Journal of Agricultural Science and Technology A 8 (2018) 306-314
doi: 10.17265/2161-6256/2018.05.006

Behavior of Watermelon Cultivars after Inoculation with *Watermelon mosaic virus* in Saudi Arabia

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Abstract: All seven watermelon cultivars that were screened for their reactions to a severe Saudi Arabian isolate of *Watermelon mosaic virus* (WMV-SA) that was found inducing a severe disease in watermelon in Riyadh region, were found to be susceptible and showed different virus-like symptoms upon mechanical inoculation. Sugar Baby, Crimson Sweet 1 and Crimson Sweet 2 cultivars showed milder symptoms and, therefore, got lower grand mean of weekly symptom ratings than Charleston Gray No. 502, Jubilee, Black Diamond and Charleston Gray No. 133 in both first and second experiments. Artificial inoculation with this isolate significantly reduced the plant height, fresh and dry weights of the tested cultivars. The reduction percentages in plant height of Sugar Baby and Crimson Sweet 2 were significantly lower than those of Crimson Sweet 1, Charleston Gray No. 502 and Charleston Gray No. 133 in both experiments. Also the reduction in percentages of fresh weights of Sugar Baby, Crimson Sweet 2 and Jubilee were significantly lower than reduction percentages of Crimson Sweet 1, Black Diamond and Charleston Gray No. 133. The dry weight reduction percentages of Jubilee, Sugar Baby and Crimson Sweet 2 were lower than those of Charleston Gray No. 502, Charleston Gray No. 133, Black Diamond and Crimson Sweet 1 in both experiments. No correlation existed between the virus titer in the infected cultivars and their performances. In general, Sugar Baby and Crimson Sweet 2 performed better than the other cultivars as they had the lowest symptom severity ratings, the lowest percentages of plant height, fresh and dry weight reductions compared to the other tested cultivars.

Key words: Plant behavior, screening, watermelon cultivars, *Watermelon mosaic virus* (WMV), Saudi Arabia.

1. Introduction

Watermelon (*Citrullus lanatus* (Thunb.) Matsum & Nakai) is one of the most important cucurbit species grown worldwide. The total production of watermelon in Saudi Arabia reached 401,058 tons from a total cultivated area of about 16,783 ha [1]. According to VIDE database, watermelon is susceptible to infection with 27 viruses, and six of which namely: *Zucchini yellow mosaic virus* (ZYMV), *Watermelon mosaic virus* (WMV), *Papaya ringspot virus* (PRSV), *Cucumber green mottle mosaic virus* (CGMMV), *Cucumber mosaic virus* (CMV) and *Squash mosaic virus* (SqMV) were considered the most common and important ones [2-5].

WMV is widespread among cucurbits, mostly in temperate and Mediterranean climatic regions of the world. WMV induces different symptoms depending on the isolate and host plant species or cultivars. On leaves, WMV infections induce mosaic, vein banding and malformation symptoms. Mosaic, discoloration, and deformation can also be found on infected plant's fruits [6]. This virus is transmitted by mechanical inoculation and by 35 aphid species in a nonpersistent manner [6, 7].

Several studies were carried out to assess susceptibility of different cucurbits to different viruses [8-10]. Generally, genetic resistance is considered the most effective and the most economical form of viral disease control. Genetic resistance against viruses can be achieved through traditional methods such as natural resistance or through transgenic techniques [9, 11, 12]. Virus resistance in cucurbits via transgenic techniques has been provided by virus coat protein [11,

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12]. Watermelon and other cucurbit species have been screened for their natural resistance against viruses. A PI accession watermelon, PI 595203, which possesses high resistance to ZYMV China strain and moderate resistance to WMV, was identified [13]. Eight PI accessions of watermelon that possess high resistance to *Papaya ringspot virus* type W (PRSV-W) were also found [10]. Methods for identifying cucumber resistance to WMV through selection and application of molecular markers linked to the virus gene were introduced [14]. Resistance of watermelon to potyviruses was reviewed [15].

