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Impact of certain pests on the response and productivity of okra cultivars in Sohag Governorate

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Abstract:

The present work was conducted at Shandweel Agricultural Research Station, Sohag Governorate during 2017 and 2018 okra growing seasons to determine the population trends and susceptibility degrees against the prevalent sap sucking arthropod pests inhabiting 4 okra cultivars. *Aphis gossypii* Glover (Hemiptera: Aphididae) , *Bemisia tabaci* (Gennadius) (Hemiptera:Aleyrodidae), *Empoasca discipiens* (Paoli) (Hemiptera: Cicadellidae) and *Tetranychus urticae* Koch. (Acari:Tetranychidae) were found to be the most dominant species on the tested okra cultivars. The highest populations of *A. gossypii*, *E. discipiens* and *T. urticae* were recorded during July, however, the highest populations of *B. tabaci* mature and immature stages were recorded during May and June. The tested okra cultivars showed varied susceptibility degrees against the studied pests. Except of, *A. gossypii*, white velvet okra cultivar showed some sort of resistance against *B. tabaci*, *E. discipiens* and *T. urticae*. It must be shed a light on the presentation of *A. gossypii* at obvious low numbers on balady green cultivar which showed some sort of resistance against this destructive insect pest. Under sprayed and unsprayed procedures, influence of the pest's infestation on some yielding characters was studied. Okra cultivars varied significantly in both seasons. Under natural infestation, the yield and great proportion of the yield components decreased significantly compared to managed infestation. golden coast okra cultivar gave the highest fresh fruit yield per feddan and followed by white velvet okra cultivar. Both cultivars harbored moderate levels of the above mentioned pests. However, white velvet recorded the lowest reduction for fresh fruit yield per feddan and followed by golden coast. So, it can be recommended using the later cultivars as a part of an integrated pest management program. Furthermore, these results could be helpful for varieties screening programs.

Introduction

Okra (*Abelmoschus esculentus* L., Malvaceae) is a warm season, annual vegetable and cash crop. It is a good source of vitamins, minerals and has a good caloric value. Okra plants are subjected to be attacked by a variety of destructive sap sucking pests from seedlings until harvest. Amongst these pests; cotton aphid *Aphis gossypii* Glover (Hemiptera: Aphididae), whitefly *Bemisia tabaci* (Gennadius) (Hemiptera:Aleyrodidae), leafhopper *Empoasca discipiens* (Paoli) (Hemiptera: Cicadellidae) and two spotted spider mite *Tetranychus urticae* (Boisd.) (Acari:Tetranychidae). These arthropod pests were recorded as the most responsible for reduction in yield and hinder its quality (El-Khawas, 2005 and Saif Ullah and Aziz, 2012). Using tolerant or resistant and high yielding cultivars as an important component of integrated pest management (IPM) program of okra pests is meaningful because they are compatible with other control methods with no adverse side effects. The susceptibility of okra cultivars to pests has been studied by several authors (Amro *et al*., 2012; Abou Hatab and Elgendy, 2013; Allam *et al.*, 2014; Akbar and Khan, 2015 and Biswas *et al.*, 2016). Even with the importance of piercing sucking pests on okra cultivation, information on losses from these pests damage or management costs are still lacking. Also, the relationships between infestation and yield components of okra are not sufficiently studied. Therefore, the present study was conducted to determine the population trend of *A. gossypii*, *B. tabaci*, *E. discipiens* and *T.urticae* infesting four okra cultivars (White velvet, balady red, golden coast and balady green). Also, there response of these cultivars to pest's infestation under sprayed and unsprayed conditions was studied. Finally, the reduction in some yield components and yield income due to pest's infestation was also included.

Materials and methods

The present studies were carried out during the summer seasons of 2017 and 2018 at Experimental Farm of Shandweel Agricultural Research Station, Sohag Governorate, Egypt. Each experimental unit was 1/400 fedddan (10.5 m^2) including 5 rows, each of 3.5 m length and 70 cm width. Sowing was done on 15^{th} April in both seasons by sowing three seeds per hill at 35 cm intervals in a randomized complete block design. Growing plants were thinned into one plant/ hill. Conventional agricultural practices were performed and insecticidal treatments were completely prevented.

1. Population trends of some piercing sucking pests infesting four okra cultivars:

Four okra cultivars (White velvet, balady red, golden coast and balady green) were cultivated in complete randomized block with three replicates. Sampling was started after emergence and continued until harvesting time. Each sample consisted of 10 leaves which picked up randomly from top, middle and lower canopy of okra plants at weekly intervals. The samples were kept into polyethylene bags and transferred to laboratory for examination using a stereomicroscope. The numbers of aphid, whitefly (adults and nymphs), leafhopper (adults and nymphs) and the two spotted spider mite (mobile stages) were counted and recorded. Population trends and peaks of each pest were determined.

