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GENETIC ENGINEERED RESISTANCE AGAINST HERBICIDE

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Introduction:

Genetic engineered herbicide resistance crops commercially grown mostly in the America, since 1995. The main principle of these crops is that, they are designed to tolerate specific broad spectrum herbicide and kills the surrounding flora but cultivated crops remain intact. With over time, surrounding flora of crops develops resistance against herbicide and application of more herbicide, increasingly. The development of genetic engineered resistance against herbicide signifies decreasing of pollution, health risk for consumers and reduce loss of biological diversity. For crop improvement several genetic traits have been introduced in plants and thereby plants efficiency has been increased several times as compared to the normal plants. Herbicides are those chemicals which are used to eliminate unwanted weeds that are two types-

(1) Selective herbicide which kills only some specific weeds and

(2) Nonselective

Herbicide or broad spectrum kills all types of weeds. Generally crop plants have lack of tolerance to the chemical by one or more of the major world crops, e.g. rice, maize, soybean, wheat and rapeseed. Use of multiple types of herbicides to broaden the spectrum of the affected weeds, which in turn increases the possibility that the crop is injured also and lack of high toxicity to weeds while crops are not affected. An ideal herbicide must have some characteristics features like it should control all types of weeds or all types of species except the crop of interest, a high degree of environmental safety i.e. it should be not harmful for the environment, minimum persistence in soil i.e. it should be easily degrade by soil microorganism. However it is difficult to find herbicide having all these properties.

Problems in the application of herbicide:

- Lack of tolerance to the chemical by one or more of the major world crops, e.g. rice, maize, soybean, wheat, rapeseed.
- Use of multiple types of herbicides to broaden the spectrum of the affected weeds, which in turn increases the possibility that the crop is injured also.
- Lack of high toxicity to weeds while crops are not affected.

Properties of an ideal herbicide:

- Control all types of weeds or all types of species except the crop of interest.
- A high degree of environmental safety *i.e.* it should be not harmful for the environment.
- Minimum persistence in soil *i.e.* it should be easily degraded by soil micro-organism.
- However it is difficult to find herbicide having all these properties.

Basic strategies:

The development of crop plants that are tolerant to herbicide is an important approach to control weed. Development of transgenic plants resistant to certain biodegradable herbicides was the first major achievement of genetic engineering. Three main approaches are as follows-

(1) Over expression of target gene
(2) Modification of target protein, and
(3) Detoxification of herbicide.

Resistance against glyphosate:

An active component of round herbicide is used as nonselective post emergence herbicide. It is suggested that glyphosate inhibits aromatic amino acids (phenyl alanine, tyrosine and tryptophan) biosynthesis by competitive inhibitor of EPSPS enzyme (5enolpyruvyl shikimate3 phosphate synthase) encoded by aroA gene from *Agrobacterium spp.* and *Salmonella typhimurium*.

Figure 1: Round up soybean having resistance against Glyphosate.

Resistance against sulfonylurea and imidazolinone:

The herbicide action of sulfonylurea and imidazolinone is based on their ability to inhibit noncompetitively an enzyme of branched chain amino acid biosynthesis, acetolactate synthase (ALS). ALS is the 1st enzyme in the biosynthesis of Valine, leucine and isoleucine.

Resistance against phosphinothricin:

L-phosphinothricin (PPT) is a naturally occurring amino acid with herbicidal activity and it is active component of herbicide "Basta". PPT is a potent inhibitor of glutamine synthase and thus causes rapid increase in ammonia concentration in plants and this leads to death of plant cell. Phosphinothricin acetyl transferase (PAT) enzyme (bar gene of *Streptomyces hygroscopicus*) that acetylates the free NH2 groups of phosphinothricin and renders it inactivates the herbicide Basta. This 'bar' gene with Camv-35S promoter has been transferred to tomato, tobacco and potato plants using Ti plasmid of agrobacterium.

Table 1: Types of herbicides by chemical families.

Chemical family	Affected system	Target protein
Triazines (atrazine, ametryne, cyanazine, prometryn, simazine)	Photosystem II, electron transport from QA to QB	D1 protein, product of psbA gene
Sulfonylureas, Imidazolinones	Amino acid synthesis	Acetolactate synthetase (ALS)
Cyclohexanediones	Lipid synthesis	Acetyl coenzyme A carboxylase (ACCase)
Glyphosate	Amino acid synthesis	5 Enoyl pyruvyl shikimate 3phosphats (EPSPS)
Bromoxynil	Photosystem II	D1 protein
Phosphinothricin	Glutamine	Glutamine synthase

Advantage of herbicide tolerant crops:

Excellent weed control and hence higher crop yields, possible to control weeds later in the plant's growth, reduced numbers of sprays in a season, reduced fuel use, reduced soil compaction, use of low toxicity compounds which do not remain active in the soil and the ability to use conservation till systems, with consequent benefits to soil structure and organisms.

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