

(Original Article)



Assessment of Certain Zucchini Cultivars Response to Infection with Papaya Ringspot Virus (PRSV) and Watermelon Mosaic Virus (WMV) Under Greenhouse and Field Conditions

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DOI: 10.21608/AJAS.2024.299077.1374

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Abstract

Zucchini (*Cucurbita pepo*) is a common vegetable crop worldwide. It belongs to Family Cucurbitaceae which is one of the largest plant families and has a high economic impact worldwide. Zucchini can be infected by several plant viral pathogens which cause severe losses in cucurbits production. This study aims to identify certain viruses which infect zucchini in Assiut governorate, Egypt using Reverse Transcription Polymerase Chain Reaction (RT-PCR). The response of four zucchini cultivars (Hytech, Safa, Malat, and 03) to viral infection was evaluated under both greenhouse and field conditions. The assessment was conducted through measuring some parameters including disease severity (D.S), yield, total chlorophyll, and total carbohydrates contents. In general, zucchini cultivars differed significantly in their susceptibility to the infection with Watermelon mosaic virus (WMV) and Papaya ringspot virus (PRSV). Cultivars 03 and Malat were the most tolerant cultivars while Hytech followed by Safa were the most susceptible ones. The obtained data showed that zucchini cultivars differ significantly in their total carbohydrate and chlorophyll contents post the infection with WMV and PRSV. The highest chlorophyll and carbohydrate contents were obtained in 03 and Malat cultivars while the lowest chlorophyll and carbohydrate contents were in case of Hytech followed by Safa under both greenhouse or field conditions. Further studies are required to establish safe and eco-friendly strategies to control these viruses.

Keywords: *Cultivars, Papaya ringspot virus, Watermelon mosaic virus, Tolerance, Zucchini.*

Introduction

Zucchini (*Cucurbita pepo* L.) is an important vegetable crop worldwide which has many cultivars (Afechtal *et al.*, 2019). It belongs to the family Cucurbitaceae. (Veronezi and Jorge, 2012) which is the second largest plant family after Solanaceae (Jeffrey, 1980). Family Cucurbitaceae includes about 118 genera and 825 species. Among these species, the most common one are cucumbers, muskmelons, watermelons, Zucchini, squashes, gourds, and pumpkins (Painkra *et al.*, 2019). However, cucurbits are infected by more than

70 different plant pathogenic viruses (Lecoq and Katis, 2014). These viruses can cause severe losses in annual production (Sastry *et al.*, 2014), among these viruses Papaya ringspot virus - W (PRSV-W), and Watermelon mosaic virus (WMV) are considered the most common viruses infecting cucurbits worldwide. Both viruses belong to genus Potyvirus family Potyviridae and are being transmitted by different aphid species such as *Aphis gossypii* and *Myzus persicae* in non-persistent manner and has a wide host range (Yamamoto *et al.*, 1982; von Wechmar *et al.*, 1995; Fletcher *et al.*, 2000; Damicone, *et al.*, 2007; and Hasiów-Jaroszewska *et al.*, 2010).

Both PRSV and WMV can limit the production of zucchini worldwide and application of insecticides to control these viruses is not efficient method to control these diseases because these viruses are being transmitted in non-persistent manner as aphids, species can transmit these viruses within minutes. In addition, application of insecticides has many adverse effects on environments, so there is a need to find another alternative method to control these viruses. growing tolerant or resistant cultivars against plant viruses is an efficient and safe method to control these diseases and may present a promising alternative to control these viruses. Several studies have been conducted to assay the degree of susceptibility among cucurbits to viral infection (Yu *et al.* 2011; Ootani *et al.*, 2017).

This study aimed to evaluate the degree of tolerance among the most common zucchini cultivars grown in Assiut governorate (Hytech - Malat - Safa - 03) against the infection with WMV, PRSV or both viruses under greenhouse and field conditions during two successive growing seasons 2022-2023.

