

Journal of Plant Protection and Pathology

Journal homepage: www.jppp.mans.edu.eg
Available online at: www.jppp.journals.ekb.eg

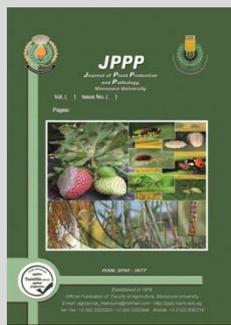
Effect of Intercropping Between Garlic and Faba Bean on Yield and Infestation by Some Piercing-Sucking Insect Pests

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ABSTRACT

Faba bean is an important food crop in Egypt, with seeds of 22 % protein. In addition, it is considered a land reclaiming crop, as it enriches the soil with some nitrogen fertilizer. The current study was conducted at the experimental farm of Sakha Agricultural Research station to manage some piercing-sucking insects with unconventional methods. Garlic was intercropped with faba bean to find the repellent effect of garlic, as a volatile crop, against the abovementioned insects. The solid faba bean gave the highest values of faba bean yield, number of branches, pods and seeds per plant, as well as number of seeds / pod, 100-seed weight and protein content. On the other hand, these values, except plant height, were higher in case of intercropping faba bean with Balady garlic compared to Sids-40 garlic. Concerning garlic yield attributes, Balady garlic intercropped with faba bean produced higher values of bulb diameter and bulb weight / plant, as well as number of cloves per bulb and clove weight compared to Sids-40 garlic. In 2018 / 19 season, the population density of *Aphis craccivora* was reduced by 55.66 and 32.47 % due to intercropping between faba bean and Balady garlic or Sids-40 garlic, respectively. *Empoasca lybica* population was reduced by 54.67 and 35.72%, and that of *Bemisia tabaci* was 59.92 and 35.26 %. Similar results were obtained in 2019/20 season. The current results show that intercropping between faba bean and garlic enhanced the total net crop income, and helped in managing these insects.

Keywords: intercropping, piercing-sucking insect pests, faba bean, garlic, net income .

INTRODUCTION

Faba bean (*Vicia faba* L.) is an important crop for the people in several regions of the world, including Egypt. It is a main nutritive source for human beings and their domestic animals, as its seeds contain 22 % protein, 58% carbohydrates and 2 % fat (Köpke and Nemeck, 2010), in addition to many vitamins and other nutrients (Mohammed 1996). As well as, it plays an essential role in improving the soil as it fixes nitrogen, which enriches the soil for the following crop in rotation (Owolade *et al.*, 2004).

Faba bean is subject to infestation by several insect pests, among of which are the aphid (*Aphis craccivora* Koch.), leafhopper (*Empoasca lybica* De Berg.) and whitefly (*Bemisia tabaci* Gennadius). These insects cause economic damage to faba bean by feeding on leaves and may transmit virus diseases (Ward *et al.*, 2002 and Lanzoni *et al.* 2003).

Garlic (*Allium sativum* L.) is one of the potential plants that could be inserted into crops to reduce the pest occurrence in neighboring host crop plots (Zhou *et al.*, 2013). The semiochemicals produced by non-host plants deter the insects from its host crops (Bai *et al.*, 2011). This phenomenon is an important cultural practice for reducing pest problems in an agroecosystem (Konar *et al.*, 2010 and Vaiyapuri *et al.*, 2010). Inserting volatile non-host crops with the main host crops has been found to have repellent and antifeedant effects against insect pests (Simmonds 1992). Mutiga *et al.* (2010) indicated that cabbage aphid population was 6-7 times higher in control plots, compared

to those containing cabbage and spring onion. Mohammed (2015) counted low numbers of aphids and whiteflies, and high pod faba bean yield, when faba bean was intercropped with garlic. Intercropping between faba bean and coriander had a decline effect against *Aphis craccivora*, as well as increase of faba bean yield (Abdullah and Fouad 2016). Mollaei *et al.* (2021) recorded sharp reduction in the population density of cabbage aphid, *Brevicoryne brassicae* L. when the cabbage was intercropped with garlic, with enhancement and diversity of natural enemies.

The present studies were conducted to investigate the effect of intercropping between faba bean and garlic on yield and yield attributes of faba bean and garlic. In addition, the negative effect of garlic varieties against some piercing-sucking insect pests was studied.

