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Cisgenesis: Novel Approach for Crop Improvement

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SUMMARY

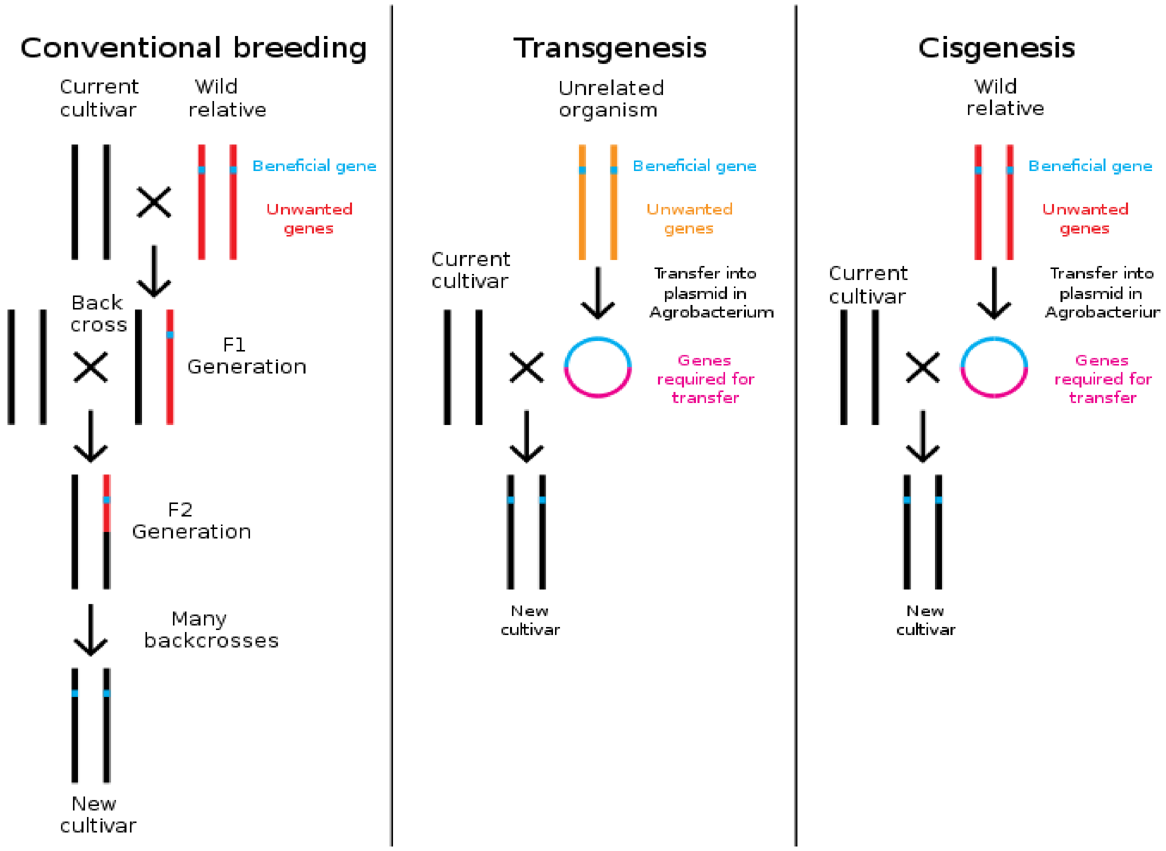
Cisgenesis is the trademark gaggle of genetically modified plants. A multitude of categorizations have been presented that rank genetic engineering techniques according to the nature of the added genotypical changes rather than the progress of the research. Cisgenesis is the process of transferring advantageous alleles from traversable species to a recipient plant through genetic alteration. The cisgenesis donor genes are identical to those utilised in traditional breeding." It can reduce linkage drag and enhance the efficiency of existing gene alleles. Traditional breeding strategies are combined with current biotechnology in this strategy, which substantially expedites the breeding process. This allows for the refinement of plant genomes while retaining plants in the gene flow. As a corollary, cisgenic plants should not be considered transgenic in terms of environmental issues.

INTRODUCTION

GM (genetically modified) plants based on the phylogenetic distance between the recipient and the DNA donor, firstly categorised by [12]. He proposed that ecological assessments of genetically modified plants be conducted using these categories. Three Dutch researchers [14] evolved the cisgenic notion in 2006, with the hope that cisgenic crops will be more popular with the general population [13]. The initial thought of cisgenesis, however, arose a few years earlier, in 2000, in the book "Toetsen en begrenzen. Jochemsen and Schouten's "Een ethische en politieke beoordeling van de moderne biotechnologie" [9]. The major cisgenesis principle postulated was that the genes or gene elements should be derived from the genetically engineered species. Extended sequences were not required, such as introns or regulatory sequences derived from the same gene as the coding sequences. However, in 2006, Schouten et al. published a new definition that became internationally established and is valid till today. [13] coined the term "cisgenesis" to designate this new breeding methodology, classifying a cisgenic plant as "a crop plant that has been genetically transformed with one or more genes extracted from a crossable donor plant." In the scientific opinion of the [European Food Safety Authority [4], Cisgenesis is defined as the introduction of specific alleles/genes from the breeder's gene pool into new varieties without the linkage drag (co-transfer of DNA sequences intertwined to the gene of interest) that occurs in traditional breeding.