Materials and Methods

1. Source of viruses

Samples of Cucurbitaceae plants such as pumpkin (*Cucurbita maxima*) and zucchini (*Cucurbita pepo*) plants showing viral-like symptoms including mosaic, yellowing, mottling, leaf deformation and stunting were collected from the Farm of the Faculty of Agriculture, Assiut University, Assiut, Egypt during 2022 growing season. The collected samples showed symptoms of infection with Watermelon mosaic virus (WMV) or Papaya ring spot virus (PRSV-W).

2. Identification of viruses

In the present study, two-step Reverse-Transcription Polymerase Chain Reaction (RT-PCR) were used for molecular identification of PRSV and WMV using specific primers to amplify Coat Protein (CP) of WMV.

To synthesize cDNA for RT-PCR, total RNA was extracted from fresh infected zucchini leaves (*C. pepo*) as well as healthy leaves using the ABT Total RNA Mini Extraction Kit according to the manufacturer's instructions (Applied Biotechnology, EGYPT). Extracted RNA was then stored at -20 °C until use.

Synthesis of cDNA for RT-PCR was performed using ABT H-minus cDNA synthesis kit according to the instructions of manufacturer. RNA template was

incubated with reverse transcriptase enzyme, dNTPs, WMV reverse primer and ribonuclease inhibitor at 50 °C for 60 min.

The RT-PCR assay was conducted using specific primers to amplify the Coat Protein (CP) gene of PRSV and WMV as described by (Ali *et al.*, 2012).

3. Mechanical Inoculation

One week post planting, squash seedlings were mechanically inoculated with infected sap prepared by crushing 1 gm of symptomatic zucchini leaf in 1 ml of sterilized phosphate buffer (K_2HPO_4 and KH_2PO_4), pH 7 in sterilized and cold mortar and pestle under greenhouse conditions. Cotyledon leaves were gently washed with distilled sterilized water, then leaves were dusted with carborundum powder (600 mesh), and then each cotyledon leaf was gently rubbed with 100 μ l of plant sap from infected zucchini leaves. Then, the leaves were gently washed with distilled sterilized water and kept under insect-proof greenhouse conditions.

4. Assessment of the reaction of four zucchini cultivars to the infection with certain viruses (WMV or PRSV or WMV+PRSV) under greenhouse conditions

The most cultivated zucchini cultivars (Hytech - Safa - Malat - 03) under upper Egypt conditions especially in Assiut governorate were tested for their reaction to the infection with (WMV), or (PRSV) or simultaneous infection with both viruses. Zucchini cultivar seeds were sown in formaldehyde (5%) sterilized pots (30 cm in diameter) containing formaldehyde sterilized soil (clay and sand) Zucchini seedling at the first true leaf stage were mechanically inoculated separately in cotyledon leaves with sap from infected leaves with WMV and / or PRSV or both viruses together. Three replicates were done for each treatment, zucchini cultivar with either WMV or PRSV or both viruses. All treatments were kept under greenhouse conditions at a temperature ranging between 25 and 30 °C.

5. Assessment of the reaction of four zucchini cultivars to the infection with certain viruses (WMV or PRSV or WMV+PRSV) under field conditions

The same zucchini cultivars used in greenhouse (Hytech - Safa - Malat - 03) were used in field experiments to evaluate their response against infection with WMV or PRSV or simultaneous infection with both viruses under natural infection. Four blocks were used, and each block contained one of these four tested zucchini cultivars. Natural infection was conducted through distribution of squash plants infected with either PRSV or WMV or PRSV & WMV around and inside the row in presence the insect vectors in field to make sure the occurrence of viral infection.

6. Measurements and Disease Severity % (DS%)

Data were recorded after three and six weeks from mechanical inoculation, symptoms severity index recorded by following rating scale for WMV as described by Abdalla *et al.* (2017)

0 = no symptoms at all, 1 = yellowing, 2 = yellowing and mosaic, 3 = severe mosaic and severe mottling, 4 = malformed leaves, stunting plant growth, severe mosaic, or death of the plant.