MATERIALS AND METHODS

A field experiment was conducted at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, during two successive growing seasons (2018 / 19 and 2019/ 20). The station is situated at 31°-07' N latitude, 30°-57' E longitude with an elevation of about 6 metres above the sea level. It represents the conditions and circumstances of the Northern part of the Middle Nile Delta region. A split plot design, in a Randomized Complete Block arrangement with three replications, was applied. The main plots were devoted to the two garlic varieties; Balady and Sids-40 (secondary crop). The faba

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DOI: 10.21608/jppp.2021.203163

bean (main crop) was grown on both ridges at the normal density. The sub – plots were allocated for the three mixed intercropping treatments of faba bean with garlic as follows;

- 1-garlic was grown on the top of ridges alternative with faba bean
- 2-garlic was grown on south of ridges alternative with faba bean
- 3- garlic was grown on the north of ridges alternative with faba bean

In addition, each of faba bean and garlic was sown as sole crops (control treatments). The area of each sup-plot was 1/250 fed (4.8 × 3.5 m). The row wide was 0.6 m. The pure stand of faba bean was sown at a seeding rate of 30 kg fed⁻¹, while pure stands of garlic ;Balady and sids 40 were sown at a seeding rate of 250 and 400 kg fed⁻¹ bulbs, respectively. Rates used for faba bean and garlic sole crops reflected the rates commercially used in the region as recommended by Ministry of Agricultural, Egypt. Cloves of garlic were sown by hand on 5th and 8th of October, while, seeds of Sakha 4 faba bean variety were sown on 18th and 13th of November in 2018/2019 and 2019/2020, respectively. The recommended agricultural practices were applied throughout the season. During land preparation, super phosphate (15% P₂O₅) was mixed with the soil at a rate of 100 kg fed⁻¹. Nitrogen fertilizer was applied as urea (46% N) as 15 kg fed⁻¹ two weeks after sowing (at the second irrigation). Regardless of rains, three irrigations were practiced.

The experiment was established on a clayey and well-drained soil. The previous crop was maize during both seasons.

Data recorded:

At harvest, data of yield and its attributes were recorded on 10 plants randomly chosen for each crop and from each plot as follows:-

Faba bean:

Plant height, number of branches/plant, number of pods/plant, number of seeds/ pod, weight of 100 seeds (g), protein %, number of seeds/ plant , and seed yield (ardab./fed).

Garlic :

Plant height , no. of leaves /plant , bulb diameter, fresh bulb weight /plant, no. of cloves/ bulb, clove weight (g), dry blub weight /plant, yield (ton /fed).

Insect pests:

The population of *A. craccivora* (nymphs and adults), was weekly counted on 15 faba bean plants (5

plants from each replicate) one month after planting.To evaluate the population density of *Empoasca lybica* (nymphs and adults) and *Bemisia tabaci* (adults), weekly samples of 30 leaflets representing the three levels of faba bean plant height were randomly selected from each replicate. The numbers of insect pests were directly counted on the plants early in the morning before the insects tend to be more active.

Statistical analysis:

Reduction % = Number of insects in control (solid faba bean) -Number of insects in intercropped crops (faba bean + garlic) / Number of insects in control X 100.

Data were subjected to ANOVA and statistically different means were compared using Duncan's Multiple Range Test (Duncan, 1955).

The statistical analysis was carried out for each crop separately according to Snedecor and Cochran (1989), using MSTATC computer V4 (1986). LSD at 0.05 level of probability was used to compare between treatment means.

The interrelationships among seed (as resultant variables) and its related characters (as casual variables) for faba bean under intercropping were studied using the following methodologies:

Land equivalent ratio (LER)

LER, described by Willey and Osiru (1972), was determined according to the following formula:

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where:

Yaa and Ybb are pure stand of crop a and b, respectively. Yab is the mixture yield of a crop and Yba is the mixture yield of b crop.

RESULTS AND DISCUSSION

1. Effect of intercropping between garlic and faba bean on yield and yield attributes

Data presented in Table (1) show that faba bean intercropped with Balady garlic gave higher values of yield and yield attributes than those of faba bean intercropped with Sids-40 garlic in 2018/2019 and 2019/2020 seasons. The exception case was that of plant height that appeared higher in Sids-40 garlic than in Balady garlic. However, solid planting of faba bean gave the maximum values of yield and yield attributes including plant height. Theses results are in harmony with those obtained by Mohammed (2015), Moshira and Iman (2016).

Table 1. Effect of garlic varieties on yield and yield attributes of faba bean intercropped with garlic

Intercropping System	Plant height (cm)	No. of branches/Plant	No.of pods/Plant	No.of seeds/Pod	100-seed weight(g)	Protein %	No. of seeds/ plant	Seed yield/Fed (Ardab)
2018/2019								
Faba bean +Balady garlic	124.23	4.15	35.24	3.56	80.50	25.33	71.58	9.02
Faba bean + Sids 40 garlic	130.8	3.85	34.3	3.48	79.25	24.44	70.41	8.61
L.S.D. at 5%	4.432	0.247	0.971	0.356	0.863	0.820	1.033	0.414
Solid faba bean	135.38	4.85	42.63	3.69	80.87	24.53	73.86	9.11
2019/2020								
Faba bean +Balady garlic	124.53	4.22	35.33	3.54	80.56	25.36	71.64	9.65
Faba bean + Sids 40 garlic	131.05	3.89	34.4	3.51	49.29	24.41	70.50	9.28
L.S.D. at 5%	2.201	0.244	0.918	0.319	0.909	0.822	1.047	0.531
Solid faba bean	135.43	4.88	43.01	3.72	81.04	24.55	73.92	9.13

Data presented in Table (2) show that garlic sown on the south of ridge alternative with faba bean gave the highest

values of faba bean yield and yield attributes during both seasons of study. In the first season, the plant height was

least when garlic was sown on the south of ridges. The above and below ground competition between plants for light energy intercepted, water and nutrients might account much for the superiority of these traits when faba bean was

sown on one row at the south side of the bed .The results are in accordance with those obtained by Moshira and Iman (2016), Moshira et al., (2016).