2. Relative susceptibility of okra cultivars to infestation with certain piercing sucking pests:

The same 10 okra leaves were used to determine the relative susceptibility of the tested cultivars to the above mentioned pests. The pest's mean numbers were used to determine the relative susceptibility degree of the tested cultivars as described by Chiang and Talekar (1980) equation. Relative susceptibility degree was dependent on the general mean number of the pest ($\bar{X}$) and the standard deviation (SD). Cultivars that had mean numbers more than $\bar{X}$+2SD, were considered highly susceptible (HS), between $\bar{X}$ and $\bar{X}$+2SD, susceptible (S), between $\bar{X}$ and $\bar{X}$-1SD, low resistant (LR), between $\bar{X}$-1SD and $\bar{X}$-2SD, moderately resistant (MR) and less than $\bar{X}$-2SD, were considered highly resistant (HR). Data were statistically analyzed by using F-test; means were compared according to Duncan's multiple range tests as described by Steel and Torrie (1982).

3. Response of four okra cultivars to pest's infestation under sprayed and unsprayed procedures:

To determine the effect of the selected piercing sucking pests on some vegetative and yield component, each of the above mentioned cultivars were sown in 6 plots. After germination, all the cultural practices were performed throughout the growing season uniformly in all plots. Piercing sucking pests were allowed to develop on three plots whereas the others were kept free from pests by spraying imidacloprid and abamectin three times. Ten plants were randomly taken from each plot to determine the following characters:

3.1.Fresh fruit yield characteristics:

3.1.1. Number of fresh fruits per plant:

Ten plants were randomly taken from each plot, the mean of the ten plants was used to determine the number of fresh fruits/ plant. The fruits were picked for fresh fruit at edible fruit maturity stage.

3.1.2. Fresh fruit yield. (Ton./fed.):

The average weight of fresh fruit / plot was calculated and multiplied by 400 to obtain fresh fruit yield /fed.

3.2. Seed yield and quality characteristics:

The following measurements were calculated

3.2.1. Number of seeds per dry fruitaverage (50 mature fruits from each plot).

3.2.2. 100- seeds weight (g).

3.2.3. Seed yield (kg/fed.).

4. Yield loss:

Loss in the yield of unsprayed plots was compared to the yield of sprayed plots and percent loss was calculated for each cultivar using the following formula:

Yield loss (%) = (sprayed plots yield −unsprayed plots yield)/ sprayed yield)×100

5. Statistical analysis:

Mean population of *A. gossypii*, *B. tabaci*, *E. discipiens* and *T. urticae* from unsprayed plots were analyzed by analysis of variance (ANOVA) to determine the susceptibility of four okra cultivars. However, the data of vegetative, some yield component and yield were analyzed by analysis of variance for sprayed and unsprayed plots. Differences in means were conducted using the least significant difference (LSD) procedure at P = 5% (Snedecor and Cochran, 1971). Comparisons within each okra cultivar between the sprayed and unsprayed were performed by using the t-test.

Results and discussion

1. Population trends of some piercing sucking pests infesting four okra cultivars:

1.1. *Aphis gossypii*:

Data illustrated in Figure (1) showed that aphid started to attack okra at May 2nd then increased to form three peaks on the four tested cultivars in both seasons. Three peaks were recorded on 30th May, 27thJune and 18th July in 2017 season and in 6th June, 4th July and 1st August in 2018 season for most of the tested cultivars.This finding is in agreement with the results of Abdel Hamed *et al.*(2011). Also, Akbar and Khan (2015) found that the population of *A. gossypii* peaked was recorded in June-July.

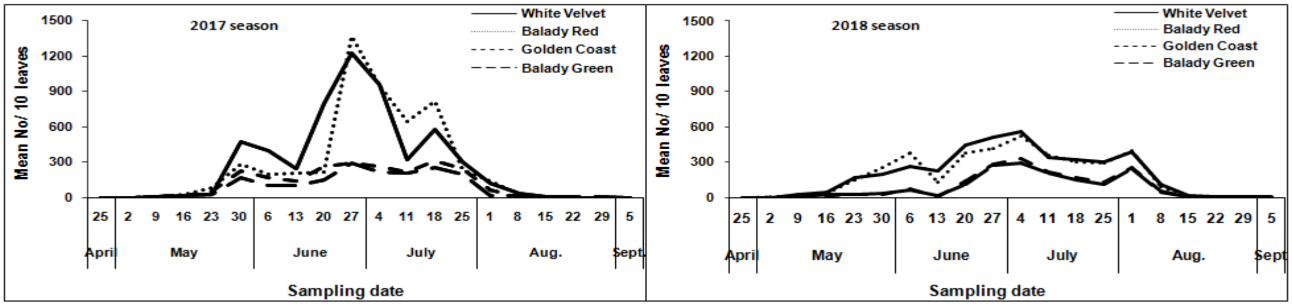

Figure (1): Population trend of *Aphis gossypii* on four okra cultivars in Sohag Governorate during 2017 and 2018 seasons.

