Egypt. J. Plant Breed. 23(4):681– 699(2019)

SUSCEPTIBILITY OF SOME FABA BEAN GENOTYPES TO *Bean yellow mosaic virus* (BYMV) INFECTION AND THE POPULATION OF APHID VECTOR (*Aphis craccivora*)

Azza F. El-Sayed[1], I.A. El-Shami[2] and Abeer M. Abo El-Wafa[3]

1. Food Legume Res. Dep., Field Crops Res. Inst., ARC, Giza, Egypt.
2. Biological Control Res. Dep., Plant Protection Res. Inst.,ARC, Giza, Egypt.
3. Plant Virology Res. Dep., Plant Pathology Res. Inst., ARC, Giza, Egypt.

ABSTRACT

The present study aimed to evaluate the susceptibility of ten faba bean (Vicia faba L.) genotypes to infection with Bean yellow mosaic virus (BYMV) and infection with aphid vector (Aphis craccivora Koch). Six promising genotypes and four commercial cultivars were sown at EL-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Agricultural Research Center, Egypt during the seasons 2016/17 and 2017/18. The results showed that all cultivars under study could be arranged according to their susceptibility to BYMV infection and aphid infestation as follows: Sakha 4; Sakha 1, Giza 716 and Giza 843. The promising genotype X-2339 was more tolerant than Giza 843, while X-2340 was lower susceptible than Sakha 4; in the same time it had the highest mean value for most yield and yield component criteria. So these promising lines could be used in BYMV resistance breeding programs to be released as new cultivars, which possess high yield under BYMV infection. A negative correlation coefficient was found between BYMV infection percentage, disease severity and A. craccivora infestation with 50% flowering, 90% maturity, plant height (cm), first pod height (cm), yield and yield components. While the correlation coefficient between both BYMV infection and Aphid craccivora infestation was highly significant and positive.

Key words: ***Faba bean, Vicia faba, Bean yellow mosaic virus, BYMV, Aphis craccivora, susceptibility, Correlation coefficient.***

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important leguminous food crop in Egypt as in many countries that provide a major source of human food protein, in addition it has ancillary benefits to the soil and environment (Al-Antary *et al* 2007).

Several investigators recorded that diseases found on faba bean were considered the most destructive and cause considerable losses in crop yield (estimated at over 50%) (Bouhassan *et al* 2004, Awaad *et al* 2005 and El-Bramawy and Shaban 2010). Among these diseases, viral diseases can affect faba bean plants which cause significant economic losses and yield reduction (Khalil and Erskine, 2001).

Among faba bean viruses, *Bean yellow mosaic virus* (BYMV) is considered as one of the most devastating viruses affecting faba bean plants in Egypt (Khattab 2002, Salem *et al* 2004, Elbadry *et al* 2006, Radwan *et al* 2008, Soliman 2013 and Al-Habashy 2018). BYMV is an aphid transmitted virus in non-persistent mode and has a wide host range (Jones 2004 and 2005). Systemic symptoms caused by infection do not kill plants, but have the potential to spread faster and further into the crop causing greater overall yield reduction (Cheng and Jones 2002 and Sidaros *et al* 2006). In spite of the widespread distribution of (BYMV), the progress made in resistance breeding is rarely comparing to other diseases, therefore, the selection of faba bean resistant varieties for disease resistance appears to be in efficient mean of controlling (El-Bramawy and El-Beshehy 2011 and 2012).

On the other hand, several aphid species may infest faba bean, cowpea aphid (*Aphis craccivora* Kock.) is the most common which causes serious economic damages by direct feeding wherever it occurs in high population concentrated at the growing tips of plants. The main concern of aphids is their capacity to act as vectors transferring viral diseases (Smith and Bayko 2007, Soliman 2013, Aly 2014 and Al-Habashy 2018). In recent years efficient and successfully production systems have been developed for faba bean breeding, however aphid-plant relationship and cultivars susceptibility to viral diseases have been considered as subject of many researchers for developing faba bean resistance (Laamari *et al* 2008 and Potarot and Nualsri 2010).

The purpose of this study was to evaluate the susceptibility of ten faba bean genotypes to BYMV infection and population density of the aphid *A. craccivora* under field conditions.

MATERIALS AND METHODS

Experimental design and agricultural practices

Six faba bean promising genotypes along with four commercial cultivars were evaluated under field conditions at El-Gemmeiza Agricultural Research Station, ARC, Egypt during the two successive seasons 2016/2017 and 2017/2018. The pedigree of these genotypes is given in Table (1).

Table 1. The pedigree of the genotypes used in the study.

No.	Genotypes	Pedigree
1	Giza 843	(561/2076/85 SKH X 461/485/83)
2	Sakha 1	Giza 716 X 620/283/85
3	Sakha 4	Sakha 1 X Improved Giza 3
4	Giza 716	Crossing between (416/842/83 X 503/453/83)
5	X-2338	Misr 1 X Misr 3
6	X-2339	(x-1714) X Misr 3
7	X-2340	(x-1714) X Giza 40
8	X-2341	Misr 1 X Nubaria 1
9	X-2342	Misr 3 X Giza 40
10	X-2343	Nubaria 1 X Giza 40

All faba bean genotypes were sown on 15^{th} of November in both seasons seeds were planted in single seeded hills, 20 cm apart. Each genotype was presented by three rows, 3 meters long and 60 cm in between. The seeds were arranged in a randomized complete block design (RCBD) with 3 replicates. The recommended cultural practices for faba bean production were adopted; no chemical application was used to evaluate the infection without any disruption by the insecticides.

Population density of *A. craccivora*

To determine aphid population density, samples initiated after 15 days of sowing at the beginning of December in both seasons; 4 leaves were randomly taken from each replicate and every 7 days till the end of season. Samples of leaves were placed separately in completely closed plastic bags, transferred to the laboratory for further inspection and counting In each sample, aphid specimens were preserved in glass tubes (7x1 cm) containing 70% ethyl alcohol for identification. Aphid identification was carried out in Piercing and Sucking Insect Research Department, Plant Protection Research Institute, ARC, Egypt.

Percentage of BYMV infection and disease severity (under field conditions)

Percent disease incidence (PDI)

After 45 days from planting, the number of plants exhibiting with BYMV symptoms was recorded, percent disease incidence (PDI) was estimated according to Reddy *et al (*1983):

PDI = (Number of symptomatic plants /Total number of plants) x 100.

