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Role of faba bean planted around and within sugar beet fields on insect infestations

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Abstract:

Faba bean is a good source of pollen and nectar for attracting natural enemies of insects, also it is a major source of protein for human and animals feeding in Egypt. Therefore, the present study was conducted at Tayfa village, Kafr El-Sheikh Governorate during 2017/2018 and 2018/2019 for investigating the role of faba bean planted around and within sugar beet fields (not intercropping) on insect infestations, natural enemies and farmer income. Obtained results demonstrated that mean numbers of infested plants (10 plants each replicate) with beet fly *Pegomyia mixta* Vill. (Deptera: Anthomyiidae), beet moth *Scrobipalpa ocellatella* (Boyd.) (Lepidoptera: Gelechiidae), tortoise beetle *Cassida vittata* Vill. (Coleoptera: Chrysomelidae) and aphid (*Aphis* spp.) in a sugar beet + faba bean field were recorded 3.00, 2.67, 2.33 and 4.50 in the first season, while, in the second season it recorded 3.67, 2.00, 4.00 and 5.00, respectively, while, in a sole sugar beet field the mean numbers of infested plants were 5.44, 6.56, 6.11 and 6.56 in the first season and 6.33, 6.16, 8.06 and 7.94 in the second season, respectively. Data also cleared that field mixed beet and faba infestation by beet fly, beet moth and tortoise beetle were beginning about 2 months (on February 25) later than sole beet, while, aphis infestation was beginning in the same time in both treatments. Statistical analysis proved significant differences between both fields during the both seasons have been detected. Further, total population of natural enemies, *Chrysoperla carnea* Steph. (Neuroptera: Chrysopidae), *Syrphus corollae* Fabricius (Diptera: Syrphidae), *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae), *Scymnus* sp. (Coccinellidae: Coleoptera) as predators and *Opius nitidulator* Nees (Hymenoptera : Braconidae) , *Monorthochaeta nigra* Blood (Hymenoptera : Trichogrammatidae) , *Agathis* sp. (Hymenoptera:Braconidae) and *Diadegma oranginator* Aubert (Hymenoptera:Ichneumonidae) as parasitoids in a sugar beet + faba bean plant were recorded 30.22 and 42.33 during 2017/2018 and 2018/2019, respectively. Whereas, in a sole sugar beet plant were recorded 7.06 and 7.39 in both seasons, respectively. Meantime, the additional return beside price the main crop was 1690 and 1470 L.E (Egyptian pound) to a sugar beet + faba bean in comparison with a sole sugar beet field.

Introduction

Nowadays, sugar beet in Egypt ranked the first in sugar production followed by sugar cane, where the total sugar production recorded 2.5 million ton in harvesting season of 2018-2019. Where sugar beet cultivation was extended to reach about 621000 feddan (about 261000 hectar) (Sugar Crops Council, 2018) in Delta (Northern Egypt).

One of the main problems associated with the Egyptian agriculture system is the low area of cultivated land per farmer. In average, 43% of the farmers own or work in fields of area one feddan or less. This led to an increase need to maximize land usage to enhance farmer's income (Ahmed *et al.* 2009). Farghaly *et al.* (2003) reported that the highest values of land equivalent ratio were found when sugar beet was intercropped with onion or faba bean. Some Egyptian Farmers used to grow faba bean in sugar beet fields (Hamdany and El-Assar, 2017).

From the insect control point of view, Risch (1984) and Baliddawa (1985) reported that population of several insect pests have been reduced under conditions of plant species diversity, indicating that intercropping could be used for the control of some insect pests. Further, the multiple cropping could be a powerful component of cultural pest control, as well as it satisfies the socio-economic objectives of the growers (Perrin, 1977). Omar *et al.* (1994) reported that reductions were recorded in cotton infestations with major insects when intercropped with cowpea, as compared with infestations in sole cotton. Wnuk and Wojciechowicz-Zytko (2007) pointed out that intercropping of two crop plants which are not shared hosts for insects is a method for insect control without usage insecticides.