Table 2. Effect of intercropping of faba bean with garlic on growth, yield and yield components of faba bean

Intercropping System	Plant height (cm)	No. of branches/Plant	No. of pods/Plant	No. of seeds/Pod	100-seed weight(g)	Protein %	No. of seeds/plant	Seed yield/ Fed(Ardab)
2018/2019								
One row garlic on the top of ridges alternative with faba bean	127.87	3.99	34.78	3.53	79.69	24.81	71.10	8.61
one row garlic on south of ridges alternative with faba bean	127.86	4.06	34.84	3.65	80.19	25.06	71.25	9.43
one row garlic on north of ridges alternative with faba bean	126.92	3.94	34.56	3.42	79.91	24.94	70.72	8.40
L.S.D. at 5% level	8.045	0.616	1.391	0.543	2.880	1.270	1.465	0.465
2019/2020								
One row garlic on the top of ridges alternative with faba bean	128.27	4.04	34.84	3.45	79.69	25.69	71.17	8.66
one row garlic on south of ridges alternative with faba bean	128.04	4.12	34.94	3.68	80.19	25.81	71.38	9.46
one row garlic on north of ridges alternative with faba bean	127.07	4.06	35.31	3.39	79.91	24.66	70.70	8.63
L.S.D. at 5% level	8.01	0.601	1.130	0.502	2.896	1.204	1.451	0.484

Data presented in Table (3) show that Sids-40 garlic intercropped with faba bean gave higher values of all traits, except plant height, number of cloves and total yield. The three latter traits were higher with Balady garlic. Solid planting of two garlic varieties ; Balady and Sids 40 gave

maximum values of yield attributes compared to intercropping system. These results are in an agreement with those reported by Abou El-Magd et al., (2012), Anwar and Gouda (2012) Abdel Razzak and El-Sharkawy (2013), and Nagla and Moshira (2017).

Table 3. Effect of garlic varieties on plant height, yield and yield components of garlic intercropped with faba bean

Intercropping System	Plant Height(cm)	no. of leaves /plant	bulb diameter /plant	fresh bulb weight/plant	no. Of cloves/bulb	clove weight(g)	dry blub weight /plant	Total Yield (ton/fed)
2018/2019								
Faba bean +Balady garlic	75.68	7.26	4.94	57.15	50.430	1.27	26.78	2.29
Faba bean + Sids 40 garlic	65.30	8.46	5.99	63.71	14.002	3.25	30.24	1.76
L.S.D.at 5%	1.425	1.142	0.149	1.306	0.345	0.159	1.711	0.17
Solid Balady garlic	75.03	8.87	5.53	60.11	50.48	1.32	27.24	4.43
Solid Sids 40 garlic	65.22	9.54	6.03	64.58	14.32	3.34	30.28	4.95
2019/2020								
Faba bean +Balady garlic	75.73	7.82	4.96	57.58	50.47	1.31	26.83	2.37
Faba bean + Sids 40 garlic	65.29	8.52	6.02	70.55	14.07	3.28	30.33	1.87
L.S.D.at 5%	1.422	0.365	0.165	1.828	0.359	0.168	1.542	0.16
Solid Balady garlic	75.11	8.90	5.58	60.14	50.52	1.36	27.28	4.45
Solid Sids 40 garlic	65.30	9.56	6.06	64.63	14.45	3.37	30.35	4.97

Data presented in Table (4) show that, in both seasons, garlic sown on south of ridges alternative with faba bean gave the highest values of garlic yield and yield attributes except plant height compared to garlic sown on

north of ridges and garlic sown on top of ridges, both intercropped alternatively with faba bean. These results are in line with those of El Nagar and El-Zohiri (2015) and Mohammed (2015).