The disease severity (DS)

The disease severity and symptoms were recorded according to the following scale: - A scale of (1–4) categories was used to assess severity:
0=no symptom; 1= mottle patterns of leaves; 2= mosaic patterns of leaves; 3= mosaic and vein yellowing patterns on all leaves; 4=yellow mosaic patterns, leaf deformation and stunting on all leaves.DS % values were calculated using the following formula according to Yang *et al* (1996).

$$\textbf{Ds (\%)} = \frac{\sum \text{(Disease grade} \times \text{Number of plants in each grade)}}{\text{(Total number of plants} \times \text{Highest disease grade)}} \times 100$$

Isolation and identification of BYMV

Samples of faba bean plants exhibiting mottle, mosaic, vein yellowing and deformation were collected from some fields in Ismailia experimental Station, (ARC), farm of Faculty of Agriculture, Ismailia Governorate and El- Gemmiza experimental Station, (ARC), El-Gharbia

Governorate. These samples were checked serologically against (BYMV) and *Broad bean mottle virus* (BBMV) by using antiserum which was provided from Serology Lab, Virus Research Department, (ARC), according to the indirect ELISA test as described by Clark and Adams (1977). To virus isolation, extracted sap of infected broad bean leaves was used to inoculate the indicator host Giza 843 as systemic host and common goosefoot (*Chenopodium amaranticolor*) , which was used as a local lesion host. To obtain virus isolate in a pure form, the single local lesion technique was followed according to Kuhn (1964) in biological purification of the virus isolate, the plants were inoculated with infected juice and kept in separate cages as a source of virus infection. Chlorotic local lesion induced by BYMV on *Chenopodium amaranticolor* was back inoculated to *Vicia faba cv.* Giza 843. The inoculum was prepared from BYMV infected top faba bean leaves, ground in a mortar containing 0.1 M phosphate buffer, pH 7.0 (1: 2). The homogenate was filtrated through two layers of muslin, and the leaves of healthy plants were dusted with carborundum and rubbed gently with a cotton swab previously dipped into the suspension of virus inoculum.

Response of some faba bean genotypes to artificial infection with BYMV (under greenhouse)

A greenhouse-pot experiment was conducted to determine the response of ten genotypes of faba bean to mechanical inoculation with the tested isolated virus. It was carried out under greenhouse conditions at Ismailia Experimental Station. Ten genotypes of faba bean (Sakha 1, Sakha 4, Giza 843, Giza 716, X-2338, X-2339, X-2340, X-2341, X-2342 and X-2343) all purchased from the Egyptian Agricultural Organization, Ministry of Agriculture, Giza, Egypt. Twenty-five faba bean plants from each genotype were used for virus inoculation (5 plants/pot, 5 pots/genotype), the same number of faba bean plants from each genotype was inoculated with distilled water served as control. Seeds of all studied plants were grown in a mixed soil (clay: peat: sand 1:1:1 v/v/v), fertilized weekly and regularly irrigated. Four true leaves of faba bean seedlings were mechanically inoculated with BYMV isolate. After 10 days the inoculated and non-inoculated broad bean plants, symptoms, percentage of infection and DS% were recorded. The plants were observed and the systemically infected plants were counted until consistent numbers were reached (20-days post-inoculation).

Inoculated plants by BYMV were numbered and percentage of infection was determined as follows:

Percentage of infection = (Number of diseased plants / Total number of plants) X 100

Yield and yield components characters

Number of days from planting to flowering 50% of plants (50 % flowering), number of days from planting to maturity 90% of plants (90 % maturity) were counted. At harvest, ten plants were handled individually from each replicate and the following characters; plant height (cm), number of branches plant^{-1}, number of pods plant^{-1}, number of seeds plant^{-1}, seed yield plant^{-1} (g) and 100-seed weight (g) were recorded. The monthly maximum, minimum air temperatures and relative humidity (%) during growth period of faba bean (November- April) at El-Gemmeiza Agricultural Research Station in 2016/2017 and 2017/2018 seasons were obtained from Egyptian Meteorological Authority (Table 2).

Table 2. Monthly maximum and minimum air temperatures and relative humidity% at El-Gemmeiza Agric. Res. Stat. in 2016/2017 and 2017/2018 seasons

Month	2016/2017				2017/2018			
	Relative humidity%	Temperature °C			Relative humidity%	Temperature C°		
		Min	Max	Mean		Min	Max	Mean
November	60.37	13.69	25.91	19.8	61.99	12.53	24.70	18.62
December	70.83	7.58	18.41	12.99	68.02	10.42	21.24	15.83
January	67.94	5.89	17.79	11.82	67.93	8.86	19.73	14.30
February	62.55	6.18	20.37	13.28	60.49	10.26	23.15	16.71
March	51.30	10.39	24.80	17.60	44.19	12.08	29.27	20.68
April	45.62	12.34	28.82	20.58	43.42	14.18	31.39	22.79

Statistical analysis

The recorded data were subjected to analysis of variance, differences among means were identified using Fisher's Least Significant Difference (LSD) test at the 0.05 probability level. Correlation coefficient was calculated between *Aphis craccivora* infection/leaf, percentage % and disease severity of BYMV infection with yield and yield components criteria according to Gomes and Gomes (1984).

RESULTS AND DISCUSSION

Agronomic and yield traits

The mean performance of 50% flowering, 90% maturity, plant height (cm) and first pod height (cm) for faba bean genotypes in both seasons is presented in Table (3).

Table 3. Mean performance of 50% flowering, 90% maturity, plant height and first pod height for faba bean genotypes in the first (1st) and second (2nd) seasons.

Genotypes	50% flowering		90% maturity		Plant height (cm)		First pod height (cm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Giza 843	54.67	49.33	161.67	128.00	102.67	73.67	22.00	23.33
Sakha 1	49.33	46.67	158.67	123.00	85.57	60.33	16.28	20.00
Sakha 4	56.67	48.00	161.33	134.33	91.67	77.33	18.67	23.00
Giza 716	59.00	50.00	162.67	133.67	95.00	71.67	19.67	22.33
L.S.D 0.05	2.56	2.42	2.51	N.S	N.S	N.S	N.S	N.S
X-2338	50.00	46.00	160.67	125.00	90.33	70.67	18.33	18.67
X-2339	58.67	51.33	162.67	127.67	90.00	76.33	21.93	26.00
X-2340	55.33	48.00	161.33	130.00	103.00	83.67	22.00	21.33
X-2341	54.33	48.67	162.67	129.00	86.33	69.00	18.00	21.33
X-2342	55.00	47.00	163.00	131.33	90.33	80.33	20.33	25.00
X-2343	53.33	47.67	162.67	125.33	101.67	70.67	18.67	25.33
General L.S.D 0.05	3.58	1.95	1.84	N.S	10.85	12.15	N.S	3.40
C.V %	3.82	2.36	0.66	3.80	6.75	9.66	20.73	8.75

N.S. = Not significant

No significant differences between chick cultivars, lines and all genotypes under study were found at 90% maturity in the second season and first pod height (cm) in the first season, meanwhile in the second season there was no significant differences between both chick cultivars and lines but there were significant differences among all genotypes under study. Plant height (cm) character showed no significant differences between chick cultivars only in both seasons, meanwhile 90% maturity character in the first season had no significant differences between lines only. Sakha 1 cultivar was the earliest genotype for maturity (158.67, 123.00 days) and the shortest genotype (85.57, 60.33 cm) in both seasons, respectively, but it had the earliest genotype for flowering (49.33 days) and the lowest first pod height (16.28 cm) in the first season only.