1.2. *Bemisia tabaci*:

In respect to the mature stage, three peaks were detected on four tested cultivars in both growing seasons (Figure, 2). The peaks were recorded on 16th May, 6th June and 11st July in 2017 season and on 16th May, 13rd June and 18th July in 2018 season. In respect to the immature stage, two and three peaks were detected on the tested cultivars in 2017 and 2018 seasons, respectively (Figure, 3). The peaks were recorded on 23rd May and 20th June in 2017 season, and on 2nd and 30th May and 20th June in 2018 season. It is important to note that immature peaks were recorded 2-4 weeks before mature peaks.

The present results are in agreement with those obtained by Leite *et al.* (2005) who reported that, whitefly adult population increased from May to June, after the appearance of nymph population peaked in April. Also, Sahito *et al.* (2012) showed that *B. tabaci* attacked okra from germination till harvest and displayed three peaks in its population when the crop was sown on 20th March.

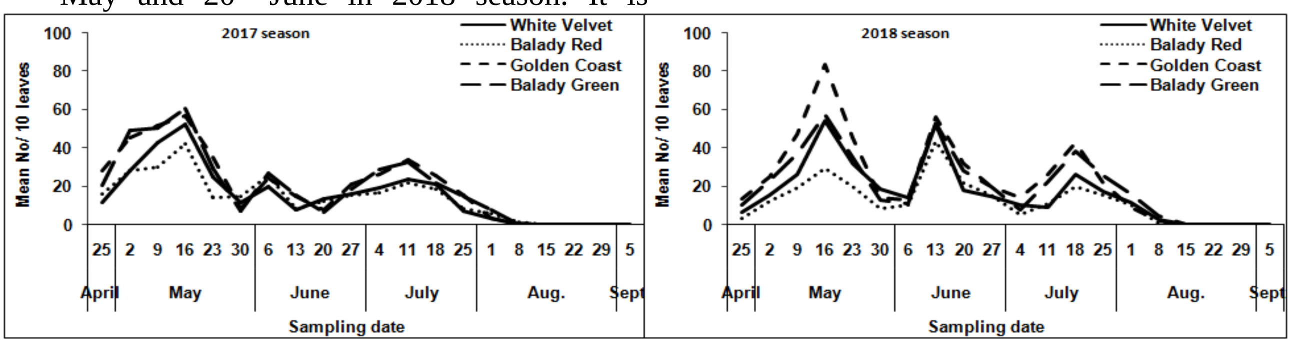

Figure (2): Population trend of *Bemisia tabaci* adults on four okra cultivars in Sohag Governorate during 2017 and 2018 seasons.

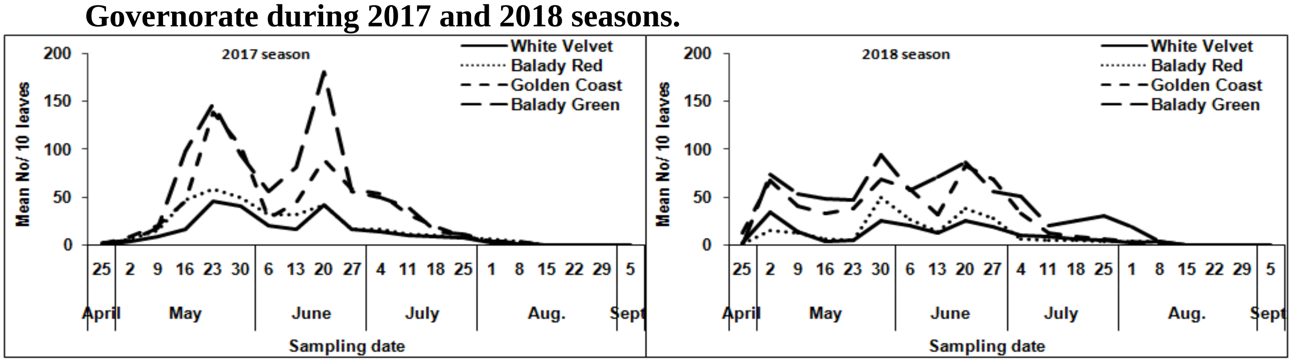

Figure (3): Population trend of *Bemisia tabaci* nymphs on four okra cultivars in Sohag Governorate during 2017 and 2018 seasons.