Table 4. Effect of intercropping garlic with faba bean on garlic yield and yield components

Intercropping System	Plant Height(cm)	No. of leaves /plant	Bulb diameter /plant	Fresh bulb weight /plant	Clove weight (g)	Dry blub weight /plant	Total yield /fed(ton)
One row on the top of ridges alternative with faba bean	71.01	7.49	5.45	59.89	2.23	27.92	2.05
one row on south of ridges alternative with faba bean	70.99	8.19	5.49	61.01	2.31	29.05	2.14
one row on north of ridges alternative with faba bean	69.95	7.90	5.44	60.41	2.25	28.58	1.91
L.S.D. at 5% level	7.52	1.246	0.743	4.47	1.33	2.417	0.465
One row on the top of ridges alternative with faba bean	71.14	8.24	5.47	60.15	2.26	27.98	2.13
one row on south of ridges alternative with faba bean	71.02	8.26	5.54	61.07	2.34	29.09	2.22
one row on north of ridges alternative with faba bean	70.16	8.09	5.38	60.48	2.28	28.68	2.02
L.S.D. at 5% level	6.92	0.699	0.811	4.55	1.335	2.461	0.352

Data in Table (5) show that there was significant effect of interaction between garlic varieties and intercropping systems in all traits of faba bean at one treatment (one row on the top of ridges alternative with

faba bean) in both garlic varieties and seasons. The results are in accordance with those obtained by Moshira and Iman (2016).

Table 5. Effect of interaction between garlic varieties and intercropping systems on growth, yield and yield components of faba bean

Garlic variety	Intercropping Systems	Plant height [(cm)	No. of branches/Plant	No. of pods/Plant	No. of seeds/pod	100-seed Weight(g)	Protein %	No. of seeds/plant	Seed yield/ fed(Ardab)
2018/2019									
Balady	1	136.84	4.830	36.29	3.82	83.24	25.78	72.61	9.03
	2	131.84	4.013	35.07	3.6	80.79	25.66	71.45	8.74
	3	123.82	3.623	34.39	3.29	77.49	24.58	70.70	8.72
Sids 40	1	128.773	4.033	35.18	3.926	81.12	25.78	71.33	9.01
	2	123.81	3.926	34.52	3.67	79.17	24.66	70.73	8.48
	3	120.116	3.603	33.23	2.85	77.48	23.49	69.36	8.09
L.S.D	5%	5.13	0.502	2.358	1.348	1.1206	1.386	1.338	0.618
2019/2020									
Garlic variety	Intercropping Systems	Plant height (cm)	No. of branches/Plant	No. of pods/Plant	No. of seeds/pod	100-seed Weight(g)	Protein %	No. of seeds/plant	Seed yield/ fed(Ardab)
Balady	1	137.12	4.923	36.41	3.87	83.33	25.813	72.69	9.06
	2	132.04	4.056	35.14	3.66	80.85	25.686	71.5	8.80
	3	124.00	3.70	34.45	3.31	77.53	24.66	70.75	8.76
Sids 40	1	128.95	4.063	35.29	3.96	81.17	25.236	71.36	9.02
	2	124.41	3.963	34.58	3.71	79.21	24.69	70.76	8.48
	3	120.24	3.663	3.33	2.87	77.52	23.52	69.39	8.09
L.S.D	5%	5.489	0.466	0.7886	0.468	1.546	1.244	1.620	0.663

1- One row on the top of ridges alternative with faba bean
 3- one row on north of ridges alternative with faba bean

2- one row on south of ridges alternative with faba bean
 N S = not significant

Data in Table (6) show that there was significant effect of interaction between garlic varieties and intercropping systems in all traits of the two garlic varieties

at one treatment (one row on the top of ridges alternative with faba bean) in both garlic varieties and seasons. The results are similar to those of Nagla and Moshira (2017).

Table 6. Effect of interaction of intercropping between faba bean and row distribution of garlic on growth, yield and yield components of garlic

Row distribution garlic varieties	Plant Height(cm)	No. of leaves/plant	Bulb diameter /plant	Fresh bulb weight/plant	No. Of cloves/bulb	Clove weight(g)	Dry blub weight/plant	Total yield/fed(ton)
2018/2019								
Balady	1	77.28	6.82	5.09	57.66	50.63	1.30	27.13
	2	75.71	7.61	5.01	57.06	50.38	1.28	26.67
	3	74.05	7.35	4.76	56.74	50.28	1.25	26.55
Sids 40	1	66.55	8.836	6.123	64.18	14.34	3.29	30.64
	2	65.40	8.43	5.99	63.88	13.89	3.25	30.44
	3	63.95	8.12	5.86	63.10	13.79	3.21	29.66
L.S.D. at 5% level	2.721	1.285	0.232	1.362	0.348	0.158	1.604	0.178
2019/2020								
Balady	1	77.35	8.25	5.12	57.73	50.67	1.34	27.19
	2	75.75	7.73	5.03	57.13	50.43	1.31	26.74
	3	74.12	7.49	4.77	56.81	50.33	1.28	26.57
Sids 40	1	66.62	8.93	6.15	64.23	14.40	3.32	30.71
	2	65.52	8.49	6.02	63.95	13.97	3.29	30.57
	3	64.04	8.16	5.91	63.60	13.88	3.25	29.73
L.S.D. at 5% level	1.495	0.439	0.297	1.267	0.367	0.164	1.60	0.163