The mean performance of yield and yield components for faba bean genotypes in both seasons (Table 4) indicates that in the first season, No. of branches plant^{-1} had no significant differences between chick cultivars, lines and all genotypes, No. of pods plant^{-1} recorded no significant differences between both chick cultivars and lines and seed yield plant^{-1} (g) had no significant differences between chick cultivars only. Meanwhile in the second season all criteria had significant and highly significant differences between chick cultivars, lines and all genotypes under study.

Table 4. Mean performance of yield and yield component traits for faba bean genotypes in both seasons.

Genotype	No. of branches plant^{-1}		No. of pods plant^{-1}		No. of seeds plant^{-1}		Seed yield plant^{-1} (g)		100-seed weight (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Giza 843	6.07	3.60	28.93	13.00	100.53	32.47	83.00	20.92	82.55	64.45
Sakha 1	5.09	2.80	42.00	8.20	94.67	18.47	77.77	16.97	82.13	91.87
Sakha 4	6.00	2.40	34.80	14.33	89.20	29.93	88.27	23.23	98.85	77.54
Giza 716	5.80	3.13	42.67	13.47	106.27	31.80	88.67	22.98	83.35	72.17
L.S.D 0.05	N.S	0.30	N.S	3.32	6.30	3.87	N.S	3.85	9.60	5.18
X-2338	5.73	2.80	62.27	15.33	122.73	34.20	94.13	20.04	76.69	58.72
X-2339	6.20	2.80	48.87	13.93	117.60	32.00	108.40	19.96	92.22	62.44
X-2340	8.60	4.00	62.33	20.33	122.93	30.00	122.00	27.85	96.26	92.89
X-2341	6.60	2.93	49.67	13.60	120.37	33.93	104.00	24.92	86.48	73.43
X-2342	7.20	2.80	53.67	14.80	152.00	31.20	118.80	19.73	78.15	63.15
X-2343	6.47	3.07	58.13	15.13	102.73	27.53	95.80	19.03	93.38	69.07
General LSD 0.05	N.S	0.29	12.29	2.76	7.04	3.12	8.03	2.65	6.51	4.11
CV %	19.93	5.64	14.82	11.33	3.64	6.03	4.77	7.16	4.36	3.30

N.S. = Not significant

In general, all lines under study recorded higher mean value than all commercial cultivars for No. of pods plant^{-1} and seed yield plant^{-1} (g); ranges were (48.87: 62.33) and (94.13: 122.93 g), respectively for lines, while they ranges were (28.93: 42.67) and (77.77: 88.67 g) among checks. In the other criteria one line or more had mean value higher than all chick cultivars under study. The 90% maturity, plant height, yield and yield component traits had severe reduction in the second season as compared to the first season; this reduction is due to the increasing of maximum and minimum air temperatures (Table 2). These results are in agreement with Mittler, *et al* (2012), Siddiqui *et al* (2015) and Bishop *et al* (2016).

X-2340 genotype was a remarkable line because it had the highest mean value for plant height (cm) (103.00, 83.67 cm) in both seasons, respectively as well as yield and yield component characters, except No. of seeds plant^{-1} (122.93, 30.00) in both seasons and 100-seed weight (96.26m g) in the first season as compared to all genotypes under study. X-2338 genotype recorded high mean performance for No. of pods plant^{-1} (62.27, 15.33) in both seasons, respectively and the highest mean value for No. of seeds plant^{-1} (34.20) in the second season as compared to other genotypes. X-2342 genotype in the first season possessed high mean value for No. of branches plant^{-1} and seed yield plant^{-1} (7.20, 118.80 g), respectively and the highest mean value for No. of seeds plant^{-1} (152.00). Meanwhile, X-2339 genotype recorded higher mean value than chick cultivars for all yield and yield components in the first season only, except 100-seed weight; in the same time it possessed medium mean value for all yield and yield components in both seasons as compared to other promising lines in this study.

Giza 843 chick cultivar had higher mean value than other chick cultivars for No. of branches plant^{-1} (6.07, 3.60) in both seasons, respectively and no. of seeds plant^{-1} ((32.47) in the second season only, Meanwhile, Giza 716 cultivar had the highest mean value for No. of pods plant^{-1} (42.67), No. of seeds plant^{-1} (106.27) and seed yield plant^{-1} (88.67 g) in the first season. Sakha 4 cultivar possessed the highest mean value for No. of pods plant^{-1} (14.33) and seed yield plant^{-1} (23.23 g) in the second season as well as 100-seed weight (98.85 g) in the first season.

Rizk (2011) estimated the susceptibility of five faba bean cultivars (Giza 3 improve, Giza 843, Sakha-1, Nubaria 1 and Misr 2) to the aphid infestation and found that Nubaria 1and Giza 843 recorded the highest mean value of seed yield /plant and per feddan.

Evaluation of *A. craccivora* infestation

Mean performance of the aphid *A. craccivora* infestation/leaf of ten faba bean genotypes for fifth weeks from first week of December to the first week of January in both seasons is presented in Table (5). No significant differences were found between chick cultivars in the first and second weeks in the first season and in the fifth week in the second season, while there were significant differences between all lines in both seasons for all weeks. In general, the population density was higher in the first season than the second one and significant differences between genotypes were detected in each of the two seasons under natural infestation in field.

Giza 843 commercial cultivar recorded the lowest mean number of aphid individuals/leaf (6.68, 2.20) in both seasons, respectively and possessed a low mean value over both seasons together (3.32) as comparing to the other chick cultivars, meanwhile Sakha 4 cultivar had the highest mean number of aphids/ leaf (11.42, 6.52) in both seasons, respectively and possessed a high mean value over both seasons together (6.56).

Table 5. Population density of A. craccivora/one leaf on ten faba bean genotypes during two seasons 2016/17 and 2017/18 in El-Gharbia Governorate.

