Transgenic plants: Next Generation Plants

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ABSTRACT

Transgenic plants are plants which are genetically modified, by using recombinant DNA techniques or rDNA which attain new characteristics to the plants. These are identified as a class of genetically modified organism (GMO). To improve the production of the crops this method is commonly used for transgenics. For thousands of years this selection has been on going. World population may reach up to nine billions by the year of 2050. To provide food for human needs in the area of the agriculture these transgenic crops are used. Over the recent decades to improve crops there is a need of using this genetic technique. By using this method we can produce the crops with even increased yields and desired traits. These crops can withstand diseases and pests which would allow growing more crops. We can feed the growing population and also produce more desirable products. Its applications have more disadvantages as well as advantages and in future these genetically modified crops have vital debate.

Introduction

By using genetic engineering techniques the DNA is modified to produce transgenic plants [1-19]. The main aim of this method is to introduce a new character to the plant as it does not occur naturally in that particular species [20-22]. Artificially one or more genes are inserted in to the transgenic plant. The gene sequence which is inserted is known as transgene [23-25]. The transgene is either from related, unrelated or it is completely different in species [26]. To make it as more productive and useful some or more combination of genes are inserted in a plant [27,28]. The main advantages of this process is to improve against a variety of biotic and abiotic stresses, shelf life, tolerant to heat, higher yield, cold and drought resistance, pest resistance, improved quality etc [29-35]. These plants are also able to produce some foreign proteins which have pharmaceutical and industrial value [36,37]. Plants made up of antibodies or vaccines are striking as plants are free of human diseases which reduce the cost of bacterial toxins and screening costs for viruses [38-42]. In 1983 the first transgenic plant was reported. In several important agronomic species of plants, many recombinant proteins have been expressed in banana, tomato, cotton, potato, corn, tobacco, canola, alfalfa etc. For preparing vaccines for human beings potatoes and bananas are genetically modified [43].

Transgenic Crops Development

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By adding one or more genes of a plant's genome, by altering the genetic make-up in a laboratory genetically engineered plants are produced [44]. For the new transgenic DNA nucleus of the plant-cell is the main source. By using Agrobacterium tumefaciens mediated transformation method most of the transgenic plants are developed [45-46]. DNA is bounded with tiny particles of Tungsten or Gold and later subsequently shot into single plant cells or plant tissue with high pressure with the help of gun. These particles now penetrate into cell membranes and cell wall [47,48]. Then the DNA will get separated from the coated metal and now it integrates into the plant genome inside the nucleus. This technique is especially applied for many crops mainly maize or wheat. This method is safe and clean. The main disadvantage in this process is serious damage that can occur in cellular tissue. Another method is also used in this technique with the help of soil-dwelling bacteria, known as Agrobacterium tumefaciens [49,50]. This bacteria has the ability to infect the plant cells with its DNA piece in plant chromosome through a tumor inducing plasmid known as Ti plasmid [51,52]. This plasmid can control the machinery of plants cells and it makes many copies of its own bacterial DNA [53]. This plasmid is a large circular DNA and it can replicate independently. The main use of this plasmid is as it contains some regions known as transfer DNA, in which we can insert a foreign gene. Agrobacterium is capable of transferring large fragments of DNA [54,55]. Not all important food crops can be infected by these bacteria. This method works effectively for dicotyledonous plants like tobacco, potatoes, and tomatoes plants [56].

Deriving from other species the genes are inserted into transgenic plants. The genes are derived from same kingdoms or different kingdoms. The DNA which is DNA should be modified to express efficiently in host organism [57]. These transgenic plants are used to express proteins, antigens for vaccinations and herbicide resistant genes [58,59].