Recently, a severe isolate of WMV has been detected and characterized from watermelon plants collected from Al-Amariyah area, Saudi Arabia [16]. As WMV is a major limitation for watermelon production; the objective of this study was to evaluate the commonly grown watermelon cultivars in Saudi Arabia for their reactions to this virus.

2. Materials and Methods

Seven watermelon cultivars commonly grown in Saudi Arabia, namely: Black Diamond, Charleston Gray No. 133, Charleston Gray No. 502, Crimson Sweet 1, Crimson Sweet 2, Jubilee and Sugar Baby were screened for their reactions to a Saudi Arabian isolate of *Watermelon mosaic virus* (WMV-SA), accession No. KC447295 isolated from symptomatic watermelon plants grown in Al-Amariyah area, Saudi Arabia [16] using several parameters including symptom severity, ELISA absorbance values, plant height, fresh and dry weights. The screening experiment was conducted in randomized complete block design. A soil mix of sand and peat moss, with a proportion of 1:3, respectively, was prepared and used. Eighty four sterile pots (16 cm height and 16 cm diameter, sterilized by washing with 5% sodium hypochlorite bleach (clorox)) were filled with the soil mix after being sterilized using Huxley autoclave (Huxley Medical Instruments Co. Ltd., Taiwan) for 20 min at 121 °C and 2 atm. Six plants of each cultivar were planted in pots (one plant per pot), dusted with carborundum and mechanically inoculated with WMV-SA at the 3-4 true leaf stage, as described earlier [17]. Six other plants from each cultivar (one plant per pot) were rubbed with sap from healthy leaves and used as controls. The experiment was conducted twice. During screening tests, all cultivars were maintained in a greenhouse at temperature ranging between 25 °C and 28 °C.

2.1 Symptoms Severity Ratings of the Tested Watermelon Cultivars

A rating system that was suggested earlier was applied [10]. Following inoculation with WMV-SA at the first true leaf stage, and were then rated weekly for six weeks on a scale of 1-6 on the basis of viral symptoms severity index, where 1 = no symptoms, 2 = mottle/mild mosaic, 3 = mosaic, 4 = mosaic, leaf malformation, 5 = mosaic, leaf malformation and stunting, 6 = dead plant. Data of each cultivar were summarized as weekly rating means and grand means. Weekly rating means were mean of six inoculated replications score which was recorded each week starting one week postinoculation until six weeks postinoculation, while grand mean rating was the means of six weekly ratings.

2.2 Detection of WMV in the Tested Watermelon Cultivars Using ELISA

At the third week postinoculation, all inoculated plants in each experiment were serologically tested using DAS-ELISA kits (Agdia Inc., 30380 County Road 6-Elkhart, IN 46514, USA) to determine the presence and concentration of WMV in the tested plants. The procedure to perform DAS-ELISA was as provided by the kit manufacturer. Tissues for DAS-ELISA test were taken from the third top leaf of each tested plant. Six inoculated plants were used per cultivar and four healthy watermelon plants were used as negative control on each ELISA plate. A cultivar was considered susceptible to WMV-SA infection if

the mean of its absorbance values was more than twice the mean of negative controls absorbance values. Data of testing plants three weeks postinoculation were recorded in the first and second experiments.

2.3 Effect of WMV-SA Infection on the Plant Heights, Fresh and Dry Weights of the Tested Watermelon Cultivars

Six weeks postinoculation, the inoculated and uninoculated plants of each cultivar were harvested at the soil level to measure their heights and fresh weights. Subsequent to plant heights and plant fresh weights measurements, each plant was then placed in a paper bag and kept in a room with temperature ranging between 23 °C and 25 °C to dry. After 10 d, the dry weight of each plant was measured.

The *t*-test was performed to plant heights, fresh and dry weights data to determine significant differences between inoculated and control plants for each cultivar. The differences between control and inoculated plants of each cultivar were converted into percentage and referred to as percent of reduction. The reductions in plant heights, fresh and dry weights data were transformed according to Little and Hills (1978) [18] to arcsine. One-way analysis of variance (ANOVA) was done with Duncan's multiple range test (DMRT) and then performed to the transformed percentages of reduction data of all cultivars in each experiment to determine the significant differences among them [19, 20]. All statistical analyses were done using SPSS 17 (IBM Corp., New York, USA).

