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Review Article

Transgenic plants: Types, benefits, public concerns and future

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ABSTRACT

The alteration of crops to improve their production was performed through the basis of selection before the creation of transgenics. This selection has been going on for thousands of years. By the year 2050, world population may reach nine billions. Food production will need to increase at the same rate or more in order to satisfy the needs of such an enormous number of people in some older centuries. So, there is a need to use the genetic techniques to improve crops over the recent decades. Through the use of transgenics, one can produce plants with desired traits and even increased yields. The transgenics would allow for more crops that last longer and withstand pests and diseases. Transgenic plant production will allow us to feed the growing population and to produce more desirable products. The future of GM crops remains a vital debate, as its applications have several advantages and disadvantages.

1. Introduction

Transgenic plants are the ones, whose DNA is modified using genetic engineering techniques. The aim is to introduce a new trait to the plant which does not occur naturally in the species. A transgenic plant contains a gene or genes that have been artificially inserted. The inserted gene sequence is known as the transgene, it may come from an unrelated plant or from a completely different species. The purpose of inserting a combination of genes in a plant, is to make it as useful and productive as possible. This process provides advantages like improving shelf life, higher yield, improved quality, pest resistance, tolerant to heat, cold and drought resistance, against a variety of biotic and abiotic stresses. Transgenic plants can also be produced in such a way that they express foreign proteins with industrial and pharmaceutical value. Plants made up of vaccines or antibodies (Plantibodies) are especially stricing as plants are free of human diseases, thus reducing screening costs for viruses and bacterial toxins.[1]

The first transgenic plants were reported in 1983. Since then, many recombinant proteins have been expressed in several important agronomic species of plants including tobacco, corn, tomato, potato, banana, alfalfa and canola.[2] Tobacco plants were generally used, however potatoes and bananas are also considered, for the purpose of vaccines for human beings.

2. Development of transgenic crops

Genetically engineered plants are generated in a laboratory by altering the genetic-make-up, usually by adding one or more

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genes of a plant's genome. The nucleus of the plant-cell is the target for the new transgenic DNA. Most genetically modified plants are generated by the biolistic method (Particle gun method) or by *Agrobacterium tumefaciens* mediated transformation method.

The "Gene Gun" method, also known as the "Micro-Projectile Bombardment" or "Biolistic" method is most commonly used in the species like corn and rice. In this method, DNA is bound to the tiny particles of Gold or Tungsten, which is subsequently shot into plant tissue or single plant cells, under high pressure using gun.[3] The accelerated particles are penetrating both into the cell wall and membranes. The DNA separates from the coated metal and it integrates into the plant genome inside the nucleus. This method has been applied successfully for many crops, especially monocots, like wheat or maize, for which transformation using *Agrobacterium tumefaciens* has been less successful.[4] This technique is clean and safe. The only disadvantage of this process is that serious damage can be happened to the cellular tissue.

The next method, used for the development of genetically engineered plants, is the "Agrobacterium" method (Fig. 1). It involves the use of soil-dwelling bacteria, known as *Agrobacterium tumefaciens*. It has the ability to infect plant cells with a piece of its DNA. The piece of DNA, that infects a plant, is integrated into a plant chromosome, through a tumor inducing plasmid (Ti plasmid). The Ti plasmid can control the plant's cellular machinery and use it to make many copies of its own bacterial DNA. The Ti plasmid is a large circular DNA particle that replicates independently of the bacterial chromosome.[3] The importance of this plasmid is that, it contains regions of transfer DNA (t DNA), where a researcher can insert a gene, which can be transferred to a plant cell through a process known as the "floral dip". A Floral Dip involves, dipping flowering plants, into a solution of Agrobacterium carrying the gene of interest, followed by the transgenic seeds, being collected directly from the plant.[3] This process is useful, in that, it is a natural method of transfer and therefore thought of as a more acceptable technique. In addition, "Agrobacterium" is capable of transferring large fragments of DNA very efficiently. One of the biggest limitations of Agrobacterium is that, not all important food crops can be infected by these bacteria.[3] This method works especially well for the dicotyledonous plants like potatoes, tomatoes and tobacco plants.

In research, tobacco and Arabidopsis thaliana are the most genetically modified plants, due to well developed transformation methods, easy propagation and well studied genomes.[5] They serve as model organisms for other plant species. Transgenic plants have also been used for bioremediation of contaminated soils. Mercury, selenium and organic pollutants, like as polychlorinated biphenyls (PCBs), have been removed from soils by transgenic plants, containing genes for bacterial enzymes.[6]

3. Types

Transgenic plants have genes inserted into them, deriving from other species. The inserted genes can come from species within the same kingdom (plant to plant) or between kingdoms (bacteria to plant). In many cases, the inserted DNA has to be modified slightly in order to correctly and efficiently express in the host organism. Transgenic plants are used to express proteins, like the cry toxins from Bacillus thuringiensis, herbicide resistant genes and antigens for vaccinations.[7]

Cisgenic plants are made up of using genes, found within the same species or a closely related one, where conventional plant breeding can occur. Some breeders and scientists argue that cisgenic modification is useful for plants that are difficult to crossbreed by conventional means (such as potatoes). Those plants in the cisgenic category should not require the same level of legal regulation as other genetically modified organisms.[8]

4. Advantages of transgenic plants

GM Technology has been used to produce a variety of crop plants to date. As the global population continues to expand, food remains a scare resource. Genetically engineered foods offer significant benefits by improving production yield,

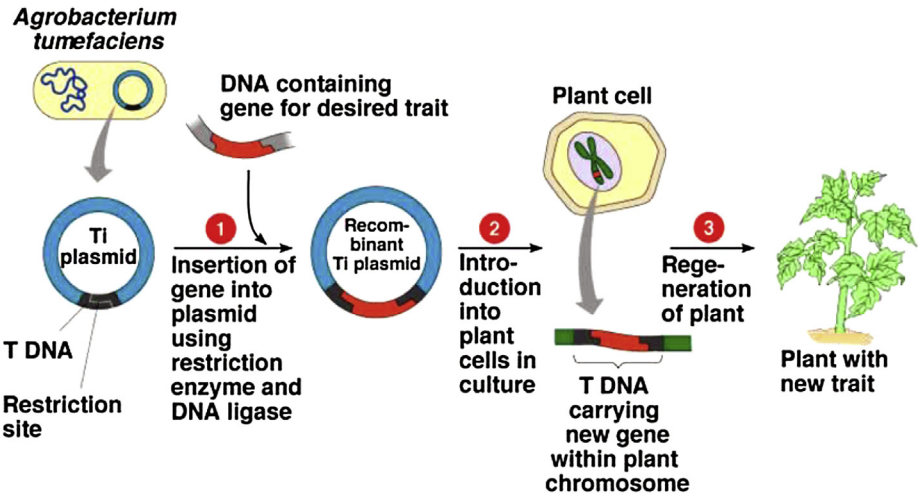

Fig. 1 – Agrobacterium mediated transformation.