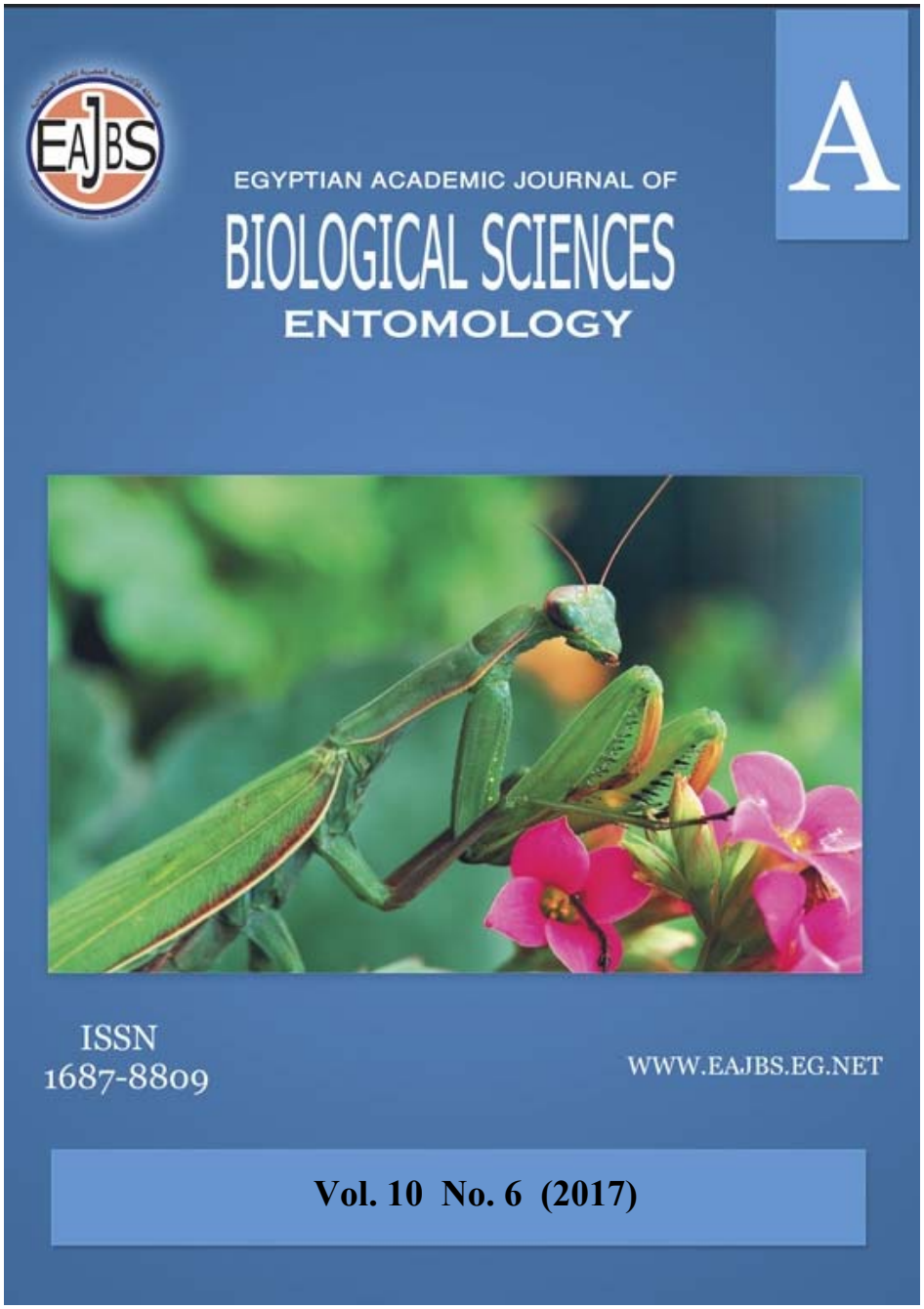

Egyptian Academic Journal of Biological Sciences is the official English language journal of the Egyptian Society for Biological Sciences, Department of Entomology, Faculty of Sciences Ain Shams University.
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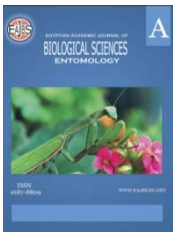
www.eajbs.eg.net

Citation: *Egypt. Acad. J. Biolog. Sci. (A. Entomology) Vol. 10(6)pp: 57- 77(2017)*

Egypt. Acad. J. Biolog. Sci., 10(6):57–77 (2017)

Egyptian Academic Journal of Biological Sciences
A. Entomology

ISSN 1687- 8809
www.eajbs.eg.net



Effect of Intercropping Three Faba Bean Varieties with Sugar Beet Plants on Piercing Sucking Insect Pests and Associated Natural Enemies Under Ridge Space and Seedling Rates in Relation Crop Yield.

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ARTICLE INFO
Article History
Received:17/8/2017
Accepted: 24/9/2017

Keywords:
Gamma irradiation
Steinernema carpocapsae
Trichogramma evanescens
Tuta absoluta.

ABSTRACT

Field experiment were conducted at Gemmiza Agricultural research Station, El Gharbia Governorate, Egypt, in 2014/2015and 2015/2016 seasons to study the effect of intercropping faba bean (*Vicia faba* L.) with sugar beet (*Beta vulgaris* L.) at different ridge width 60, 90 and 120 cm and seedling rats on the population densities of piercing sucking insect pests and their effect on the productivity of both crops and estimate the economic return.

Results was indicated that the intercropping of broad bean at 60cm ridge space with sugar beet harbored the lowest piercing sucking pest infestations. However, Giza 3 improve at 120 cm ridge space was received the highest infestation. On the other hand, Giza 716 was infested by highest infestation at 37.5% seed rates when intercropping with sugar beet. The lost infestation was recorded on sugar beet + Giza 3 improve with 12.5% seed rates.

Statistical analysis was showed the intercropping faba been with sugar beet on different ridge width significantly affected on sugar beet yield and yield components. Increasing sugar beet root length and purity % by planting on 60 cm ridge width, compared to 90 and 120 cm. On the other hand, root diameter, root fresh weight, top fresh weight, root yield/fed, top yield/fed T.S.S and sucrose were significantly increased by increasing ridge width from 60 to 120 cm. The effect of ridge width on faba bean traits revealed that increasing ridge width from 60 cm to 120 cm reduced plant height only of faba bean. On the other hand, number of pods/ plant, seeds/plant, weight of 100 seeds and grain yield /fed ardab were increased by increasing ridge width from 60 cm to 120 cm , while Protein content% was not affected by ridge width. Increasing seeding rates from 12.5 % to 37.5 % increased plant height and straw yield/ fed. The differences among faba bean varieties indicated that only plant height and number of seeds/ plant were affected by faba bean varieties. On the other hand, all the other characters were affected by faba bean varieties. highest values of Land equivalent ratio (LER), Farmer's benefit (Total return of intercropping culture , Net profit fed^{-1}) and Monetary advantage index (MAI) compared with other treatments . It could be concluded that intercropping 100 % sugar beet + 37.5 % faba bean Giza 3 improve cultivar (52500 plants / fed) on ridge width 120 cm gave the greatest values for all treatments which gave the maximum yield benefits and least competition between component crops compared with other treatments .

INTRODUCTION

Sugar beet is an important sugar crop in the world and ranks next to sugar cane as a source of sugar in Egypt. The area in Egypt had increased mostly to 450000 fed in 2012 season and the contribution of sugar beet to sugar production increased largely to 35.5 % of the total sugar production in 2012 season (Aboukhadra *et al*., 2013a and Abdel Motagally & Metwally, 2014).

But it is not enough, to narrowing the gap between consumption and production considering human population growth. Since the cultivated area in Egypt is limited, the agriculture intensification had become urgent necessity by maximizing the utilizing of unit area to enhance farmer's income. it can be achieved that by adopting suitable cultural practices such as intercropping systems. Faba bean is the most important food legume in Egypt. By means of intercropping to growing high yielding varieties of both sugar beet and faba bean at suitable plant densities, production of faba bean may be improved without significant reduction in beet yield.

Under Egyptian conditions, suger beet and faba bean plantations are considered a very desirable host plant for many insect pests. Some investigators studied the population density of the major insects of tow crop Mathew *et al.* 1971; Saleh *et al*., 1972 Vercambre 1980, Guirguis, 1985, Youssef, 1986, Abo-saied, 1987, El-khouly, 1992, Aly *et al.*, 1993, saleh 1994, Youssef 1994, Bassyouny and Bleih, 1996 El Dafrawi *et al*., 2000 and Ragab *et al*., 2002.