A cultivar was considered resistant or tolerant to the virus if the inoculated plants of the particular cultivar were proven to be free of virus by DAS-ELISA or had low symptom severity rating; their plant heights, fresh and dry weights means were not significantly different from their respective controls.

3. Results

3.1 Symptoms Severity Ratings of the Tested Watermelon Cultivars

All cultivars started to show symptoms as early as two weeks postinoculation with WMV-SA. At the sixth weekly rating of the first experiment, Sugar Baby had the least severe symptoms and therefore got the lowest rating (3.3), while Black Diamond had the highest rating (4.7). Whereas, at the sixth weekly rating of the second experiment, Crimson Sweet 2 had the lowest rating (3.2), on the contrary, Jubilee and Black Diamond had the highest rating (4.2). In general, Sugar Baby, Crimson Sweet 1 and Crimson Sweet 2 showed milder symptoms and therefore had lower grand mean of weekly ratings than Charleston Gray No. 502, Jubilee, Black Diamond and Charleston Gray No. 133 in the two experiments (Table 1). These results

Table 1 Means score of weekly observation of symptoms severity on seven watermelon cultivars inoculated with Saudi Arabian isolate of *Watermelon mosaic virus* (WMV-SA) isolate in the first and second experiments.

Cultivar	First experiment							Second experiment						
	Weekly rating[a]						Grand mean[b]	Weekly rating[a]						Grand mean[b]
	1st	2nd	3rd	4th	5th	6th		1st	2nd	3rd	4th	5th	6th	
Crimson Sweet 1	1	2	2.2	3.5	3.5	3.5	2.6	1	1.8	2	3	3.3	3.7	2.5
Crimson Sweet 2	1	2	2.3	2.8	3.3	4	2.6	1	2	2.3	2.7	3	3.2	2.4
Sugar Baby	1	2.2	3	3.2	3.3	3.3	2.7	1	1.8	2.3	2.7	2.7	3.3	2.3
Charleston Gray No. 502	1	1.8	3.2	3.3	4.2	4.2	2.9	1	1.8	2.5	2.8	3.2	3.8	2.5
Jubilee	1	2.2	3	3.8	3.8	4.2	3	1	2.3	2.5	3	3.7	4.2	2.8
Black Diamond	1	2	2.8	3.5	4.2	4.7	3	1	2.2	2.7	3.2	3.5	4.2	2.8
Charleston Gray No. 133	1	1.8	3	4.2	4.3	4.3	3.1	1	1.8	2.5	2.8	3.3	4	2.6

[a] Mean of six replications, data were recorded each week from one week postinoculation (as the first rating) until six weeks postinoculation (as the sixth rating). Plants were rated on a scale of 1-6 based on viral symptoms severity index, where 1 = no symptoms, 2 = mottle/mild mosaic, 3 = mosaic, 4 = mosaic, leaf malformation, 5 = mosaic, leaf malformation and stunting, 6 = dead plant.

[b] Mean of weekly ratings.

indicated different symptom responses for the different watermelon cultivars to WMV-SA infection and also suggested that the sixth week postinoculation with WMV-SA was probably the best time for rating since the differences in symptom severity among all the tested cultivars had become distinct at it.

3.2 Detection of WMV in the Tested Watermelon Cultivars Using ELISA

The ELISA test was positive for all the seven inoculated watermelon cultivar plants at three weeks postinoculation with WMV-SA isolate in the first and second experiments. Crimson Sweet 1 had relatively low absorbance value in the first experiment, whereas Sugar Baby had low absorbance value in the second experiment. Jubilee had low absorbance value in both experiments (Table 2). These results indicated that all the plants of the inoculated watermelon cultivars became infected with WMV-SA at three weeks postinoculation since they all showed positive reactions with ELISA at that time and also showed different types of viral symptoms.

