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Agriculture Waste Recycling With Nanotechnology for Betterment Agricultural Production

Srikanth G.A., Ravikumar C. S., Mahalinghaswamy S. S., Deeksha D., Mahima Gowda R.S., and Shamya Rai, B.

Assistant Professor, Department of Plant Physiology, Sampoorna International Institute of Agricultural Science and Horticultural Technology, Belekere, Channapatna, Karnataka

SUMMARY

Despite the fact that scientific research on the nanoscale materials in agriculture would be less than a decade long, nanotechnology's prospects in this industry are promising. The rapid advancement of nanosciences has a significant impact on agricultural practises and the food processing industry. Nanotechnology has the potential to provide smarter, tougher, and more cost-effective packaging materials, as well as biosensors for quick detection of food infections, poisons, and other pollutants or adulterants. It also contributes to the development of new pesticides with safe carriers, the retention and containers of food and food additives, the strengthening of natural fibres, the removal of various pollutants from soil and water bodies using functionalized nanoparticles, and the enhancement of the shelf-life of vegetables, flowers, and fruits. Despite the vast applications listed above, the capability is being demonstrated in some of the most successful business strategies for developing nanotechnology-based goods. The ethical and regulatory concerns about nanotechnology's application for humans, the environment, and ecosystems must be debated, especially in developing nations. Including the agri-food networks (from the operator to the consumer), there are a few potential places of direct exposure to nanomaterials, as well as the risk of nanoparticles reaching non-targeted sites, which can cause health and environmental problems. With all of the benefits and hazards associated with nanotechnology in mind, a comprehensive risk management approach should be implemented in tandem with technological progress. Furthermore, throughout the entire process (from manufacturing to consumption) of nanomaterials, a solid governance model with with ongoing interactions and relevant stakeholders should be implemented.

INTRODUCTION

Plants are a blessing to the human beings as we depend entirely on them for our food sources. Any kinds of ailment caused to plants is a threat towards food security. A plant is said to be diseased if it is attacked by various pathogenic agents thus altering its normal activity. Like humans, plants also show resistance towards disease as it is the only way for its survival and existence.Ward (1902), who reported on a plant resistance reaction to a rust pathogen, characterised the first plant resistance phenomena scientifically almost 100 years ago. Stakman (1915), later coined the term "hypersensitive response" to describe this type of reaction. The various mechanisms of resistance in plants are non-host resistance, basal resistance, R gene mediated resistance, systemic acquired resistance& gene silencing. These all are interrelated pathways and act as a protecting shield against the invading pathogens.

Different forms & mechanisms of resistance:

Non host resistance:

- It is the most common form of resistance which means that all of the individual members or lines of a species are resistant to all of the races of a given pathogenic species.
- For example, apple trees are not attacked by the pathogens of wheat and vice versa. But both of these crops have their own pathogens which cause heavy yield losses. The most probable reason for this may be the genetic makeup of apple trees are somewhat different from other host plants which are attacked by their own pathogens (Agrios, 2005).

Basal resistance:

- Plants elicit basal resistance in the form of PAMP Triggered Immunity or PTI. Upon pathogen attack, Pathogen Associated Molecular Patterns (PAMPs) such as LPS, chitin, glucan, or flagellin are detected by plasma membrane integral proteins, resulting a downstream signalling cascade called as PTI (Hatsugai*et al*., 2017; Poltronieri*et al*., 2020).

- PTI is also known as Horizontal resistance which is polygenic in nature.
- Most well studied example of PTI is recognition of flg22 (a component of bacterial flagellin) by receptor Flagelline Sensing 2 (FLS2) in plants.
- PAMP responses in plants include early responses (ion fluxes, oxidative burst); intermediate responses (ethylene production, stomatal closure) and late responses (Salicylic acid accumulation, callose deposition).

R gene mediated resistance:

- This sort of resistance is distinguished by its specificity. This indicates that some plant cultivars are only resistant to certain pathogenic races. This is a conventional gene-for-gene hypothesis that relies on the interaction of the products of a plant resistance gene (R) and a pathogenic avirulence gene (Avr) (Flor, 1971).
- This mechanism employs R-gene expressed intracellular resistance proteins to detect the presence or absence of pathogenic effectors in a direct or indirect manner. This initiates the effector-triggered immunity (ETI), also known as the hypersensitive response. (HR) (Salguero-Linares and Coll, 2019). HR leads to burst of oxidative reaction, disruption of cell membrane, release of phenolics and consequently programmed cell death (PCD).
- ETI is also known as Vertical resistance which is monogenic in nature.
- Most of the plant R genes encode nucleotide-binding leucine-rich repeat (NB-LRR) proteins that takes part in pathogenic effector recognition (Collier and Moffett, 2009).
- Recognition of Avr-Pita of rice blast pathogen by R gene rice Pi-ta is an example of R gene mediated resistance.

