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Transgenic plants resistant to harmful insects

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Abstract

Insects are the most common living group in the world. Fighting insects is one of the important issues today because of their negative effects on humans and plants. One of the most useful and common biological control methods is the use of preparations of *Bacillus thuringiensis* (Bt) bacteria. Bt is a gram-positive, facultatively aerobic, spore-forming soil bacterium that produces versatile proteins that have stark toxicity against the insects within parasporal crystals during the dormant phase of its growth cycle. These proteins, called Cry proteins, are divided into many groups according to their sequence similarity (Cry1-Cry67). It is aimed to obtain higher yields in agricultural production with transgenic plants resistant to weed pesticides (herbicides), insects and viral diseases, and to reduce the use of pesticides, especially insect-resistant plants, all over the world. Soy, corn, canola, potato, pumpkin and papaya are transgenic plant species cultivated in the world today.

Introduction

Increasing the yield per unit area in order to eliminate the nutritional problem that arises due to the continuous increase in the world population; agricultural production has gained more importance than increasing arable land and studies have been focused on this direction [1]. The period after the Green Revolution in crop production is called the "Biotechnology Revolution". Herbal modern biotechnological methods; it consists of the stages of finding, characterizing, isolating and transferring the desired genes to the target cell. Techniques used; it is based on the principle of placing a piece of DNA carrying the desired gene into the chromosomes in the tissue cell, and then obtaining genetically modified (transgenic, GM) plants from these cells by applying tissue culture techniques. Many methods have been applied to obtain insect-resistant GM plants using biotechnological methods. The most common of these methods today is the transfer of a gene of *B. thuringiensis* bacteria, which produces toxic proteins against the insects, to protect the cultivated plants. It is hoped that product loss can be minimized by applying this method to the maize plant [2]. Genetically Modified products protect plants against insect damage depending on the transmitted trait and contain selected genes found in the common soil bacterium, *Bacillus thuringiensis* (Bt). The Bt genome uses genetic information from the plant to produce a protein that is not harmful to human health but is toxic to the larvae of some pests. Since the insects that damage the plant cannot damage the plants with Bt, the productivity of the plants increases and there is no need for pesticide use [3]. B. thuringiensis is a member of the genus *Bacillus*, which includes more than 20 bacterial species that are gram-positive, aerobic, spore-forming and similar in basic biological characteristics. The bacterium was first seen in silkworm larvae in 1901, where fainting disease was encountered, and was isolated from there. The insecticidal activity of *B. thuringiensis* is due to protein inclusions produced during spore formation. These inclusions consist of ICP (insecticidal crystal protein) and ICPs (Cry protein or δ-endotoxin) are effective against many insect species. These proteins are toxic to insects of Lepidoptera, Diptera and Coleoptera. They are also active against Hymenoptera, Homoptera, Orthoptera, Mollophaga, Nematodes, Mites and Protozoa [2,4,5,6]. The active part of B. thuringiensis δ-endotoxin

consists of 3 separate sites. Zone 1 causes attachment to the insect gut and the formation of holes. The second region has the feature of binding to the receptors of the epithelial cells of the insect gut. The function of the 3rd region is not known exactly, but it is assumed that this region prevents the digestion of Cry toxins by intestinal proteases, provides the formation of ion channels, binds to the receptor and is responsible for insect specificity. Bt Cry proteins act as midgut toxin in insects. Proteins must be digested by the target insect in order to become active [4]. After digesting insect parasporal crystals, insecticidal proteins are activated by proteases in an alkaline (pH 8 – 10.5) medium in the midgut. ICP then crosses the midgut barriers to interact with the epithelium, forming pores, causing the loss of transmembrane potential; resulting in cell lysis, leakage of midgut contents, paralysis of the insect or death [2,7].

If the use and diversity of products with *Bacillus thuringiensis* continues to increase in this way, it is possible for many insect species and populations to acquire resistance to transgenic plants. Despite all its limitations, the "shelter strategy" is currently recognized by many experts as the most effective method of delaying the emergence of resilience. This strategy is based on finding host plants that do not contain Bt toxin, which will allow sensitive pest species to survive, near crops with Bt [1,2,5]. Not all pests are susceptible to plants with *Bacillus thuringiensis*. For this reason, secondary pests may gain advantage due to reduced competition with the main pest and cause economic losses as they did not do before. Another concern due to the use of transgenic plants is the damage these plants can cause to biodiversity and natural balance. It is thought that the transferred genes may jump to natural plant species, leading to the loss of genetic diversity in the natural species of their environment and a deviation in the natural structure of wild species. The rapid disappearance of natural species that cannot compete with genetically modified plant species threatens biological diversity as well as genetic diversity. This decrease; some insecticides are no longer used, the frequency of application is reduced or the area applied is reduced [1,2,5].

Results

There has been some public concern due to the negative effects of these new transgenic varieties, whose use is increasing day by day, on human health, environment and biodiversity. It is thought that these new features brought to plants will cause the deterioration of the environment and flora of the plant, the loss of genetic diversity of some natural species, the loss of species distribution and balance in the ecosystem and the extinction of some wild species. In order to prevent these concerns and biodiversity risks, new varieties should be developed using new methods and biotechnological methods as an alternative to genetically modified plants. For example, in order to increase the yield of already cultivated crops, traditional breeding methods of wild genotypes and/or recombinant DNA technologies can be used to obtain new varieties with high nutritional content, or crop loss can be prevented by intervening pests by modulating the plant immunity at the gene level. Although transgenic plants have some potential risks, considering the many advantages they provide, more comprehensive studies should be conducted on the subject matter [1,5].

Discussion

With this perspective, there should be more studies on generation of transgenic resistant plant species with higher yields without spoiling the nature for the future while obtaining these transgenic plants and products. Since Turkey is very rich in terms of biodiversity, genetically modified products should be handled comprehensively, especially in agricultural production. In fact, research, development, processing, placing on the market, monitoring, use, import and export of transgenic products are prohibited in our country in accordance with the “biosafety law” that entered into force in 2010. However, there are transgenic products that are allowed to enter our country, especially for some animal feeds, by obtaining the necessary permits. Another issue that should be emphasized is that it is an increasing possibility that each agricultural product we import from abroad is genetically modified. Therefore, a holistic approach should be adopted without delaying any necessary legal regulations and based on the protection of biodiversity while utilizing from these products by stringent control conditions to increase the agricultural yield in our country [1,2,5].

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