1.3. *Empoasca discipiens*:

Data illustrated in Figure (4) show the population density of *E. discipiens* (adults and nymphs) on four okra cultivars during 2017 and 2018 seasons. Four peaks were detected on the tested cultivars in both growing seasons. The peaks were recorded on 23rd May, 13th June, 4th and18thJuly in 2017 season, and on 6th and 27th June and 11th and 25thJuly in 2018 season. The previous results are in partial agreement with those obtained by Sahito *et al*. (2013), who found that the maximum and the minimum populations of *E. discipiens* were recorded in the start of June and during last the week of April, respectively. However, Javed *et al.* (2016) demonstrated that the *E.discipiens* population showed an increasing trend on all five okra varieties over 18 weeks, and maximum population was recorded in ambika variety during 17th week of data collection.

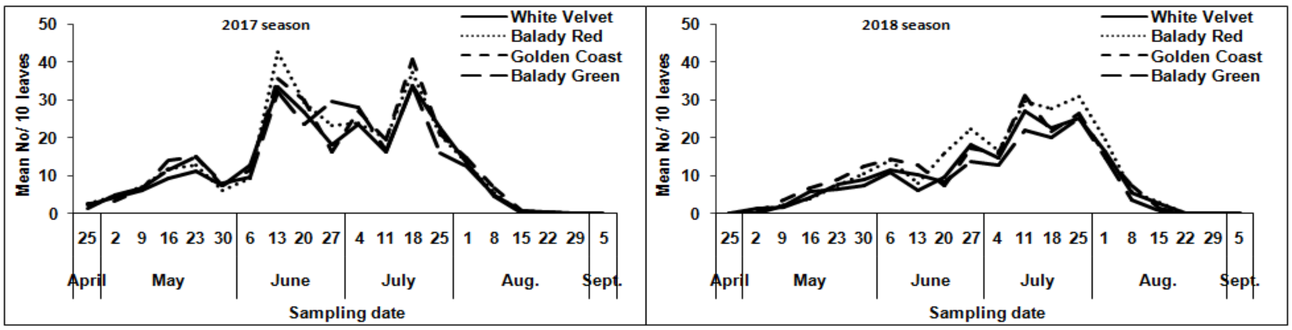

Figure (4): Population trend of *Empoasca discipiens* (adults and nymphs) on four okra cultivars in Sohag Governorate during 2017 and 2018 seasons.

1.4. *Tetranychus urticae*:

The population density of *T. urticae* mobile stages (adults and nymphs) on four okra cultivars during 2017 and 2018 seasons is graphically illustrated in Figure (5).Two peaks were detected for mobile stages on four tested cultivars in both growing seasons. The peaks were recorded on 23rd May and 27thJune in both seasons. In 2017 season, an additional peak was observed in 11thJuly for balady green cultivar. Our results are in partial agreement with those of Sahito *et al.* (2012), Amro *et al.* (2013) and Allam *et al.* (2014).

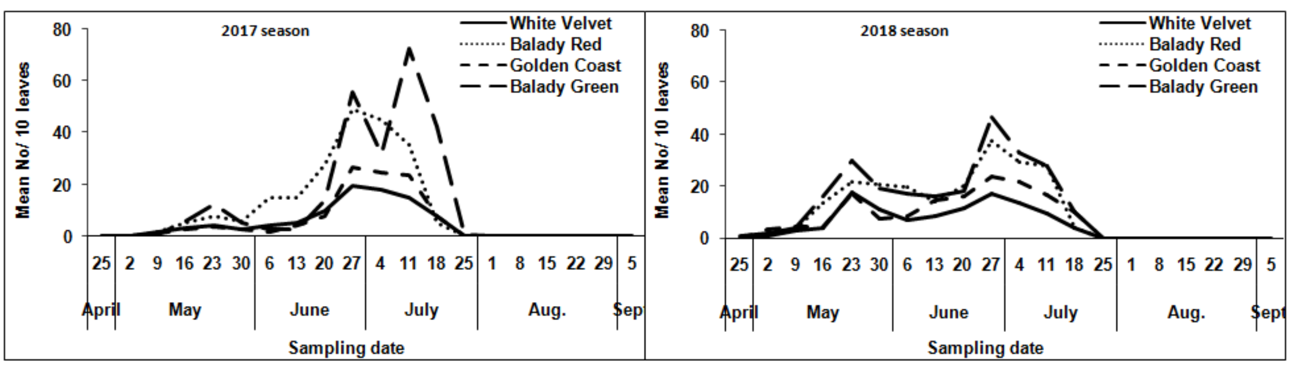

Figure (5): Population density of *Tetranychus urticae* (mobile stages) on four okra cultivars in Sohag Governorate during 2017 and 2018 seasons

According to the obtained results it can be conclude that assessment the population fluctuations of arthropod pests is the corner stone of managing insect pests associated with the crop. Determination the population fluctuation trends and peaks appearance dates of the prevalent arthropod species inhabiting okra plants was useful in pest's management in the area of study.