1- One row on the top of ridges alternative with faba bean
 3- one row on north of ridges alternative with faba bean

2- one row on south of ridges alternative with faba bean
 N S = not significant

Data in Table (7) reveal the treatment effect on land use efficiency and economics of garlic intercropped with faba bean. Data indicated that the highest value of LER was obtained from intercropping with Balady garlic cultivar at first treatment (one row on the top of ridges alternative with faba bean) in two seasons. On the other hand, the lowest value of LER was obtained with Sids-40 at the third treatment of intercropping (one row garlic on north of ridges alternative with faba bean) in two seasons. These results are in line with those obtained by Moshira and Iman (2016) and Naglaa and Moshira (2017) who reported that LER values were greater than one at any intercropping system.

Economic evaluation

The highest total net incomes (i.e. 59362.5 and 58850 L.E. in first and second seasons, respectively, Table 9) were recorded when Balady garlic variety was planted at one row on the top of ridges alternative with faba bean.

Meantime, the lowest total net incomes (i.e. 44887 and 44210 L.E. in first and second seasons, respectively) were recorded when Sids 40 garlic variety was planted at one row on north of ridges alternative with faba bean. These results are in a harmony with those reported by Moshira and Iman (2016).

2. Effect of intercropping between faba bean and garlic on the populations of piercing-sucking insect pests cowpea aphid, *Aphis craccivora* (Koch)

Data presented in Table (8) show the population densities of *A. craccivora* in solid faba bean, and faba bean intercropped with two varieties of garlic. Throughout 2018/2019 season, *A. craccivora* population density exhibited two peaks of occurrence, with 40.00 and 50.00 nymphs and adults / 5 bean plants on 6th and 20th of January, respectively with a grand mean of 17.86 individuals / 5plants. When faba bean was intercropped with Balady garlic variety, the grand mean of aphid was

reduced to 7.92 / 5 plants, while in case of intercropping between faba bean and Sids-40 garlic variety, the grand mean was 12.06 nymphs and adults / 5 plants faba bean plants. Thus, the intercropping between faba bean and garlic reduced the population density of aphids by 55.66 and 32.47 % for Balady and Sids-40 garlic varieties, respectively.

In 2019 / 2020 season, the same trend of aphid population density was detected. In solid faba bean, the aphid nymphs and adults peaked with 48.33 individuals / 5

plants on 20th of January, with a grand mean of 16.59 individuals / 5 plants. When faba bean was intercropped with Balady garlic or Sids-40 garlic, the grand means were 8.63 and 10.42 nymphs and adults / 5 faba bean plants with population density reductions of 47.98 and 37.19 %, respectively. Similar finding was recorded when cabbage was intercropped with onion (Mutiga *et al.*, 2010). Baidoo *et al.*, (2012) attributed this finding to the olfactive signals emitted from onion plants that repel the aphids away from the host plant.

Table 7. Effect of intercropping between faba bean and row distribution of garlic on land equivalent ratio (LER) and yield advantage net return and total net return (LE/ fed.)

Faba bean Row distribution	Intercropping treatment	Relative yield (RY)		LER	Gross income of faba bean	Gross income of Garlic	Total income L.E/fed	Total Cost L.E./fed.	Net income
		Faba bean	Garlic						
2018/2019									
Balady	1	0.991	0.293	1.284	33862.5	35250	69112.5	9750	59362.5
	2	0.959	0.289	1.249	32775	34800	67575	9750	57825
	3	0.957	0.276	1.233	32700	33150	65850	9750	56100
Sids 40	1	0.989	0.267	1.256	33787.5	28050	61837.5	9750	52087.5
	2	0.931	0.256	1.187	31800	26850	58650	9750	48900
	3	0.888	0.231	1.119	30337.5	24300	54637.5	9750	44887.5
Total income for solid crops ; Faba bean : 34162.5 LE. Garlic ; Balady : 120300 LE. , Sids 40: 105000 LE.									
2019 / 2020									
Balady	1	0.992	0.301	1.293	27180	41480	68660	9810	58850
	2	0.964	0.297	1.261	26400	40970	67370	9810	57560
	3	0.960	0.281	1.241	26280	38760	65040	9810	55230
Sids 40	1	0.988	0.284	1.273	27060	34000	61060	9810	51250
	2	0.929	0.266	1.195	25440	31790	57230	9810	47420
	3	0.887	0.249	1.135	24270	29750	54020	9810	44210
Total income of solid crops ; Faba bean :27390 LE. Garlic , Balady : 137870 LE. , Sids 40 : 119510 LE.									