3.2.1 Effect of WMV-SA Infection on the Watermelon Plant Heights

Plant heights of the tested cultivars were significantly reduced and different from their respective control plant heights as a result of their inoculation with WMV-SA in both screening experiments according to *t*-test (Table 3). The percent of plant height reductions in two experiments ranged between 20.5% and 51.2%. Sugar Baby and Crimson Sweet 2 had the lowest percentage of plant height reduction among all tested cultivars in both experiments. Although the percent of plant height reduction of these two cultivars were not significantly different from that of Jubilee, it was significantly different from those of Crimson Sweet 1, Charleston Gray No. 502 and Charleston Gray No. 133 in the two experiments and also from that of Black Diamond in the first experiment when compared using DMRT (Table 3).

3.2.2 Effect of WMV-SA Infection on the Fresh Weight of the Tested Watermelon Cultivars

According to *t*-test, there were significant differences between inoculated and control plants with regard to the fresh weight reductions of all tested watermelon cultivars as a result of their inoculation with WMV-SA in the first and second experiments (Table 4). In the two experiments, percent of fresh weight reductions ranged between 41.9% and 75.4%. In spite of the significant effect of WMV on the fresh weight of all the tested cultivars, fresh weight of Sugar Baby, Crimson Sweet 2 and Jubilee were the least affected with no significant differences among

Table 2 Means of absorbance values of ELISA for seven watermelon cultivars three weeks postinoculation with WMV-SA isolate in two separate experiments.

Cultivar[a]	First experiment[b]	Second experiment[b]
	3rd week[c]	3rd week[c]
Sugar Baby	1.856	0.642
Crimson Sweet 2	1.288	0.835
Jubilee	0.555	0.665
Crimson Sweet 1	0.845	1.399
Charleston Gray No. 502	1.469	0.843
Black Diamond	1.621	0.861
Charleston Gray No. 133	2.032	0.836
Negative control	0.128	0.083

[a] Six inoculated plants were used per cultivar and four healthy watermelon plants were used as negative control on each ELISA plate.
[b] Means of absorbance value at 405 nm; A cultivar was considered susceptible to WMV-SA infection if mean of its absorbance value was more than twice mean of negative controls absorbance value.
[c] Data were recorded three weeks posinoculation in the first and second experiments.

Table 3 Effect of WMV-SA infection on the plant height (cm) and comparison of the percent of plant height reduction among seven watermelon cultivars inoculated with the virus in the first and second experiments

Cultivar[x]	First experiment			Second experiment		
	Control[y]	Inoculated[y]	Reduction (%)[z]	Control[y]	Inoculated[y]	Reduction (%)[z]
Sugar Baby	72.9 a	57.9 b	20.5 a	69.3 a	53.1 b	23.4 a
Crimson Sweet 2	70.6 a	53.1 b	24.8 a	72.4 a	54.1 b	25.3 a
Jubilee	75.3 a	51.3 b	31.9 ab	75.2 a	48.3 b	35.8 ab
Black Diamond	80.6 a	46.8 b	41.9 ab	79.4 a	44.9 b	43.5 b
Crimson Sweet 1	79.8 a	43.3 b	45.7 b	78.5 a	46.9 b	40.3 b
Charleston Gray No. 502	78.9 a	42.7 b	45.9 b	83.7 a	48.8 b	41.7 b
Charleston Gray No. 133	75.4 a	36.8 b	51.2 b	78.5 a	45.8 b	41.7 b

[x] For each treatment, six plants were used per cultivar; data were recorded six weeks postinoculation.

[y] For each cultivar, means followed by the same letter in control and inoculated columns are not significantly different according to *t*-test ($p = 0.05$).

[z] Average percent of reduction for the cultivars followed by the same letter are not significantly different according to Duncan's multiple range test (DMRT) ($p = 0.05$).

Table 4 Effect of WMV-SA infection on the plant fresh weight (g) and comparison of the percent of fresh weight reduction among seven watermelon cultivars inoculated with the virus in the first and second experiments.