Genotype / Date of inspection	First season						General mean
	1st week	2nd week	3rd week	4th week	5th week	Mean	
Giza 843	9.08	13.58	8.25	2.5	0	6.68	3.32
Sakha 1	10.25	18.25	10.75	4.58	0.83	8.93	4.75
Sakha 4	10.75	20.92	15.08	6.25	4.08	11.42	6.56
Giza 716	9.92	14.67	10.08	2.58	0	7.45	4.21
L.S.D 0.05	N.S	N.S	1.63	1.40	0.22	-	-
X-2338	6.67	16.42	8.42	3.83	0	7.07	5.12
X-2339	5.42	10.08	6.25	0.83	0.33	4.58	2.54
X-2340	19.75	21.33	9.83	0.92	0	10.37	6.42
X-2341	9.83	26.25	12.67	8.67	1.25	11.73	5.57
X-2342	12	10.67	11.25	4.58	0.17	7.73	4.37
X-2343	12.92	21.08	9.08	8.67	0	10.35	5.78
General L.S.D 0.05	3.73	6.52	1.33	1.31	0.20	-	-
C.V %	18.73	20.77	7.05	14.98	7.09	-	-
Genotype / Date of inspection	Second season						General mean
	1st week	2nd week	3rd week	4th week	5th week	Mean	
Giza 843	0.92	4.83	4.75	0.50	0.00	2.20	3.32
Sakha 1	3.33	14.33	6.58	2.33	0.50	5.41	4.75
Sakha 4	4.25	15.25	7.83	4.75	0.50	6.52	6.56
Giza 716	1.58	6.00	6.50	0.83	0.00	2.98	4.21
L.S.D 0.05	1.20	4.34	0.84	0.33	N.S	-	-
X-2338	2.08	12.33	6.83	1.25	0.33	4.56	5.12
X-2339	0.17	3.17	5.75	0.92	0.08	2.05	2.54
X-2340	3.75	16.67	7.00	2.33	0.05	5.95	6.42
X-2341	2.50	9.17	10.25	1.42	0.27	4.68	5.57
X-2342	2.08	9.58	6.33	0.75	0.33	3.81	4.37
X-2343	2.67	8.33	11.58	1.08	0.00	4.73	5.78
General L.S.D 0.05	0.94	4.17	0.78	0.25	0.05	-	-
C.V %	15.69	21.43	6.24	6.26	6.16	-	-

*** This trait was transformed according to X+1**

Sakha 1 showed mean number of aphid individuals/leaf (8.93, 5.41) lower than Sakha 4, followed by Giza 716 which recorded mean number of aphid individuals/leaf (7.45, 2.98) in both seasons, respectively. From these data we can conclude that Sakha 1 and Giza 716 had higher susceptibility to aphid infestation than Giza 843 these results are in harmony with those found by Ebadah *et al* (2006) and Rizk (2011).

X-2339 possessed the lowest mean No. of aphid individuals/ leaf as compared to all genotypes under study (4.58, 2.05) in both seasons, respectively. X-2340 showed the highest mean no. of aphids across both seasons (6.42) as compared to other promising lines, but it showed lower mean than Sakha 4.

The population of *A. craccivora* appeared on faba bean genotypes at the 1st week of December (after 15 days of sowing) with chick cultivar numbers which considered as the first peak of populations in both seasons. These results were in agreement with Mahmoud *et al* (2015). On the other hand, the population of aphid increased in the second week of December in both seasons for Giza 843, Sakha 1, Sakha 4, X-2338, X-2339 and X-2340 genotypes in both seasons. The same results were found by Gameel (2014) who reported that the population of *A. craccivora* reached to the maximum peak during the second week of December in the late sowing date under the New valley conditions. The population density of *A. craccivora* declined gradually from the third week of December and almost disappeared in the first week of January. Ali and Rizk (1980) under the New Valley conditions reported that the population density of *A. craccivora* began to appear in the field with the beginning of the vegetative stage and reached its maximum during the pod developmental stage and diminished during the harvest stage.

Response of faba bean genotypes to infection with BYMV

All inoculated faba bean genotypes were found to be susceptible to BYMV infection as shown in Table 6 and Figs. 1 and 2. Symptoms started to appear 12-15 days after inoculation on cv. Giza 843 with BYMV, where vein-yellowing followed by mottle. The susceptible cultivars Giza 843 and Giza 716 were used earlier as indicator host for BBMV by Sallam *et al* (2013) and Khattab *et al* (2014).

This virus was isolated in previous studies from faba bean, by other investigators in different countries. (Hemida 2005; Mahdy *et al* 2007; El-Bramawy and El-Beshehy 2011 and 2012; Hosseini and Hosseini 2014; Sofy *et al* 2014 and Farag *et al* 2015).

Table 6. Mean performance of percentage of infection% and disease severity (DS%) with BYMV for faba bean genotypes under natural and artificial infection.

Genotypes	Natural infection			Artificial infection		
	Symptoms	Percentage of disease incidence%	Percentage of disease severity (DS%).	Symptoms	Percentage of infection%	Percentage of disease severity (DS%).
Giza 843	MO	41.74	23.09	MO	38.20	17.98
Sakha 1	MO - VY	61.08	39.43	MO - VY	66.60	26.26
Sakha 4	MO - D	73.26	41.52	M - D	71.28	28.59
Giza 716	MO - VY	57.23	40.73	MO - VY	58.66	27.21
L.S.D 0.05	-	11.50	8.41	-	12.63	7.06
X-2338	MO	59.53	40.81	MO	67.66	27.65
X-2339	MO - VY	50.64	23.43	MO - VY	48.33	23.20
X-2340	MO - VY - D	82.59	63.05	M - VY - D	80.41	40.73
X-2341	MO - VY	63.70	24.52	MO - VY	65.02	25.27
X-2342	MO - VY	65.88	37.49	MO - VY	75.36	34.33
X-2343	MO - VY	78.57	53.51	M	76.70	36.10
General L.S.D 0.05	-	12.30	9.13	-	9.82	5.51
CV%	-	6.08	8.21	-	4.38	5.41

*** These traits were transformed according to $\sqrt{X}$**

*** MO: Mottle, VY: Vein Yellowing, D: Deformation, M: Mosaic**

The results showed that chick cultivar Sakha 4 revealed highest percentage of natural and artificial infection (71.5%) and (71.28%) respectively. On the contrary, the lowest percentage of natural and artificial infection was obtained by chick cultivar Giza 843 (41.74%) and (38.2%) respectively .While X-2340 revealed highest percentage of natural and artificial infection (82.59%) and (80.41%) respectively. On the contrary, the lowest percentage of natural and artificial infection was obtained by X-2339 (50.64%) and (48.33%) respectively .On the other hand, the chick cultivar Sakha 4 revealed the highest value of DS % in natural and artificial infection (41.52%) and (28.59%) respectively.