Modern agriculture has often caused the simplification of biological and environmental structures in the agro-ecosystem mainly through intensive cropping practices. One of the methods of enhancing the population of natural enemies is enriching the field neighborhood with flowering plants. Wnuk and Wojciechowicz-Zytko (2007) showed that *Phacelia tanacetifolia* Benth is a good source of pollen and nectar for beneficial insects (Predators + parasitoids). They added that *P. tanacetifolia* was intercropped with Faba bean, the population of *Aphis faba*e Scop. was reduced because of the synergistic effect of *P. tanacetifolia* pollens and nectars to the predatory Syrphids that feed upon aphids. The rate of infestations by *Pegomyia mixta* Vill. (Deptera: Anthomyiidae) and *Cassida vittata* Vill. (Coleoptera: Chrysomelidae) were less in sugar beet plants intercropped with faba bean as compared with their numbers in sole sugar beet (El- Fakharany *et al.*, 2012). In addition, higher population densities of the insect predators, *Chrysoperla carnea* Steph. (Neuroptera: Chrysopidae), *Paederus alfierii* Koch (Coleoptera: Staphylinidae) and *Scymnus* spp. (Coccinellidae: Coleoptera) were recorded in intercropped fields. Badawi and Shalaby (2015) indicated that in plant protection programs, it has become necessary to use non-chemical methods for controlling insect pests. In such concern, intercropping of two crops which do not act as hosts for the same pest can contribute in reducing insect pest populations. Thus, adoption of intercropping is to create more favorable conditions for beneficial insect species and inhibit pest infestations.

The current investigation aimed to study the effect of faba bean planting within (on canal and detachers) and around (on borders) sugar beet fields on insect infestations, natural enemies and the net farmers income.

Materials and methods

The current investigation was carried out at Tayfa village, Kafr El-Sheikh Governorate, during 2017/2018 and 2018/2019 growing seasons. This study aimed at the role of faba bean planted around and within sugar beet fields (not intercropping) on insect infestations, natural enemies and farmer income. The experimental area was about one feddan divided into two halves, the first half was planted with sugar beet only (Karam variety). The second half was planted with the same sugar beet variety + faba bean (Sakha variety) sowing within and around the second half. Distance as border between the halves about 200 meters left without sowing.

Every half divided into three equal area plots acted as three replicates es. The experimental design was Randomized Complete Block (RCBD). Sugar beet was cultivated on 20th October, whereas, faba bean was cultivated on 15th November during the two seasons. The study was carried out by:

1. **Recording infestation by four insects *i.e. Pegomyia mixta, Scrobipalpa ocellatella, Cassida vittata* and *Aphis* spp.:**

Numbers of infested plants were counted by visual examined monthly using randomly 10 plants from each replicate, from 30th December till 10th May during two seasons.

2. **Recording insect predators and parasitoids:**

Numbers of insect predators (*C. carnea* larvae + adult and *Syrphus corollae* Fabricius (Diptera: Syrphidae) adult, *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae) larvae + adult, *Scymnus* spp. and adult parasitoids such as *Opius nitidulator* Nees (Hymenoptera : Braconidae), Monorthochaeta nigra Blood (Hymenoptera : Trichogrammatidae) , *Agathis* sp. (Hymenoptera:Braconidae) and *Diadegma oranginator* Aubert (Hymenoptera:Ichneumonidae) were taken by sweep net method (50 double strikes per examination). After sweeping, the catch was put into paper pages, after that transferred to the laboratory and it put into refrigerator for 30 minutes to anethetizate the catch. Finally, the catches were put into petri dishes containing 70% ethyl alcohol for identifying by a stereoscope (4.8 – 56.0 x magnification).

3. **Statistical analysis:**

Mean numbers of infested plants and natural enemies population during 2017/2018 and 2018/2019 seasons in sugar beet + faba bean and a sole sugar beet were statistically analyzed according to the method described by Gomez and Gomez (1984). Means of the treatments were compared using the least significant difference (LSD) at 5 % level of probability.

Results and discussion

1. **Effect of faba bean planting around and within sugar beet on infestations with major insect pests and their associated natural enemies:**

Data presented in Tables (1, 2, 3 and 4) showed that the effect of f. bean planting around and within sugar beet fields (not intercropping) on infestations with certain insect pests during 2017/2018 and 2018/2019 seasons in comparison with a sugar beet field alone without faba bean. Mean numbers of

infested plants per 10 plants with beet fly (*P. mixta*), beet moth (*S. ocellatella*), tortoise beetle (*C. vittata*) and aphid species (*Aphis* spp.) in a sugar beet + faba bean field were 3.00, 2.67, 2.33 and 4.50 in the first season, respectively, while, in the second season were recorded 3.67, 2.00, 4.00 and 5.00, respectively. In a sole sugar beet field, the mean numbers of infested plants with the same insects were recorded 5.44, 6.56, 6.11 and 6.56 in the first season, whereas, in the second season number of infested plants with the four insects were 6.33, 6.16, 8.06 and 7.94, respectively. Statistical analysis showed that faba bean planted within (on canal and detachers), and around (on borders) sugar beet fields have reduced significantly the rate of sugar beet pest infestations as compared with their infestations in sole sugar beet during the two seasons.