The percentage of disease severity infection was calculated using the following formulation.

$$\text{Disease severity(DS) \%} = \frac{\sum(\text{Disease grade} \times \text{Number of plants in each grade})}{(\text{Total number of plants}) \times (\text{The highest disease grade})} \times 100$$



Fig. 1: Disease index to determine the disease severity of Papaya ringspot virus (PRSV) & Watermelon mosaic virus (WMV).

7. Determination of physiological changes in zucchini cultivars due to viral infection

Total chlorophyll

Total chlorophyll was assessed using chlorophyll meter SPAD - 502 plus, made in Japan, (Khadka *et al.*, 2020).

Total carbohydrate

Using anthrone sulphuric acid method to estimate the total carbohydrates by hydrolyzing 25 g fine powder leaves with 0.2 N HCL for 24 H, then in water bath at 100°C for 2 H, after march -out the solution from water bath, it was filtrated into 50 ml measuring flask then completed to 50 ml by distilled water. Then put 1ml from this filtration and 5 ml from anthrone sulphuric acid indicator in tube, and then in water bath at 100°C for 5 m, after march-out measure calorimetrically at 620 nm wavelength (Hansen and Moller, 1975).

8. Assessment of the yield in four zucchini cultivars infected with certain viruses

To determine the difference in yield among the four zucchini cultivars due to viral infection squash fruit yield from each one of the four tested squash cultivars was estimated on the weekly basis after the ripening of first squash fruits. and the total yield was calculated at the end of the growing season.

9. Experimental site and soil type

The greenhouse experiments were conducted at Greenhouse at Faculty of Agriculture - Assiut University, while field experiments were conducted in the Experimental Farm Faculty Agriculture, Assiut University during two successive growing seasons of summer 2022 and summer 2023. The used soil was clay

loamy to sand at 3:1 ratio in case of greenhouse conditions. While the soil was clay in case of farm experiments.

10. Statistical analysis

The design of experiments was randomized complete block design (RCBD) in Greenhouse and Field conditions. Statistical analysis was performed using Costat software (CoHortSoftware, 2006; Birmingham, UK), depending on two-way ANOVA test. All data were tested by utilizing Two-way Randomized Blocks methodology, and then compare mean to generate L.S.D. at ($P \leq 0.05$).

Results

1. Identification of Papaya ring spot virus and Watermelon mosaic virus

Using specific forward and reverse primers to amplify the CP gene of PRSV and WMV resulted in production of PCR bands that have the same expected size to be amplified of these primers of 1000 bp in case of PRSV and 1500 bp in case WMV specific primer (Fig 2). These results confirm the identification of Papaya ringspot virus and Watermelon mosaic virus.