Some Egyptian farmers used to grow faba bean in sugar beet fields. Identifying the most suitable plant population of faba bean intercropped with sugar beet without applicable reduction in beet yield was the target of this study. This would provide farmers with proper technology for achieving better land utilization and greater income. (Egbe, 2010), reported that, Intercropping is important because it offers potential advantages for resource utilization, decreased inputs and increased sustainability in crop production Egbe (2005) , contended that intercropping might positively impact on the future food problems in developing countries. This may be through efficient use of solar energy and other growth resources. Also optimization of land resources use could be achieved when crops are grown under intercropping . Undie *et al*.,(2012) revealed that Cereal-legume mixtures have been adjudged the most productive form of intercropping since the cereals may benefit from the nitrogen fixed in the root nodules of the legumes in the current year . Thole (2007) reported that intercropping increases total yield per given piece of land and resulted in higher land. Kazemeini S. A. and Sadeghi. H, (2012). indicated that different crop density in intercropping systems affect safflower yield. Sangakkara *et al*., (2003) reported that intercropping is the growing of two or more crops simultaneously on the same field. Dasbak and Asiegbu, (2009) showed that intercropping is used in many parts of the world for the production of food and feed crops. Manna *et al*., (2003) found that Legumes are known to fix atmospheric nitrogen, thus enriching soil fertility, and helping to meet the N needs of cereals to sugar beet nutrient. Dhima *et al*., (2007) demonstrated that Intercropping of legumes and cereals with sugar beet, had great advantages. Increased productivity and optimal use of available resources (land, labor, time, water and nutrients), increasing the efficiency of land use. (Pandey & Prakash, 2002). Intercropping also reduces intensity of weeds and offers the possibility of capturing a great share of available resources than in mono-cropping. Besides, it also reduces weeding cost and realizes higher total productivity of the system and monetary return. The aim of the present study to evaluating the effect of two crops treatments and the experimental condition on the main insect pests and their main natural enemies population.

MATERIALS AND METHODS

Field experiments were conducted at Gemmiza Agricultural research Station El Gharbia Governorate, Egypt, in 2014/2015and 2015/2016 seasons to study the effect of intercropping faba bean (*Vicia faba* L.) 3 verities at different ridge width, plants

population densities and cultivars with sugar beet (*Beta vulgaris* L.), on the productivity of both crops and estimate the economic return also the effect of the mentioned condition on the population density of insect pastes and their natural enemies. The soil texture of the experimental farm was clay loam with pH 7.9 and 2.35% organic matter content. The experiment was designed as split split blocks with three replications. The experiment included nine intercropping treatments in addition to solid crops. The area of each plot was 21.6 m^2 (3 m length x7.2 m width).

Ridge width (The main plots) 60, 90 and 120 cm the treatments were as follows:

Ridge width 60 cm was 12 ridges 60 cm width, 3 m in length.

Ridge width 90 cm was 8 wide beds 90 cm width, 3 m in length

Ridge width 120 cm was 6 wide beds 120 cm width, 3 m in length

Seed rates (Sub plots)

T1: 100% sugar beet + 12.5% faba bean (17500 plant/ fed).

T2: 100% sugar beet + 25% faba bean (35000 plants/ fed).

T3: 100% sugar beet + 37.5% faba bean (52500 plants/ fed).

faba bean cultivars (sub-sub plots)

Giza 3 improve, Giza 716 and Broad bean

The main crop, sugar beet, was planted at the recommended seed rate (4 kg fed-1) by the Egyptian Ministry of Agriculture, for both the intercropping treatments and pure stands. Sugar beet crop, monoculture, was seeded in hills spaced 20 cm on one side of ridges 60 cm and in intercropping patterns on both sides of wide beds 90 and 120 cm apart, three weeks after sowing sugar beet, germinated weeds were controlled and sugar beet was thinned to one seedling per hill to achieve full stand (a plant population of 35000 plants/fed).

The secondary crop, Faba bean as a sole crop was seeded in hills spaced 20 cm apart and two plants per hill on both sides of the ridge to achieve full stand of 33 plants / m^2 (140000 plants/fad) at the recommended seed. Faba bean seeds, as an intercrop, were sown in hills (40 cm apart) on the other side of the ridge 60 cm (ridge 1,5,9,12) at all intercropping densities and leaving four ridge without intercropping , while was sown in on two rows in hills (40 cm apart) on top of the seed bed of the wide bed 90 cm (wide bed 2,5,8) at all intercropping densities and leaving three wide bed without intercropping , meanwhile was sown in on two rows in hills (40 cm apart) on top of the seed bed of the wide bed 120 cm (wide bed 1,4,6) at all intercropping densities and leaving three wide bed without intercropping, and later thinned to two plants per hill.. Sowing of intercropping treatments was in a manner that each crop was sown on adjacent sides of successive ridges, *i.e.* rows of faba bean alternating with rows of sugar beet to increase light penetration of sugar beet. Sugar beet was planted on October 12^{th} and 16^{th} in 2014 and 2015 seasons, respectively. In both seasons, the preceding crop was maize. Calcium super phosphate 15.5% P_2O_5 was added at a rate of 150 kg/fad before planting sugar beet. Ammonium nitrate 33.5% N was added to sugar plants at a rate of 60 kg N/fad in two equal doses at 21 and 60 days after sugar beet sowing. At 190 days after sowing, sugar beet plants grown on the four inner ridges (7.2 m^2) of each plot were pulled, topped, counted and fresh weight recorded. Root length and diameter were recorded on a random sample of roots. Total soluble sugar percentage (TSS%) was determined using hand refract meter. Sucrose percentage was polarimetrically determined on a lead acetate extract of fresh macerated root according to the method of Le-Docte (1927). Purity percentage was calculated by dividing sucrose percentage on TSS percentage. Sugar yield/fad was calculated by multiplying root yield/fad by root sucrose percentage.

Faba bean was harvested 150 days after sowing (40 days before sugar beet harvest).

Ten plants were randomly taken from each plot to determine plant height, number of branches, number of pods, Noumber of seeds /plant , Weight of 100 seeds (gm) , Straw yield/fed(ton), Grain yield /fed (ardab) and protein %, were estimated from the central area (7.2 m^2) of each plot.

Insects sampling

One month after sowing, sampling started and continued till harvesting. Five plants from sugar beet were chosen randomly from each replicate and inspected weekly to count the piercing sucking insect pests and their natural enemies for each plot, Also Samples of three faba bean varities Which intercropping with sugar beet inspected weekly to count piercing sucking insect pests and their natural enemies. 10 Apical leaves of plants were randomly collected for each replicate to be counted the number of Aphides. Also, samples of 10 leaves from each replicate where picked weekly at random from three levels of the plant upper, middle and lower parts examined to count the other sucking insects. Direct count using manual lens (5X) for associated predators. (paederus alferii, syrphus corollae, Scymnus syriacus, Chrysoperla Carnea and Orius SP.) were carried out and 5 plants were randomly chosen for farther examination.

The **percentage of occurence was calculated as follows:**

Occurrence % = (No. of individual of spices/ No. of all individuals of spices) X100.

Predatory and parasitic insect species found in the colonies of aphids or infesting faba bean and sugar beet leaves were collected and taken as soon as possible to the laboratory. Infested faba bean and sugar beet plants were examined for any stages of predacious arthropods. In addition, of leaves with parasitized aphids (mummies) were picked up and localized in glass jars to rear parasitoid insect species. The emerging hymenopterous parasitoids were collected every other day and the species were mounted and identified. The predator and parasitoid species were identified using keys of Hodek (1973) for coccinellids, Stary (1976), Alford (1984) and center of biological control, Faculty of Agriculture-Cairo University-Cairo-Arab Republic of Egypt for hymenopterous parasitoids.

Competitive relationships:

Land equivalent ratio (LER), calculated according to Andrews and Kassam (1976).

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

Where: Yaa and Ybb were pure stand of crop and b respectively. Yab is mixture yield of a and Yba is mixture yield of b crop.`Formula is used If LER is greater than one, intercropping will be better than pure cultivation (Mazaheri *et al.* 2002) and if LER is less than one, pure cultivation will be better (Hauggaard-Nielsen *et al.* 2001).

Farmer's benefit: calculated by determining the total costs and net ret return of intercropping culture as compared to recommended solid planting of suger beet.

Total return of intercropping culture = Price of faba bean yield + Price of suger beet yield (L.E) To calculate the total return the average of faba bean yield and suger beet yield price presented by Agriculture Statisticics (2014 and 2015) seasons were used.

The total income fed^{-1} was calculated for each treatment in Egyptian pounds, using the average farm gate of the two seasons, for faba bean of L.E 900 ardab^{-1}, for suger beet veild LE 375 /ton^{-1}.

Net profit fed^{-1} was calculated according to **Younis *et al* ., (1991)** , NP = {(YXP) – TC }, where NP is the profit (L.E fed^{-1}) , Y is the yield ton (fed^{-1}) , P the yield price (L.E ton^{-1}) and TC is the total costs (L.E fed^{-1}) .

Monetary advantage index (MAI) fed^{-1} was calculated according to Willey (1979) ,

MAI= Value of combined intercrops x LER -1
LER

Economic evaluation: The total income from each treatment was calculated at market price of LE 375 per ton of fresh sugar beet roots and LE 900 per ardab of faba bean (one ardab = 155 kg & fed = 4200 m^2).

Statistical analysis of the collected data was carried out using the computer program MSTAT-C package by Freed *et al* (1988) according to Gomez and Gomez (1984). Barlett test was used to assess the variance of experimental error of both seasons. Least significant difference (LSD 5%) was used for comparison among the means.

RESULTS AND DISCUSSION

Population density of piercing sucking insect pests and their associated natural enemies under ridge spaces and seeds rate during seasons, 2014/2015 and 2015/2016.