2. Relative susceptibility of okra cultivars to infestation with certain piercing sucking pests:

Data in Tables (1 and 2) present the susceptibility degrees of four okra cultivars to infestation with *A. gossypii*, *B. tabaci*, *E.discipiens* and *T.urticae* during 2017 and 2018 okra growing seasons.

2.1. *Aphis gossypii*:

Data presented in Table (1) revealed that *A. gossypii* was presented in so high numbers on okra leaves during 2017 growing season with an average of 278.93, 262.12 and 113.72 individuals / 10 leaves on white velvet, balady red, golden coast, respectively. Consequently these cultivars were appeared as susceptible (S) cultivars to this insect pest. It is important to note that balady green cultivars occupied the least numbers with an average of 91.02 individuals / 10 leaves and appeared as low resistant (LR) cultivar. Except of balady green cultivar which appeared as moderately resistant (MR) cultivar, similar results were recorded during the second season of study (Table, 2). It must be focusing on the presentation of *A. gossypii* at clearly low numbers on balady green cultivar which showed some sort of resistance against this destructive insect pest. Data revealed significant and high significant variations between the infestation of the tasted cultivars (F= 6.32* and 51.22**, respectively). In this approach, Abang *et al.* (2019) evaluated resistant in some okra accessions.They found that accession VI041210 was resistant to aphid infestation during the first season, while, VI057245 and gombo caféier were resistant during the second season.

2.2. *Bemisia tabaci*:

Concerning *B. tabaci*, data in Tables (1 and 2) revealed that golden coast and balady green occupied the highest numbers of its adults during 2017 and 2018 growing seasons and appeared as susceptible (S) cultivars. However, white velvet and balady red cultivars occupied lower numbers and showed some sort of resistance to *B.tabaci* adults and consequently appeared as low resistant (LR) and moderately resistant (MR) cultivars. Similar defense behavior was observed against *B.tabaci* nymphs by the golden coast and balady green okra cultivars. Significant and high significant variations between the infestations of the tasted cultivars were recorded during 2017 and 2018 growing seasons, respectively. This finding could be attributed to the antixenosis phenomenon presented by the latter cultivars toward *B.tabaci* adult's oviposition behavior and the antibiosis phenomenon against its immature stag as described by Knipling (1979). In the same approach, Chatterjee *et al.*(2019) stated that none of 15 okra genotypes were found completely free from the attack of whitefly. However, OH05 cultivar proved to be resistance against whitefly, while the variety samrat performed least.

2.3. *Empoasca discipiens*:

Although, the leafhopper *E.discipiens* was recorded in quietly low numbers on the 4 tested okra cultivars, white velvet and balady green showed some sort of resistance to this insect pest and occupied less numbers (12.30 and 12.78 individuals / 10 leaves during 2017 season and appeared as moderately resistant (MR) and low resistant (LR) cultivars, respectively. Similar results were obtained during 2018 season. Non significant and significant were recorded between the tested cultivars during 2017 and 2018 seasons, respectively (Tables, 1 and 2) . Similarly, Kadu *et al.* (2018) reported that none of the tested genotypes was found completely free from leafhopper infestation, although they significantly differed in their degree of pest number.

2.4. *Tetranychus urticae*:

The lowest mobile stages number of *T.urticae* was recorded on white velvet in both seasons, followed by golden coast in both seasons. However, the highest infestation was recorded on balady green followed by balady red. Mean numbers of 4.57, 10.57, 5.27 and 12.20 individuals/ 10 leaves were recorded on white velvet, balady red, golden coast and balady green cultivars, respectively, in 2017 season and 5.42, 10.70, 7.42 and 12.05 individuals/ 10 leaves were recorded on the previous cultivars, respectively, in 2018 season. Data revealed that the differences between four okra cultivars were high significant in both seasons. It can be note that cultivars occupied the lowest numbers appeared as moderately resistant (MR) and low resistant (LR) cultivars. However, the others appeared as susceptible (S) cultivars (Tables, 1 and 2). Allam *et al*. (2014) screened 8 okra varieties against *T. urticae*, and they found that the population of *T. urticae* varied significantly on the tested varieties. Also, the sensitivity of okra varieties varied according to months.

Except of, *A.gossypii*, white velvet okra cultivar showed some sort of resistance against *B. tabaci*, *E.discipiens* and *T.urticae*. Also, it must be shed a light on the presentation of *A. gossypii* at obvious low numbers on balady green cultivar which showed some sort of resistance against this destructive insect pest.

Table (1): Susceptibility of four okra cultivars to infestation by certain piercing sucking pests in Sohag Governorate during 2017 season.