Table (1): Mean of infested sugar beet plants with *Pegomyia mixta* / 10 plants each examination during 2017/2018 and 2018/2019 seasons.

Examination Date	2017/2018		2018/2019	
	Sugar beet + Faba bean	Sugar beet	Sugar beet + Faba bean	Sugar beet
30/12	0.00	1.00	0.00	1.67
26/1	0.00	2.33	0.00	4.33
25/2	3.33	5.00	4.33	6.33
30/3	5.00	9.67	6.33	9.67
24/4	5.00	8.33	6.00	8.33
10/5	4.67	6.33	5.33	7.67
Mean	3.00	5.44	3.67	6.33
Significant Status	**L.S.D Value at 0.05 = 2.389**		**L.S.D Value at 0.05 = 2.499**	

Table (2): Mean of infested sugar beet plants with *Scrobipalpa ocellatella* / 10 plants each examination during 2017/2018 and 2018/2019 seasons.

Examination Date	2017/2018		2018/2019	
	Sugar beet + Faba bean	Sugar beet	Sugar beet + Faba bean	Sugar beet
30/12	0.00	3.00	0.00	3.33
26/1	0.00	3.00	2.00	5.00
25/2	0.00	6.33	0.00	5.67
30/3	3.67	8.33	3.00	7.00
24/4	6.33	9.67	3.33	7.67
10/5	6.00	9.00	3.67	8.33
Mean	2.67	6.56	2.00	6.16
Significant status	**L.S.D Value at 0.05 = 3.031**		**L.S.D Value at 0.05 = 3.623**	

Table (3): Mean of infested sugar beet plants with *Cassida vittata* / 10 plants each examination during 2017/2018 and 2018/2019 seasons.

Examination Date	2017/2018		2018/2019	
	Sugar beet + Faba bean	Sugar beet	Sugar beet + Faba bean	Sugar beet
30/12	0.00	0.00	0.00	5.67
26/1	0.00	3.67	0.00	7.33
25/2	0.00	5.33	5.00	8.67
30/3	3.00	8.67	7.33	10.00
24/4	6.67	9.67	6.33	9.33
10/5	4.33	9.33	5.33	7.33
Mean	2.33	6.11	4.00	8.06
Significant status	**L.S.D Value at 0.05 = 3.576**		**L.S.D Value at 0.05 = 3.446**	

Table (4): Mean of infested sugar beet plant with aphid species / 10 plants each examination during 2017/2018 and 2018/2019 seasons.

Examination Date	2017/2018		2018/2019	
	Sugar beet + Faba bean	Sugar beet	Sugar beet + Faba bean	Sugar beet
30/12	1.33	4.67	1.33	6.00
26/1	2.00	3.33	2.67	5.33
25/2	4.67	6.33	5.33	7.67
30/3	6.33	8.33	6.00	9.33
24/4	7.00	9.00	7.00	10.00
10/5	5.33	7.67	7.67	9.33
Mean	4.50	6.56	5.00	7.94
Significant status	**L.S.D Value at 0.05 = 1.953**		**L.S.D Value at 0.05 = 2.111**	

Worth to mention that the infestation by beet fly, beet moth and tortoise beetle were began about 2 months (on February, 25) later in sugar beet+ faba bean as compared by sole sugar beet where the infestation began in the end of Dec. (Tables, 1, 2 and 3), meantime, aphis infestation was began in the same time in both beet + faba and sole beet (Table, 4). Such effect give evidence that delayed plant infestation has a vital role in lesser the damage caused by these insects in beet crop. .