On the contrary, the lowest value of DS % in natural and artificial infection was obtained by chick cultivar Giza 843 (23.09%) and (17.98%) respectively. While X-2340 revealed highest value of DS% in natural and artificial infection (63.05%) and (40.73%) respectively. On the contrary, the lowest value of DS % in natural and artificial infection was obtained by X-2339 (23.43%) and (23.20%) respectively. The cultivar Sakha1 was detected before as a susceptible one in previous work by El-Bramawy and El-Beshehy (2011).

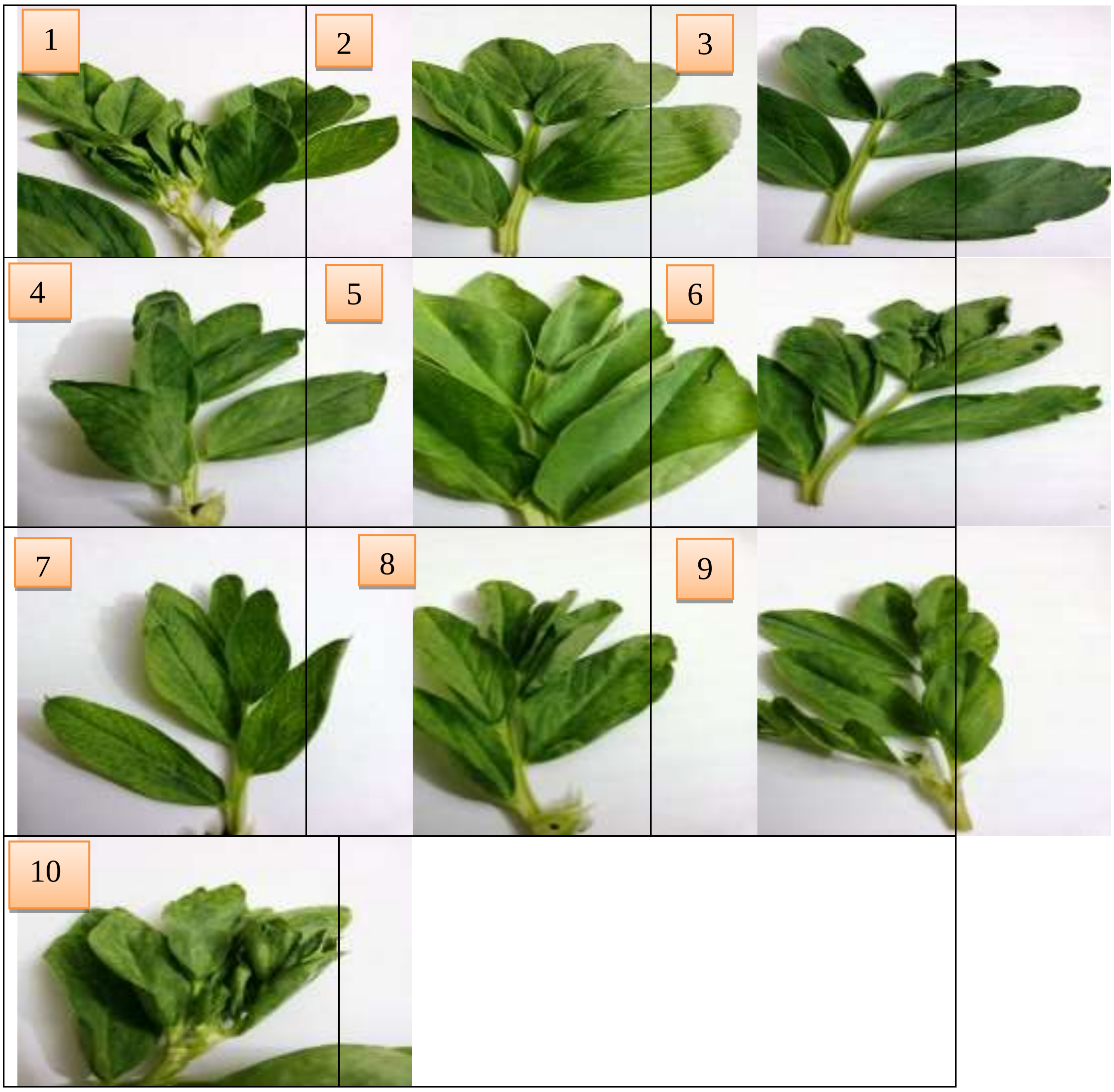

Fig. 1. Naturally infected faba bean plants 1- Giza 843 cv. showing mottle, 2- Sakha 1 cv. Showing mottle and vein yellowing, 3- Sakha 4 cv. showing mottle and deformation, 4- Giza 716 cv. showing mottle and vein yellowing, 5- X-2338 genotype showing mottle, 6- X-2339 showing mottle and vein yellowing, 7- X-2340 genotype showing mottle, vein yellowing and deformation, 8- X-2341 showing mottle and vein yellowing, 9- X-2342 showing mottle and vein yellowing, 10- X-2343 genotype showing mottle and vein yellowing.

