GM Crop Database

Database Product Description

GU262 (ACS-GMØØ3-1)

Host Organism	*Glycine max* (Soybean)
Trait	Phosphinothricin (PPT) herbicide tolerance, specifically glufosinate ammonium.
Trait Introduction	Microparticle bombardment of plant cells or tissue
Proposed Use	Production for human consumption.
Product Developer	Bayer CropScience (Aventis CropScience(AgrEvo))

Summary of Regulatory Approvals

Country	Food	Feed	Env	Notes
United States	1998	1998	1998	

Introduction

Soybean line GU262 was developed through a specific genetic modification to allow the use of glufosinate ammonium, the active ingredient in phosphinothricin containing herbicides (Basta, Ignite, Rely, Liberty, Harvest, and Finale), as a weed control option in soybean crops. The *pat* gene, which encodes the enzyme phosphinothricin-N-acetyltransferase (PAT) and confers tolerance to glufosinate ammonium, was isolated from the common aerobic soil actinomycete, *Streptomyces viridochromogenes* strain Tü 494 and introduced into the parent soybean line.

Glufosinate is a short name for the ammonium salt, glufosinate-ammonium. It is a broad-spectrum contact herbicide and is used to control a wide range of weeds after the crop emerges or for total vegetation control on land not used for cultivation. Glufosinate is a natural compound isolated from two species of Streptomyces fungi. It inhibits the activity of an enzyme, glutamine synthetase, which is necessary for the production of glutamine and for ammonia detoxification. The application of glufosinate leads to reduced glutamine and increased ammonia levels in the plant tissues. This causes photosynthesis to stop and the plant dies within a few days. Glufosinate also inhibits the same enzyme in animals. It is highly biodegradable, has no residual activity, and very low toxicity for humans and wild fauna. The PAT enzyme detoxifies phosphinothricin by acetylation into an inactive compound.

In the United States, the transgenic soybean lines A2704-12, A2704-21, and A5547-35 were designated as the antecedent organisms for GU262 for the purposes of conducting an environmental safety assessment. The soybean GU262 and its progeny were similar to the antecedent organisms as they were genetically engineered to express the same *pat* gene, and they all exhibited similar agronomic characteristics. Based on the similarity between between GU262 and the antecedent organisms A2704-12, A2704-21, and A5547-35, and on an analysis of scientific data and field tests, the soybean line GU262 was judged not to have any characteristics

that would have a significant impact on any beneficial organisms in the environment or on any threatened or endangered species.

Summary of Introduced Genetic Elements

Code	Name	Type	Promoter, other	Terminator	Copies	Form
pat	phosphinothricin N-acetyltransferase	HT	CaMV 35S	CaMV 35S poly(A) signal	2	Native
bla	beta lactamase	SM	bacterial promoter			Partial, not expressed

Characteristics of *Glycine max* L. (Soybean)

Center of Origin	Reproduction	Toxins	Allergenicity
Southeast Asia; wild soybean species endemic in China, Korea, Japan, Taiwan.	Self-polinated; rarely displays any dormancy characteristics; does not compete well with other cultivated plants.	Raw soybeans contain trypsin inhibitors, which are toxin when eaten.	Soy allergies are common, and eating soy products can cause rashes and swelling of the skin in sensitive individuals.

Donor Organism Characteristics

Latin Name	Gene	Pathogenicity
Streptomyces viridochromogenes	pat	*S. viridochromogenes* is ubiquitous in the soil. It exhibits very slight antimicrobial activity, is inhibited by streptomycin, and there have been no reports of adverse affects on humans, animals, or plants.

Modification Method

The soybean line GU262 was produced via biolistic transformation of a soybean line with a pUC19 based plasmid vector, pB2/35SacK, containing the pat gene and sequences encoding the beta-lactamase enzyme that confers resistance to beta-lactam antibiotics such as ampicillin. Expression of the *pat* gene was regulated by including promoter and terminator sequences from the 35S transcript of cauliflower mosaic virus (CaMV).

The *bla* gene, encoding beta-lactamase, was employed as a selection method during the development process in order to identify bacterial colonies that had been transformed with recombinant plasmids. The promoter sequences for the *bla* gene were only active in bacteria and there was no expression of these sequences in the modified soybean lines.

Characteristics of the Modification

The Introduced DNA

Southern blot analysis of genomic DNA from GU262 indicated the incorporation of 2 copies of the *pat* gene into the host genome. In addition, GU262 also contained partial copies of *bla* antibiotic marker gene, which was not expressed in plant tissue. Only the *pat* gene was fully intact and functional in the plants.

Environmental Safety Considerations

Field Testing

Transgenic soybean line GU262 was field tested in the United States (1996-1998). Field trial reports from these tests demonstrated that the transformed soybean line did not exhibit weedy characteristics, and had no effect on nontarget organisms or the general environment.

Outcrossing

Gene introgression from transformed soybean line GU262 was extremely unlikely as there are no relatives of cultivated soybean in the continental United States and soybean plants are almost completely self-pollinated.