Systemic Acquired Resistance:

- Ross (1961) first described Systemic Acquired Resistance(SAR) in tobacco plants infected by Tobacco Mosaic Virus.
- Typically, SAR is activated in healthy systemic tissues of locally infected plants. When a pathogen infects a cell, a mobile signal travels through the vascular system, activating defence responses in distal tissues.
- Salicylic acid is a signal molecule that is required for the activation of SAR, which activates a large set of genes encoding Pathogenesis related proteins (PRs) with antimicrobial properties.
- It has been demonstrated that the plant protein NPR1 is required for the synthesis of the salicylic acid signal for SAR. By reducing the disulfide bonds, NPR1 is converted from an inactive oligomeric to an active monomeric state. SAR can only be activated by the monomeric NPR1 protein. (Mou*et al*., 2003).

Gene silencing:

- Gene silencing occurs in cytoplasm after transcription.
- Covey *et al*., (1997) reported that the virus-infected plant which initially displayed typical symptoms later recovered without displaying symptoms or containing viruses. This recovered symptom-free plant material also showed resistance to subsequent viral infections, indicating an acquired resistance. This type of plant resistance could well be due to gene silencing (Baulcombe, 1996).
- The silenced gene is usually transcribed in the transgenic plant, but the messenger RNAs are degraded, a phenomenon known as post-transcriptional gene silencing (PTGS).
- It has also been demonstrated that certain portions of the viral genome (e.g., the coat protein gene or the viral replicase gene) transformed into plants can induce resistance (silencing) to viral infections, a phenomenon known as Virus Induced Gene Silencing (VIGS).

CONCLUSIONS:

Both innate and acquired resistance appear to exist in plants and animals, but the mechanisms are not identical, though they are mostly analogous. There are two types of innate resistance: non-specific and specific. In addition to the specific HR-associated resistance that has been the focus of the majority of previous research, several new resistance mechanisms have recently been identified. More research on the importance of non-host, basal resistance & gene silencing mechanisms are needed. Furthermore, using genome sequencing and computational methods, the focus of research should now be on elucidating fungal PAMPs and their related receptors. This will result in a comprehensive way to create plants that are resistant to a wide range of pathogens having combinations of long-lasting disease resistance mechanisms.

REFERENCES:

Agrios, G.N. *Plant Pathology*, Fifth Edition, London: Elsevier, Academic Press; 2005, p.208.

Baulcombe, D. C. (1996). Mechanisms of pathogen-derived resistance to viruses in transgenic plants. *The plant cell*, *8*(10), 1833.

Collier, S. M., & Moffett, P. (2009). NB-LRRs work a “bait and switch” on pathogens. *Trends in plant science*, *14*(10), 521-529.

Covey, S. N., Al-Kaff, N. S., Lángara, A., & Turner, D. S. (1997). Plants combat infection by gene silencing. *nature*, *385*(6619), 781-782.

Flor, H. H. (1971). Current status of the gene-for-gene concept. *Annual review of phytopathology*, *9*(1), 275-296.

Hatsugai, N., Igarashi, D., Mase, K., Lu, Y., Tsuda, Y., Chakravarthy, S., ... &Katagiri, F. (2017). A plant effector- triggered immunity signaling sector is inhibited by pattern- triggered immunity. *The EMBO journal*, *36*(18), 2758-2769.

Mou, Z., Fan, W., & Dong, X. (2003). Inducers of plant systemic acquired resistance regulate NPR1 function through redox changes. *Cell*, *113*(7), 935-944.

Poltronieri, P., Brutus, A., Reca, I. B., Francocci, F., Cheng, X., &Stigliano, E. (2020). Engineering plant leucine rich repeat-receptors for enhanced pattern-triggered immunity (PTI) and effector-triggered immunity (ETI). In *Applied Plant Biotechnology for Improving Resistance to Biotic Stress* (pp. 1-31). Academic Press.

Ross, A. F. (1961). Systemic acquired resistance induced by localized virus infections in plants. *Virology*, *14*(3), 340-358.

Salguero-Linares, J., &Coll, N. S. (2019). Plant proteases in the control of the hypersensitive response. *Journal of experimental botany*, *70*(7), 2087-2095.

Stakman EC. (1915). Relation between *Pucciniagraminis* and plants highly resistant to its attack. *J Agric* Res 4: 139-200.

Ward, H. M. (1902). On the relations between host and parasite in the bromes and their brown rust, Pucciniadispersa (Erikss). *Annals of Botany*, *16*(62), 233-315.