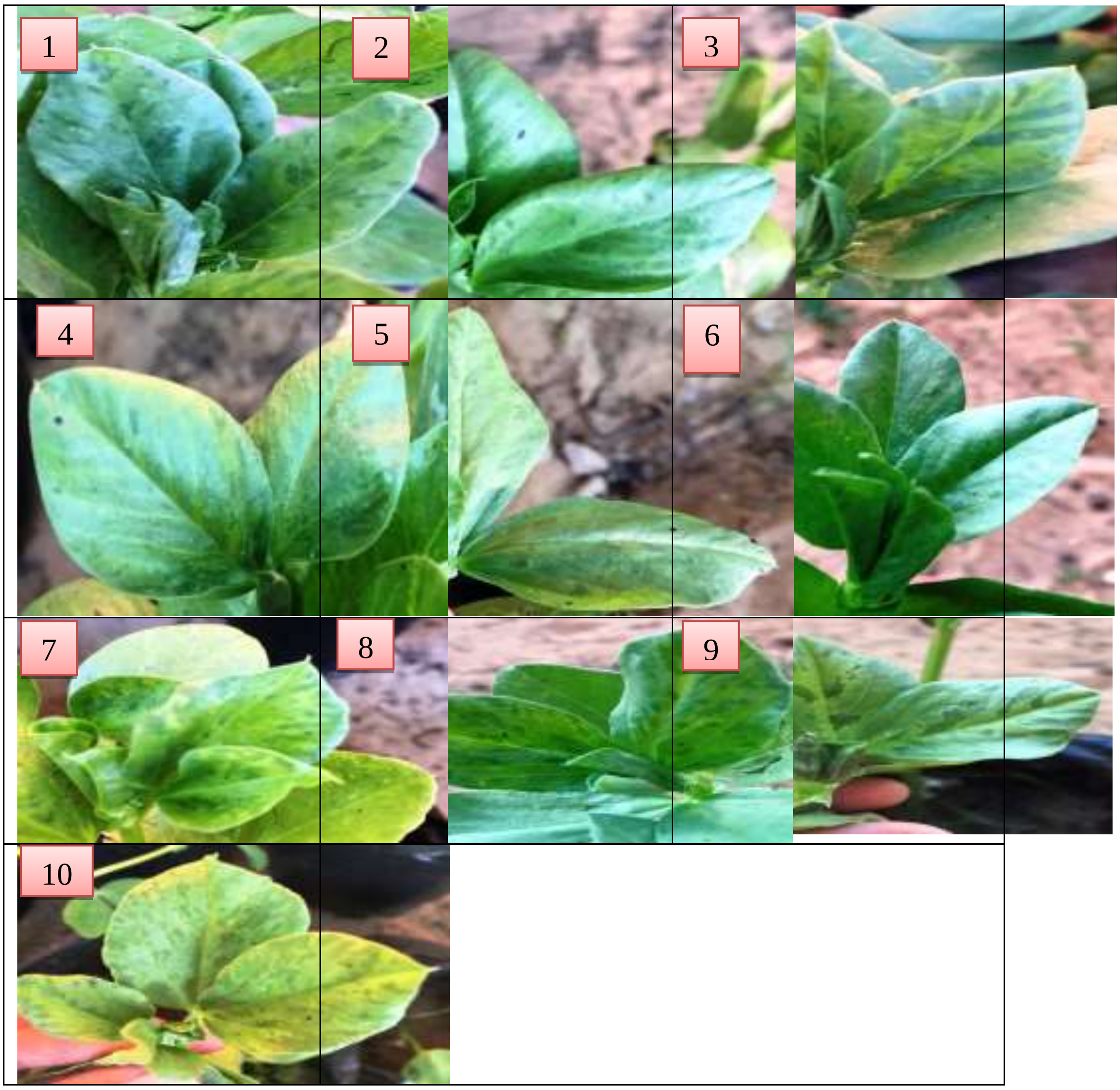

Fig. 2. Symptoms caused by BYMV on faba bean genotype 1- Giza 843 cv. showing mottle, 2- Sakha 1 cv. Showing mottle and vein yellowing, 3- Sakha 4 cv. showing mosaic and deformation, 4- Giza 716 cv. mottle and vein clearing, 5- X-2338 genotype showing mottle, 6- X-2339 showing mottle and vein yellowing, 7- X-2340 genotype showing mosaic and vein yellowing and deformation, 8- X-2341 showing mottle and vein yellowing, 9- X-2342 showing mottle and vein yellowing, 10- X-2342 genotype showing mosaic.

Ninty lines and cultivars of *Vicia faba* were exposed to infection with a locally occurring Egyptian strain of BYMV and only five proved resistant Tolba (1980).

From data presented in Tables (4, 5 and 6) we can arrange all cultivars under study according to their susceptibility to aphid's infestation and BYMV infection as follows: Sakha 4, Sakha 1, Giza 716 and Giza 843. X-2339 promising line was more tolerant than Giza 843 and X-2340 was lower susceptible than Sakha 4; in the same time it had the highest mean value for most yield and yield component criteria. So these promising lines could be used in BYMV resistance breeding programs to be released as new cultivars, which possess high yielding under BYMV infection.

Relationships between *A. craccivora* infestation and BYMV infection with yield and yield components

Correlation coefficient (r) between *A. craccivora* infestation, percentage of BYMV infection%, disease severity with yield and yield components (Table 7) showed that there was a negative relationship between 50% flowering, 90% maturity, plant height , first pod height, yield and yield components with *A. craccivora* infestation, percentage of BYMV infection% and disease severity. *A. craccivora* infestation recorded the highest and highly significant r value (-0.92^{**}) with height of first pod followed by days to flowering 50% of plants (-0.86^{**}) then No. of seeds/plant (-0.79^{**}), while it recorded a significant and negative relationship with both height of plant (-0.67^{*}) and seed yield/plant (-0.63^{*}). These results are in agreement with Rizk (2011), who found a significant and negative correlation (-0.92) between seed yield/plant and mean number of aphids/plant.

On the other hand the percentage of infection with BYMV % recorded highly significant and negative correlation (-0.76^{**}) with No. of seeds/plant. Severity of disease also had a significant and negative relationship (-0.69^{*}) with height of first pod.

It became clearly that infestation with *A. craccivora* or infection with BYMV causes a sever reduction in faba bean seed yield; the same result was reported by Mahdy *et al*(2007), Kumari and Van leur (2011), Rizk (2011), El-Bramawy and El-Beshehy (2011 and 2012) and El-Ammari *et al* (2015).

The correlation coefficient between both *A. craccivora* infestation and BYMV infection was highly significant and positive (0.79^{**}). This confirms that aphids act as vectors to virus diseases. Also there was a highly significant and positive correlation (0.85**) between disease severity and percentage of infection%, meanwhile there was non-significant and negative relationships between severity with yield and yield components except first pod height (-0.69*).

Table 7. Correlation coefficients between *aphis craccivora* infestation and bean yellow mosaic virus (BYMV) infection with yield and yield components for faba bean genotypes.

Trait	*A. craccivora* infestation	Percentage of BYMV infection%	Disease severity
50 % flowering	- 0.86**	- 0.50	- 0.37
90 % maturity	- 0.61	- 0.52	- 0.24
Plant height (cm)	- 0.67*	- 0.44	- 0.30
First pod height (cm)	- 0.92**	- 0.38	- 0.69*
No. of branches/plant	- 0.04	- 0.46	- 0.29
No. of pods/plant	- 0.33	- 0.61	- 0.10
No. of seeds/plant	- 0.79**	- 0.76**	- 0.60
Seed yield/plant (g)	- 0.63*	- 0.56	- 0.47
100-seed weight (g)	- 0.21	- 0.17	- 0.28
Disease severity	0.54	0.85**	-
Percentage of BYMV infection%	0.79**	-	-

*** = significant at 0.05, ** = significant at 0.01 probability level.**

REFERENCES

Al-Antary, T., M. Ateyyat and T. Thalji (2007). Effect of eight cultivars of faba bean, *Vicia faba* L., on the black bean aphid, *Aphis fabae* Scopoli (Homoptera: Aphididae), in the field. Agriculture Sciences, 34(1 and 2): 34-38.

