Biotechnology in plant sciences-

Genetic Engineering has allowed us to produce genetically modified plants with diversified properties such as resistance against pest, drought, abiotic stress.

Insect control- Insect uses plants for nutrition and reduces the crop yield. There are two ways to control the effect of insects on the crop; reduction in the number of insects in the affected area or generation of plants with insect resistantance.

Sterile male insects- In this approach, male insects are exposed to the radiation or other treatment in the laboratory to render them infertile. These sterile male insects are spread over the infected area. In the field, female mate with these sterile males but no offspring is produced. As a result over the course of time, the insect population will be reduced. The classicial example of this approach is irradication of boll weevil, an insect responsible for the loss of cotton crop in USA.

Insect resistant plants-A genetically altered crop is produced to develop resistantance against insects. One of the approach is to genetically modify the plant which will express a toxin to kill the insects but will be safe for human consumption. Bacillus thuringiensis (Bt) is a bacteria which secretes a insecticidal toxin. Spraying Bt toxin was in circulation to control the insect population. With the use of genetic engineering transgenic plants are produced which express Bt toxin in their somatic cells. When insect feeds on the plant, toxin reach to the stomatch and causes internal bleeding to kill the insect.

Herbicide resistant plants- Weeds grow very fast and they compete for nutrients with the crop plant. Chemical herbicides are used in the agriculture to eradicate weeds from the fields. Herbicides are either selective towards a class of plant or nonselective to kill all plants they applied to and used more often to kill all vegetation. Glyphosate is one of the first herbicide designed to kill weeds. It interferes biosynthesis of aromatic amino acid tyrosine, phenylalanine and tryptophan by inhibiting enzyme 5- enolpyruvylshikimate-3-phosphate synthase (EPSP). The enzyme catalyzes the conversion of the shikimate-3-phosphate to the 5-enolpyruvylshikimate-3-phosphate.The treated plant can not be able to produce these amino acids as well as protein needed and dies. There are two approaches, adopted to develop herbicide resistantance in crop plant.

Few bacterial strains use an alternate form of EPSP that is resistant to the glyphosate inhibition. The modified version of EPSP gene was isolated from the Agrobacterium strain CP4 and cloned into the crop plant to provide herbicide resistantance. Plant commercially available with herbicide resistantance are soy, maize, sorghum, canola and cotton.

Disease resistant plants-Plants are under continuous exposure to the pathogenic organism and the environmental conditions. Pathogenic organisms (bacteria, fungi, mycoplasma, virus) attack on plants to gain nutrients for their growth and disturb its metabolism to exhibit pathological symptoms. There are multiple approaches to develop disease resistant plant.

Production of Resistance Protein- Plants have R gene (resistance gene) which produces R protein and these virulence factors allow acquiring resistance to combat pathogens. Every R gene recongnizes pathogen protein in a receptor-ligand reaction and as a result R gene product provides resistance against a particular pathogen or a family of related pathogens. R gene has the ability to modify its product to acquire resistance against new species of pathogen. A good example include barley MLO against powder mildew, wheat Lr34 against leaf rust, and wheat Yr36 against stripe rust.

Abiotic stress resistant plants-Over-production of systemin and Hyp Sys has been found to provide resistance in plant against salt and UV radition. In the transgenic plants, systemin lower down the stomatal opening in comparison to the normal plants to reduce the loss of water. Whereas in higher salt solution, plants had larger stomotal opening, lower concentration of abscisic acid and proline.

Examples of GMOs Resulting from Agricultural Biotechnology

Genetically Conferred Trait	**Example Organism**	**Genetic Change**
APPROVED COMMERCIAL PRODUCTS		
Herbicide tolerance	Soybean	Glyphosate herbicide (Roundup) tolerance conferred by expression of a glyphosate-tolerant form of the plant enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) isolated from the soil bacterium *Agrobacterium tumefaciens*, strain CP4
Insect resistance	Corn	Resistance to insect pests, specifically the European corn borer, through expression of the insecticidal protein Cry1Ab from *Bacillus thuringiensis*
Altered fatty acid composition	Canola	High laurate levels achieved by inserting the gene for ACP thioesterase from the California bay tree *Umbellularia californica*
Virus resistance	Plum	Resistance to plum pox virus conferred by insertion of a coat protein (CP) gene from the virus
PRODUCTS STILL IN DEVELOPMENT		
Vitamin enrichment	Rice	Three genes for the manufacture of beta-carotene, a precursor to vitamin A, in the endosperm of the rice prevent its removal (from husks) during milling
Vaccines	Tobacco	Hepatitis B virus surface antigen (HBsAg) produced in transgenic tobacco induces immune response when injected into mice
Oral vaccines	Maize	Fusion protein (F) from Newcastle disease virus (NDV) expressed in corn seeds induces an immune response when fed to chickens
Faster maturation	Coho salmon	A type 1 growth hormone gene injected into fertilized fish eggs results in 6.2% retention of the vector at one year of age, as well as significantly increased growth rates

Reference: Open access

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