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Review Article

Pathogenicity of RNA Satellite Associated with *Cucumber mosaic virus* (CMV) on Plants

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Abstract

The main obstacle in the cultivation of large red chili (*Capsicum annum* L.), tomato and tobacco is the occurrence of diseases caused by viruses. One of them is infected with the *Cucumber mosaic virus* (CMV), this virus infection is very dangerous for large red chili, tomato and tobacco farming which results in quite large losses for farmers in Indonesia. Controlling viral infections caused by CMV is very difficult due to the high genetic diversity of CMV making it difficult to obtain resistant types of red pepper, tomato and tobacco, the range of CMV host plants is wide, and CMV can be transmitted by aphids and ticks. non-persistent whiteheads. The aim of this journal review was to determine the pathogenicity of sat-RNA associated with CMV in red chilies, tomatoes and tobacco. Based on the results of reviews from several journals, it can be seen that satellite RNA is effective against CMV infection in red chili, tomato, and tobacco plants. Which can be seen by administering the CARNA vaccine to each plant treatment.

Introduction

Cucumber mosaic virus (CMV) is a virus that infecting chili. This infection can affect red chili cultivations. Several controls, such as insecticide, can be used in charge to control virus infections. It can help reduce the number of attack vectors, but it is considered ineffective and harms the environment by leaving residues in crop yields (Ernawati *et al*., 2021).

The CMV infection does not only occur in red chili and tomato plants, but also it infects tobacco plants. It can cause enormous losses to tobacco farmers so that this virus infection is hazardous for chili, tomato, and tobacco which results in immense losses for farmers in Indonesia (Mochizuki *et al*., 2014).

Wrong way of treatment or not in accordance with existing standards, can result in plants will be susceptible to viruses and can result in yields that are not optimal, low sales results, can even result in crop failure. The main pests of red chili and tomato including caterpillars, armyworms, aphids, whitefly, thrips, mites, and fruit flies that can cause plant suffer from disease (Fitriani and Febrianto, 2020). Controlling the CMV virus infection is challenging due to a high genetic diversity of virus and the difficulty to obtain the resistant cultivar of large red chili and tomato a wide distribution of host plants, and CMV is easily transmitted non-persistently by vectors of whitefly and aphids (Martin *et al*., 1997).

Control of viral infections that can take advantage of cross protection properties has been successfully carried out in several agriculture, such as viruses in oranges, tomato, papaya, tobacco, and red chili. Cross protection is plant protection using weak virus strains as plant protection from infection with virulent strains of the virus (Aranda *et al*., 1995). Viruses selected from the field are an effective control and not harmful to the environment because of the adjustment and production of strain according to the existing environment. Controlling viruses using this technique does not generate a new mutation of viruses that can interact with viruses been already in the field so that they do not cause plant-destroying diseases (Suhara & Yulianti, 2017; Taufik et al., 2005).

Based on the problems described earlier, the virus infection control can be conducted with a biological control using sat-RNA. This journal review aims to determine the pathogenicity of the relationship between sat-RNA and CMV in red chili.

Methods

This review was based on original articles of *Cucumber mosaic virus* (CMV) and collected from international databases Science Direct and Google Scholar. The analysis and search for this article are using the PICO Model with "*Cucumber mosaic virus* (CMV)", and "Pathogenicity of RNA satellite associated" keywords. Inclusion and exclusion criteria were used to select the article in this review. Inclusion criteria were based on article name. Considering that, inclusion criteria must be primary data and original articles about *Cucumber mosaic virus* (CMV). The article should be a full text and publication year within ten years from 2013 to 2023. Exclusion criteria were used to select which article could be included. These criteria are review articles, articles with topics about *Cucumber mosaic virus* (CMV) besides chili, and articles about other microbial sources from the chili. Articles were searched by connecting keywords, names, and abstracts with the inclusion and exclusion criteria. The selected articles are reviewed for *Cucumber mosaic virus* (CMV), data is analyzed in a descriptive way.

Results and Discussion

CMV-satRNA Pathogenicity in Plants Red Chili

The pathogenicity of CMV-satRNA in red chili peppers is lower when compared to CMV-G malignant strains. This is evidenced by several observed changes, such as plant height, length, number and weight of red chili produced. CMV-satRNA infection did not reduce the quality and quantity of red chili yields as indicated by the fruit length and fruit weight of the chilies produced which were the same as the control (Suhara & Yulianti, 2017; Taufik et al., 2005). On the other hand, red chili plants infected with the CMV-G strain experienced a decrease in the quality and quantity of fruit produced, as can be seen in Table 1.

Table 1. Plant height, Number, Length, and Weight of Red Chili Fruits Infected with CMV-G and CMV-satRNA (Suhara & Yulianti, 2017; Taufik et al., 2005)

Inoculation treatment	Plant Height (cm)	Fruit length (cm)	Amount of fruit	Fruit weight
CMV-satRNA	110.0 a	11.697 b	33.4 a	65.94 b
CMV-G	114.4 a	8.786 a	29.6 a	51.50 a
Control (without inoculation)	108.4 a	11.452 b	33.8 a	74.60 b

Note: Numbers followed by the same letter in the same column have no significant difference at the αa = 0.05 level of the BNJ test.