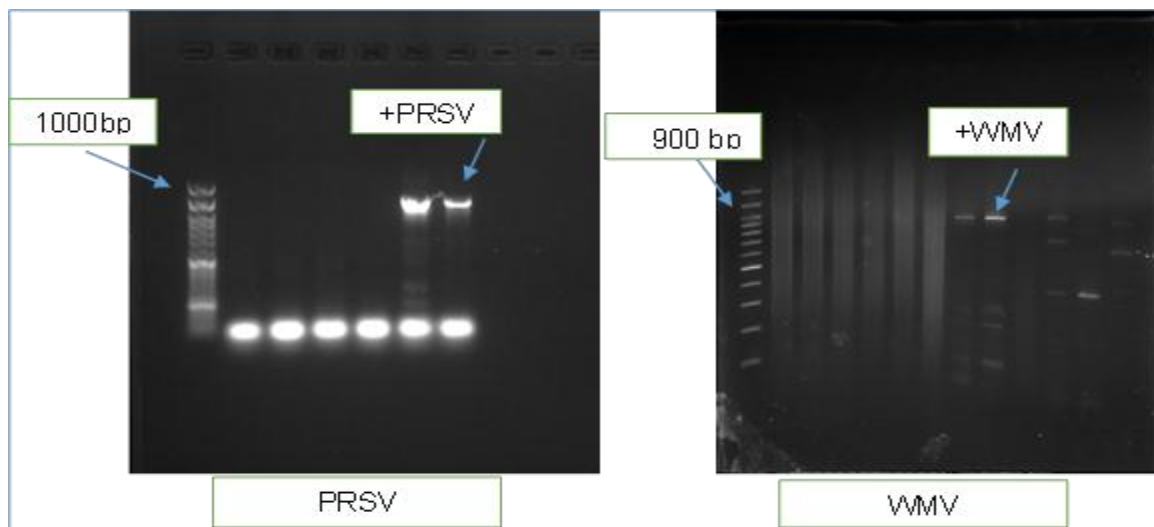


Fig. 2: Reverse transcription polymerase chain reaction (RT-PCR) results of Papaya ringspot virus (PRSV) and Watermelon mosaic virus (WMV).

2. Assessment of the reaction of four zucchini cultivars to the infection with Papaya ringspot virus (PRSV) or Watermelon mosaic virus (WMV) or (WMV +PRSV) under greenhouse conditions, Mean of the three methods

The four tested zucchini cultivars were significantly different in their response to the infection with PRSV or WMV or mixed infection between PRSV & WMV at both growing seasons, three- and six-weeks post inoculation (Table 1,2).

In general, Data of disease severity % (DS) at the 1st season after three weeks showed that cultivar 03 followed by Malat were the most tolerant cultivars against the infection with either PRSV alone, WMV alone, or mixed infection between WMV & PRSV. The means of DS % were 13.6 and 16.7%, respectively. The most susceptible cultivars were Hytech followed by Safa,

(mean of DS % were about 47.2 and 30.6%, respectively). Meanwhile, after six weeks, the results showed that cultivar Malat and 03 were the most tolerant cultivar to the infection of tested viruses, as the means of DS % were 33.3 and 38.8%, respectively, but cultivar Hytech followed by Safa were the most susceptible after infection with these viruses, as the means of DS % were 69.4 and 63.8%, respectively.

Data at the 2nd season showed that the most tolerant cultivar were 03 followed by Malat three and six weeks post the inoculation with the tested viruses as the means of DS % were 11.11 and 16.7% post three weeks and 19.4 and 33.3% after six weeks, respectively. While Safa followed by Hytech were the most susceptible cultivars after infection with the tested viruses, as the means of DS % were 33.3 and 30.5% after three weeks while Hytech followed by Safa after six weeks had mean DS % of 58.3 and 41.7%, respectively.

Table 1. Response of zucchini cultivars to viral infection under greenhouse conditions during summer 2022.

Cultivars	Disease severity(%)							
	Growing season 2022							
	After 3 weeks				After 6 weeks			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	50	41.7	50	47.2	66.7	66.7	75	69.4
Malat	25	16.7	8.3	16.7	41.7	33.3	25	33.3
Safa	33.3	33.3	25	30.6	66.7	58.3	66.7	63.8
03	8.3	25	8.	13.9	25	50	41.7	38.8
Mean	29.2	29.2	22.9		52.1	52.1	50	
L.S.D at 0.05								
Varieties (A)		11.1				14.1		
Viruses (B)		9.6				12.2		
A x B		19.2				19.2		

Table 2. Response of certain zucchini cultivars to viral infection under greenhouse conditions during summer 2022.

Cultivars	Disease severity(%)							
	Growing season 2023							
	After 3 weeks				After 6 weeks			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	41.7	25	25	30.5	58.3	50a	66.7	58.3
Malat	16.7	25	8.3	16.7	41.7	25d	33.3	33.3
Safa	33.3	33.3	33.3	33.3	41.7	33.3	50	41.7
03	8.3	8.3	16.7	11.11	8.3	25	25	19.4
Mean	25	23	21		43.8	37.5	33.3	
L.S.D at 0.05								
Varieties (A)		12.6				13.1		
Viruses (B)		10.9				11.3		
A x B		21.8				22.6		

3. Determination of total chlorophyll in four zucchini cultivars due to viral infection under greenhouse conditions

Data in Table (3) demonstrated that there was a significant difference in total chlorophyll content among four different zucchini cultivars as response to the infection with either PRSV alone or WMV alone or PRSV+WMV at both seasons tested.