Pest	Mean no./ 10 leaves and susceptibility degree				Mean ± SD	F. value	L.S.D. value
	White Velvet	Balady Red	Golden Coast	Balady Green			
Aphis gossypii	278.93 (**S**)	262.12 (**S**)	113.72 (**S**)	91.02 (**LR**)	186.45±847.67	6.32*	134.59
***Bemisia tabaci* adults**	15.20 (**LR**)	13.95 (**MR**)	20.00 (**S**)	19.60(**S**)	17.19±2.65	7.34*	3.91
***Bemisia tabaci* nymphs**	12.73 (**MR**)	17.75 (**LR**)	33.00 (**S**)	42.90 (**S**)	26.59±12.01	7.23*	17.86
Empoasca discipiens	12.30 (**MR**)	13.50 (**S**)	13.63(**S**)	12.78(**LR**)	13.05±0.54	2.80	N.S.
Tetranychus urticae	4.57 (**MR**)	10.57 (**S**)	5.27 (**LR**)	12.20 (**S**)	8.15±3.29	31.34*	2.35

(*): The F value is significant at $P \leq 0.05$
S=Susceptible LR= Low Resistant MR= Moderately Resistant

Table (2): Susceptibility of four okra cultivars toinfestation by certain piercing sucking pests in Sohag Governorate during 2018 season.

Pest	Mean no./ 10 leaves and susceptibility degree				Mean ± SD	F. value	L.S.D. value
	White Velvet	Balady Red	Golden Coast	Balady Green			
Aphis gossypii	195.37 (**S**)	188.02 (**S**)	87.15 (**LR**)	81.40 (**MR**)	137.99±53.81	51.22**	30.04
***Bemisia tabaci* adults**	16.37 (**LR**)	12.18 (**LR**)	23.22 (**S**)	20.17 (**S**)	17.99±4.13	14.73**	4.31
***Bemisia tabaci* nymphs**	9.80 (**MR**)	11.20 (**LR**)	28.23 (**S**)	36.78 (**S**)	21.50±11.42	120.19**	4.16
Empoasca discipiens	9.02 (**LR**)	10.90 (**S**)	10.15 (**S**)	8.35 (**LR**)	9.61±0.99	8.98*	1.32
Tetranychus urticae	5.42 (**MR**)	10.70 (**S**)	7.42 (**LR**)	12.05 (**S**)	8.89±2.62	249.34**	0.66

(*): The F value is significant at $P \leq 0.05$
S=Susceptible LR= Low Resistant MR= Moderately Resistant

3. Response of four okra cultivars to pest's infestation under sprayed and unsprayed procedures:

3.1. Fresh fruit yield characteristics:

The tested okra cultivars varied significantly under sprayed and unsprayed conditions in case of a number of fresh fruits per plant and fresh fruits yield per fedden in both seasons. It is clear that pest infestation affected on the response of okra cultivars (Table, 3). Also, the differences between sprayed and unsprayed plots were significant (Table, 4).

When plants left to natural infestation, the tested cultivars arranged into two significantly groups in both season, the highest included balady red (24.60 and 24.40 fresh fruits/ plant) and balady green (23.06

and 23.37 fresh fruits/ plant), while, the lowest one included white velvet (20.53 and 20.87 fresh fruits/ plant) and golden coast (20.47 and 20.93 fresh fruits/ plant) in the two seasons, respectively (Table, 3). Also, balady green and golden coast recorded the highest and the lowest mean number of fresh fruits/ plant, respectively under sprayed conditions in both seasons. On the other hand, balady red recorded the lowest reduction percentages, with 5.26 and 6.15% in 2017 and 2018 season, respectively, comparing with 28.50% and 31.81% in 2017 and 2018 seasons, respectively in balady green (Table, 4). Pest infestation reduced significantly number of fresh fruits per plant for all cultivars, except for balady red in 2017 season.

Golden coast recorded the highest weight of fresh fruit yield (Ton/fed.) under sprayed and unsprayed conditions in both seasons, followed insignificantly by balady green under sprayed conditions in 2017 season. However, the lowest weight of fresh fruit yield (Ton/fed.) recorded in balady green under unsprayed conditions in both seasons and in white velvet under sprayed one in both seasons, by insignificant difference with balady red in 2017 season. This behavior may due to pest infestation, balady green recorded 34.52% and 34.64% in the two seasons, respectively as the highest reduction, However, white velvet recorded 13.93% and 12.24% reduction as the lowest one in the two seasons, respectively (Table, 4).

These results were in harmony with Shannag *et al.* (2007) who demonstrated that aphid free cultivars varied considerably between each other in the number of pods and total pod weight per plant. Also, Jahangir *et al.* (2017) who tested five okra varieties against leafhopper and they found that the maximum fresh fruits yield per cultivated unit was recorded in green wonder variety (9074.997 kg/hectare) and the minimum was recorded in Sabzpari (7049.711 kg/hectare). Similarly, Rehmana *et al.* (2017) tested four okra varieties under field conditions against bollworm, whitefly and Jassid and they concluded that variety sada bahar resulted in maximum yield (1529.62 kg/ ha). Many authors found that the yield of fresh fruits increased in sprayed plots compared with infested one in regardless cultivar (Shannag *et al.*, 2007 and Samaila and Oaya, 2014).

