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CAROLINE DA CRUZ MARTINES

AVALIAÇÃO DA INCIDÊNCIA E TRANSMISSÃO VERTICAL DO passiflora virus Y EM SOJA E CARACTERIZAÇÃO BIOLÓGICA E MOLECULAR DO bidens mosaic virus EM PATCHOULI

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Aos meus amados pais,

Pedro e Rosana,

Dedico

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“Grandes coisas fez o SENHOR por nós, e, por isso, estamos alegres”.

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ABSTRACT

This work was divided into two chapters. In Chapter 1, the objectives were to assess the occurrence of the potyvirus passiflora virus Y (PaVY) in soybean crops in the state of São Paulo and investigate aspects related to the seed transmission of this potyvirus. The results demonstrated a low incidence of PaVY in soybean fields in the major producing regions of São Paulo state. It was also observed that PaVY was seedborne but was not seed transmitted in soybean seeds. Therefore, vertical transmission of PaVY in soybean plants is unlikely to have epidemiological significance. In Chapter 2, the objective was to perform the biological and molecular characterization of bidens mosaic virus (BiMV) infecting patchouli (*Pogostemon cablin*) in Brazil. Potyvirus infections have been previous documented in patchouli plants from the states of São Paulo, Pará, and Sergipe in Brazil. Despite the possibility of BiMV infection in the previously identified plants, the identification of the potyvirus responsible for these infections could not be determined due to the absence of nucleotide sequence data in the previous findings. Thus, based on biological and molecular tests, we present here the first confirmation of BiMV infection in patchouli plants in Brazil. Further studies are needed to assess the incidence of this potyvirus in commercial crops and to determine the damage caused to plant development, as well as the quantity and quality of essential oil produced by patchouli plants.

Keywords: Potyvirus; PaVY; BiMV; *Glycine max*; *Pogostemon cablin*.

RESUMO

Este trabalho foi dividido em dois capítulos. No Capítulo 1, os objetivos foram avaliar a ocorrência do potyvirus passiflora virus Y (PaVY) em campos de soja no estado de São Paulo e investigar aspectos relacionados à transmissão do vírus através das sementes. Os resultados demonstraram uma baixa incidência do PaVY em campos de soja das principais regiões produtoras do estado de São Paulo durante as safras de 2021/2022 e 2022/2023. Também foi observado que o PaVY pode ser detectado nas sementes, mas não foi transmitido através delas para as mudas. Portanto, a transmissão vertical do PaVY em plantas de soja parece não possuir importância epidemiológica. No Capítulo 2, o objetivo foi realizar a caracterização biológica e molecular do potyvirus bidens mosaic virus (BiMV) infectando plantas de patchouli (*Pogostemon cablin*) no Brasil. Infecções de plantas de patchouli com potyvirus foram anteriormente relatadas nos estados de São Paulo, Pará e Sergipe. Apesar da possibilidade destas plantas estarem infectadas com o BiMV, o potyvirus presente nelas não foi identificado devido à ausência de sequências de nucleotídeos. Assim, com base em testes biológicos e moleculares, apresentamos aqui a primeira confirmação da infecção de plantas de patchouli com o BiMV no Brasil. Estudos adicionais são necessários para avaliar a incidência deste potyvirus em campos comerciais, os danos ocasionados no desenvolvimento das plantas, bem como na quantidade e qualidade do óleo essencial produzido pelas plantas de patchouli.

Palavras-chave: Potyvirus; PaVY; BiMV; *Glycine max*; *Pogostemon cablin.*

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GENERAL INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is one of the major agricultural crops worldwide, playing a crucial role in human and animal nutrition, as well as serving as a versatile source of biomass and biodiesel (Bergmann *et al.*, 2013). Presently, Brazil stands as the leading global producer of soybean grains and is also recognized as the largest exporter of this commodity (USDA, 2023).

Soybean cultivation faces constant challenges due to the presence of various pathogens that can cause significant losses in yield and grain quality. Several diseases affect soybean production, and some of them are caused by viruses. In Brazil, soybean plants have been reported naturally infected with viruses belonging to the genera *Potyvirus, Orthotospovirus, Carlavirus, Alfamovirus, Begomovirus, Comovirus, Ilarvirus*, and *Sobemovirus* (Kitajima 2020).