Transgenic Plants Advantages

1. Genetically Modified Technology has been used to produce a variety of crop plants to date [60].
2. Improves production of yield, enhancing the nutritional content and lowering transportation costs [61,62].
3. Production of commercial varieties [63]
4. Viruses and pests resistance [64]
5. Herbicide resistance tolerance

The Plants which are resistance to herbicides are called Herbicide Resistant Plants. The active ingredient is Glyphosate and it is a broad spectrum herbicide of Tobacco, Tomato, cotton, potato etc. Bacillus thuringiensis is a bacterium that is pathogenic for a number of insect pests [65-69]. It produces a protein toxin which has a lethal effect. The toxin gene can be inserted directly into the genome of the plant through recombinant DNA method which expresses and provides protection against insect pests of the plant. Tomato plants and TMV resistant tobacco are produced by inserting viral coat proteins [70-72]. The viral resistant transgenic plants are YMV resistant green gram, Potato virus resistant potato plants, YMV resistant black gram, RSV resistant rice etc. Transgenic plants such as papaya are modified as Papaya-ring-spot-virus resistant papaya has been commercialized and grown. In half a million children Vitamin A deficiency causes blindness either totally or partially [73-75]. The staple food for a large fraction of the World's human population is milled rice. For producing crops which contains high concentration of vitamin A this traditional breeding method is used [76].
Three genes two from daffodils and one from a microorganism should be inserted into rice to produce transgenic rice which has of beta-carotene as a precursor to Vitamin A and the seed is yellow in color. Efficient usage and Water availability is a global issue \( [77-80] \). Soils are subjected to extensive tillage (plowing) for preparing seed beds and controlling weeds \( [81] \). In the treatment and diagnosis of human diseases therapeutic proteins are produced in plants \( [82] \). The proteins produced in transgenic plants for therapeutic use, are of three types vaccines, antibodies and proteins.

Antibodies directed against cholera, certain cancers, hepatitis B virus, rheumatoid arthritis, dental caries, \textit{E. coli} diarrhea, herpes simplex virus, malaria, influenza, rhinovirus etc \( [83-85] \). An anti-cancer antibody has recently expressed in rice and wheat seed that recognizes cells of lung, breast and colon cancer and hence could be useful in both diagnosis and therapy in the future \( [86,87] \).

**Disadvantages of Transgenic Crops**

1. Transgenic crops cause allergies for some people \( [88] \)
2. The antibiotic resistance genes which are inserted in these crops have resistance to antibiotics and leads to super bugs and these bugs can't be killed with antibiotic treatments
3. Causes damage to the natural environment \( [89] \)
4. Plant and product contamination by endogenous metabolites, pesticides, mycotoxins and herbicides \( [90] \)

**The Future of Transgenic Crops**

Around the globe, genetically modified crops offer a potential solution to food shortages but the viability of their cultivation remains questionable. The main uses of producing these GM crops to enhance health concerns, carries hidden costs in environment, eliminate hunger etc. Some Significant benefits of transgenic crops are:

1. Hybrid seed effective production
2. No usage of insecticide \( [91] \)
3. Decreases loss of viruses and insect pests
4. Weed control \( [92] \)
5. Resistance against storage pests
6. Increase in nutritional quality \( [93] \) (oil in canola)
7. Marketing flexibility
8. For better shelf life
9. Decrease in post-harvest losses
10. Safer environment

In future, the transgenic crops will be used not only for improved agronomic traits, but also for traits involving food processing, pharmaceuticals (including edible vaccines) and specialty chemicals \( [94,95] \). Transgenic rubber tree has also been produced and will be used for a variety of purposes. Thus the future of transgenic crops is bright and optimistic. These goals will be achieved by sustained efforts, both in industrialized and developing countries. The farmers and public will have to respond to this changing scenario \( [96] \).
CONCLUSION

In developing countries we hope to be able to provide medicines in GM foods and vaccinations which are used as medications in future [97]. Medications incorporated into food are easier to transport and can store conventional medicine. There is a great impact on the lives of many as these transgenic plants have much advancement. For administering human antibodies and producing the transgenic plants has an offer to new approach. Biopharmaceuticals like Insulin to treat diabetes and erythropoietin to treat anemia are produced by using genetic engineering method [98]. Future generations of GM plants are intended to be suitable for production of Bioenergy and Biofuels, for harsh environments, enhancement of nutrient content, production of pharmaceutical agents etc [99,100].

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