Al-Habshy, Z. N. Aml (2018). Cowpea aphid *Aphis craccivora* Koch as insect vector of Faba Bean Necrotic Yellow Virus (FBNYV) on broad bean plants. J. Plant Prot. and Path., Mansoura Univ. 9 (1): 31 – 33**.**

Ali, A.M. and M.M. Rizk (1980). Population studies on certain pest infesting broad bean and the associated natural enemies in the New Valley. Egypt. Assiut. J. Agric. Sci. 11:117-125.

Aly, A. A. (2014). Toxicity and persistence of selected neonicotinoid insecticides on cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae). Archives of Phytopathology and Plant Protection 47: 366-376

Awaad, H.A., A.H. Salem, A.M. Mohsen, M.M. Atia, E.E. Hassan, M.I. Amer and A.M. Moursi (2005). Assessment of some genetic parameters for resistance to leaf miner, chocolate, rust and yield of faba bean in F_3 and F_4 generations. Egypt J. Plant Breed. 9 (1): 1-15.

Bishop, J., S.G Potts and H.E. Jones (2016). Susceptibility of faba bean (*Vicia faba* L.) to heat stress during floral development and anthesis. Journal of Agronomy and Crop Science, 202: 508–517.

Bouhassan, A., M. Sadiki and B. Tivoli (2004). Evaluation of a collection of faba bean (*Vicia faba* L.) genotypes originating from the Maghreb for resistance to chocolate spot (*Botrytis fabae*) by assessment in the field and laboratory. Euphytica 135: 55–62.

Cheng, Y. and R.A.C. Jones (2002).Deploying strain specific hypersensitive resistance to diminish temporal virus spread. Ann Appl Biol. 140:69 –79.

Clark, M.F. and A.N. Adams (1977). Characteristics of the microplate method of enzyme linked immune sorbent assay for the detection of plant viruses. J. of Gen. Virology 34: 475-483.

Ebadah, I.M.A., Y.A. Mahmoud and S.S. Moawad (2006). Susceptibility of some faba bean cultivars to field infestation with some insect pests. Res. J. Agric. and Biol. Sc. 2(6): 537-540.

El-Ammari, A.S., O.M. El-Sanousi and F.S. El-Mesmari (2015). Effect of BYMV on faba bean productivity in Libya. International Scholarly and Scientific Research and Innovation 9(10) page 200.

El-Badry, M., R.M. Taha, K.A. El-Dougdoug and H. Gamal-Eldin (2006). Induction of systemic resistance in faba bean (*Vicia faba* L.) to bean yellow mosaic potyvirus (BYMV) via seed bacterization with plant growth promoting Rhizobacteria. J. Plant Dis. Prot. 113 (6):247–251.

El-Bramawy, M.A.S.A. and E.K.F. El-Beshehy (2011). The resistance of Bean Yellow Mosaic Virus (BYMV) in faba bean *(Vicia faba* L.) with diallel analysis. Journal of Biology and Life Science 2(1):1-15.

El-Bramawy, M. A.S.A. and E. K. F. El-Beshehy (2012). Inheritance of resistance to Bean Yellow Mosaic Virus in faba bean plants. International Journal of Virology 8(1): 98-105.

El-Bramawy, M.A.S.A. and W.I. Shaban (2010). Effects of potassium fertilization on agronomic characters and resistance to chocolate spot and rust diseases in faba bean. Tunisian Journal of Plant Protection; 5(2): 131-150.

Farag,A.G , E.A. Khattab and I.M. Al-Shamrany (2015). Nucleotide Sequence of Capsid Protein Gene of *Bean yellow mosaic potyvirus* in Bean Plants from Al Makhwah Governorate, Saudi Arabia. International Journal of Virology 11 (2): 41-53.

Gameel, S.M.M. (2014). Effect of planting date on seasonal abundance of the *Aphis craccivora* Koch and the associated predators in the new Valley-Egypt. Egypt Acad. 7 (2): 97-103.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. 2 Ed. John Wiley and Sons, New York.

Hemida ,S. K. H.(2005). Effect of *Bean Yellow Mosaic Virus* on Physiological Parameters of *Vicia faba* and *Phaseolus vulgaris*. International journal of agriculture and biology 7 (2): 154–157.

Hosseini,A. and S. Hosseini (2014). Occurrence and Distribution of *Bean common mosaic virus* and *Bean yellow mosaic virus* from common bean fields of Kerman province, Iran. Indian Journal of Fundamental and Applied Life Sciences, 4 (2): 528 -535.

Jones, R. A .C. (2005). Aphid-borne viruses in lupin stands under four different Patterns of spread of two non-persistently infection scenarios. Annals of Applied Biology 146:337- 357.

Jones, R.A.C. (2004). Using epidemiological information to develop effective integrated virus disease management strategies. Virus Res.100:5–30**.**

Khalil, S.A. and W. Erskine (2001). Combating disease problems of grain legumes in Egypt. Grain Legumes; a32 (2): 24-26.

Khattab, A. H. Eman (2002). Recent techniques to study some broad bean viral diseases. Ph. D Thesis, Fac. of Agricuture. Zagazig University, Egypt.

Khattab , A.H. Eman, A.H. Ebrahem, Om-Hasheim M. El-Banna and Hanan F. EL-Kammar (2014). Polyclonal antibodies production against *Broad bean mottle virus* affecting faba bean (*Vicia faba* L.) plants in Egypt. Egyptian J. Virol. 11 (2): 184-199

Kuhn, C.W. (1964). Separation of cowpea virus mixtures. Pytopathology 54:739-740.

Kumari, S. G and J. A. G Van Leur (2011). Viral diseases infecting faba bean (*Vicia faba* L.). Grain Legumes (56): 24-26.

Laamari, M., L. Khelfa and A. Coeur d̓Acier (2008). Resistance source to cowpea aphid (*Aphis craccivora* Koch) in Algerian landrace collection. African Journal of Biotechnology 7(14): 2486-2490.

Mahdy, A.M.M., R.N. Fawzy, M.A. Hafez, Hanan A.N. Mohamed and Eman, S.E. Shahwan (2007). Inducing systemic resistance against *Bean Yellow Mosaic Potyvirus* using botanical extracts. Egyptian J. Virol. 4: 223-241.