Cultivar[x]	First experiment			Second experiment		
	Control[y]	Inoculated[y]	Reduction (%)[z]	Control[y]	Inoculated[y]	Reduction (%)[z]
Sugar Baby	27.2 a	14.9 b	41.9 a	23.1 a	12.1 b	47.3 a
Crimson Sweet 2	17.4 a	9.1 b	46.2 ab	15.5 a	8.2 b	46.1 a
Jubilee	22.2 a	11.5 b	47.3 ab	20.5 a	10.1 b	50.9 a
Charleston Gray No. 502	22.1 a	8.2 b	61.4 bc	19.3 a	7.7 b	57.8 ab
Crimson Sweet 1	25.7 a	7.9 b	68.1 c	22.7 a	7.7 b	64.9 b
Black Diamond	25.1 a	7.4 b	68.1 c	19.8 a	6.1 b	68.8 b
Charleston Gray No. 133	21.4 a	5.2 b	75.4 c	25.1 a	9.1 b	63.3 b

[x] For each treatment, six plants were used per cultivar; data were recorded six weeks postinoculation.

[y] For each cultivar, means followed by the same letter in control and inoculated columns are not significantly different according to *t*-test ($p = 0.05$).

[z] Average percent of reduction for the cultivars followed by the same letter are not significantly different according to Duncan's multiple range test (DMRT) ($p = 0.05$).

them according to DMRT, however those three cultivars significantly out yielded Crimson Sweet 1, Black Diamond and Charleston Gray No. 133 with regard to their fresh weight (Table 4).

It is interesting that Charleston Gray No. 502 seems to have an intermediate response to WMV-SA infection compared to other cultivars. Although it showed significant fresh weight loss from Sugar Baby in the first experiment with a percent of fresh weight reduction of 61.4%, it did not show significant fresh weight reduction from all other cultivars. However, in the second experiment, Charleston Gray No. 502 did not reflect significant fresh weight reduction difference from all watermelon cultivars with a percent of fresh weight reduction of 57.8% (Table 4).

3.2.3 Effect of WMV-SA Infection on the Dry Weight of the Tested Watermelon Cultivars

Data of the two experiments indicated significant differences between dry weights of the inoculated plants of all cultivars compared to their respective control plants (Table 5). Percent of dry weight reductions ranged between 45.4% and 75.5% in the two experiments. Jubilee, Sugar Baby and Crimson Sweet 2 had lower percent of dry weight reductions compared to the other tested cultivars, with no significant differences among those three cultivars.

Table 5 Effect of WMV-SA infection on the plant dry weight (g) and comparison of the percent of dry weight reduction among seven watermelon cultivars inoculated with the virus in the first and second experiments.

Cultivar[x]	First experiment			Second experiment		
	Control[y]	Inoculated[y]	Reduction (%)[z]	Control[y]	Inoculated[y]	Reduction (%)[z]
Jubilee	2.3 a	1.2 b	45.6 a	2.1 a	0.9 b	53.7 ab
Sugar Baby	2.9 a	1.5 b	46.6 ab	3.1 a	1.6 b	46.7 a
Crimson Sweet 2	1.9 a	0.9 b	54.5 abc	1.2 a	0.6 b	45.4 a
Charleston Gray No. 502	2.2 a	0.8 b	62.5 bc	1.9 a	0.7 b	61.3 ab
Charleston Gray No. 133	1.9 a	0.6 b	67.6 c	2.7 a	0.8 b	75.5 b
Black Diamond	2.8 a	0.8 b	69.9 c	1.7 a	0.6 b	60.9 ab
Crimson Sweet 1	2.7 a	0.8 b	71.3 c	2.5 a	0.9 b	66.3 b

[x] For each treatments, six plants were used per cultivar; data were recorded 10 d after measurement of the first experiment's fresh weight.

[y] For each cultivar, means followed by the same letter in control and inoculated columns are not significantly different according to *t*-test ($p = 0.05$).

[z] Average percent of reduction for the cultivars followed by the same letter are not significantly different according to Duncan's multiple range test (DMRT) ($p = 0.05$).

However, the dry weight reductions of Crimson Sweet 2 and Sugar Baby were significantly lower than that found in Charleston Gray No. 133 and Crimson Sweet 1 in the two experiments and also than that of Black Diamond in the first experiment according to DMRT (Table 5).

