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RNA Interference Mechanism in Insects and Exploitation in Plant Pest Control

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SUMMARY

In the last decade, using the RNA interference gene mechanism to silence key genes in pest insects has emerged as a promising new pest management technique. The RNAi mechanism is relay on the identification of a critical insect pest target gene and its production as a double-stranded RNA or stem-loop RNA molecule, which is recognized by the host RNAi machinery and processed into small interfering RNAs (siRNAs). The siRNA binds to the complementary mRNA and induces gene silencing at the post-transcriptional level with the help of the RNA-induced silencing complex (RISC). In this article we discussed the basic mechanism of RNAi in insects against the virus as well as how it is being explored to control insect pests of crop plants.

INTRODUCTION

RNA interference (RNAi) is a cellular level gene silencing mechanism triggered by double-stranded RNA (dsRNA) that is likely to underpin the next generation of insect-resistant transgenic plants. In some studies, successful ingestion of dsRNA molecules resulted in the expected essential gene target silencing, which led to death or reduced the viability of the target insect, resulting in pest control (Huvenne and Smagghe.,2010; Whyard et al., 2009). In general, Long dsRNAs are processed by species-specific RNase-III-like enzymes, resulting in smaller double-strands. These shorter RNAs are loaded into RNA complexes as a guide for locating target mRNAs that are either cleaved or blocked for translation in posttranscriptional silencing, or inducing histone modifications in transcriptional silencing responses (Meister and Tuschl.,2004; Jinek and Doudna., 2009).

RNAi mechanism in insects:

RNAi is an endogenous catalytic pathway that is triggered by double-stranded RNA (dsRNA). In insects, the siRNA pathway is activated when double-stranded (ds)RNA molecules, as products of viral replication, are recognized in the cytoplasm and processed into siRNAs of 18-24 nt by the RNase type III enzyme Dicer-2 (Siomi and Siomi, 2009). In insects, this pathway is the innate immune system, acting as first line defence mechanism against viral infections. Hence, plant researchers can exploit this mechanism to introduce exogenous dsRNA, targeting an endogenous gene in the cell (Figure 1). Research findings have confirmed that RNAi triggers such as artificial microRNAs (amiRNAs), hairpin-structured RNAs (hp RNAs) and ds RNAs can be specifically designed to selectively target the expression of specific genes or gene sequences in a target organism. As such, a target species or a group of species could be targeted while leaving non-target species unharmed (Whyard et al., 2009 and Bachman *et al*., 2013). This sequence-dependent mode of action, efficiency and selectivity offers unique advantage over agrochemicals usage.

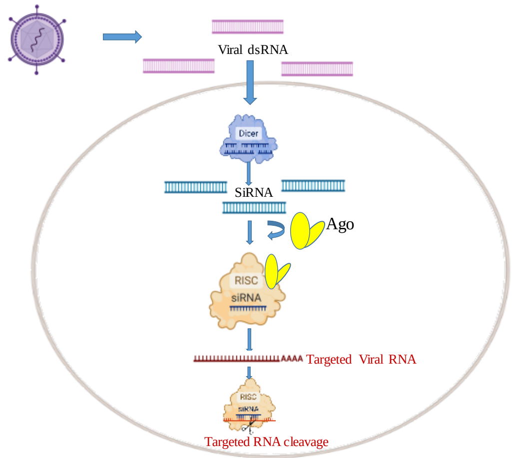

Figure 1. **The Simplified model of siRNA pathway is triggered by dsRNA (Viral) molecules.**

The dsRNA molecules are recognized in the cytoplasm and processed into siRNAs by Dicer. Cleavage of targeted viral RNA targets or endogenous transcripts is then further exerted by an Ago-containing RISC, which encompasses the siRNA guide strand.

CONCLUSION

RNAi is highly efficient, user and eco friendly, flexible technique for insect pest control. It has been widely exploited as a powerful reverse genetic tool involving the basic conserved mechanism and this feature makes it a suitable approach to study the function of genes and biological control of various agricultural insect pests and pathogens. However, the use of RNAi approach for control of pests at field level is still emerging and the continuous supply of dsRNA is required in sufficient amounts at the specific site for effective silencing of target genes due to the absence of silencing signal amplification system in insects. This problem could be overcome by identifying the vital genes, change in the expression, which will have detrimental effect on insect survival, and by engineering plants for the production of dsRNA molecules against such target genes. The availability of the whole genome sequences of most of the insects aids in better understanding of the RNAi mechanism, identification of novel target genes and in overcoming the hurdles faced during the application of RNAi approach as a pest control strategy This new information will facilitate the emerging trends in insect pest control strategies based on RNAi.

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