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# Advancement in molecular approaches for biotic stress tolerance in plants

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## Introduction

'Stress' in plants can be defined as any external factor that negatively influences plant growth, productivity, reproductive capacity or survival. This includes a wide range of factors that can be broadly divided into two main categories: abiotic or environmental stress factors and biotic or biological stress factors. **Biotic stress** occurs as a result of damage done to the plant by other living organisms such as bacteria, viruses, fungi, parasites, beneficial and harmful insects, weeds and cultivated or native plants (David *et al.* 2001).

## Types of biotic stresses

Fungi Virus Bacteria and Nematode

Types of response in stress:

1) Reactive oxygen species
2) Calcium signaling
3) Hypersensitive response
4) Systemic acquired response
5) Salicylic acid
6) Jasmonic acid
7) PR Proteins

Strategies for imparting stress tolerance in plants: Convectional breeding, molecular breeding, genetic engineering and novel approaches

## Review of research work

**Sohrab *et al.* (2016)** studied transgenic cotton plants that were developed by using βC1 gene in antisense orientation gene driven by Cauliflower mosaic virus-35S promoter and nos (nopaline synthase) terminator and mediated by Agrobacterium tumefaciens transformation and somatic embryogenesis system. The developed transgenic and inoculated plants remained symptomless till their growth period. the plants were observed as resistant to CLCuV.

**Nekrasov *et al.* (2017**) reported on Tomelo a non-transgenic tomato variety resistant to the powdery mildew fungal pathogen using the CRISPR/Cas9 technology. They used whole-genome sequencing to showthat Tomelo does not carry any foreign DNA sequences but only carries a deletion that is indistinguishable from naturally occurring mutations. They also presented evidence for CRISPR/Cas9 being a highly precise tool, as they did not detect off-target mutations in Tomelo.

**Nevame *et al.* (2018)** studied that TYLCV resistance has been based mostly on Ty-3 as a race- specific resistance gene by introgression originating from wild tomato species relatives. The newly developed marker was named ACY. The reliability and accuracy of ACY were evaluated against those of Ty-3 linked marker P6-25 through screening of commercial resistant and susceptible tomato hybrids, and genetic segregation using F2 population derived from a commercial resistant hybrid AG208. With the use of bioinformatics and DNA sequencing analysis tools, deletion of 10 nucleotides was observed in Ty-3 gene sequence for susceptible tomato variety. ACY is a co-dominant indel-based marker that produced clear and strong polymorphic band patterns for resistant plants distinguishing it from its susceptible counterpart.

**Liu *et al.* (2020)** selected a panel of *Yr* gene pyramiding lines with Chuanyu12 as the background parent. The number of pyramided *Yr* genes was significantly correlated with stripe rust resistance. *Yr15*, *Yr62*, and *Yr65* are effective to the current *Pst* races. Pyramiding more than four effective or partially effective *Yr* genes can provide enough resistance to stripe rust. Additive effects or epistatic effects existed in gene combinations in this study such as *Yr26* + *Yr48, Yr30* + *Yr64*, and *Yr30* + *Yr48*. *Yr*-gene pyramiding lines with desirable agronomic traits were obtained for durable controlling *Pst* in wheat breeding.

## Conclusions

- Convectional knowledge has almost saturated in finding the solution for the increasing biotic stress resulting due to climatic change and other causes.
- Genetic engineering has proved its worth in tweaking the plant's ability to cope with various stresses.
- CRISPR/Cas9 has the ability to generate specific double-stranded breaks and able to precise editing ofthe genome.
- The antisense approach has also been utilized, based on homology dependent for development of resistant transgenic plants against disease resistance.

## References


1. Adam, A. L.; Nagy, Z. A.; Katay, G.; Mergenthaler, E. and Viczian, O. (2018). Signals of systemic immunity in plants: progress and open questions. *International journal of molecular sciences*, **19**(4): 1146.
2. Aldon, D.; Mbengue, M.; Mazars, C. and Galaud, J. P. (2018). Calcium signalling in plant biotic interactions. *International journal of molecular sciences*, **19**(3): 665.
3. Gomes da Conceiçao, M. A.; Hauser-Davis, R. A.; de Souza, A. N. and Vitória, A. P. (2016). Metal phytoremediation: General strategies, genetically modified plants and applications in metal nanoparticle contamination. *Ecotoxicology and Environmental Safety*, **134**: 133-147.
4. Guilfoyle, T.; Hagen, G.; Liu, X.; Rockett, K. S.; Korner, C. J. and Pajerowska Mukhtar, K. M. (2015). Salicylic acid signaling: new insights and prospects at a quarter-century milestone. *Essays in biochemistry*, **58**:101-113.
5. Kannojia, P.; Sharma, P. K.; Kashyap, A. K.; Manzar, N.; Singh, U. B.; Chaudhary, K. and Sharma, S. K. (2017). Microbe-mediated biotic stress management in plants. In *Plant-Microbe Interactions in Agro Ecological Perspectives* (pp-627-648). Springer, Singapore.
6. Kumar, A. and Verma, J. P. (2018). Does plant microbe interaction confer stress tolerance in plants? *Microbiological Research*, **207**: 41-52.
7. Liu, R.; Lu, J.; Zhou, M.; Zheng, S.; Liu, Z.; Zhang, C. and Zhang, L. (2020). Developing stripe rust resistant wheat (*Triticum aestivum* L.) lines with gene pyramiding strategy and marker-assisted selection. *Genetic Resources and Crop Evolution*, **67**(2):381-391.
8. Nekrasov, V.; Wang, C.; Win, J.; Lanz, C.; Weigel, D. and Kamoun, S. (2017). Rapid generation of a transgene-free powdery mildew resistant tomato by genome deletion. *Scientific reports*, **7**(1): 1-6.
9. Nevame, A. Y. M.; Xia, L.; Nchongboh, C. G.; Hasan, M. M.; Alam, M.; Yongbo, L., and Longting, S. (2018). Development of a new molecular marker for the resistance to tomato yellow leaf

curl virus. *BioMed research international*, *2018*.

10. Pande, A. and Arora, S. (2017). Molecular strategies for development of abiotic stress tolerance in plants. *Celland Cellular Life Sciences Journal,* **2** (2): 000112.
11. Rhodes, D. and Nadolska, O. A. (2001). "Plant Stress Physiology". In eLS; American Cancer Society: Atlanta, GA, USA, ISBN 978-0-470-01590-2.
12. Rubio, C. P.; and Ceron, J. J. (2021). Spectrophotometric assays for evaluation of Reactive Oxygen Species (ROS) in serum: general concepts and applications in dogs and humans. *BMC Veterinary Research*, **17**(1): 1-13.
13. Sohrab, S. S.; Kamal, M. A.; Ilah, A.; Husen, A.; Bhattacharya, P. S., and Rana, D. (2016). Development ofCotton leaf curl virus resistant transgenic cotton using antisense ßC1 gene. *Saudi journal of biological sciences*, **23**(3):358-362.