4. Discussion

An important factor for the difficulty of management of potyviruses, where WMV belongs, is their readily transmission by aphids [21]. Application of pesticides to control their aphid vectors is usually not effective since the aphids are able to acquire and subsequently transmit the viruses rapidly [22]. Therefore, host resistance or tolerance becomes the most effective means against potyviruses infection. The use of resistant plants reduces concerns about virus vectors. This method is also considered simple, since it only requires little input from the plant growers [21]. The watermelon cultivars screening experiments performed using the five previously mentioned parameters were mainly used to recommend the best cultivar out of the seven tested ones to avoid the severe effects and significant losses incurred by WMV-SA infection. Although none of the individual plants of all tested cultivars was dead during both screening experiments, all other symptoms that indicated different responses for different watermelon cultivars to the infection by this virus isolate, such as mottle, mosaic, leaf malformation and stunting, were evident on the inoculated plants of each of the tested cultivars in both experiments, with mosaic being the most common one (Fig. 1). Stunting was most common in Black Diamond both in the first and second experiments. However, severe symptoms such as stunting and leaf malformation were found to be slightly less prevalent in the second experiment than in the first one which might be due to the slight temperature and light intensity differences between times during which the two experiments were carried out since they were conducted during different times of the year. This has also resulted in slightly lower grand mean of weekly ratings of the second experiment compared to that of the first one.

Plant heights of all cultivars were significantly reduced in both experiments. The same results were obtained on comparison of fresh and dry weights of inoculated plants with their respective controls. These results showed that all cultivars were affected by the WMV-SA infection which resulted in the significant reduction of their plant heights, fresh and dry weights.

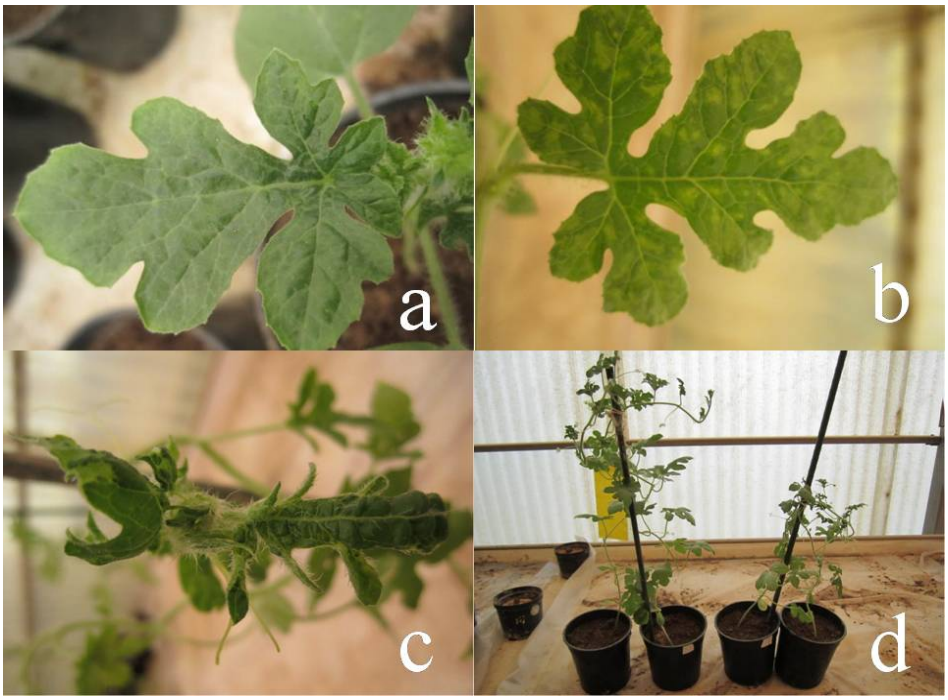

Fig. 1 Different Saudi Arabian isolate of *Watermelon mosaic virus* (WMV-SA) symptoms observed on tested watermelon cultivars, two weeks postinoculation, except (d) which was observed 40 d postinoculation.
(a) leaf mottle on Charleston Gray No. 133; (b) Mosaic on Black Diamond leaf; (c) Leaf malformation on Charleston Gray No. 502; (d) Stunting on Charleston Gray No. 502 plant (right).