A crucial step in the epidemiology of viral diseases is the transmission of the virus from infected plants to healthy ones. Plant viruses can be transmitted through aphids, whiteflies, thrips, beetles, nematodes, fungi, vegetative propagation organs, and seeds (Tomlinson, 1987). Seed transmission plays a particularly important role, enabling the spread and survival of the viruses in different environments and geographical regions. Seed transmission also allows for long-distance dissemination of viruses. Furthermore, it can serve as a source of primary inoculum and facilitate virus spread through vectors present in the area (Pagán, 2022). Seed transmission is a characteristic shared by the main viruses currently infecting soybean crops in Brazil (Costa, 1971; Porto & Hagedorn, 1975; Barreto da Silva *et al.*, 2020; Uzan, 2023).

In 2020, the potyvirus passiflora virus Y (PaVY) was identified infecting soybean in Brazil (Ribeiro-Junior *et al.*, 2022). PaVY was first described infecting *Passiflora foetida* plants in Indonesia in the early 2000s (Parry *et al.*, 2004). PaVY was also found infecting commercial passionfruit (*P. edulis*) plants in orchards in Australia. Infected plants exhibited symptoms of yellow/green mosaic, sometimes with ringspots and chlorotic spots (Parry et al., 2004). Subsequently, PaVY was identified naturally infecting *Macroptilium atropurpureum, Rhynchosia minima,* and *Vigna trilobata* plants in Australia, *M. atropurpureum* in Taiwan (Chiang *et al.*, 2012), and *Passiflora* sp. in China (Chen *et al.*, 2021).

The nearly complete nucleotide sequence of the Brazilian isolate of PaVY (PaVY-Br) is 9,679 nt long and shares 84.6% nucleotide and 96.5% amino acid

sequence identity with the PaVY isolate from China (Ribeiro-Junior, 2022). PaVY-Br induced chlorotic spots and systemic mosaic on soybean, as well as chlorotic local lesions on *P. edulis* and *Sesamum indicum*. The virus was successfully transmitted to soybean plants by *Myzus persicae* (Ribeiro-Junior, 2022). Due to its recent introduction in Brazil, little is known about the incidence of this potyvirus in soybean fields in the major producing regions of the country. It is also unknown whether PaVY can be transmitted through soybean seeds, which has significant epidemiological importance.

Pogostemon cablin Benth. is a plant species belonging to the Lamiaceae family, commonly known as patchouli. It is a highly valued medicinal aromatic plant due to its high demand for its essential oil. Patchouli is extensively used in the fragrance and pharmaceutical industries (van Beek & Joulain, 2018). Its essential oil possesses a unique woody scent and is an important component in many women's and men's fragrances, as well as various cosmetic products. It is considered one of the most important elements available to perfumers, serving as a fragrance fixative, and ranks among the top ten most important essential oils (van Beek & Joulain, 2018). In patchouli plants, viral infections have been found to have negative consequences, including impaired growth and reduced essential oil production (Sugimura *et al.*, 1995).

Bidens mosaic virus (BiMV) is a member of the *Potyviridae* family, and genus *Potyvirus*. Initially identified in 1961, found infecting *Bidens pilosa* in Brazil (Kitajima *et al.*, 1961). Since its discovery, BiMV has been documented naturally infecting plants of *Arracacia xanthorrhiza, Helianthus annuus, Lactuca sativa*, and *Pisum sativum*. Additionally, ornamental plants such as *Coreopsis lanceolata, Zinnia elegans, Centella asiatica*, and *Galinsoga parviflora* have also been reported as hosts of BiMV in Brazil (Kitajima, 2020; Camelo-Garcia *et al.*, 2021).

In 2022, six patchouli plants showing mosaic symptoms were found in a flower shop in Botucatu, São Paulo state, Brazil. The plants were taken to the laboratory and maintained in a greenhouse for identification of the causal agent. In this study, we conducted biological and molecular analyses to identify the virus present in the symptomatic patchouli plants.

The present study was structured into two chapters. In the first chapter, the objectives were to determine the occurrence of PaVY in soybean fields in the state of São Paulo and investigate its transmission through soybean seeds to subsequent

generations. The second chapter focused on the biological and molecular characterization of BiMV infecting patchouli plants in Brazil.

FINAL CONSIDERATIONS

Currently, the potyvirus passiflora virus Y (PaVY) occurs at a low incidence in soybean fields in the major producing regions of the state of São Paulo. This potyvirus is seedborne but not seed transmitted in soybean seeds. Therefore, vertical transmission of PaVY in soybean plants is unlikely to have epidemiological significance.

The potyvirus bidens mosaic virus (BiMV) was identified naturally infecting plants of patchouli (*Pogostemon cablin*) in Brazil. This is the first confirmation of BiMV infection in patchouli plants in the country. Further studies are needed to assess the incidence of this potyvirus in commercial crops and to determine the damage caused to plant development, as well as the quantity and quality of essential oil produced by patchouli plants.

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