Survey of piercing sucking pests and their associating natural enemies:

The presented data was focus to light on the identification and relative abundance of some piercing sucking insect pests and their associated natural enemies on three faba bean varieties (Giza 3 improve, Giza 716 and Broad bean varieties) intercropped with sugar beet under 3 ridge spaces and seedling rates during two successive seasons, 2014/2015 and 2015/2016. Total of 16 insect species representing 14 genera, belonged to 11 families' and following 6 orders were collected and identified (Diagram, 1).

The predators:

During the two investigated seasons, six predatory insect species represented in six genera, belonged to five families and following four orders were collected and recovered from faba bean plants intercropped with sugar beet. The six predatory insect species were the anthocorid bugs, *Orius* sp. (Hemiptera: Anthocoridae) in a few number associated with aphid colonies, *Chrysoperla carnea* (Stephens) (Neuroptera: Family) was occurred during February and March in the two investigated years on aphid colonies and white flies, two species belong family Coccinellidae (Coleoptera) (namely *Scymnus syriacus* Mars. and *Coccienella undecimpunctata* L.), *Paederus alferii* (Koch) (Coleoptera: Staphylinidae) in a few numbers associated with aphid colonies and hover flies, *Syrphus corollae* Faber larvae as common predators of aphids.

The parasitoids:

Three parasitoid insect species was represented in two genera, belonged to two families' and following one order were collected and recovered from faba bean and sugar been plants. The first family namely Aphelinidae (Hymenoptera) was found as the chalcidoid parasite, *Aphelinus* sp.as known as endo-parasite of aphids. The other one was Aphidiidae (Hymenoptera) was included two species namely as *Praon flavinode* (Holiday) which was found in a few numbers and the minute wasp, *Diaeretiella rapae* (M'Intosh) as the most abundant endo-parasite species associated with *A. craccivora* on faba bean and sugar beet plants.

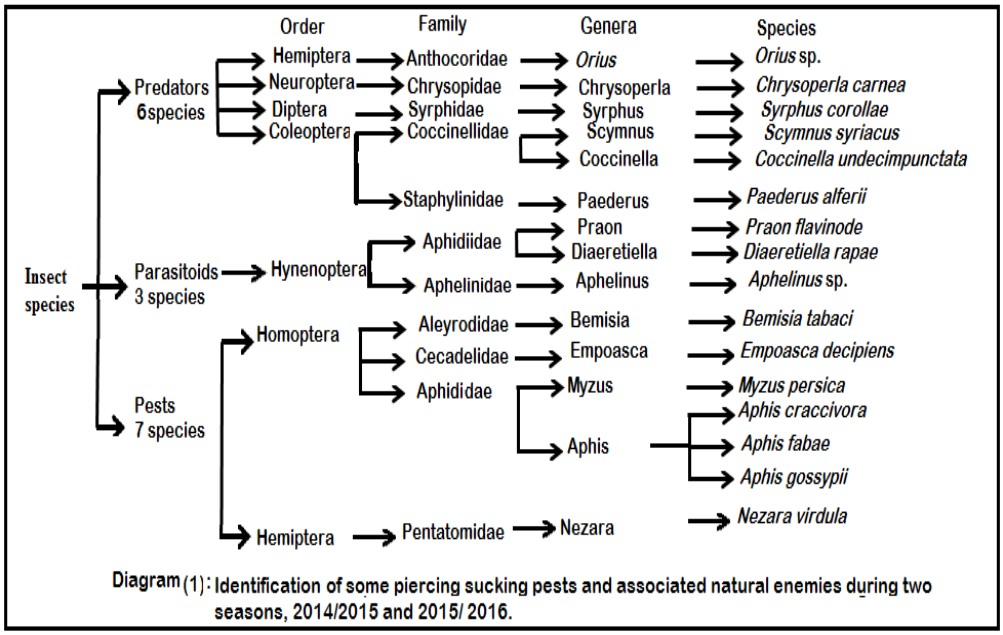

Diagram (1): Identification of some piercing sucking pests and associated natural enemies during two seasons, 2014/2015 and 2015/ 2016.

Pests :

Data in diagram (1) illustrated that seven species (*Bemisia tabaci*, *Aphis craccivora*, *A. fabae, A. gossypii, Myzus persica, Nizara viridula and Emposeca decipiens*) were considered as important pests on faba bean and sugar beet plants during the two successive seasons, 2014/2015 and 2015/2015. The variation in the percent densities of piercing sucking pests (individuals) differed on the three varieties (Giza 3 improve, Giza 716 and broad bean) which intercropping with sugar beet at different ridge spaces, 60, 90 and 120 cm during both two seasons. Under intercropping of different seed rates of faba bean varieties, results asserted that a different occurrence of seven piercing sucking pests and their associated natural enemies was recorded during two both seasons at different seed rates, 12.5 %, 25% and 37.5%.

The present results are supportive of the finding results by Hassan *et al.* (1985) and Ali *et al.* (1986). Moreover, the staphylinid predator, *Pedirus alfierii* and coccinellid predators, *C. undecimpunctata* and *C. vicina* var. *nilotica* were appeared in sugar beet fields which associated with *Myzus persica* from April to June (Guirguis, 1985). The coccinellids, *Paederus alfierii* peaks were observed from March to May in sugar beet fields in Egypt (Guirguis, 1985), September to December (Youssef, 1994). Otherwise, the chrysopid, *Chrysoperla carnea* was detected by Mesbah (1991) in sugar beet fields in Egypt, Sengonca *et al.* (1995) in Germany with *Aphis fabae*. The different predators were noticed association with different pests as like *P. alfierii, Ch. carnea, C. undicempunctata* by Zawrah (2000) in sugar beet fields, and *Chrysopa carnea* Stephens, *Orius* Sp. and *Scymnus syriacus* by Rizk (2011) in association with *B. tabaci*.

Numerous piercing sucking pests including *Nezara viridula* and *Aphis gosspyii* was observed by Awadallah *et al.* (1992) in sugar-beet in Egypt, *B. tabaci* by Nuessly *et al.* (1994) in sugar beet in USA.

Effect of intercropping of different three faba bean varieties with sugar beet plant during 2014/2015 and 2015/2016 seasons.

Pests:

Result in Table (1a) asserted that intercropping Faba bean with sugar beet on different spaces was demonstrated a significant difference between the mean

numbers of piercing sucking pastes during seasons 2014/2015 and 2015/2016 planting on 60 cm ridge space compared with 90 and 120 cm. The highest values of the mean of piercing sucking pests individuals were observed in sugar beet (single), followed by sugar beet + Giza 3 improve on ridge space 120 cm, sugar beet + Giza 716 on ridge space 60 and 120cm, sugar beet + Giza 3 improve on ridge space 90cm, Sugar beet + Broad bean on ridge space 120 and 90 cm, Sugar beet + Giza 3 improve on ridge width 60 cm, Sugar beet + Giza 716 on ridge space 90cm and sugar beet + Broad bean on ridge space 60cm with an average (208.3), (148.3), (134.8), (126.6), (121.9), (121.0), (111.5), (110.9), (106.2) and (105.7). Individuals per 5 sugar beet plants, respectively.

Table 1a: The mean number of piercing sucking insect pests, predators and parasitoids individuals on sugar beet intercropping with three faba bean verities at different ridge spaces during seasons, 2014/2015 and 2015/2016.

Treatments		Piercieng sucking pests					Predators					Parasitoids				
		2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %
Improved Giza 3	60 cm	110.9 ef	158.2 f	134.6 e	1547.5	8.7	8.0 a	19.5 a	13.8 a	122.6	11.2	1.8 a	2.3 a	2.0 a	15.0	13.5
	90 cm	121.9 cde	164.1 ef	143.0 de		9.2	7.2 a	18.5 a	12.9 a		10.5	0.8 ab	2.4 a	1.6 ab		10.8
	120 cm	148.3 b	173.6 de	160.9 b		10.4	6.1 a	18.1 ab	12.1 ab		9.8	0.7 ab	3.3 a	2.0 a		13.4
Giza 716	60 cm	134.8 bc	178.7 cd	156.8 bc		10.1	8.1 a	19.8 a	14.0 a		11.4	1.0 ab	1.5 a	1.3 ab		8.6
	90 cm	106.2 f	180.2 bcd	143.2 de		9.3	7.9 a	17.7 ab	12.8 a		10.4	0.9 ab	2.1 a	1.5 ab		10.1
	120 cm	126.6 cd	190.8 b	158.7 bc		10.3	7.8 a	16.1 ab	11.9 ab		9.7	0.6 ab	3.1 a	1.9 ab		12.3
Baldi broad bean	60 cm	105.7 f	165.1 ef	135.4 e		8.8	9.1 a	18.9 a	14.0 a		11.4	0.2 b	1.3 a	0.7 b		4.9
	90 cm	111.5 def	179.9bcd	145.7 cde		9.4	7.4 a	18.4 a	12.9 a		10.5	1.1 ab	1.7 a	1.4 ab		9.5
	120 cm	121.0 cdef	188.6 bc	154.8 bcd		10.0	8.1 a	13.7 ab	10.9 ab		8.9	0.9 ab	2.6 a	1.8 ab		11.8
Sugar beet (Single)		208.3 a	220.5 a	214.4 a		13.9	6.5 a	8.3 b	7.4 b		6.1	0.2 b	1.3 a	0.8 b		5.2
F value		33.54	18.62	25.98	—		0.32	1.07	1.17	—		1.29	0.99	1.22	—	
LSD		15.67	12.11	13.30			4.60	9.96	5.35			1.21	2.10	1.23		

Values signed by the same letter in the same row are, statistically, non-significant.