However, the effect of infection with this isolate was different from one cultivar to another, which can be observed from percent of plant height, fresh and dry weight reductions of each cultivar (Tables 3-5).

The similar trend observed between the symptoms expressed on the tested watermelon cultivars as a result of WMV-SA infection, the plant heights, fresh and dry weights suggest that there were correlations between these parameters. In general, cultivars that showed severe symptoms (leaf malformation and stunting), such as Charleston Gray No. 133 and Black Diamond, tend to have high percent reduction of plant heights, fresh and dry weights. So, it can be concluded that the reduction of plant height, fresh and dry weights in the infected plants of the tested cultivars were mainly resulted from the disruption of the growth and development of the inoculated plants of each of these cultivars and that the two cultivars mentioned above seem to be more susceptible and hence were substantially affected by virus infection compared to the other cultivars.

Detection of WMV in all the inoculated watermelon cultivars by ELISA was achieved as early as three weeks postinoculation (Table 2). Hence, there was no need to test the plants by ELISA at six weeks as was previously proposed [23]. However, the ELISA absorbance values suggested that no correlation existed between the virus titer in the infected cultivars and their performances. Some of the cultivars that showed mild symptoms and low percent of reduction in plant height, fresh weight and dry weight, such as Sugar Baby and Crimson Sweet 2, had high ELISA readings. But, other cultivars that shared severe symptoms and high percent of reduction in plant height, fresh and dry weight, such as Charleston Gray No. 502, had similar ELISA reading to cultivars that performed well on the three parameters used to evaluate WMV-SA infection, such as Crimson Sweet 2.

Screening of genus *Citrullus*, where watermelon belongs, to their resistance to viruses has also been done in other studies. Six hundred and seventy

Citrullus spp. accessions were previously screened for resistance to WMV [24]. Ten of those *C. lanatus* accessions (PI 189316, PI 189317 and PI 189318 from Zaire; PI 244018, PI 244019 and PI 255137 from South Africa; PI 164708 from India; PI 306782, PI 494529 and 'Egun' from Nigeria) that were screened for virus resistance were found to be resistant to WMV in both field and greenhouse conditions. They also found five *C. colocynthis* PI accessions (PI 386016, PI 386024, PI 386025 and PI 386026 from Iran, and PI 388770 from Morocco) had some resistance to WMV under the conditions mentioned above. A PI accession of watermelon, PI 595203, had been reported to have moderate resistance to WMV which was controlled by at least two recessive genes [13]. This watermelon accession was also reported to be resistant to PRSV-W [10].

Infection of the WMV-SA produced different levels of symptom severity on the tested cultivars and significantly affected their plant heights, fresh weights and dry weights. Despite those facts, Sugar Baby and Crimson Sweet 2 can be considered the cultivars that performed better than the others against WMV-SA infection. Although proven to be susceptible to WMV-SA infection by ELISA, those cultivars managed to have low symptom severity rating, low percent of reductions in plant height, fresh weight and dry weight compared to the other tested cultivars in both first and second screening experiments.

5. Conclusions

All the seven tested watermelon cultivars were found to be susceptible to the WMV isolate. However the cultivars were variable in their responses based on the employed parameters. Cultivar Sugar Baby and Crimson Sweet 2 excelled all the other tested cultivars in most of the parameters, hence, were considered the best available cultivars. In spite of the relatively better performance of some cultivars over others according to DMRT, the fact remains that research toward testing local or foreign cucurbit germplasm for development of watermelon cultivars resistant or tolerant to such severe isolates of WMV should be encouraged since significant differences still occur between the treated and the control plants of each of the tested cultivars based on the Student's *t*-test.

Acknowledgments

The authors are grateful to King Abdulaziz City for Science and Technology (KACST), Riyadh, Saudi Arabia, and the Agricultural Research Center at the College of Food and Agriculture Sciences, King Saud University for funding this research.

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