the normal-sense orientation.

3) Intragenesis :

The crop intragenic is a technology that inserts gene cassettes containing specific genetic sequences from crops that are belonging to the same breedable gene pool into a host crop genome. In this case, the gene coding sequences (with or without introns) can be regulated by promoters and terminators of different genes as far as those genes that contribute towards the transgene regulation belong to the same cross breedable gene pool.

Why Cisgenesisis important?

Cisgenic plants are presumably considered safer than those produced through conventionally breeded plants because of the lack of linkage drag. In cisgenesis, only the desired genes are introduced without the undesirable genes. Cisgenesis furnishes no unnecessary hazard compared to induced translocation or mutation breeding. Therefore, cisgenesis 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.

The primary biological advantage of cisgenesis is that it does not disrupt favorable heterozygous states, particularly in asexually propagated crops such as potato, which do not breed true to seed. One application of cisgenesis is to create blight resistant potato plants by transferring known resistance loci wild genotypes into modern, high yielding varieties. There are also legitimate public reasons that brought the obligation to clearly differentiate cisgenes from the transgenes. The notion towards transgenic technology often brought annoying circumstances to many people, followed by their firm regulation worldwide. Common people are also found to be much satisfied with cisgenic crop than transgenic crops. In Mississippi, ananalysis revealed that 81% of public favored to eat cisgenic vegetables while only 14 – 23% for transgenic vegetables.

Advantages of Cisgenesis over Traditional Breeding:

1. Maintains original genetic constituent:

In a hybridization method, the genetic makeup of the progeny plant varies from its parents because of mixture of both the parental genomes. Though there is a necessity to conserve some part of the genome which revealed certain constructive traits. Through conventional plant breeding such an approach is not possible. Traditional breeding programme will no longer confer disease and pest resistance to the notable parent cultivars. However cisgenesis allow the target gene and original makeup of cultivar in which it is inserted.

2. Overcome linkage drag:

Introgression of innovative traits into the cultivated varieties by conventional methods comprises wide crosses and widespread backcrossing. However, these traits are constantly linked within a large share of unwanted chromosomes, i.e. linkage drag. In vegetatively

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propagated crops like potatoes and apples, their heterozygous nature may conquer in successful transfer of traits of interest. Hence, direct transfer of desired genes through cisgenesis into an existing variety without altering any of the properties enviable for the consumers can be accomplished. It is followed by the selection of plants in the growth chamber then glasshouse and field. Selection of the best performing plants with realistic gene insertions and least negative side effects is made in the field where linkage drag with unwanted gene is deficient.

3. Time Saving :

In conventional hybridization, there is linkage drag, where there is inheritance of thousands of unwanted genes to the progeny. Several backcrossed generations are required to get rid of such kind of undesired genes. Cisgenesis overcomes the problem of linkage drag and only the gene of interest is introduced into the genome of the recipient plant within a short period of time. Thus, this saves a lot of time. Cisgenesis could be employed for the rapid introduction of desired traits into commercially successful cultivars without changing their constructive characteristics through introgression by traditional methods.

4. Lessen pesticide application :

The main purpose of cisgenesis is to transfer disease resistance genes to susceptible varieties. The vital goal here is to lessen substantial pesticide application. As a result, there is decline in the input costs of the farmers and decreased pesticide applications on the plants and also in their products. It also helps in sustainable agricultural development because of decline in pesticide application reduces environmental pollution. [16].

Application of cisgenesis in crop improvement :

Cisgenic plants are enriched through the addition of one or more genes that belong to the same species or from a cross compatible species. New traits are introduced or existing traits are modified to add value to the existing germplasm/ lines. Such modifications include improved resistance to biotic and abiotic stresses, quality enhancement and nutritional value etc.

Crops that can be commercially clone, like potato, apple, strawberry, and grapevine, were some of the crops in which cisgenic approaches for improvements were attempted for the first time. Recently, cisgenesis is applied to apple and potato in order to obtain polygenic durable resistance to apple scab (Venturia inaequalis) and Phytophthora infestans, respectively. A cisgenic approach, with the aim of enhancing fungal disease resistance in grapevine through the insertion of a grapevine pathogenesis-inhibiting protein is currently under development. Another cisgenic approach has been used in poplar in which plants with different growth types are produced due to over expression of growth-related poplar genes.

Future trend :

A major limitation for using this approach in plant breeding is the issue of consumer acceptance and the argument that the use of DNA from within cross-compatible species is a safer option than transgenesis. There is reasonable evidence that consumers are more comfortable with the use of genes from within the same species than transgenes originating from organisms such as bacteria. Development of cisgenesis into a powerful new breeding tool will depends on several factors like treatment of existing legal frameworks towards cisgenic plants consumer acceptance of end products; whether plants and end products derived from them must be considered as GMOs or non-GMOs; and intellectual property rights (IPRs) on GM genes and technologies. Recently a survey was conducted in the USA and from that it came to know that consumers are willing to pay more money for intragenic vegetables with enhanced nutritional value when the vegetables are labelled as such.

LITERATURE CITED:

[1]. Devi E.L., Chongtham S. K., Holeyachi P., Kousar N., Singh M., Behera C., Telem R. S., Singh N.B., and Wani S. H. (2013). Cisgenesis and Intragenesis: Twin Sisters for Crop Improvement. Research Journal of Agriculture and Forestry Sciences. 1 **(10)** : 22-26.

[2]. EFSA Journal (2012): EFSA Releases Opinion on Safety Assessment of GM Plants Developed Through Cisgenesis and Intragenesis.

[3]. Joshi S. G., Soriano J. M., Kortstee A., Schaart J. G., Krens F. A., Jacobsen E. and Schouten H.J. (2015). Development of Cisgenic Apples with Durable Resistance to Apple Scab. Acta Horticulture. 839 : 403-406.

[4]. Schouten H.j., Krens F. A. and Jacobsen E. (2006). Cisgenic plants are similar to traditionally bred plants: International regulations for genetically modified organisms should be altered to exempt cisgenesis.. EMBO Rep. 7(8): 750-753.

[5]. Telem R.S., Wani S. H., Singh N. B., Nandini R., Sadhukhan R., Bhattacharya S. and Mandal N. (2013). Cisgenics – A sustainable approach for crop improvement. Current genomics. 14: 468-476.

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[6]. Tuteja N., Verma S., Sahoo R., Sebastin R. and Reddy I. N. (2012). Recent advances indevelopment of marker-free transgenic plants: Regulation and biosafety concern. Journal of Biosciences 37:167–197.
[7]. Yousuf N., Nabi S. U. and Sheikh A. A. (2018). Cisgenesis : an alternate approach for crop improvement and protection. Plant biotechnology journal. 63-70.