Plant genome sequencing advances have made it easier to retrieve plant genes from crossable species. Cisgenes are the nomenclature for these genes. A growing number of these cisgenes have been discovered, and new transformation procedures that do not leave marker genes behind have been devised. This allows for the modification of plant genomes while keeping plants in the gene pool. A transgenic plant, on the other hand, acquires gene(s) from an organism other than a plant, or from a donor plant that is sexually incompatible with the receiver plant. For example, transgenesis occurs when the Bt gene from the bacteria Bacillus thuringiensis is rerouted to the cotton genome to generate pest-resistant cotton. Transgenic plants have been developed to produce biofuels, vaccines, and antibodies while also being more resistant to natural challenges [1]. Foreign genes have been embraced in the genomes of many species of plants, comprising major crops such as rice, soybean, maize, cotton, canola, potato, cassava, squash, papaya, peanut, oilseeds, and a variety of vegetables and fruits [3,8,10,11,2,7]. Transgenic crops, have raised significant concerns regarding their safety and influence on human health and the environment. This is due to the random insertion of foreign genes from other species, such as bacteria, or manufactured DNA, such as DNA boundaries, into plant genomes, which may have unanticipated side consequences.

Cisgenic plants seem to be more plausible than transgenic plants to be endorsed by the general people. According to a survey conducted in the United States, 55–77 percent of people would eat a cisgenic or intragenic vegetable (based upon the number of alleles and the source of the gene), however 17–25 percent would eat a vegetable containing a gene from a microbe or an animal. In a Mississippi poll, 81 percent said they would eat a cisgenic or intragenic vegetable, while just 14–23 percent said they would eat a transgenic vegetable made from non-plant sources [15]. Customers in the EU are expected to be increasingly accepting of cisgenic plants [5]. Cisgenesis has also been used in cereal crops and trees with tremendous success. In barley, a marker-free cisgenic variety has been generated, with an incremental phytase gene added to augment phosphate bioavailability by enzymatically digesting phytic acid [6].



A diagram comparing the genetic changes achieved through conventional plant breeding, transgenesis and cisgenesis.

Advantage of Cisgenesis:

1. The distinct biological virtue of cisgenesis is that it does not impede favourable heterozygous situations, which is especially important in vegetatively reproduced crops that do not breed true to seed, such as potatoes.
2. **Conquer the setback of linkage drag**: In traditional breeding methods, numerous back crossing generations are obligated to cope of linkage drag in traditional breeding methods. Cisgenesis nullifies linkage drag by introducing only the gene of interest into the genome of the recipient plant in a brief period.
3. **Maintains original genetic make-up of plant variety:** The genetic heritage of the progeny plant differs from its parents in a hybridization procedure since it was a blend of both parental genomes, however in cisgenesis, a new gene was inserted without modifying their genetic makeup.
4. **Reduction in pesticide application:** The main goal of cisgenesis is to transfer disease resistance genes from vulnerable varieties to susceptible variations. The main goal here is to reduce the number of pesticides used.
5. **Time saving:** Cisgenesis could be used to triage and prioritization desirable features into economically viable cultivars while preserving their beneficial properties.

Limitations of Cisgenesis:

- Despite cisgenics innovation has a number of advantages over its transgenic predecessor, it does have certain constraints, such as the inability to insert characters from beyond the interbreeding genus.
- The plant's sequencing information is incomplete.
- In order to create a high quantity of transformants, elevated transformation efficiencies are required.
- The impact of positioning on gene expression and phenotypic variation is possible.
- The production of marker free plants frequently necessitates the invention of novel protocols, since such protocols may not be easily available for the crop.

Achievements

- By transplanting known resistance loci wild genotypes into current, high producing cultivars, cisgenesis can be used to develop blight resistant potato plants.
- The development of cisgenic Apple plant17 employed the use of ORF of endogenous apple scab resistance gene HcrVf2 from the wild relative Malus floribunda under the control of its own regulatory sequence into scab susceptible cultivar 'Gala'.
- Cisgenic barley with improved phytase activity18 was demonstrated with barley phytase gene (HvPAPhy_a) which is expressed during grain filling.
- Cisgenic inhibition of the potato cold induced phosphorylase L gene expression and decrease in sugar contents19 uses RNA silencing construct controlled by 35S promoter and the OCS terminator and selected putative transgenic shoots on kanamycin-containing medium.
- Expression of KxhKN4 and KxhKN5 genes in Kalanchoë blossfeldiana 'Molly' results in novel compact plant phenotypes.
- Gibberellin-associated cisgenes modify growth, stature and wood properties in Populus21 by inserting five cisgenes that encode proteins involved in gibberellin metabolism or signalling.
- Cisgenesis has been applied to transfer of natural resistance genes to the devastating disease Phytophthora infestans in potato and scab (*Venturia inaequalis*) in apple.

CONCLUSION

Cisgenesis is a type of genetic modification that involves the transfer of a gene and its promoter to a recipient species. Transgenic plants, on the other hand, are created by introducing 'foreign' or artificial gene-promoter pairings. Cisgenesis differs fundamentally from transgenesis in that it respects species boundaries. Cisgenic plants are similar to traditionally bred plants because the transferred genes come from the same gene pool. As a result, cisgenic plants are just as safe as traditional bred plants. Cisgenesis is becoming more viable as biotechnology advances in terms of utilizing gene resources and specifically obtaining novel agricultural features without the use of foreign genes or gene fragments.

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