In general, the highest total chlorophyll content (30.41) was observed in 03 cultivar followed by the Malat cultivar (29.78 reading/plant), while the least total chlorophyll content was observed on Hytech cultivar was 22.16 followed by the Safa cultivars (26.08 SPAD reading/plant at the 1st season). While at the 2nd season, the highest total chlorophyll contents were observed in Malat or 03 cultivars (15.9 and 15.4 SPAD reading/plant respectively), and the least total chlorophyll content observed on Hytech or Safa cultivars (11.5 and 12.8 SPAD reading/plant respectively).

Table 3. Chlorophyll contents in certain zucchini cultivars (SPAD measurement) as response to viral infection under greenhouse conditions during 2022 and 2023.

Cultivars	Total Chlorophyll contents (SPAD Reading)							
	Growing season 2022				Growing season 2023			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	19.49	25.11	21.88	22.16	12.3	11.2	10.8	11.5
Malat	34.52	27.23	27.37	29.78	12.9	10.8	14.6	15.9
Safa	25.77	27.07	25.32	26.08	17.4	13.1	17.2	12.8
03	27.58	32.77	30.93	30.41	15.9	17.3	13	15.4
Mean	26.81	28.04	26.37		14.6	13.1	13.9	
L.S.D at 0.05								
Varieties (A)				3.8				2
Viruses (B)				3.3				1.7
A x B				19.2				24.4

4. Determination of total carbohydrates in four zucchini cultivars due to viral infection under greenhouse conditions

Results in Table (4) showed that there was a significant difference in total carbohydrates content among the four zucchini cultivars after infection with either PRSV or WMV or WMV+PRSV at both seasons tested.

In general, the highest total carbohydrates content was observed in Malat cultivar followed by 03 cultivar which contained 6.7 and 6.28 %/plant, respectively, while the least total carbohydrates content was observed in Hytech and Safa cultivars (4.26 and 4.34 %/plant respectively at the 1st season.

Also, in 2nd season the highest total carbohydrate contents were observed in case of Malat or 03 cultivars as were 6.42 and 6.36 %/plant respectively and the least total carbohydrate contents observed on Hytech or Safa cultivars were 3.7 and 4.96 %/plant respectively.

Table 4. Total carbohydrates contents (%) in different zucchini cultivars as response to viral infection under greenhouse conditions during summer 2022 and 2023.

Cultivars	Carbohydrates contents (%)							
	Growing season 2022				Growing season 2023			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	4.12	4.32	4.36	4.26	3.66	3.56	3.9	3.7
Malat	6.8	7.28	6	6.7	6.02	6.22	7.02	6.42
Safa	4.14	4.38	4.5	4.34	4.72	5.3	4.84	4.96
03	5.58	6.62	6.68	6.28	4.92	8.5	5.66	6.36
Mean	5.16	5.64	5.38		4.84	5.9	5.36	
L.S.D at 0.05								
Varieties (A)				0.58				1.32
Viruses (B)				0.5				0.74
A x B				1				2.28

5. Assessment of the reaction of four zucchini cultivars to the infection with certain viruses (Mean of three methods WMV or PRSV or WMV +PRSV) under field conditions

Results in Table (5,6) showed that the tested zucchini cultivars differed significantly in their response to the infection with PRSV alone, WMV alone and mixed infection between WMV+PRSV at two growing seasons.

In general, cultivar Malat was the most tolerant cultivar against the viral infection with PRSV, WMV, or PRSV+ WMV followed by 03 cultivar as the mean of DS were 8.3 and 15% three weeks post viral inoculation and 40 and 43.3% post six weeks, while that the most susceptible cultivar to viral infection was Hytech Followed by Safa cultivar as the mean of DS were 31.7, 23.3% after three weeks and 66.7 and 50% after six weeks during the 1st season tested.