1- One row on the top of ridges alternative with faba bean 2- one row on south of ridges alternative with faba bean
3- one row on north of ridges alternative with faba bean NS = not significant

Table 8. Population fluctuation of *Aphis craccivora* (nymphs and adults) on solid faba bean and faba bean intercropped with garlic

Date of inspection	Av. number of aphids / 5 faba bean plants					
	2018 / 2019			2019 / 2020		
	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic
16-Dec.	1.66	3.00	8.33	2.33	6.00	7.33
23	5.33	8.33	12.66	12.66	5.00	11.66
30	21.66	16.33	21.33	29.00	18.66	9.00
06-Jan	40.00	17.00	27.33	30.00	19.66	23.00
13	38.33	23.33	18.66	43.33	22.00	22.33
20	50.00	23.66	65.00	48.33	21.33	26.66
27	48.33	27.00	37.33	41.66	37.00	36.33
3-Feb.	30.00	9.66	6.33	30.00	9.33	23.33
10	28.33	3.00	5.00	20.00	2.00	9.33
17	21.66	2.33	1.00	11.66	2.00	5.33
24	12.66	1.00	1.00	5.66	1.66	1.00
3-Mar.	3.66	0.00	0.66	4.66	1.00	0.66
10	2.00	0.00	0.33	2.00	0.66	0.66
17	0.00	0.00	0.00	0.33	0.33	0.00
24	0.00	0.00	0.00	0.33	0.00	0.66
31	0.00	0.00	0.00	0.00	0.00	0.00
7-Apr.	0.00	0.00	0.00	0.00	0.00	0.00
Grand mean ±SE	17.86±10.54 a	7.92±5.61 c	12.06±10.20 b	16.59±9.87 a	8.63±6.35 c	10.42±6.68 b
Reduction %	-	55.66	32.47	-	47.98	37.19

There are means accompanied with different letters are significantly different according to Duncan's Multiple Range Test at 0.05 probability level

The cotton leaf hopper, *Empoasca lybica* De Berg.

Results shown in Table (9) present the population densities of *E. lybica* nymphs and adult on solid faba bean, and faba bean intercropped with garlic.

In 2018 / 2019 season, *E. lybica* appeared on solid faba bean exhibited low population densities during December, early January, late March and early April. In the remaining inspections, the densities were moderate;

11.66 on 13th of January up to 12.00 nymphs and adults / 5 faba bean plants on 24th of March. In case of intercropping of faba bean with Balady and Sids-40 garlic varieties, the insect densities declined. The grand means of *E. lybica* populations were 10.72, 4.86 and 6.89 nymphs and adults / 5 plants on solid faba bean, Balady garlic, Sids-40 garlic, respectively. Consequently, the population densities of this

leafhopper were reduced by 54.67 and 35.72% due to Balady garlic and Sids-40 garlic treatments, respectively.

Data of 2019 / 2020 season were similar to those of 2018 / 2019 season, with reductions in leafhopper densities with 57.76 and 40.19 %, respectively.

Parker *et al* (2013) explained the reductions in insects due to intercropping that the non-host crop works as a physical barrier and thus confuse the insects searching for the host crop.

Table 9. Population fluctuation of *Empoasca lybica* (nymphs and adults) on solid faba bean and faba bean intercropped with garlic

Date of inspection	Av. number of <i>Empoasca lybica</i> / 5 faba bean plants					
	2018 / 2019			2019 / 2020		
	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic
16-Dec.	0.00	0.00	0.66	3.33	0.00	0.33
23	2.66	0.33	1.33	6.00	0.66	2.33
30	3.33	1.33	4.00	12.00	2.33	4.00
06-Jan	8.00	1.66	6.00	13.00	4.00	4.00
13	11.66	3.33	7.00	13.33	3.00	5.00
20	19.00	3.33	6.33	14.00	3.66	3.66
27	15.33	4.33	7.66	15.00	4.00	2.66
3-Feb.	16.66	6.00	8.66	16.33	3.00	8.33
10	18.33	11.00	8.33	17.66	3.66	8.00
17	17.33	8.33	9.33	15.00	3.33	11.33
24	15.00	13.00	10.66	14.33	6.00	10.66
3-Mar.	13.33	7.33	15.00	10.66	6.00	11.33
10	11.33	6.33	16.66	8.33	7.00	10.00
17	10.33	6.33	7.66	6.66	10.00	10.66
24	12.00	6.00	4.66	6.00	8.33	8.33
31	5.33	2.33	2.33	3.66	5.66	3.66
7-Apr.	2.66	1.66	1.00	3.00	4.66	2.33
Grand mean ±SE	10.72±3.51 a	4.86±2.06 c	6.89±2.61 b	10.48±2.83 a	4.43±1.48 c	6.27±2.14 b
Reduction %	-	54.67	35.72	-	57.76	40.19

There are means accompanied with different letters are significantly different according to Duncan's Multiple Range Test at 0.05 probability level

The cotton whitefly, *Bemisia tabaci* Gennadius

Data presented in Table (10) show the population densities of *B. tabaci* on solid faba bean and that

intercropped with garlic. In general, the white fly densities were low in all treatments and in both seasons.

