AgriCos e-Newsletter
ISSN: 2582-7049 www.agricosemagazine.com
Volume: 01 Issue: 01 May 2020 Article No: 05

Genetic Engineering for Biotic Stress Tolerance in Agricultural Crops

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SUMMARY

Pests, diseases and weeds are the limiting factors affecting the crop yield and production. Genetic engineering approach has been demonstrated to provide enormous options for the selection of the resistance genes from different sources to introduce them into plants to provide resistance against different biotic stresses. Conventional breeding is a time-consuming method of transferring desired traits into a superior cultivar. To combat biotic stress chemicals are used that may have adverse effects on human health and the environment, may develop chemical-resistant insects and weeds. Genetic transformation by *Agrobacterium* mediated approaches has been demonstrated and used for economically important crop. RNAi technique has been quite successfully used for virus resistance crop plant in addition to coat protein genes. Amidst all the hue and cry raised against genetically modified crops, it is imperative to highlight the scientific principles involved so as to make full use of a technology that could very well solve the problem of food shortage.

INTRODUCTION

Agricultural Biotechnology has offered tremendous scope and potential to conventional methods of crop improvement, crop quality management, crop protection and improving other agronomical traits. It remarkably opens an opportunity to enhance productivity by providing new genotypes for breeding purpose, supply of disease-free and healthy planting material, enhancing shelf-life, improvement in fruit quality, availability of biopesticides, biofertilizers, etc. Genetic engineering refers to a set of techniques used for transferring desirable gene(s) from any source across taxonomic boundaries into a certain plant by non-conventional methods. Genetic engineering could offer a remedy through more precise targeting of pest and viral diseases. A number of genes including natural and synthetic *Cry* genes, *trypsin inhibitors, protease inhibitors* and *cystatin* genes have been used to incorporate nematode and insect resistance. For providing protection against fungal and bacterial diseases, various genes like *osmotin*, *chitinase*, *glucanase* and *pathogenesis-related* genes are being transferred to many agricultural crops. Precise genome editing tools, such as CRISPR/Cas9 efficiently applied in tomato, potato and petunia for epigenome editing.

Biotic Stress Management through Transgenic Approach

Insect-Pest Resistance:

At present, resistance to insect-pest is lacking in many crop plants. The use of chemical control measures is proving hazardous to the consumers and also not environmentally sustainable. To overcome this problem farmers are recommended to use chemical control measures, which are hazardous to the consumers as well as to environment. From a grower's perspective, any genetic improved crop that could reduce the cost of cultivation by reducing chemical application to combat pests would be of significant benefit. *Bacillus thuringinesis* (Bt) is a soil-dwelling bacterium, the hero of the tale. For years, agriculturists have known Bt for its ability to produce a Bt toxin that can kill insects. The CRY toxin binds to specific receptors in attacking insect gut and are solubilized leading to cell lysis and subsequently to death (Daniel et al. 2001). The same technology has been employed in various crop plant such as cotton, maize, papaya, and rice (Christou et al. 2006). Other than *bt* gene lectins from garlic was expressed in tobacco plants which were tested for the efficiency of resistance against the aphid Myzus persicae. Likewise, the barley trypsin inhibitor used in rice var. indica and japonica conferred resistance against the rice weevil Sitophilus oryzae (Alfonsorubi et al. 2003)

Disease Resistance:

The next foremost constraint limiting the production of agricultural crops is different diseases caused by pathogenic fungi, viruses, and bacteria. systemic acquired resistance (SAR)-related genes have paramount importance among different strategies used for genetic engineering for disease resistance. Developed transgenic tomato plants were resistance against tomato mosaic virus (ToMV) and enhanced heat tolerance. Chitinase gene has been transferred to a number of crops for harboring fungal resistance. In carrot, ChiC gene from tobacco class I has shown resistance against Botrytis cinereal.

Virus Resistance:

Fruit crop papaya is grown in many tropical countries, but Papaya Ring Spot Virus (PRSV) threatened its cultivation and productivity, a disease that is considerably lowering its yield. Using biotechnological involvements, the coat protein gene of the virus has been introgressed into papaya to confer PRSV resistance. RNAi technology has been found effective to impart resistance to various viral diseases in agricultural plants. Transgenic poinsettia plants resistant to Poinsettia Mosaic Virus have been developed by Using a hairpin RNA gene silencing strategy (Clarke et al. 2008).

CONCLUSION

The applications of genetic engineering or r-DNA technology in crop improvement are immense to solve the problem of global hunger as population is increasing with depriving sustainable intensification. The different strategies and genes that are used for engineering resistance seem to be common in different pathogens and pests. The function of R genes, for example, is common to pathogens ranging from bacteria to nematodes. RNAi is even more appealing and new avenues are being cleared in this area with the advancement in technology. Transgenic technology delivers a potential for genetic enhancement using desirable trait of interest in plants. Transcript some sequences of several agricultural crops are now available in public databases. These databases now resolved the problem of lack of genetic information and thus helped the target gene/site to be modified using genome editing technology. This immense information will assist in identification of various genes governing important traits and will help in identifying the target sites for genome editing and genetic transformation.

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