Additionally, the data revealed that the DS at the 2nd season showed that cultivar Malat was the most tolerant zucchini cultivar followed by cultivar (03) three weeks viral inoculation as the mean of DS were 16.7, 18.3% but after six weeks from inoculated were cultivar 03 more tolerance then Malat cultivar, as DS were 25, 30% respectively, while the most susceptible cultivar was Hytech followed by Safa among after three weeks and six weeks as the mean of DS were 31.7, 21.7% after 3 weeks and 61.7, 40% after 6 weeks.

Table 5. Response of zucchini cultivars to viral infection under field conditions during summer 2022.

Cultivars	Disease severity (%)							
	Growing season 2022							
	After 3 weeks				After 6 weeks			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	25	45	25	31.7	55	70	75	66.7
Malat	10	5	10	8.3	20	45	55	40
Safa	25	20	25	23.3	50	50	50	50
03	15	10	20	15	40	40	50	43.3
Mean	20	20	18.7		41.2	51.2	57.5	
L.S.D at 0.05								
Varieties (A)				12.8				16.6
Viruses (B)				11.1				14.4
A x B				22.1				28.9

Table 6. Response of zucchini cultivars to viral infection under field conditions during summer 2023.

Cultivars	Disease severity (%)							
	Growing season 2023							
	After 3 weeks				After 6 weeks			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	40	35	20	31.7	65	65	55	61.7
Malat	15	15	20	16.7	30	25	35	30
Safa	15	20	30	21.7	25	40	55	40
03	20	20	15	18.3	30	20	25	25
Mean	22.5	22.5	21.2		37.5	37.5	42.5	
L.S.D at 0.05								
Varieties (A)				10.9				12.4
Viruses (B)				9.4				10.7
A x B				18.9				21.5

6. Determination of mean total chlorophyll in four zucchini cultivars due to viral infection under field conditions

Results in Table (7) showed that there was a significant difference in total chlorophyll content among four different zucchini cultivars as response after infection with either (PRSV or WMV or PRSV+WMV) at both growing seasons.

In general, the highest total chlorophyll content was observed in Malat cultivar followed by 03 cultivars in both season as chlorophyll content were 29.2 and 27.9 SPAD reading/plant, respectively in at 1st season and 43.3 SPAD reading/plant for both cultivars in the 2nd season.

While the least total chlorophyll contents observed on Hytech followed by Safa at both seasons as mean chlorophyll contents of the three infection methods were 21.6 and 25.9 SPAD reading/plant in the 1st season and 25.3, 37.8 SPAD reading/plant at the 2nd season respectively.

Table 7. Chlorophyll contents in certain zucchini cultivars (SPAD measurement) as response to viral infection under field conditions during summer 2022 and 2023

Cultivars	Total chlorophyll contents (SPAD reading)							
	Growing season 2022				Growing season 2023			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	18.4	28	21.3	21.6	26.8	29	20.1	25.3
Malat	27.3	33.5	26.9	29.2	45.1	43.5	41.3	43.3
Safa	26.5	26.4	24.8	25.9	37.6	38.3	37.6	37.8
03	22	31.3	30.5	27.9	45.8	44.9	43.1	43.3
Mean	23.5	29.7	25.8		38.8	38.9	35.3	
L.S.D at 0.05								
Varieties (A)				4.1				2.9
Viruses (B)				3.6				2.6
A x B				7.2				5.2

7. Determination of total carbohydrate in four zucchini cultivars due to viral infection under field conditions

Results in Table (8) indicated that there was a significant difference in total carbohydrates content within four different zucchini cultivars after the infection with PRSV, WMV, or PRSV+WMV at both seasons tested.