The intercropping faba bean with sugar beet in three spaces (60, 90 and 120 cm) was significantly differences on that mean number of piercing sucking pests during season 2015/2016 planting. The mean numbers of piercing sucking pest individuals ranged from 158.2 to 220.5 individuals/ 5 sugar beet on sugar beet + Giza 3 improve at 60 cm ridge space and sugar beet (single), respectively (Table, 1a). Also, the same trend was observed in the total mean of the piercing sucking pests during two successive seasons, the high infestation was detected on sugar beet (single), while the lowest was noticed on sugar beet + Giza 3 improve at 60 cm ridge space (Table, 1a). According to studies the occurrence % of these pests, the highest level of occurrence % was 13.9% on sugar beet (single). The present data asserted that intercropping faba bean with sugar beet on different seeds rate was significantly differences on that mean number of piercing sucking insect pests throughout season, 2014/2015 planting at 12.5%, 25% and 37.5% seed rates. The highest population of piercing sucking insect pests (190.7 individuals/ 5 sugar beet plants) was observed in the case of sugar beet+ Baldi broad bean at 25% seed rate , however, the lowest population was 113.0 individuals/ 5 sugar beet plants at 12.5% seed rate on sugar beet + Giza 3 improve (Table, 1b). Data showed in Table (1b) asserted that a highly effect of planting by different three seed rates (12.5%, 25% and 37.5%) of faba bean varieties Giza 3 improve, Giza 716 and broad bean (F value = 17.16 and LSD=

20.02). The infestation of piercing sucking pests was ranged between 172.6 and 96.4 individual/ 5 sugar beet plants on sugar beet+ Giza 3 improve at 37.5% seed rate and Sugar beet + broad bean with 25% seed rate during 2015/2016. The total mean of pest infestations was ranged from 118.3 - 176.8 individuals/5 sugar beet plants for Giza 3 improve at 12.5% seed rate and Giza 716 at 37.5% seed rate, respectively (F=7.89 and LSD = 19.058)(Table, 1b).

Table (1b): The mean number of piercing sucking insect pests, predators and parasitoids individuals on sugar beet intercropping with three faba bean verities under different seed rates during seasons, 2014/2015 and 2015/2016.

Treatments		Piercieng sucking pests					Predators					Parasitoids				
		2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %
Improved Giza 3	12.5%	113.0 d	123.5 b	118.3 e	1503.0	7.9	16.7 a	14.5 a	15.6 a	84.5	18.4	0.3 c	2.1 a	1.2 abc	12.9	9.1
	25%	145.7 c	157.9 a	151.8 bc		10.1	7.7 bc	5.5 b	6.6 bcd		7.8	1.5 ab	1.6 ab	1.6 ab		12.2
	37.5%	157.9 bc	172.6 a	165.3 ab		11.0	5.5 c	6.9 b	6.2 cd		7.3	1.6 ab	0.5 b	1.1 abc		8.2
Giza 716	12.5%	125.8 d	124.2 b	125.0 de		8.3	13.3 ab	8.4 b	10.8 b		12.8	0.9 bc	2.4 a	1.6 ab		12.8
	25%	156.5 bc	167.7 a	162.1 abc		10.8	7.8 bc	5.8 b	6.8 bcd		8.1	0.7 bc	1.4 ab	1.1 abc		8.3
	37.5%	190.1 a	163.4 a	176.8 a		11.8	6.3 c	5.4 b	5.9 d		7.0	1.5 ab	1.2 ab	1.4 abc		10.6
Baldi broad bean	12.5%	165.6 b	157.3 a	161.5 abc		10.7	14.7 a	6.4 b	10.5 bc		12.5	1.9 a	1.4 ab	1.6 ab		12.5
	25%	190.7 a	96.4 c	143.5 cd		9.6	7.4 bc	8.4 b	7.9 bcd		9.4	1.4 ab	2.1 a	1.8 ab		13.6
	37.5%	151.8 bc	157.3 a	154.6 bc		10.3	7.6 bc	6.4 b	7.0 bcd		8.3	0.6 bc	1.3 ab	1.0 bc		7.5
Sugar beet (Single)		186.3 a	102.0 c	144.2 c		9.6	6.2 c	8.2 b	7.2 bcd		8.5	0.2 c	1.2 ab	0.7 c		5.2
F value		15.43	17.16	7.89	—		3.58	2.06	3.81	—		3.13	1.56	1.85	—	
LSD		19.72	20.02	19.05			6.25	5.51	4.59			1.01	1.33	0.77		

Values signed by the same letter in the same row are, statistically, non-significant.

Data in Table (2a) showed that the piercing sucking insect pests individuals were observed in Baladi broad been (single) (205.7 individuals/ 10 leaves), followed by other single varieties, Giza 716 and Improved Giza 3 (176.5 and 176.2 individuals/ 10 leaves, respect.), Giza 3 improve (153.1 individuals/ 10 leaves) on ridge space 120cm, Giza 716 (129.5 individuals/ 10 leaves) on ridge space 60cm, Giza 3 improve on ridge space 90 cm (129.5 individuals/ 10 leaves) and 60 cm (127.9 individuals/ 10 leaves), Giza 716 on ridge space 90cm (126.6 individuals/ 10 leaves) , Broad bean on ridge space 90 cm (116.3 individuals/ 10 leaves) and 120 cm (99.4 individuals/ 10 leaves) and Giza 716 on ridge space 120cm (89.5 individuals/ 10 leaves). With respected the intercropping of three faba bean varieties with sugar beet, the population density of the insect pests was ranged between 218.5 – 156.6 individuals/ 10 leaves on Giza 716 (single) and Baldi broad bean at 120cm ridge space. The overall mean numbers of piercing sucking insect pests was ranged between 207.6 to 128.0 individuals/10 leaves of Baldi broad bean (single) and Baldi broad bean (intercropping), respectively (F= 8.46 and LSD= 25.00)(Table, 2a). According to seed rates of faba bean varieties, a significant differences was noticed with the mean number of piercing sucking insect pastes at seed rates of 12.5%, 25% and 37.5% of three different varieties during 20114/2015 (F= 6.04 and LSD= 18.04) (Table, 2b). The intercropping of sugar beet with broad bean at 12.5% seed rate was received the highest population of pests (181.4 indiduals/ 10 leaves). While, Giza 716 with sugar beet at 25% seed rate was harbored the lowest insects populations (117.2 individuals/ 10 leaves) (Table, 2b).

Table 2a: The mean number of piercing sucking insect pests, predators and parasitoids individuals on three faba bean varieties at different ridge spaces during seasons, 2014/2015and 2015/2016

Treatments		Piercieng sucking pests					Predators					Parasitoids				
		2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %
Improved Giza 3	60 cm	127.9 d	197.0 abcd	162.4 c	2005.4	8.1	7.0 a	11.4 abc	9.2 bc	125.6	7.3	0.1 b	1.6 bc	0.9 cd	15.8	5.4
	90 cm	129.5 d	185.7 bcde	157.6 c		7.9	8.1 a	12.0 abc	10.0 abc		8.0	0.4 ab	2.3 b	1.4 bcd		8.7
	120 cm	153.1 c	188.8 abcd	170.9 c		8.5	6.6 a	14.8 abc	10.7 abc		8.5	0.4 ab	1.4 bc	0.9 cd		5.7
Giza 716	60 cm	152.2 c	193.2 abcd	172.7 bc		8.6	6.9 a	13.2 abc	10.1 abc		8.0	0.9 ab	3.6 a	2.2 a		14.0
	90 cm	126.6 d	183.6 cde	155.1 cd		7.7	8.0 a	14.0 abc	11.0 abc		8.8	0.9 ab	2.4 ab	1.6 ab		10.3
	120 cm	89.5 f	173.1 de	131.3 de		6.5	9.2 a	18.2 ab	13.7 ab		10.9	0.7 ab	2.3 b	1.5 bcd		9.4
Baldi broad bean	60 cm	171.2 bc	177.4 de	174.3 bc		8.7	5.1 a	16.0 abc	10.6 abc		8.4	0.7 ab	1.7 bc	1.2 bcd		7.6
	90 cm	116.3 de	186.9 bcde	151.6 cde		7.6	7.9 a	20.9 a	14.4 ab		11.5	0.9 ab	2.2 bc	1.5 bcd		9.7
	120 cm	99.4 ef	156.6 e	128.0 e		6.4	9.6 a	21.2 a	15.4 a		12.2	1.1 a	2.3 b	1.7 ab		10.5
Improved Giza 3 (single)		176.2 b	216.5 ab	196.4 ab		9.8	4.7 a	6.4 c	5.5 c		4.4	0.7 ab	1.3 bc	1.0 bcd		6.3
Giza 716 (single)		176.5 b	218.5 a	197.5 ab		9.8	6.3 a	7.0 bc	6.7 c		5.3	0.7 ab	1.7 bc	1.2 bcd		7.3
Baldi broad bean (single)		205.7 a	209.6 abc	207.6 a		10.4	8.0 a	9.0 bc	8.5 bc		6.8	0.7 ab	1.0 c	0.8 d		5.2
F value		25.51	2.83	8.46	———		0.69	1.56	2.04	———		0.82	2.68	2.82	———	
LSD		20.08	31.29	25.00			5.16	11.44	6.01			0.86	1.20	0.73		

Values signed by the same letter in the same row are, statistically, non-significant.