Table (3): Number of fresh fruits per plant and fresh fruits yield per fed. of four okra cultivars under sprayed and unsprayed conditions in Sohag Governorate during 2017 and 2018 seasons.

Plant characteristics	Treatment	Season	Okra cultivars				F. value	L.S.D.
			White Velvet	Balady Red	Golden Coast	Balady Green		
No. of fresh fruits per plant	Unsprayed	2017	20.53	24.60	20.47	23.06	8.51	2.40
		2018	20.87	24.40	20.93	23.37	18.39	1.43
	Sprayed	2017	23.21	25.97	23.55	32.25	30.7	2.61
		2018	24.13	26.00	23.73	34.27	194.85	1.22
Fresh fruits yield (ton/fed.)	Unsprayed	2017	4.70	4.62	5.25	4.16	94.98	0.15
		2018	4.68	4.54	5.27	4.18	233.17	0.10
	Sprayed	2017	5.46	5.66	6.45	6.35	40.19	0.27
		2018	5.34	5.62	6.48	6.40	890.23	0.07

(*): The F value is significant at P ≤ 0.05

Table (4): Reduction percentages on number of fresh fruits per plant and fresh fruits yield per fed. of four okra cultivars caused by certain piercing sucking pests on in Sohag Governorate during 2017 and 2018 seasons.

Plant characters	Reduction%							
	2017 season				2018 season			
	White Velvet	Balady Red	Golden Coast	Balady Green	White Velvet	Balady Red	Golden Coast	Balady Green
No. fruits per plant	11.52*	5.26	13.09*	28.50*	13.54*	6.15*	11.8*	31.81*
Fresh fruits yield (ton/fed.)	13.93*	18.37*	18.56*	34.52*	12.24*	19.32*	18.77*	34.64*

(*): The difference between sprayed and unsprayed is significant at $P \leq 0.05$

3.2. Seed yield and quality characteristics:

From the data in Table (5), it is evident that the four okra cultivars varied significantly under sprayed and unsprayed conditions in case of 100- seeds weight, number of seeds per dry fruit and seed yield per fed. in both seasons, however, in case of seed weight per plant, the differences between the previous cultivars were insignificant and significant in the two seasons, respectively. Also, it is clear that the differences between sprayed and unsprayed plots were significant in both seasons (Table, 6).

The highest weight of 100-seeds was recorded in balady green in both of sprayed (6.43 and 6.25 g) and unsprayed conditions (5.60 and 5.59 g), followed insignificantly by golden coast under unsprayed conditions in both seasons and by balady red under sprayed conditions in the 2017 season. While, the lowest weight of 100-seeds was recorded in white velvet in both of sprayed (4.49 and 4.48 g) and unsprayed conditions (3.77 and 3.68 g), followed insignificantly by golden coast under unsprayed conditions in both seasons and by balady red under sprayed conditions in the 2017 season. Golden coast proved insignificant difference between sprayed and unsprayed plots for weight of 100-seeds in both seasons of the study, this cultivar received the lowest loss of 4.41% and 1.91% in the two seasons, respectively (Table, 6). However, white velvet gave the highest reduction of 15.90% and 17.78% in the two seasons, respectively.

The highest number of seeds/ dry fruit was recorded in white velvet in regardless to pest infestation conditions with 85.33 and 86.22 seeds/ dry fruit under unsprayed conditions and with 88.73 and 87.17 seeds/ dry fruit in 2017 and 2018 seasons, respectively. No significant differences were found between the last one and golden coast in the first season under unsprayed conditions and balady green in both seasons under sprayed conditions. On the other hand, balady red recorded the lowest mean numbers of 52.83 and 56.72 seeds/ dry fruit under unsprayed conditions and 71.67 and 68.40 seeds/ dry fruit under sprayed conditions in the two seasons, respectively, followed insignificantly by golden coast in 2017 season. No significant differences were found between sprayed and unsprayed plots in case of white velvet and golden coast in both seasons, the two okra cultivars recorded 3.83% and 2.59%, respectively in 2017 season and 1.09% and 1.95%, respectively, in 2018 season (Table, 6). While, balady red and balady green affected significantly by pest infestation, the previous two cultivars recorded 26.28% and 28.15%, respectively, in 2017 season and 17.08% and 28.28%, respectively, in 2018 season.

No significant differences were found between the four tested cultivars under unsprayed and sprayed condition in the first season in case of seed yield per plant. While, in the second season, golden coast recorded the highest seed yield per plant 27.97 and 27.65 g/ plant under sprayed and unsprayed conditions, respectively, followed insignificantly by balady green under sprayed. While the lowest seed yield per plant was recorded in balady red with 24.80 and 24.33 g/ plant under sprayed and unsprayed conditions, respectively, followed insignificantly by white velvet under both sprayed and unsprayed conditions, and by balady green under sprayed conditions. From t-test, it is evident that the differences between sprayed and unsprayed plots were insignificant for all cultivars for seed weight per plant in both seasons, except for balady green in 2018 season, which recorded 10.59% and 8.80% in the two seasons, respectively.