The highest mean total carbohydrates content (for the three inoculation methods) was observed in case of Malat and 03 (6.96 %/plant for both cultivars), and the least total carbohydrates content was observed in case of Hytech or Safa (were 3.88 and 4.86 %/plant, respectively) at the 1st first season. While the highest total carbohydrates content was observed in case of Malat followed by 03 (10.24 and 8.7 %/plant, respectively), and the least total carbohydrate contents was observed in case of Hytech or Safa (were 4.68, 5.28 %/plant respectively) at the 2nd second season.

Table 8. Total carbohydrates contents (%) in certain zucchini cultivars as response to viral infection under field condition during summer of 2022 and 2023.

Cultivars	Carbohydrates contents (%)							
	Growing season 2022				Growing season 2023			
	WMV	PRSV	W+P	Means	WMV	PRSV	W+P	Means
Hytech	4.86	2.48	4.26	3.88	4.24	4.28	5.5	4.68
Malat	7.64	6.42	6.84	6.96	11.26	9.62	9.82	10.24
Safa	6.16	5.38	3.04	4.86	5.12	6.14	4.58	5.28
03	8.36	6.76	5.76	6.96	8.66	8.16	9.28	8.7
Means	6.76	5.26	4.98		7.32	7.04	7.3	
L.S.D at 0.05								
Varieties (A)				2.3				0.46
Viruses (B)				1.98				0.4
A x B				3.98				0.8

8. Assessment of the yield in four zucchini cultivars infected with certain viruses under field conditions

Results in Table (9) showed that there was a significant difference in total yield among four different zucchini cultivars as response after infection with either (PRSV, WMV, or PRSV+WMV) at both seasons tested.

The highest yield per plant was obtained in case of Malat followed by Safa and 03 as the mean of yield was 3.3, 2.6, 2.4 kg / plant or plot respectively, and the least yield occurred on Hytech as yield per plant was 1.3 k/plant the 1st season. While in 2nd season the highest yield per plant was recorded in case of Malat and 03 followed by Safa as the mean of yield was 3.8, 3.6, 3.2 kg/plant respectively, and the least yield per plant was recorded in case of Hytech cultivar as was 1.8 kg/plant in second season.

Table 9. Effect of viral infection on the yield of certain zucchini cultivars under field conditions during summer of 2022 and 2023 (kilogram per plant).

Cultivars	Yield							
	Growing season 2022				Growing season 2023			
	WMV	PRSV	W+P	Mean	WMV	PRSV	W+P	Mean
Hytech	1.1	1.2	1.7	1.3	1.7	1.9	1.8	1.8
Malat	3.3	2.9	3.5	3.3	3.7	3.9	3.8	3.8
Safa	2.2	2.5	2.9	2.6	3.2	3.2	3	3.2
03	2.3	3	1.8	2.4	3.4	3.7	3.6	3.6
Mean	2.2	2.4	2.5		3.01	3.2	3.05	
L.S.D at 0.05								
Varieties (A)				0.45				0.43
Viruses (B)				0.38				0.37
A x B				0.77				0.75

Discussion

Cucurbits are being infected by several plant pathogenic viruses, among these viruses PRSV and WMV are being considered the most important viruses (Jossey and Babadoost, 2008; Ali *et al.*, 2012)

Management of plant pathogenic viruses infecting cucurbits is a difficult task, as there is no efficient method to control these viruses, especially because these viruses are being transmitted by aphids in non-persistent manner. One of the promising methods to control plant viruses is using resistant or tolerant cultivars (Matthews and Hull, 2002; Murphy and Dane, 2009; Ghosh and Biswas, 2018 and Shrestha *et al.* 2021).

This study aims to determine the degree of resistance among certain zucchini cultivars to the infection with PRSV or WMV.

The results of the current experiment revealed that there was a significant difference in the cultivar's susceptibility to viral infection, but there was no complete resistant zucchini cultivar against viral infection among tested cultivars in this experiment.

In general, Malat followed by 03 were the most tolerant cultivars against infection, while the Hytech and Safa were the most susceptible zucchini cultivars.