Concerning the natural enemies, data in Table (5) showed that mean population of natural enemies in a sugar beet + faba bean field were 30.22 and 42.33 during 2017/2018 and 2018/2019, respectively, while, the mean population in a sole sugar beet field were 7.06 and 7.39 during both seasons, respectively. Statistical analysis showed that faba bean planted within (on canal and detachers), and around (on borders) sugar beet fields have increased significantly number of natural enemies as compared with sole sugar beet during two seasons. These results indicated that the reduction of sugar beet insect infestations in sugar beet + faba bean field may be due to the high populations of various natural enemies in this field in comparison with sole sugar beet ones.

Table (5): Mean of natural enemies in sole sugar beet and sugar beet + faba bean by sweep net (50 double strikes) each examination during 2017/2018 and 2018/2019 seasons.

Examination Date	2017/2018		2018/2019	
	Sugar beet + Faba bean	Sugar beet	Sugar beet + Faba bean	Sugar beet
30/12	17.33	3.33	23.67	3.67
26/1	20.33	6.00	29.00	6.33
25/2	22.00	7.33	33.00	6.33
30/3	29.67	7.00	41.00	8.00
24/4	41.67	10.00	57.33	9.33
10/5	50.33	8.67	70.00	10.67
Mean	30.22	7.06	42.33	7.39
Significant status	**L.S.D Value at 0.05 = 3.778**		**L.S.D Value at 0.05 = 3.881**	

The obtained results are in agreement with those of Baliddawa (1985), Perrin (1987), Omar *et al.* (1994), Farghaly *et al.* (2003), Wnuk and Wojciechowicz-Zytko (2007), El-Fakharany *et al.* (2012) and Badawy and Shalaby (2015) who demonstrated that the rate of infestations by sugar beet insects were less in sugar beet plants intercropped with faba bean as compared with in sole sugar beet. Moreover, higher populations of natural enemies were recorded in intercropped fields. Sengonca and Frings (1988) referred a reduction in *Aphis faba*e Scopoli (Hemiptera: Aphididae) population on sugar beet crop when *Phacelia* sp. was sown in beet field.

In this connection, Ruppert and Mollhan (1991) indicated that one of the methods of enhancing the population of natural enemies is enriching the field neighborhood with flowering plants. Altieria (1999) demonstrated that modern agriculture has often caused the simplification of biological and environmental structures in the agro – ecosystem mainly through intensive cropping practices. Morris and Li (2000) stated that coriander attracts hover flies and reduce pest infestation. Rizk (2005) found that *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) population were significantly diminished on different tomato strains intercropped with coriander as compared with control treatment. Risk (2011) also added that intercropping faba bean crop with *Coriandrum sativum* is a highly recommended method in pest control programs, it is a cheap, effective and safe method to minimize *Aphis craccivora* Koch (Hemiptera: Aphididae) population, to attract more predators as well to conserve biodiversity. Finally, Al-Beltagy (2015) suggested that intercropping systems create more favorable conditions for natural enemies and reduce insect infestations.

Concerning the aphid species, Hokkanen (1991) reported that trap crops are plant stands that are grown to attract insects to protect target crops from insect attack.

2. Economic benefits of faba bean planting around and within sugar beet:

Data presented in Table (6) showed that the importance of faba bean planted around and within sugar beet to farmer's income. Data cleared that sugar beet + faba bean have not spraying with insecticides, at the same time the farmer income increases due to the selling faba bean seeds after harvest. Therefore, the total sum income of sugar beet + faba

bean was 1690 and 1470 L.E (Egyptian pound) at the two seasons, respectively comparison with sole sugar beet. This profit considered as additional return beside price of the main crop.

Table (6): Effect of faba bean planting around and within sugar beet on farmers income during 2017/2018 and 2018/2019 seasons.

Seasons	2017/2018		2018/2019	
Crops	Sugar beet + faba bean	Sugar beet	Sugar beet + faba bean	Sugar beet
Insecticides spraying (L.E)	—	500	—	480
Price of faba bean seeds (L.E)	1190 (119 kg × 10 L.E)	—	990 (99 kg× 10 L.E)	—
Total return (L.E)	1690		1470	

The obtained results agree with those of Badawy and Shalaby (2015), El-Shamy *et al.* (2016) and Hamdany and El-Assar (2017).

It is concluded that the importance of faba bean for attracting and enhancing natural enemies, subsequently reducing the insect infestations. Further, additional increase in farmer income due to faba bean crop and to some extend to saving the cost of insecticides.

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