Mahmoud, M. A., K. A. El-Khawass, S.A. Hammad and M. I. Ali (2015). Susceptibility of three faba bean cultivars to field infestation with legume aphids *Aphis craccivora* Koch (Homoptera: Aphididae).International Journal of Environment 4(1):116-120.

Mittler, R., A.Finka and P. Goloubinoff (2012). How do plants feel the heat? Trends Biochem. Sci. 37 (3): 118–125.

Potarot, S. and C. Nualsri (2010). Inheritance of resistance to cowpea aphid (*Aphis craccivora* Koch.) in IT82E-16. Proceedings of the 7th IMT-GT UNINET and the 3rd International PSU-UNS Conferences on Bioscience: 7-8 October, Prince of Songkla University, Hat Yai, Songkla, Thailand.35-39.

Radwan, D. E. M., G LU , K. A. Fayez, S.Y. Mahmoud and A. Hamad (2008). Protective action of salicylic acid against bean yellow mosaic virus infection in *Vicia faba* leaves. Journal of Plant Physiology 165: 845-857.

Reddy, D.V.R., P.W. Amin, D. Mcdonald and A.M. Ghanekar (1983). Epidemiology and control of groundnut bud necrosis and other diseases of legume crops in India caused by *Tomato spotted wilt virus*. Pages 93-102 in Plant virus epidemiology (Plumb, R.T., and Thresh, J.M., eds.). Oxford, UK: Blackwell Scientific Publications.

Rizk, M. Amany (2011).Effect of strip-management on the population of the aphid, *Aphis craccivora* Koch and its associated predators by intercropping faba bean, *Vicia faba* L. with coriander, *Coriandrum sativum* L. Egyptian Journal of Biological Pest Control 21(1): 81-87.

Salem, N., A. Mansour , T. Al-Antary and A. Al-Nsour (2004). Faba Bean Necrotic Yellows Virus: virus vector relationships and effect of inoculation stage on yield components in faba bean. Dirasat Agric. Sc. 31(1): 12-20.

Sallam, A. A .A, E. K .F. Elbeshehy, Hoda M.A. Waziri, Samia I. Massoud and Abeer M. Abo El-Wafa.(2013). Pathological and antiviral studies on *Broad bean mottle virus* affecting Faba bean plants in Ismailia Governorate . Egyptian Journal of Virology 10:124-142.

Sidaros, S. A., S. A. El-kewey, Eman A. H. Khatab and M. M. El-Sharkawy (2006). Purification, serology and prevalence of *Broad bean stain comovirus* (BBSV) and *Cowpea aphid borne mosaic Potyvirus* (CABMV). Egyptian J. Virol. 3(1), 71-88.

Siddiqui, M. H., M. Y. Al- Mohammed, A. Al-Qutam , M. H. Al-Whaibi, A. Grover, H. M. Ali and Mona S. Al-Wahibi (2015). Morphological and physiological characterization of different genotypes of faba bean under heat stress. Saudi Journal of Biological Sciences 22: 656–663.

Smith, C., and E. Boyko (2007). The molecular bases of plant resistance and defense responses to aphid feeding: current status. *Entomol. Exp. Appl*. 122: 1–16.

Sofy ,A. R., M.S. Attia, M.A. Sharaf and K. A. El-Dougdoug (2014). *Bean yellow mosaic potyvirus* potential on nodulation and N2-fixation of faba bean plants. New York Science Journal 7(9): 101-109.

Soliman, M. M. (2013). Avoidance of black bean aphids, the vector of necrotic yellow virus (FBNYV) to faba bean plants - middle Egypt: An Overview. Global Journal of Plant Ecophysiology 3(2): 74-82.

Tolba, M.A. (1980): A note on Bean yellow mosaic and other viruses in Egypt. Faba Bean Information Service Newsletter, No. 2, pp. 42.

Yang, X., K. Llangyi and P. Tien (1996). Resistance of tomato infected with *cucumber mosaic virus* satellite RNA to potato spindle tuber viroid. Ann Appl Biol. 129 (3): 543–551.

حساسية بعض التراكيب الوراثية من الفول البلدى للاصابة بفيروس الموزايك الأصفر وحشرة من اللوبيا السوداء

عزه فتحى السيد[١]، ابراهيم ابو المعاطى الشامى[٢] و عبير محمد ابوالوفا[٣]

١. قسم بحوث المحاصيل البقولية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية.
٢. قسم بحوث المكافحة الحيوية – معهد بحوث وقاية النباتات – مركز البحوث الزراعية.
٣. قسم الفيروس و الفيتوبلازما – معهد بحوث امراض النباتات – مركز البحوث الزراعية.

تهدف هذه الدراسة لتقييم حساسية عشرة تراكيب وراثية من الفول البلدى للإصابة بفيروس الموزايك الاصفر والإصابة بمن اللوبيا السوداء . تم زراعة ست سلالات وأربعة أصناف محلية من الفول البلدى خلال الموسمين الزراعيين ٢٠١٦/ ١٧ و٢٠١٧/ ١٨بمحطة بحوث الجميزه – محافظه الغربية. أوضحت النتائج أنه يمكن ترتيب جميع الأصناف المستخدمة فى هذه الدراسة تبعا لحساسيتها للإصابة بكلا من فيروس الموزايك الاصفر وحشرة مناللوبيا السوداء كما يلى : سخا ٤، سخا ١، جيزة ٧١٦ ، جيزة ٨٤٣. كانت السلالة المبشرة X-2339 أكثر تحملا من الصنف جيزة ٨٤٣ بينما X-2340 كانت أقل حساسية مقارنة بالصنف سخا ٤ وفى نفس الوقت حققت أعلى قيم للمتوسطات فى أغلب صفات المحصول ومكوناته . لذلك يمكن استخدام هذه السلالات المبشرة فى برامج التربية للمقاومة للإصابة بفيروس الموزايك الأصفر لاستنباط أصناف جديدة ذات انتاجية عالية تحت ظروف الإصابة بالفيروس .وجد معامل ارتباط سالب بين ميعاد تزهير ٥٠% من النباتات، ميعاد نضج ٩٠% من النباتات ، طول النبات (سم) وارتفاع أول قرن (سم) وصفات المحصول ومكوناته مع النسبة المئوية للإصابة بالفيروس وشدة الإصابة به وكذلك الإصابة بحشرة المن. بينما كان معامل الإرتباط بين الإصابة بالفيروس والإصابة بحشرة المن معنوية جدا وموجبة.

المجلة المصرية لتربية النبات ٢٣(٤) : ٦٨١- ٦٩٩ (٢٠١٩)