These results agree with previous results that indicated that the using resistant cultivars is an efficient method to control plant viruses (Rahman *et al.*, 2002; Nawar and Kuti, 2003; and Wu *et al.*, 2018). Using resistant or tolerant cultivars proved to be an efficient method to control many fungal and viral diseases (Bao *et al.*, 2004). But using tolerant cultivars is not enough to control plant viruses alone and should be accompanied with another management methods.

Carbohydrates and chlorophyll contents were measured in the four zucchini cultivars after infection with PRSV or WMV or both viruses.

The result of the experiment showed that these zucchini cultivars varied in their content of carbohydrate and chlorophyll either in greenhouse or field conditions.

In general, 03 and followed by Malat are the highest cultivars in carbohydrate and chlorophyll contents, while Hytech followed by Safa had the lowest carbohydrate and chlorophyll contents.

The results are in partial agreement with results obtained by Técsi *et al.* (1994); Srivastava and Tiwari (1998), and Radwan *et al.* (2007) who suggest that viral infection can significantly affect the carbohydrate and chlorophyll contents in plants and lead to certain physiological changes in infected plants.

This study concluded that using resistant or tolerant zucchini cultivates may be useful to reduce the disease severity of viral infection, but this method is not enough alone to control these viruses completely, and there is a need to be

applied beside another management method. Therefore, this study recommends the application of an integrated strategy to control plant viruses infecting zucchini plants and using tolerant cultivars is one of the essential elements of this strategy.

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تقييم استجابة بعض أصناف الكوسة للإصابة بفيروس التبقع الحلقى في الباباظ وتبرقش البطيخ تحت ظروف الصوبة والحقل

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الملخص

تعد الكوسة أحد محاصيل الخضر الهامة في العالم، التي تنتمي للعائلة القرعية وهي من أكبر العائلات النباتية ذات التأثير الاقتصادي المرتفع في العالم. ومع ذلك، تصاب الكوسة بالعديد من الفيروسات المسببة لأمراض النبات والتي تسبب خسائر كبيرة في إنتاج الكوسة. وتهدف هذه الدراسة إلى تعريف بعض الفيروسات التي تصيب الكوسة في محافظة أسيوط - مصر. وذلك باستخدام تقنية النسخ العكسي لتفاعل البلمرة المتسلسل (RT-PCR). وكذا تقييم استجابة أربعة أصناف من الكوسة (صافا وهايتك وماليت و03) للإصابة بالفيروسات تحت ظروف الحقل والصبوة. وتم التقييم بتقدير بعض القياسات مثل الشدة المرضية، وكمية المحصول، والمحتوى الكلي للنبات من الكلوروفيل والكربوهيدرات. بصفة عامة، كانت هناك فروق معنوية بين حساسية أصناف الكوسة للإصابة بفيروس موزيك البطيخ ((WMV) وفيروس تبقع الباباظ الحلقى (PRSV)، وكان الصنفان 03 وماليت أكثر الأصناف تحملاً، بينما الصنف هايتك يتبعه الصنف صافا أكثرهم حساسية. أظهرت النتائج وجود فروق معنوية في محتوى أصناف الكوسة الأربعة المختبرة من الكربوهيدرات والكلوروفيل بعد إصابتها بفيروس WMV أو PRSV، وقد وجد أن أعلى محتوى في الكربوهيدرات والكلوروفيل الكلي في حالة صنف 03 وماليت، بينما أقل محتوى من الكربوهيدرات والكلوروفيل الكلي كان في حالة صنف هايتك يتبعه صافا، تحت ظروف الحقل والصبوة. أوضحت نتائج هذه الدراسة أن استخدام بعض أصناف الكوسة المحتملة للإصابة الفيروسية يساهم في تقليل شدة الإصابة الفيروسية، ويساعد في وضع استراتيجية لمكافحة الفيروسات بطريقة آمنة وصديقة للبيئة.

الكلمات المفتاحية: الأصناف التحمل، فيروس التبقع الحلقى في الباباظ، فيروس تبرقش البطيخ، الكوسة