Weediness Potential

The gene that confers tolerance to the herbicide, glufosinate, will not provide soybean line GU262 or their progeny with any measurable selective advantage over non-transformed soybean plants in their ability to disseminate or to become established in the environment. GU262 lines did not exhibit any increased weediness characteristics relative to that of traditional varieties or the unmodified parental line.

Secondary and Non-Target Adverse Effects

It was concluded that soybean line GU262 would not have a significant adverse impact on organisms beneficial to plants or agriculture, nontarget organisms, or on any threatened or endangered species.

Abstract

Soybean (*Glycine max*) is grown primarily for its seed, which has many uses in the food and industrial sectors, and represents one of the major sources of edible vegetable oil and of proteins for livestock feed use. The major producers of soybeans were the United States, Brazil, Argentina, China, India, Paraguay and Canada.

A major food use of soybean in North America and Europe is as purified oil, used in margarines, shortenings, and cooking and salad oils. It is also a major ingredient in food products such as tofu, tempeh, soya sauce, simulated milk and meat products, and is a minor ingredient in many processed foods. Soybean meal is used as a supplement in feed rations for livestock.

Weeds are a major production problem in soybean cultivation. Typically, weeds are managed using a combination of cultural (*e.g.*, seed bed preparation, using clean seed, variety selection, and planting date) and chemical controls. Depending on the production area and the prevalent weed species, herbicides may be applied before planting (*e.g.*, pendimethalin, trifluralin, metribuzin), after planting but before emergence (*e.g.*, pendimethalin, linuron, imazethapyr), and/or after emergence (*e.g.*, bentazon, acifluorfen, fomesafen). Commonly, several different herbicides are required to adequately control weeds in soybean fields.

The soybean line GU262 was genetically engineered to express tolerance to glufosinate ammonium, the active ingredient in phosphinothricin herbicides (Basta®, Rely®, Finale®, and Liberty®). Glufosinate chemically resembles the amino acid glutamate and acts to inhibit an enzyme, called glutamine synthetase, which is involved in the synthesis

of glutamine. Essentially, glufosinate acts enough like glutamate, the molecule used by glutamine synthetase to make glutamine, that it blocks the enzyme's usual activity. Glutamine synthetase is also involved in ammonia detoxification. The action of glufosinate results in reduced glutamine levels and a corresponding increase in concentrations of ammonia in plant tissues, leading to cell membrane disruption and cessation of photosynthesis resulting in plant withering and death.

Glufosinate tolerance in GU262 soybean is the result of introducing a gene encoding the enzyme phosphinothricin-N-acetyltransferase (PAT) isolated from the common aerobic soil actinomycete, *Streptomyces viridochromogenes*, the same organism from which glufosinate was originally isolated. The PAT enzyme catalyzes the acetylation of phosphinothricin, detoxifying it into an inactive compound. The PAT enzyme is not known to have any toxic properties. The *pat* gene was introduced into the soybean genome by micro-particle acceleration (biolistic) transformation, and the resulting soybean line, GU262, displayed field tolerance to phosphinothricin-containing herbicides, thereby permitting farmers to use this herbicide for weed control in soybean cultivation.

The transgenic soybean line GU262 was field tested in the United States from 1996 to 1998, and field trial reports indicated that this line did not exhibit weedy characteristics, and had no effect on non-target organisms or the general environment. In the United States, the transgenic soybean lines A2704-12, A2704-21, and A5547-35 were designated as the antecedent organisms to GU262 for the purposes of conducting an environmental safety assessment. The soybean line GU262 and its progeny were similar to the antecedent organisms as they were genetically engineered to express the same pat gene, and they all exhibited similar agronomic characteristics. Based on the similarity between GU262 and the antecedent organisms A2704-12, A2704-21, and A5547-35, and on an analysis of scientific data and field tests, the soybean line GU262 was judged not to have any characteristics that would have a significant impact on any beneficial organisms in the environment or on any threatened or endangered species.

Soybean does not have any weedy relatives with which it can crossbreed in the continental United States or Canada. Additionally, soybean plants are almost completely self-pollinated, and the reproductive and growth characteristics of GU262 were unchanged by the genetic modification resulting in glufosinate-tolerance. It was therefore concluded that the potential for transfer of the glufosinate-tolerance trait from the transgenic line to soybean relatives through gene flow (outcrossing) was negligible in managed ecosystems, and that there was no potential for transfer to wild species in Canada or the continental United States.

Links to Further Information

U.S.Department of Agriculture, Animal and Plant Health Inspection Service

AgrEvo USA Company Application for an Extension of the Determination of Nonregulated Status for Glufosinate Resistant Soybean Transformation Evens (96-068-1p): Event GU262 (http://cera-gmc.org/files/cera/GmCropDatabase/docs/decdocs/05-242-036.pdf) [PDF Size: 2.13M bytes]

USDA-APHIS Environmental Assessment

Approval of AgrEvo Request (98-238-01p) Seeking Extension of

Determination ofNon-regulated Status For Glufosinate Resistant Soybean Transformation Event GU262 (http://cera-gmc.org/files/cera/GmCropDatabase/docs/decdocs/01-290-080.pdf) [PDF Size: 36.97K bytes]