Also, the intercropping faba bean with sugar beet on deferent space was significantly different on that mean number of piercing sucking pests during season 2015/2016 planting on seeds rate 12.5% compared with 25% and 37.5% (Table, 2b). The highest individuals of piercing sucking insect pests were observed in Giza 3 improve on seeds rate 25% with an average of 195.3 individuals per 10 leaves during 2015/2016 season. On the other hand, the exhibited results in Table (2b) showed a significant differences between the overall mean numbers of these pests infested the three verities of faba bean with the highest value 172.2 individuals /10 leaves of Giza 3 improve at 25% seed rate during two seasons (F= 7.35 and LSD= 16.27) (Table, 2b). Similar results were recorded by (Prasad D *et al*., (1987), Trenbath BR (1993), Patil S *et al*., (1997), Ibrahim Sahar, T.; *et al*., (2010), El Sadany, M.F and M.A. El-Shamy. (2016).

Predators:

With respect the study of predators, a slight significant different was noticed in case of predators during the two tested successive seasons, 2014/2015 and 2015/2016. During 2014/2015 season, the associated predators was ranged between 6,1 – 9,1 individuals on improved Giza 3 at 120cm ridge space and Baldi bean at 60cm ridge space, respectively (Table, 1a). However, the highest mean numbers of associated predators was 19.8 individuals/5 sugar plants during 2015/2016 season (Table, 1a). The occurrence % recorded the highest value on Giza 716 and baldi broad bean at 60cm ridge space (Table, 1a). Data in Table (1b) illustrated that the associated predators was recorded the highest mean numbers on improved Giza 3 at 12.5% seed rate intercropping with sugar beet with 18.4% of the occurrence %. Data in Table (2a) showed that the highest mean numbers of 9.6 and 12.2 individuals/ 10 leaves on Baldi broad bean at 120cm ridge space during 2014/2015 and 2015/2016 seasons, respectively. According seed rates, the lowest mean numbers of associated predators was noticed on improved Giza 3 at 12.5% seed rate with 6.1% of occurrence%, the highest was reported on Baldi broad bean varieties at 37.5% seed rate with 12% of occurrence % (Table, 2b).

The present results are similar to the finding results Ali *et al.* (1986). Moreover, the coccinellid predators, *C. undecimpunctata* and *C. vicina* var. *nilotica*

were appeared in sugar beet fields which associated with *Myzus persica* from April to June (Guirguis, 1985). The coccinellids, *Paederus alfierii* peaks were observed from March to May in sugar beet fields in Egypt (Guirguis, 1985), September to December (Youssef, 1994).

Table 2b: The mean number of piercing sucking insect pests, predators and parasitoids individuals on three faba bean varieties under different seed rates during seasons, 2014/2015 and 2015/2016.

Treatments		Piercieng sucking pests					Predators					Parasitoids				
		2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %	2014/2015	2015/2016	Mean	Total Mean	Occerance %
Improved Giza 3	12.5%	152.1 b	150.9 bc	151.5 bc	1761.2	8.6	6.4 b	7.8 ab	7.1 d	115.9	6.1	1.6 ab	1.3 b	1.5 b	24.3	6.0
	25%	149.1 b	195.3 a	172.2 a		9.8	9.4 ab	6.1 b	7.7 cd		6.7	1.5 ab	3.6 ab	2.6 ab		10.5
	37.5%	142.6 bc	127.2 e	134.9 de		7.7	11.9 ab	11.5 ab	11.7 abc		10.1	0.5 b	1.3 b	0.9 b		3.8
Giza 716	12.5%	150.9 b	136.1 bcde	143.5 cde		8.1	7.8 b	7.7 ab	7.7 cd		6.7	1.3 ab	1.2 b	1.3 b		5.2
	25%	145.0 bc	153.9 b	149.4 bcd		8.5	8.6 b	9.4 ab	9.0 bcd		7.8	1.4 ab	2.7 b	2.1 b		8.6
	37.5%	117.2 d	140.6 bcde	128.9 e		7.3	11.6 ab	12.7 a	12.2 ab		10.5	1.3 ab	1.7 b	1.5 b		6.1
Baldi broad bean	12.5%	181.4 a	149.3 bcd	165.4 ab		9.4	11.7 ab	8.5 ab	10.1 abcd		8.7	1.9 a	10.3 a	6.1 a		25.2
	25%	142.5 bc	132.2 cde	137.4 cde		7.8	11.1 ab	11.1 ab	11.1 abcd		9.6	1.4 ab	1.7 b	1.5 b		6.3
	37.5%	129.1 cd	130.2 de	129.6 e		7.4	14.9 a	13.0 a	13.9 a		12.0	1.0 ab	1.8 b	1.4 b		5.8
Improved Giza 3 (single)		147.7 b	190.5 a	169.1 a		9.6	8.7 b	5.8 b	7.3 d		6.3	1.5 ab	3.6 ab	2.5 ab		10.5
Giza 716 (single)		138.5 bc	149.2 bcd	143.9 cde		8.2	8.0 b	8.6 ab	8.3 bcd		7.2	1.3 ab	2.2 b	1.8 b		7.2
Baldi broad bean (single)		140.3 bc	130.6 de	135.5 cde		7.7	10.2 ab	9.4 ab	9.8 abcd		8.5	0.9 ab	1.4 b	1.2 b		4.8
F value		6.04	10.86	7.35	——		1.29	1.46	2.34	——		0.74	0.99	1.12	——	
LSD		18.04	19.95	16.27			6.00	5.73	4.19			1.23	7.39	3.82		

Values signed by the same letter in the same row are, statistically, non-significant.

Otherwise, the chrysopid, *Chrysoperla carnea* was detected by Mesbah (1991) in sugar beet fields in Egypt, Sengonca *et al.* (1995) in Germany with *Aphis fabae*.

Parasitoids:

In case of sugar beet, a few mean numbers of associated parasitoids was recorded during the two seasons, 2014/2015 and 2015/2016 under different ridge spaces (60, 90 and 120cm) and seed rates (12.5, 25 and 37.5% seed rates) (Tables, 1a,b). The occurrence % was ranged between 4.9-13.5 on Baldi broad bean and improved Giza 3 at 60 cm ridge space.

Also, a scarred mean numbers of associated parasitoids was noticed during two seasons under different ridge spaces and seed rates (Table, 2 a,b). The highest occurrence % was 14% on Giza 716 at 60cm ridge space (Table, 2a), and was 25.2% of occurrence % on Baldi broad bean under 12.5% seed rates (Table, 2b). These data are in accordance with those obtained by (Geo, J. F. (1990), Mustafa, - G.; *et al*., (2000), Ragab, M.E; A. *et al*., (2002), Rakhshani, -E; *et al*., (2005).

Effect of intercropping on sugar beet traits:

Effect of ridge width:

Result in Table (3) indicated that intercropping faba been with sugar beet on different ridge width significantly differences on sugar beet yield and yield components. significantly affected the root length and root diameter of sugar beet, in both growing seasons , significantly affected the top fresh weight , top yield/fed and purity % only in the first growing season by planting on 60 cm ridge width, compared to 90 and 120 cm. The highest values for all studied traits were observed in solid planting, followed by intercropping faba been with sugar beet on ridge width 120 , 90 and 60 cm respectively , which ridge width 120 cm gave the highest values for all traits except root length cm and purity % gave the lowest values , meanwhile ridge width 60 cm gave the lowest values for all traits except root length cm and purity % gave the highest values in both growing seasons . Similar result was

observed by Heba *et al*. (2016) Aboukhadra *et al*. (2013a) when sugar beet was intercropped with faba bean at variable row spacing. This effect may be due to the companion crop plants which resulted in greater exposure of the plant canopy to the solar radiation, shading effect and the high competition for light which negatively affect to the rate of photosynthesis was reflected the reduction of sugar beet root yield with increasing the companion crops density .The effect of intercropping on the root yield of sugar beet, mainly depends on the nature and growth habit of the companion crop. Abdel Motagally & Metwally (2014), similar to the current study, it was reported that the maximum significant root yield of sugar beet was achieved for pure stands followed by the lowest intercropping density of the companion crop, when sugar beet was intercropped with faba bean (Mohammed *et al*., 2005).

Table 3: Yield and sugar quality of sugar beet as affected by ridge spaces.

Treatments	Root			Top fresh weight / plant (kg)	Top yield (ton) /fed	Yield of		Sugar quality		
	Length (cm)	Diameter (cm)	Fresh weight (g)			Roots (ton) /fed	Sugar (ton) /fed	Sucrose %	TSS %	Purity
ridge spaces	2014/2015seasons									
60 cm	18.56	11.50	0.760	0.140	4.892	26.57	4.632	14.16	17.24	81.59
90 cm	18.12	11.94	0.771	0.156	5.472	26.99	5.212	14.31	17.56	80.36
120 cm	17.75	12.43	0.782	0.192	6.728	27.39	5.592	14.35	17.71	78.89
L.S.D. 5%	0.11	0.06	N.S	0.006	0.268	N.S	N.S	N.S	N.S	0.319
Sug. beet	18.96	12.99	1.396	0.435	8.840	31.935	4.16	14.29	17.62	80.74
	2014/2015seasons									
60 cm	17.93	11.27	0.745	0.124	4.332	26.060	4.146	13.89	16.95	80.86
90 cm	17.77	11.51	0.756	0.145	5.071	26.440	4.737	14.13	17.29	80.05
120 cm	17.31	12.17	0.767	0.172	6.036	26.890	5.103	14.21	17.56	78.37
L.S.D. 5%	0.514	0.217	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Sug. beet	18.66	12.67	1.289	0.408	8.494	30.788	4.14	14.17	17.55	80.28

* and NS indicate $p < 0.05$ and not significant, respectively.

