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PLANT BASED ANTIVIRAL PROTEINS: A NEW HORIZON IN PLANT VIRAL DISEASE MANAGEMENT

Email

anikicar61@gmail.com

Anik Majumdar

Department of Plant Pathology, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, West Bengal, India

Managing plant viral diseases have always been a cause of headache for all the plant pathologists, researchers, scientists and moreover for the farmers as there is no such effective chemical management practices available. Plant-based proteins with antiviral capabilities could be a boon in this situation. Antiviral proteins are produced by human or plant cells in order to prevent viral multiplication. These proteins are separated in order to prevent the virus from multiplying in the cells of the host and spreading to additional cells. Argonautes (AGOs), RNA-dependent RNA polymerases (RDRs), and members of the plant Dicer-like (DCL) protein family are all involved in the antiviral RNA silencing pathway. All of these proteins are thought to be involved in plant defence responses to viral infections and could be useful in plant viral disease management.

Mode of action of antiviral proteins:

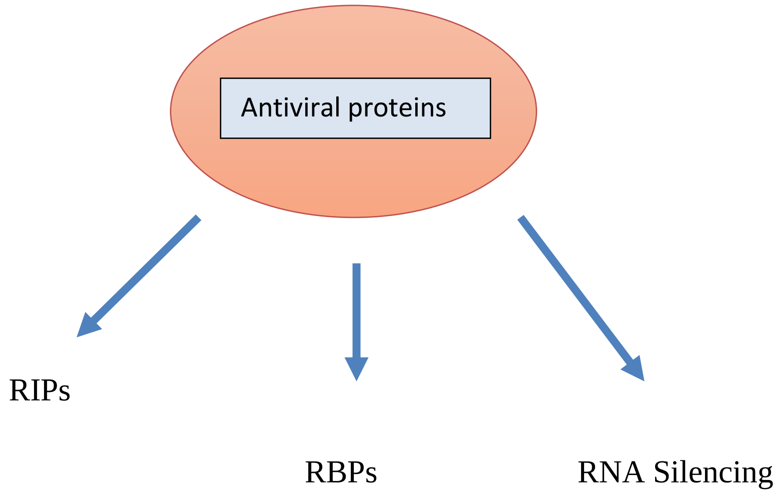

Fig 1. Mode of action of antiviral proteins

- **Ribosome Inactivating Proteins** (RIP), inhibit translation by destroying ribosomes enzymatically. Ricin and Abrin, extracted from the seeds of *Ricinus communis* and *Abrus precatorius*, respectively, were the first RIPs to be discovered (Olsns and Pihl, 1973; Knight,1979; Nielsen and Boston,2001). On the other hand, Pokeweed antiviral protein (PAP) in *Phytolacca americana* is one of many RIPs discovered in many plant species (Irvin,1983). PAP has been discovered to make tobacco and potato plants more resistant to viruses like Potato Virus Y (PVY), Potato Virus X (PVX), and Cucumber Mosaic Virus (CMV). *Phytolacca insularis* antiviral protein (PIP)-transformed potato plants were resistant to PVY, PVX, and Potato leafroll virus infection (Moon *et al*., 1997).

- **RNA binding proteins**(RBPs) are thought to interact with specific target mRNAs. RBPs are a group of heterogeneous proteins that interact directly with RNA molecules to regulate post-transcriptional regulation. They use an RNA-binding domain (RBD) to bind target RNAs, which can be sequence-specific or non-specific. They also play a role in RNA virus replication, motility, and translation inhibition. As a result, RBPs may play a role in the viral RNA-targeted defence system against RNA viruses at the transcriptional and translational levels. Arabidopsis thaliana glycine-rich RNA-binding protein 7 (AtGRP7), for example, is involved in plant defence against Tobacco Mosaic Virus (Lee *et al*., 2012). *Arabidopsis* dsRNA-binding protein 4 (DRB4) also activates plant defence against Turnip Yellow Mosaic Virus Infection (Jakubiec*et al*., 2012).

- Certain proteins also resist viral infections via **RNA silencing pathway**. Some of these are-

  - Dicer like ribonucleases:

    *Arabidopsis thaliana*DCL2 produces small interfering RNAs(siRNAs) from natural cis-acting antisense transcripts thus mediating antiviral resistance.

  - RNA dependent RNA Polymerase:

    RDRs, in addition to DCLs, are responsible for siRNA synthesis in plants. The first RNA silencing elements discovered were RDRs. Endogenous RDRs in plants convert single stranded RNA to double stranded RNA, which is then processed into siRNAs by Dicer-like nucleases. RDR1 and RDR6 from *A. thaliana* have

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been shown to have antiviral activities against a variety of plant viruses, including the Turnip Yellow Mosaic Virus (Garcia-Ruiz *et al*., 2015) and Brome Mosaic Virus.

- Argonautes (AGOs):

To build the molecular platform for RNA silencing machinery, siRNAs are incorporated into AGOs, which are a component of the RNA Induced Silencing Complex (RISC). Through post-transcriptional gene silencing, they play an important role in plant defence mechanisms. The genome of *A. thaliana* encodes ten distinct AGOs that have been linked to plant defence against viruses such as Cucumber Mosaic Virus (CMV), Potato Virus X (PVX), and others.

Table 1. Some proven plant based antiviral proteinsagainst plant viruses

Protein	Family	Source plant	Target virus	References
AGO1	AGO	*Arabidopsis thaliana*	Brome Mosaic virus, Cucumber Mosaic Virus	Dzianott*et al*, 2012. Morel *et al*., 2002 & Wang *et al*., 2011.
AGO4	AGO	*Nicotiana benthamiana*	Potato Virus X	Bhattacharjee*et al*., 2009.
DCL4	DCX	*Arabidopsis thaliana*	Potato Virus X	Andika*et al*., 2015.
RDR1	RDR	*Nicotiana benthamiana*	Tobacco Mosaic Virus	Bally *et al*., 2015.
PAP	RIP	*Phytolacca americana*	Potato Virus X, Potato Virus Y, Cucumber Mosaic Virus	Lodge *et al*., 1993.

Conclusion

It's vital to remember that antiviral activity of plant proteins measured using various methods isn't always comparable. On the other hand, *In vitro* results provide some further information about the possible applications of plant antiviral proteins. The use of RNA silencing to combat virus infections has shown to be a powerful strategy in the designing of resistant crops. These proteins could be utilised to create transgenic plants that produce large levels of antiviral proteins in the presence of the pathogen, potentially improving plant resistance to virus infections, lowering crop loss, and reducing the need for pesticides. Thus this approach paves way for a more specific and eco-friendly management of plant viral diseases.

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