Table 10. Population fluctuation of *Bemisia tabaci* (adults) on solid faba bean and faba bean intercropped with garlic

Date of inspection	Av. number of <i>Bemisia tabaci</i> / 5 faba bean plants					
	2018 / 2019			2019 / 2020		
	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic	Solid faba bean	Faba bean intercropped with balady garlic	Faba bean intercropped with Sids 40 garlic
16-Dec.	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00
30	1.00	0.33	0.66	2.66	0.33	0.00
06-Jan	2.33	2.00	2.00	3.00	0.66	1.00
13	5.66	1.66	4.00	4.33	3.00	2.33
20	8.66	4.00	4.00	7.00	2.33	2.66
27	10.66	5.00	6.50	12.33	3.00	2.33
3-Feb.	9.66	6.66	5.00	15.33	3.33	4.66
10	10.33	2.00	3.66	14.33	4.00	4.33
17	9.33	3.00	3.33	10.00	5.00	7.00
24	8.00	3.33	4.66	7.33	5.33	8.33
3-Mar.	5.66	2.00	6.33	6.00	6.66	6.66
10	4.00	2.66	6.66	6.33	3.33	6.00
17	5.00	1.33	4.33	5.33	5.66	5.66
24	4.33	1.00	2.66	5.00	6.00	6.00
31	2.00	0.33	2.00	3.00	5.66	5.66
7-Apr.	1.66	0.00	1.33	1.00	0.33	3.33
Grand mean ±SE	5.19±2.13 a	2.08±1.09 c	3.36±1.20 b	6.06±2.68 a	3.21±1.32 b	3.88±1.54 b
Reduction %	-	59.92	35.26	-	47.02	35.97

There are means accompanied with different letters are significantly different according to Duncan's Multiple Range Test at 0.05 probability level

In 2018 / 2019 season, the grand means of *B. tabaci* adults / 5 faba bean plants were 5.19, 2.08 and 3.36 individuals, respectively. This means that intercropping reduced the densities of *B. tabaci* with 59.92 and 35.00 % due to Balady garlic and Sids-40, respectively. The corresponding values of the second season were similar to those of the first one. Grand means were 6.06, 3.21 and

3.88 adults of *B. tabaci*, respectively. Thus, inserting Balady garlic and Sids-40 garlic reduced the white fly populations by 47.07 and 35.97 %, respectively.

Sulvai *et al.* (2016) indicated that inserting garlic or onion with main host crops leads to emitting chemicals that confuse the specialist insects, and thus cannot reach to their hosts. In addition, Degri *et al.* (2014) concluded that volatile

crops inserted with the host crop produce some chemicals that attract the natural enemies which manage the insect pests.

3. Effect of infestation by piercing –sucking insect pests on faba bean yield and yield components under intercropping

Data presented in Table (11) show the effect of insect population density on faba bean yield and yield components. The solid faba bean produced the highest values of yield and yield components, with the exception of protein content in the first season, and faba bean yield in the second season. This result agrees with those of Mohamed (2015) and Moshira and Imam (2016) who found that solid faba bean produced the maximum values of yield and yield attributes compared to different intercropping patterns. Intercropping between faba bean

and garlic varieties reduced the population densities of piercing-sucking insect pests which reflected a significant differences in insect density between Balady garlic and Sids-40 garlic. All yield and yield components of faba bean were usually higher in faba bean intercropped with Balady garlic than in faba bean intercropped with Sids-40 garlic.

It can be concluded that, From the current data, the intercropping between faba bean and garlic helps in reducing the population densities of piercing-sucking insects. This technique manages the populations of these insects with no applications of insecticides. Several authors attributed the antagonistic effects of volatile non-host crops act as repellents barriers and confusing to insects. In addition the total net income increased due to intercropping between Garlic and faba bean.

Table 11. Effect of infestation by piercing –sucking insect pests on faba bean yield and yield components under intercropping