Effect of Seedling rates (plant population):

Result in Table (4) indicated that intercropping faba been with sugar beet under plant population; 12.5, 25 and 37.5% significantly affected on yield, yield components and yield quality/. All traits were increased by decreased faba been density, except root length. The gradual decrease in these traits from 37.5% to 25 to 12.5% populations was associated with increasing faba bean plant density. The highest values for all studied traits were observed in solid planting, followed by intercropping 100 % sugar beet and 12.5 % faba bean population, gave the highest values for all traits except root length cm and purity % gave the lowest values, meanwhile intercropping 100 % sugar beet + 37.5% faba been gave the lowest values for all traits except root length cm and purity % gave the highest values in both growing seasons. Such results are mainly due to the effect of both intra and inter crop competition among sugar beet and faba been plants especially at higher faba been densities. Sugar beet plants were shaded by faba bean especially at higher bean densities, which decreased beet growth compared with solid culture. Similar findings to the current study were also reported by (Heba *et al*. 2016, El-Sahami *et al*., (2016) and Aboukhadra *et al*. (2013a). Root and sugar yields/fed took similar trend. The highest root yields were obtained from of 100% sugar beet sugar + 12.5 % faba. These results are in agreement with those of (Heba *et al*. (2016), El-Sahami *et al*., (2016), Aboukhadra *et al*. (2013a) and Abd El-All (2002). With respect sucrose and

T.S.S. percentage, analysis of variance revealed that significantly affected by the companion crop percentage, in both growing seasons which observed that increase sucrose and T.S.S. percentage of sugar beet intercropped with low densities of faba bean, respectively. Meanwhile purity percentage, significantly affected by the companion crop percentage, in both growing seasons which observed that increase purity percentage of sugar beet intercropped with hight densities of faba bean, respectively. This attributed such increase, to the considerable increase in root yield and, thus the amount of sugar extracted from the roots. Similar results were recorded by (Heba *et al*. (2016), El-Sahami *et al*., (2016), Aboukhadra *et al*. (2013a) and Abd El-All (2002).

Table 4: Yield and quality of sugar beet as affected by seeds rates.

Treatments	Root			Top fresh weight /plant (kg)	Top yield (ton) /fed	Yield of		Sugar quality		
	Length (cm)	Diameter (cm)	Fresh weight			Roots (ton) /fed	Sugar (ton) /fed	Sucrose %	TSS %	Purity
seeds rates.	2014/2015seasons									
12.5 %	17.62	12.04	0.786	0.207	7.119	27.510	7.404	15.22	18.48	78.35
25 %	18.08	11.97	0.771	0.160	5.600	26.930	4.725	14.51	17.45	80.59
37.5 %	18.73	11.86	0.756	0.122	4.262	26.450	3.309	13.09	16.58	81.89
L.S.D. 5%	0.060	0.077	0.009	0.006	0.121	0.173	0.106	0.110	0.178	0.149
Sug. beet (solid)	18.96	12.99	1.396	0.435	8.840	31.935	4.16	14.29	17.62	80.74
	2014/2015seasons									
12.5 %	17.20	11.82	0.770	0.376	6.907	26.970	6.522	15.05	18.29	77.69
25 %	17.60	11.60	0.756	0.357	5.149	26.470	4.410	14.27	17.21	80.17
37.5 %	18.20	11.54	0.741	0.338	3.383	25.950	3.053	12.91	16.30	81.42
L.S.D. 5%	0.114	0.075	0.009	0.006	0.123	0.174	0.129	0.056	0.245	0.172
Sug. beet (solid	18.66	12.67	1.289	0.408	8.494	30.788	4.14	14.17	17.55	80.28

* and NS indicate $p < 0.05$ and not significant, respectively.

Effect of faba bean cultivars:

Data presented in Table (5) showed that faba bean varieties was significantly affected on yield, yield components and yield quality in all traits in the first growing season , meanwhile root yield/fed^{-1}**, sugar** yield/fed^{-1}, sucrose**%**, T.S.S **%** and purity % was significantly affected only in the second growing season. The gradual increase in these traits were observed in solid planting followed by intercropping giza 3 improve, giza 716 and broad bean varieties, respectively. The highest values for all studied traits were observed in solid planting, followed by intercropping sugar beet + giza 3 improve gave the highest values for all traits except root length cm and purity % gave the lowest values in both growing seasons, meanwhile intercropping sugar beet + broad bean gave the lowest values for all traits except root length cm and purity % gave the highest values in both growing seasons. These data may be due to inheritance characters of these varieties are not similar, as well as different nature of vegetable growth between these varieties which broad bean vegetable growth was bigger and taller than giza 716 and giza 3 improve, respectively. These data are in accordance with those obtained by Khosvavi & Ramezanpour (2004), Liben *et al*. (2001), Fen *et al*. (2006) and Abou-Keriasha *et al*. (2008).

Table 5: Yield and quality of sugar beet as affected by faba bean cultivars.

Treatments	Root			Top fresh weight /plant (kg)	Top Yield (ton) /fed	Yield of		Sugar quality		
	Length (cm)	Diameter (cm)	Fresh weight (gm)			Roots (ton) /fed	Sugar (ton) /fed	Sucrose %	TSS %	Purity
faba bean cultivars	2014/2015seasons									
Giza3 improve	17.21	11.99	0.874	0.150	6.868	30.600	5.553	14.46	17.68	79.13
Giza 716	18.05	11.97	0.759	0.127	5.794	26.560	5.223	14.26	17.50	80.09
Broad bean	19.17	11.93	0.680	0.089	4.429	23.780	4.663	14.09	17.33	81.62
L.S.D. 5%	0.0375	0.008	1.646	2.917	0.003	0.003	0.001	0.006	0.002	0.072
Sug. Beet (solid)	18.96	12.99	1.396	0.435	8.840	31.935	4.16	14.29	17.62	80.74
	2014/2015seasons									
Giza3 improve	16.66	11.69	0.859	0.130	5.802	29.070	5.149	14.19	17.39	78.61
Giza 716	17.50	11.63	0.745	0.120	5.273	26.560	4.632	14.08	17.28	79.83
Broad bean	18.82	11.62	0.665	0.088	4.363	23.760	4.204	13.95	17.13	80.84
L.S.D. 5%	N.S	N.S	N.S	N.S	N.S	0.003	0.003	0.013	0.004	0.086
Sug. beet (solid)	18.96	12.67	1.289	0.408	8.494	30.788	4.14	14.17	17.55	80.28

* and NS indicate p <0.05 and not significant, respectively.

Effect of intercropping on faba bean traits:

Effect of ridge width:

Data in Table (6) recorded that the significantly effect of ridge width on faba bean traits in both growing seasons except protein content % has not affected by ridge width only in the second growing season. Increasing ridge width from 60 cm to 120 cm reduced plant height only of faba bean. This is was true due to crowding plant population on ridge width of 60 cm, compared to 90 and 120 cm width.

Table 6: Yield and quality of faba bean (*Vicia faba* L.) as affected by ridge spaces.

Treatments Ridges specs spaces	Plant height/ cm	Number of branches/ plant	Number of bods/ plant	Number of seeds/ plant	Weight of 100 seeeds/ gm	Straw yield/ fed (ton)	Grain yield/ fed (ardab)	Protein %
2014/2015 season								
60 cm	119.46	3.84	16.71	46.72	69.26	0.577	4.42	20.13
90 cm	118.14	4.17	17.89	52.30	71.44	0.584	4.94	20.62
120 cm	116.85	4.89	19.05	57.18	72.58	0.588	5.49	20.73
L.S.D. at 5% level	0.202	0.242	0.168	0.533	0.046	1.452	0.046	0.067
Faba bean (solid) Giza 3	111.58	3.71	19.67	59.01	45.67	0.928	9.528	22.66
Faba be (solid) Giza 716	119.66	4.88	20.45	61.35	52.33	1.196	9.603	21.87
F. b (sold) Broad bean	129.33	4.67	21.66	64.98	55.78	1.346	10.590	20.67
2015/2016 season								
60 cm	118.63	3.42	15.84	46.36	68.26	0.566	4.19	20.14
90 cm	117.57	3.80	16.75	51.68	70.51	0.574	4.91	20.28
120 cm	115.90	4.41	17.33	56.99	71.61	0.579	5.36	21.95
L.S.D. at 5% level	0.176	0.067	0.168	0.489	0.033	2.625	0.043	ns
Faba bean (solid) Giza 3	110.42	3.66	19.33	57.99	45.12	0.919	9.466	22.45
Faba bean (solid) Giza 716	119.33	4.26	19.66	58.98	52.11	1.185	9.536	21.33
F. b (sold) Broad bean	128.99	4.33	20.33	60.99	55.33	1.284	9.960	20.27

* and NS indicate p <0.05 and not significant, respectively.