This study shows that CMV-sat RNA has the potential to be a virulent biological control agent against CMV strains. This ability showed that there is no a significant impact of CMV-satRNA infecting the control plants, both on the reproductive and vegetative growth variables of red chili, as shown in Table 1. The use of CMV-satRNA to control CMV has been successfully carried out for CMV strains that attack red chili plants (Suhara & Yulianti, 2017; Taufik et al., 2005).

Effectiveness of Cross Protection of Two CARNA-5.1 and CARNA-5.2 Vaccines Against Malignant Strain Infection CMV in tomato plants

Based on the results of a journal review on tomato plants, it shows that tomato plant protection against strains malignant Observations began 2 weeks after inoculation day. Tomato protection against malignant strains has been shown by the height of the tomato stem, where tomato given the vaccination of CARNA 5.2 did not show a high growth retardation, same as control plant. This was shown by the CARNA 5.2 vaccinated tomato, where CMV malignant strains were not inoculated, in contrast to the CARNA 5.1 vaccinated plants which did not inhibit the growth of plant height, as shown in Figure 1. Tomato that were inoculated by CARNA 5.2 and CARNA 5.1 had higher fruit weights that the plant without any vaccine protection. Therefore, CARNA 5.2 and CARNA 5.1 prevented tomato and were quite effective in protecting the plant from CMV infection (Suhara & Yulianti, 2017).

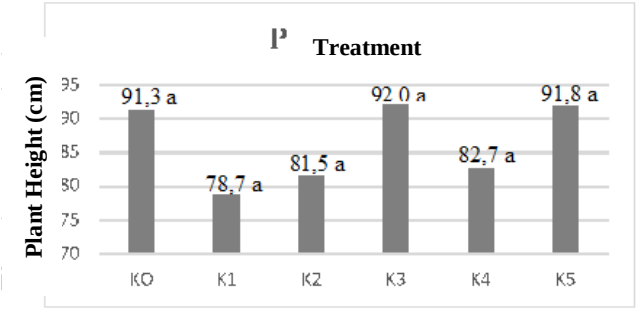

Figure 1. The average height of tomato per treatment. K0 (control); K1 (tomatoes inoculated with the dangerous strains CMV-G); K2 (tomatoes that have been vaccinated with CARNA 5.1); K3 (tomato that have been vaccinated with CARNA 5.2); K4 (tomato that had been vaccinated with CARNA 5.1 before CMV-G inoculation treatment); and K5 (tomato vaccinated with CARNA 5.2 before CMV-G inoculation (Suhara & Yulianti, 2017)

The CARNA 5.1 and CARNA 5.2 vaccines protect tomato against the virulent CMV-G strain. It shows that the vaccinated tomato were higher than those that have not been vaccinated. Even though the severity of the virus infection was relatively high in the vaccinated plants, it produced heavier fruit weights than plants infected with malignant strains (Suhara & Yulianti, 2017).

Incidence and severity of *Cucumber mosaic virus* (CMV) on Tobacco

Meanwhile, the severity of CMV infection also occurred in tobacco that were inducted with the CARNA-5 vaccine, which was significantly different from the plants that were not vaccinated. The severity of infection on tobacco showed a significant difference. The plants that were vaccinated with CARNA-5 (D3; D4; D5; and D6) had a severity of 8.33-10.83%, while the plants that were not applied with the vaccine (D1 and D2) had a higher severity, ranged between 18.33-20.33% (Table 2). However, the elevated damage caused by infection in tobacco has been inducted by the CARNA-5 vaccine at a lowest concentration of 5%, namely 1.3 %/day. Otherwise, tobacco without a vaccination reached 0.95 %/day. In tobacco given 10% CARNA-5 vaccinations, but not inoculated and CMV inoculated, the development of viral infection was 0.5%/day and 0.86-0.89%/day (Taufik et al., 2005).

Table 1. Percentage of occurrence and severity of mosaic disease and its rate of development at 39 HIS with various doses of CARNA-5 treatment (Taufik et al., 2005)

Treatment	Disease occurrence		Disease severity	
	(%)	Day	(%)	Day
D1	48,33 a	1,57	20,33 a	0,96
D2	50,00 a	2,13	18,00 ab	0,95
D3	26,67 b	1,48	8,33 c	0,5
D4	28,33 b	1,57	10,83 bc	1,3
D5	25,83 b	1,44	9,67 c	0,89
D6	27,50 b	1,53	8,33 c	0,86

Conclusion

From the results of the journal review above, it can be concluded that the infection using CMV containing satellite RNA in chili plants does not reduce, both the quantity and quality of crop yields. In tomato plants, the CARNA 5.1 and CARNA 5.2 vaccines were effective in protecting tomatoes from the CMV infection indicated by a low disease severity, that had the same plant height with control plants, but with a higher tomato yield. Meanwhile in tobacco, the treatment of CARNA 5 vaccine at all concentrations (5%, 10%, and 15%) could reduce the incidence and severity of diseases.

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