

Role of Biotechnology in Agriculture

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Introduction

The increase in human population worldwide has become a major threat to food security. Biotechnology is one of the fastest growing areas in science that made a great development in various fields such as agriculture, medicine, pharmacy, industry and environment science. In fact, biotechnology is the science and technology of peaceful and humanitarian use of living things to human welfare and environmental protection. Along with the development of this technology, agriculture has been taken into account. Biotechnology improves production, saves time and money and causes reduction in chemical application. Agricultural biotechnology plays a crucial role in economic growth sustainability and economic competitiveness, especially in developing countries.

Agricultural biotechnology

Agricultural biotechnology is a collection of scientific techniques used to improve plants, animals and microorganisms. Based on an understanding of DNA, scientists have developed solutions to increase agricultural productivity.

Plant biotechnology

- ✚ **Synthetic seed:** Different micro propagation material such as somatic embryo, shoot bud, shoot tip, embryogenic calli formed invitro are coated (encapsulated) in gel containing nutrients and other additives are designated as synthetic or artificial seed. This approach is being utilized in many crops such as mango, banana etc.
- ✚ **Plant tissue culture:** Regeneration of plant from totipotent cell is known as plant tissue culture and this technique is quite helpful to produce disease free plant using micro propagation and mass multiplication of true to type in lesser area is also possible only with plant tissue culture.
- ✚ **Embryo rescue and culture:** This technique proved to be a milestone in overcoming the post fertilization barriers during distant hybridization and many success stories are

associated with this technique like successful cross of *Musa acuminata* x *Musa bulbisiana* and *Carica papaya* x *Carica cauliflora* etc.

- ✚ **Bio-fertilizers:** Phosphate and nitrogen are important for the growth of plants. These compounds exist naturally in the environment but plants have a limited ability to extract them and utilize them directly. Phosphate plays an important role in crop stress tolerance, maturity, quality and directly or indirectly, in nitrogen fixation. A fungus, *Penicillium biiai* helpful in unlocking of phosphate from the soil. Bio fertilizer made from this organism is applied by either coating seeds with the fungus as inoculation, or putting it directly into the ground. *Rhizobium* is a bacteria used to make biofertilizers for nitrogen fixation in the soil.
- ✚ **Bio-herbicides:** Weeds are the major problem for farmers. They not only compete with crops for water, nutrients, sunlight, and space but also harbour insect and disease pests; clog irrigation and drainage systems; undermine crop quality; and deposit weed seeds into crop harvests. Bio-herbicides are another way of controlling weeds without environmental hazards posed by synthetic herbicides. A gene from the soil bacterium *Agrobacterium tumefaciens*, is used in genetically engineered herbicide tolerant crops. It makes the recipient plant tolerant to the broad spectrum herbicide glyphosate. Resistance to synthetic herbicides has been genetically engineered in crops like maize, soybean, cotton, sugar beet, rice and flax etc.
- ✚ **Biotic and abiotic stress resistance:** The common soil bacterium *Bacillus thuringiensis* (*Bt*) genes have been inserted to build up a particular protein in cotton crop. This protein is toxic to certain insects such as pink bollworm and cotton bollworm and is partially effective in controlling tobacco budworm and fall armyworm. As a result *Bt* varieties have superior yield performance over a wide range of growing conditions. Transgenic plants conferring drought resistance have also been developed. Antifungal gene in grapes against downy mildew has been transferred similarly *Bt* gene in cabbage and cauliflower also used. In India the only commercialized transgenic crop is *Bt* cotton (Gupta *et al.* (2018)
- ✚ **Biofuel Production:** Biofuel is a great substitution of fossil fuel. Remains of many crop can be used to produce the biofuel. In India banana plant stem which is known as pseudo stem is being used as lignocellulosic substrate. Banana pseudo stem is a

source for bioethanol production. *Aspergillus ellipticus*, *Apergillus fumigates* and *Saccharomyces cerevisiae* are used in pretreatment saccharification of cellulosic substrate for further biofuel production.

- ✚ **Delayed fruit ripening:** fruits and vegetable which highly perishable in nature are not suitable for long distance transport due to rotting. But now with the help of biotechnological tool likes antisense RNA and RNAi for gene silencing the ripening of perishable products may be delayed. This promotes the interstate and international shipping of fruits and vegetable. This delayed ripening also improves the shelf life of agricultural produce and hence these can be stored for longer time (Gupta *et al.*, 2018).
Improved nutritional value: nutritional value of many crops has been improved with the help of biotechnology like in case of rice; the golden rice was developed with three transgenes which allow plant to produce more beta carotene (precursor of vitamin A biosynthesis). Recently the anthocyanin rich tomato variety has been developed. Now a days edible vaccine is also a new concept and many crops like potato being used to produce edible vaccine (Singh *et al.*, 2013).

Animal Biotechnology

It includes various advance approaches for animal improvement like embryo transfer and surrogacy, vaccine development, clone development, transgenic animals for milk and meat purpose. Genetically engineered vaccines are being developed to protect fish and livestock against pathogens and parasites. Today, quality improved, vaccines are available for example Newcastle disease, classical swine fever and rinderpest. NDRI, Karnal developed clones like Pratham and Garima and this institute playing a appreciable role in animal improvement using biotechnology similarly IVRI, Izatnagar, Bareilly also contributing very much in animal biotechnology for animal welfare.

References:

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