On the other hand, Number of branches/plant, number of pods/plant, number of seeds/plant, weight of 100 seeds, straw yield / fed (ton) and grain yield /fed ardab were increased by increasing ridge width from 60 cm to 120 cm except plant height were decreased by increasing ridge width from 60 cm to 120 cm.

The highest values for all studied traits were observed in solid planting, followed by intercropping faba been with sugar beet on ridge width 120, 90 and 60 cm respectively, which ridge width 120 cm gave the highest values for all traits except plant height cm gave the lowest values, meanwhile ridge width 60 cm gave the lowest values for all traits except plant height gave the highest values in both growing seasons. Similar result was observed by Heba *et al*. (2016) Aboukhadra *et al*. (2013a) when faba bean was intercropped with sugar beet at variable row spacing. This effect may be due to the companion crop plants which resulted in greater exposure of the plant canopy to the solar radiation and the high competition for light which negatively affect to the rate of photosynthesis was reflected the reduction of faba bean yield with increasing the companion crops density. The effect of intercropping on the yield of faba bean, mainly depends on the nature and growth habit of the companion crop. Abdel Motagally & Metwally (2014). Similar to the current study, it was reported that the maximum significant faba bean was achieved for pure stands followed by the lowest intercropping density of the companion crop, when faba bean was intercropped with sougar beet (Mohammed *et al*., 2005).

Effect of Seed rates (plant population)

Data in Table (7) demonstrated that, increasing seed rates from 12.5 % to 37.5% increased plant height, straw yield/ fed and decrease other studied traits. These data are true due to crowding plants and much population, so plants got taller to act with solar energy and escape from shading.

Table 7: Yield and quality of faba bean (*Vicia faba* L.) as affected by seeds rates.

Treatments Seeds rate	Plant height/ cm	Number of branches/ plant	Number of bods/ plant	Number of seeds/ plant	Weight of 100 seeeds/ gm	Straw yield/ fed (ton)	Grain yield/ fed (ardab)	Protein %
2014/2015 season								
12.5 %	107.83	5.08	18.74	55.06	73.76	0.245	2.97	21.63
25 %	118.18	4.24	17.96	51.54	72.07	0.592	5.09	20.53
37.5 %	128.43	3.57	16.97	49.59	69.05	0.733	6.79	19.93
L.S.D. at 5% level	0.135	0.198	0.119	0.268	0.046	1.070	0.020	0.058
Faba bean. (solid) Giza 3	**111.58**	**3.71**	**19.67**	**59.01**	**45.67**	**0.928**	**9.528**	**22.66**
Faba bean. (sold) Giza 716	**119.66**	**4.88**	**20.45**	**61.35**	**52.33**	**1.196**	**9.603**	**21.87**
Faba bean (sold)Broad bean	**129.33**	**4.67**	**21.66**	**64.98**	**55.78**	**1.346**	**10.590**	**20.67**
2015/2016 season								
12.5 %	107.08	4.84	17.57	54.83	72.87	0.417	2.86	21.47
25 %	117.01	3.51	16.26	51.15	71.09	0.584	4.96	21.30
37.5 %	127.63	3.27	15.73	49.05	68.12	0.718	6.63	19.60
L.S.D. at 5% level	0.095	0.067	0.099	0.309	0.033	1.186	0.0232	1.152
Faba bean. (solid) Giza 3	**110.42**	**3.66**	**19.33**	**57.99**	**45.12**	**0.919**	**9.466**	**22.45**
Faba bean (sold) Giza 716	**119.33**	**4.26**	**19.66**	**58.98**	**52.11**	**1.185**	**9.536**	**21.33**
Faba bean (sold) Broad bean	**128.99**	**4.33**	**20.33**	**60.99**	**55.33**	**1.284**	**9.960**	**20.27**

* and NS indicate $p < 0.05$ and not significant, respectively.

The gradual decrease in these traits from 37.5% to 25 to 12.5% populations was associated with increasing faba bean plant density. The highest values for all studied traits were observed in solid planting, followed by intercropping 12.5 % faba bean population + 100 % sugar beet, gave the highest values for all traits except plant height cm gave the lowest values, meanwhile intercropping 37.5% faba been + 100 % sugar beet gave the lowest values for all traits except plant height cm gave the highest values in both growing seasons.

Such results are mainly due to the effect of both intra and inter crop competition among faba been and plants sugar beet especially at higher faba been densities, which decreased faba been growth compared with solid culture, may be due to the less disturbance in the habitat in homogeneous environment of mono cropping systems (Grime, 1977). Similar findings by other researchers (Farghally *et al*., 2003; Mohammed *et al*., 2005 and Abo Mostafa *et al*., 2012), they reported that some faba bean yield components like seed yield per plant, number of seeds per pod and 100-seed weight were decreased with increasing the percentage of faba bean intercropped with sugar beet . Similar findings to the current study were also reported by (Heba *et al*. (2016), El-Sahami *et al*., (2016) and Aboukhadra *et al*. (2013a).

Effect of faba bean cultivars:

Data in Table (8) Showed that, significantly differences effect among faba bean varieties on yield, yield components and yield quality in all traits in both growing season. The highest values for all studied traits were observed in solid planting, followed by intercropping broad bean + 100 % sugar beet, gave the highest values for all traits except number of branches / plant and protein content % gave the lowest values, meanwhile intercropping Giza 3 improve + 100 % sugar beet gave the lowest values for all traits except number of branches / plant and protein content % gave the highest values in both growing seasons.

Table 8: Yield and quality of faba bean (*Vicia faba* L.) as affected by Faba bean varieties.

Treatments Faba bean varieties	Plant height/ cm	Number of branches/ plant	Number of bods/ plant	Number of seeds/ plant	Weight of 100 seeeds/ gm	Straw yield/ fed (ton)	Grain yield/ fed (ardab)	Protein %
2014/2015 season								
Giza 3 improve	115.66	4.45	17.83	50.61	62.70	0.571	4.76	20.72
Giza 716	117.83	4.35	17.66	51.66	79.66	0.584	4.80	20.69
Broad bean	120.96	4.09	18.17	53.96	92.84	0.594	5.29	20.68
L.S.D. at 5% level	0.126	0.213	0.126	0.272	0.021	0.890	0.021	0.029
Faba bean. (solid) Giza 3	111.58	3.71	19.67	59.01	45.67	0.928	9.528	22.66
Faba bean (sold) Giza 716	119.66	4.88	20.45	61.35	52.33	1.196	9.603	21.87
Faba bean (sold) Broad bean	129.33	4.67	21.66	64.98	55.78	1.346	10.590	20.67
2015/2016 season								
Giza 3 improve	114.96	4.25	16.33	50.21	61.62	0.559	4.37	20.81
Giza 716	116.90	3.71	16.51	51.12	78.55	0.574	4.76	20.80
Broad bean	119.86	3.66	16.72	53.70	91.54	0.586	4.98	20.76
L.S.D. at 5% level	0.087	0.078	0.074	0.213	0.021	3.034	0.021	0.017
Faba bean. (solid) Giza 3	110.42	3.66	19.33	57.99	45.12	0.919	9.466	22.45
Faba bean (sold) Giza 716	119.33	4.26	19.66	58.98	52.11	1.185	9.536	21.33
Faba bean (sold)Broad bean	128.99	4.33	20.33	60.99	55.33	1.284	9.960	20.27

* and NS indicate $p < 0.05$ and not significant, respectively.

These data may be due to inheritance characters of these varieties are not similar, as well as different nature of vegetable growth between these varieties which broad bean vegetable growth was bigger and taller than giza 716 than giza 3 improve, respectively, and where the dense sowing would lead to severe competition among plants for water, light and nutrients, resulting in the production of less vigorous plants. These data are in accordance with those obtained by Aboukhadra *et al*., (2013a). Khosvavi &Ramezanpour (2004), Liben *et al*. (2001), Fen *et al*. (2006) and Abou-Keriasha *et al*. (2008). They reported that increased above and below ground competition in the intercropping system, where the dense sowing would lead to severe competition among plants for water, light and nutrients, resulting in the production of less vigorous plants, and Ghosh *et al*. (2009) and Abou-Keriasha *et al*. (2011). Indicated that short in intercropped faba bean plants might due to more shading effect of intercropped crops density and adverse low of the intercepted light competition for nutrients, carbon dioxide might have had reflect adverse effect on growth of faba bean when intercropping on sugar beet.