Intercropping System	Insect pests			No. of branches/ Plant	No. of pods/ Plant	No. of seeds/ Pod	100-seed Weight (g)	Protein %	No. of seeds/ plant	Seed yield/Fed (Ardab)
	Aphis craccivora	Empoasca lybica	Bemisia tabaci							
2018/2019										
Faba bean + Balady garlic	7.92 ±5.61 c	4.86 ±2.06 c	2.08 ±1.09 c	4.15 ±0.052 b	35.24 ±0.057b	3.56 ±0.121a	80.50 ±0.288a	25.33 ±0.191a	71.58 ±0.046b	9.02 ±0.02a
Faba bean + Sids 40 garlic	12.06 ±10.20 b	6.89 ±2.61 b	3.36 ±1.20 b	3.85 ±0.064 c	34.3 ±0.115c	3.48 ±0.075a	79.25 ±0.144b	24.44 ±0.254b	70.41 ±0.236c	8.61 ±0.066b
Solid faba bean	17.86 ±10.54 a	10.72 ±3.51 a	5.19 ±2.13 a	4.85 ±0.011 a	42.63 ±0.17 a	3.69 ±0.023a	80.87 ±0.017a	24.53 ±0.132b	73.86 ±0.034a	9.11 ±0.028a
2019/2020										
Faba bean + Balady garlic	8.63 ±6.35 c	4.43 ±1.48 c	3.21 ±1.32 b	4.22 ±0.04b	35.33 ±0.196b	3.54 ±0.069ab	80.56 ±0.043b	25.36 ±0.031a	71.64 ±0.034b	9.65 ±0.028a
Faba bean + Sids 40 garlic	10.42 ±6.68 b	6.27 ±2.14 b	3.88 ±1.54 b	3.89 ±0.049c	34.4 ±0.115c	3.51 ±0.051b	49.29 ±0.098c	24.41 ±0.017b	70.50 ±0.231c	9.28 ±0.003b
Solid faba bean	16.59 ±9.87 a	10.48 ±2.83 a	6.06 ±2.68 a	4.88 ±0.046a	43.01 ±0.005a	3.72 ±0.063a	81.04 ±0.023a	24.55 ±0.069b	73.92 ±0.051a	9.13 ±0.075b

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تأثير تحميل الثوم مع الفول البلدي على المحصول والإصابة ببعض الآفات الحشرية الثاقبة الماصة

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الفول البلدي من المحاصيل الغذائية الهامة في مصر ، خصوصاً وأن بذوره تحتوى على 22% بروتين . وعلاوة على ذلك فإنه يعتبر محصولاً مصلحاً ومغنياً للتربة ، حيث تقوم جذوره بتثبيت الأزوت الجوى . ولسوء الحظ ، فإن هذا المحصول يتعرض للإصابة ببعض الحشرات الثاقبة الماصة . أجريت الدراسة الحالية خلال موسمي 2018 / 2019 ، 2019 / 2020 في المزرعة البحثية لمحطة بحوث سحا لمكافحة الحشرات الثاقبة بطرق غير تقليدية بعيداً عن استخدام المبيدات الحشرية. تم تحميل الفول البلدي مع صنفين من الثوم (بلدي ، سدس 40) لدراسة تأثير رائحة الثوم والمواد الطيارة على تقليل الإصابة ببعض الحشرات الثاقبة الماصة التي تهاجم نباتات الفول. أعطت زراعة الفول البلدي منفرداً أعلى قيم للمحصول ومكوناته (عدد الفروع ، القرون و البذور / نبات ، عدد البذور في القرن الواحد ، وزن ال 100 بذرة والنسبة المئوية للبروتين). ومن ناحية أخرى كانت جميع هذه القيم أعلى في الفول البلدي المحمل مع الثوم البلدي منها في الفول البلدي المحمل مع الثوم سدس 40 ، باستثناء طول النبات الذي كان أعلى في حالة الصنف سدس 40. كما أعطت زراعة الثوم على الريشة القليلة للفول البلدي أعلى القيم للصفات السابقة مقارنة بزراعة الثوم في ظهر خطوط الفول أو على الريشة البحرية. وبالنسبة لمحصول الثوم كان قطر فصوص الثوم ، ووزن الفصوص ، وعدد الفصوص في الرأس ووزن الرأس أعلى عند تحميل الفول البلدي مع الثوم البلدي، بالمقارنة بالتحميل مع الثوم سدس 40. أوضحت النتائج أيضاً أن تحميل الفول مع الثوم قلل من كثافة تعداد الحشرات الثاقبة الماصة : المون *Aphis craccivora* ، نطاط الأوراق *Empoasca lybica*، الذبابة البيضاء *Bemisia tabaci* . أدى تحميل الفول البلدي مع كل من الثوم البلدي والثوم سدس 40 في الموسم الأول إلى تقليل تعداد المن بنسبة 55.66، 32.47% على التوالي وكانت القيم المناظرة في حالة نطاط الأوراق هي 54.67، 35.72% وفي حالة الذبابة البيضاء 59.92، 35.26% عند تحميل الفول البلدي مع الثوم البلدي والثوم سدس 40 على التوالي. وكانت نتائج الموسم الثاني مطابقة لنتائج الموسم الأول. وفي ضوء نتائج البحث الحالي يمكن القول أن تحميل الفول البلدي مع الثوم هي إحدى الطرق الزراعية التي تساعد في تقليل الإصابة ببعض الحشرات الثاقبة الماصة دون استخدام المبيدات الحشرية. وعلاوة على ذلك ، فإن نتائج هذه الدراسة تشير إلى أن هذا النظام من التحميل ساهم في زيادة الدخل الصافي من المساحة ، خصوصاً عند تحميل الفول البلدي مع الثوم البلدي عند زراعة الثوم على ظهر خطوط الفول.