In both sprayed and unsprayed treatments, the highest seed yield per fed.was recorded in balady green with 573.90 and 573.78 kg/ fed. under sprayed and with 531.65 and 535.02 kg/ fed under unsprayed in 2017 and 2018 seasons, respectively, followed insignificantly by golden coast, except the first season of unsprayed. On the other hand, balady red recorded the lowest mean numbers of 538.19 and 538.27 kg/ fed. under sprayed and 501.67 and 511.07 kg/ fed. under unsprayed in 2017 and 2018 seasons, respectively, followed insignificantly by white velvet in both seasons. It is clear that white velvet recorded the lowest loss in seed yield (kg/fed.) with 5.54% and 4.62% in the two seasons, respectively, however, the highest one was recorded in Golden Coast with 7.3 to 8.47%.

Table (5): Seed yield and quality characteristics of four okra cultivars under sprayed and unsprayed conditions in Sohag Governorate during 2017 and 2018 seasons.

Plant characteristic	Treatment	Season	Okra cultivars				F. value	L.S.D.
			White Velvet	Balady Red	Golden Coast	Balady Green		
100 seeds weight	Unsprayed	2017	3.77	5.04	5.56	5.60	33.00*	0.51
		2018	3.68	5.05	5.48	5.59	584.27 *	0.13
	Sprayed	2017	4.49	6.00	5.82	6.43	28.71*	0.54
		2018	4.48	5.99	5.59	6.25	157.61 *	0.21
No. seeds per dry fruit	Unsprayed	2017	85.33	52.83	70.13	60.40	6.04*	19.75
		2018	86.22	56.72	70.27	60.87	322.5*	2.52
	Sprayed	2017	88.73	71.67	72.00	84.07	34.4*	5.09
		2018	87.17	68.40	71.67	84.87	116.79 *	3.00
Seed weight per plant (g)	Unsprayed	2017	24.27	22.31	25.79	24.28	1.83	N.S.
		2018	25.30	24.33	27.65	24.59	7.19*	1.95
	Sprayed	2017	26.13	26.03	27.72	27.15	0.72	N.S.
		2018	25.53	24.80	27.97	26.97	9.88*	1.57
Seed yield (kg/fed.)	Unsprayed	2017	511.29	501.67 c	522.66	531.65	6.62*	17.61
		2018	514.98	511.07 c	526.02	535.02	54.5*	5.09
	Sprayed	2017	541.28	538.19 b	571.05	573.90	61.72*	8.35
		2018	539.90	538.27 b	567.47	573.78	57.57*	8.39

(*): The F value is significant at $P \leq 0.05$

Table (6): Reduction percentages on some seed yield components of four okra cultivars caused by certain piercing sucking pests in Sohag Governorate during 2017 and 2018 seasons.

Plant characters	Reduction%							
	2017 season				2018 season			
	White Velvet	Balady Red	Golden Coast	Balady Green	White Velvet	Balady Red	Golden Coast	Balady Green
100 seeds weight	15.90*	16.06*	4.41	12.90*	17.78*	15.65*	1.91	10.51*
No. seeds per dry fruit	3.83	26.28*	2.59	28.15*	1.09	17.08*	1.95	28.28*
Seed weight per plant (g)	7.14	14.30	6.96	10.59	0.91	1.88	1.13	8.80*
Seed yield (kg/fed.)	5.54*	6.79*	8.47*	7.36*	4.62*	5.05*	7.3*	6.76*

(*): The difference between sprayed and unsprayed is significant at $P \leq 0.05$

These results are in the same line with Samaila and Oaya (2014) who reported that the dry fruit yields in the sprayed plants were significantly greater as compared to the unsprayed plants for both tall and short cultivars during the two seasons. Furthermore,Wagan *et al.* (2014) revealed that the huge application of pesticides did not improved yield of okra crop. Also, Poudel *et al.* (2018) studied the effect of different management practices on reduction in yield of five okra varieties. They stated that Julie variety can be the promising variety that showed the relatively lower yield reduction compared to other variety.

It was concluded that among the four tested cultivars none of them was found completely resistant against piercing sucking pests. Golden coast gave the highest yield fresh fruit per feddan followed by white velvet. Both cultivars received moderately levels of most tested pests. On the other hand, white velvet recorded the lowest reduction followed by golden coast. So, It can be suggest that the two previous cultivars could be successfully cultivated as a part of integrated pest management system. Furthermore, these results could be helpful for varieties screening programs.

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