Competitive relationships:

Land equivalent ratio (LER),:

Data in Table 9, indicated that the interaction between the companion crop species and percentage had a positive impact on the land usage, in both growing seasons. Generally intercropping sugar beet with faba bean under three tested, ridge width, seed rates and faba bean varieties tended to increase the land usage. LER from the combined data for both years were greater than one. It could be concluded that actual productivity was higher than the expected productivity. The highest LER was achieved with the highest companion crop percentage (100 % sugar beet + giza 3 improve variety + 37.5 % giza 3 seed rates) gave 1.73 followed by (100% sugar beet + Giza 716 variety + 37.5% Giza 716 Seed rates) gave 1.61, followed by (100% sugar beet + Broad bean variety + 37.5 % Broad bean seed rates) gave 1.48, respectively. As observed in the current study, due to the different root systems of sugar beet and faba bean varieties, Where the depth of the root system (Giza 3 small, Giza 716 medium and broad bean large), which allows crops in the system of intercropping using soil moisture and nutrients at different depths, hence the difference of underground competition between them do comparing the values of the LER. These results are agreement with those obtained by, Abou Mostafa et al. (2012) and Abd El-All (2002) when intercropping sugar beet with faba bean, and Ahmed et al. (2013), espoused that LER values were greater than 1.00 in any intercropping system of sugar beet with faba bean. Similar trend to that of LER was also observed for Return Land equivalent fed^{-1} (L.E), Total income, fed^{-1} (L.E), Total cost, Net profit and Monetary advantage index (MAI), which is an indicator of the economic feasibility of intercropping system of sugar beet with faba bean, Similar results were observed by Fen *et al*. (2006), Abou-Keriasha *et al*. (2008) and Eskandari & Ghainbarf (2010). Conclusion Intercropping faba bean on other winter crops like sugar beet are important factor which help increased productivity and decrease gap between the local production and human consumption.

Table 9: Land equivalent Ratio (LER), Return Land equivalent fed^{-1} (L.E), Total income, fed^{-1} (L.E), Total cost, Net profit and Monetary advantage index (MAI) of faba bean as affected by intercropping with sugar beet during 2014/2015and 2015-2016 seasons.

treatments	Land. Equvil. Ratio			Return L.E fed^{-1}		Total income	Total cost	Net profit	Mai
	ler S	ler F	LER	ler suger	ler Faba b				
12.5 %	0.97	0.24	1.21	11413.13	2128.95	13542.08	3687.5	9854.5	6167.0
60cm – gyza 3 25	0.95	0.46	1.41	11255.63	3979.80	15235.43	3875.0	11360.4	7485.4
37.5 %	0.94	0.59	1.53	11111.25	5124.15	16235.40	4062.5	12172.9	8110.4
12.5 %	0.97	0.29	1.26	11518.13	2545.65	14063.78	3687.5	10376.2	6688.7
90cm – gyza 3 25	0.97	0.53	1.50	11465.63	4588.20	16053.83	3875.0	12178.8	8303.8
37.5 %	0.95	0.71	1.66	11176.88	6123.15	17300.03	4062.5	13237.5	9175.0
12.5 %	0.98	0.30	1.28	11596.88	2588.40	14185.28	3687.5	10497.7	6810.2
120cm – gyza 3 25	0.97	0.55	1.52	11499.38	4770.45	16269.83	3875.0	12394.8	8519.8
37.5 %	0.96	0.77	1.73	11353.13	6613.20	17966.33	4062.5	13903.8	9841.3
12.5 %	0.84	0.24	1.08	9909.37	2143.80	12053.17	3687.5	8365.6	4678.1
60cm - gy 716 25	0.83	0.46	1.29	9772.50	4009.50	13782.00	3875.0	9907.0	6032.0
37.5 %	0.81	0.60	1.41	9594.37	5197.05	14791.42	4062.5	10728.9	6666.4
12.5 %	0.84	0.29	1.13	9995.62	2554.65	12550.27	3687.5	8862.7	5175.2
90cm - gy 716 25 –	0.83	0.53	1.36	9851.25	4617.90	14469.15	3875.0	10594.1	6719.1
37.5%	0.82	0.71	1.53	9725.62	6118.20	15843.82	4062.5	11781.3	7718.8
12.5 %	0.85	0.30	1.15	10100.60	2594.70	12695.30	3687.5	9007.8	5320.3
120cm - gy 716 25	0.85	0.56	1.41	10008.70	4838.85	14847.55	3875.0	10972.5	7097.5
37.5 %	0.83	0.78	1.61	9838.12	6682.50	16520.62	4062.5	12458.1	8395.6
12.5 %	0.76	0.26	1.02	9050.62	2335.95	11386.57	3687.5	7699.0	4011.5
60cm - Broad 25	0.71	0.47	1.18	8433.75	4289.85	12723.60	3875.0	8848.6	4973.6
37.5 %	0.70	0.61	1.31	8263.12	5688.90	13952.02	4062.5	9889.5	5827.0
12.5 %	0.78	0.27	1.05	9181.87	2558.70	11740.57	3687.5	8053.0	4365.5
90cm - Broad 25	0.75	0.50	1.25	8874.37	4695.30	13569.67	3875.0	9694.6	5819.6
37.5 %	0.71	0.66	1.37	8388.75	6141.15	14529.90	4062.5	10467.4	6404.9
12.5 %	0.78	0.45	1.23	9181.87	4193.55	13375.42	3687.5	9687.9	6000.4
120cm Broad 25	0.76	0.54	1.30	9043.12	5006.25	14049.37	3875.0	10174.3	6299.3
37.5 %	0.76	0.72	1.48	8977.50	6704.55	15682.05	4062.5	11619.5	7557.0
Solid Suger beet	1.0	-	1.0	11760.56	-	11760.56	3500	8260.5	4760.5
Solid Faba bean				-					
Giza 3 improve	-	1.0	1.0	-	8547.30	8547.30	1500	7047.3	5547.3
Giza 716	-	1.0	1.0	-	8964.00	8964.00	1500	7464.0	5964
Broad bean	-	1.0	1.0	-	9247.50	9247.50	1500	7747.5	6247.5

CONCLUSION

It could be concluded that intercropping 100 % sugar beet + 37.5 % faba bean Giza 3 improve cultivar (52500 plants / fed) on ridge width 120 cm gave the greatest values for all treatments which gave the maximum yield benefits and least competition between component crops compared with other treatments and gave the highest values of Land equivalent ratio (LER), Farmer's benefit (Total return of intercropping culture , Net profit fed^{-1}) and Monetary advantage index (MAI) compared with other treatments to increase total productivity per unit area improve land equivalent ratio. Also intercropping 100% sugar beat +25% faba bean Baladi Broad bean cultivar (3500 plants /fed). On ridge space 60 cm infested by the lowest number of piercing sucking insect pests.

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ARABIC SUMMARY

تأثير تحميل ثلاثة أصناف من الفول البلدي مع بنجر السكرعلى الحشرات الثاقبة الماصة وأعدائها الحيوية تحت معدلات تخطيط و معدلات تقاوي على إنتاجية كلا المحصولين

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أجريت هذة التجربة بمحطة البحوث الزراعية بالجميزة ، محافظة الغربية موسمى 2014 /2015 بهدف دراسة تأثير تحميل الفول البلدى مع بنجر السكر تحت معدلات تخطيط (60 و90 و 120 سم) و معدلات تقاوى (12.5 - 25 و37.5 % من الفول البلدى) وثلاثة أصناف من الفول البلدى (جيزة 3 محسن و جيزة 716 و هجين بلدي) على إنتاجية كلاالمحصولين.

استخدم تصميم القطع المنشقة مرتين مع استخدام ثلاث مكررات حيث وضع معدل التخطيط فى القطع الرئيسية و معدلات التقاوى فى القطع التحت شقية و اصناف الفول البلدى فى القطع التحت تحت شقية.

وكانت النتئج المتحصل عليها كالتالى:

أثرت معدل التخطيط معنويا على انتاجية بنجر السكر حيث اعطى معدل التخطبط 60 سم أعلى معدل النتائج لطول الجذر بينما سجل معدل التخطيط 120 سم أعلى النتائج لكل من قطر الجذر والمجموع الخضرى للنبات و انتاجية الجذور للفدان.

أثر معدل التقاوى للفول البلدى معنويا على قطر الجذر وانتاجية الفدان و وزن المجموع الخضرى وكمية السكر للفدان حيث زادت هذه القياسات بنقص كمية التقاوى من 37.5 حتى 12.5% .

لم تؤثر اختلاف الاصناف على مكونات وانتاجية محصول البنجر.

أثرت معدل التخطيط معنويا على انتاجية الفول البلدى حيث اعطى معدل التخطبط 120 سم اعلى النتائج مع عدد القرون للنبات و عدد الحبوب للنبات و وزن ال100 حبة ووزن محصول الفدان.

أثر معدل التقاوى للفول البلدى معنويا على انتاجية الفول البلدى حيث اعطى معدل التقاوى 37.5 % اعلى النتائج مع عدد القرون للنبات و عدد الحبوب للنبات و وزن ال100 حبة و وزن محصول الفدان الكلى.

تم دراسة الحشرات المرتبطة بكلا المحصولين تحت ظروف المعاملات المذكورة والأعداء الحيوية المرتبطة بها وأظهرت النتائج أن هناك فروقاً معنوية بين الأصناف من حيث درجة الإصابة بالحشرات والأعداء الحيوية المرتبطة بها ولم يكن هناك أي فروق معنوية بين متوسطات الأصناف عند إهمال المسافات ومعدلات التقاوي.

أثر اختلاف الاصناف معنويا على مكونات وانتاجية محصول الفول البلدى حيث سجل الصنف الهجين أعلى النتائج.

أتضح من الدراسة أن تحميل 100% من بنجر السكر (35000 نبات / فدان) مع الفول البلدي الهجين بمعدل تقاوي 25% (3500 نبات لكل فدان) على مسافة 60سم أعطت أقل نسبة إصابة بالنسبة للحشرات على هذا الصنف.