Academic Journal of Entomology 16 (3): 113-122, 2023
ISSN 1995-8994

DOI: 10.5829/idosi.aje.2023.113.122

Studies on Sensitivity of Two Sweet Potato Cultivars to Some Insect Pests and Their Associated Natural Enemies, in Dakahlia Governorate, Egypt

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Abstract: Sweet potato (Ipomoea batatas) plays a critical role in food security and it considered one of the most important root crop worldwide following potato. In this study, field experiments were conducted at Dakahlia Governorate during two successive seasons 2021-2022 to determine the sensitivity of two sweet potatoes varieties Abees and Beauregard to some insect pests and their associated natural enemies, as well as to study the population density of these pests on the two cultivars. Twelve insect pest species were surveyed in Abees cultivar have the potential for feeding on sweet potato foliage as belonging to eleven families and four orders; Hemiptera, Orthoptera, Lepidoptera and Diptera. Seven species are recognized as main sweet potato pests. The most occurring insect pests were *Empoasca decipiens* (22.55 % and 16.33 %), *Spodoptera littoralis* (17.37 % and 17.93%), *Agrius convolvuli* (7.77 % and 10.66%), *Spodoptera exigua* (7.87% and 8.98%), *Bemisia tabaci* (10.76 % and 22.64%), *Ostrinia nubilalis* (7.64 % and 6.59%) and *Herpetogramma hipponalis* (4.97% and 4.41%) in the first and second seasons respectively, While eleven insect pest species were surveyed in Beauregard cultivar as belonging to nine families and three orders; Hemiptera, Orthoptera and Lepidoptera. The most occurring insect pests were *Phenacoccus solenopsis* (36.73 % and 42.14 %), *Bemisia tabaci* (24.16% and 13.81 %), *Empoasca decipiens* (18.49 % and 10.52 %), *Spodoptera littoralis* (12.79 % and 9.90%), *Spodoptera exigua* (5.05 %4.75 %) and *A. convolvuli* (3.17 % and 8.06%) in the first and second seasons, respectively. The Abees cultivar was sensitive to *Aphis gossypii* and *Ostrinia nubilulis* than Beauregard cultivar while, Beauregard was sensitive to *Phenacoccus solenopsis* and *Eysarcoris ventralis* than Abees cultivar. The primary foliage-damaging pests are noctuid and Sphingidae, moth larvae (Lepidoptera) in both cultivars and *Phenacoccus solenopsis* (Hemiptera) in Beauregard cultivar.

Key words: *Ipomoea batatas* · Sweet potato · Beauregard · Abees

INTRODUCTION

Sweet potato, *Ipomoea batatas* (L.) Lam. (Convolvulaceae), is the sixth most important food crop worldwide, following rice, wheat, potatoes, maize and cassava [1]. This important root crop plays a critical role in food security, especially in developing countries. China is the largest producer of sweet potato, accounting for over 70% of the world's production, followed by Sub-Saharan Africa. While global sweet potato production has been relatively stable for the past 45 years [2]. Also sweet potato is one of the most important root crops in Egypt and many other countries in the world especially the Eastern and Southern parts of the African continent [3]. It consider not only provide a source of carbohydrates, but are a major source of vitamins A (carotenoids from the orange-fleshed types), C, B1, B2 (riboflavin), B3 (niacin), B6, E, biotin and pantothenic acid, as well as dietary fiber, potassium, copper, manganese and iron; additionally, they are low in fat and cholesterol [4, 5]. The total cultivated area in the year of 2017 reached about 18590 feddan with a total production of about 287244 tons and a mean of 9-17 tons/fed. Sweet potato cultivated area in Egypt El-Behera, Kafr-Elsheikh and Damietta governorates [6]. Meanwhile, sweet potato infection with Seventy-two species or genera of insects collected from or observed in commercial sweet potato *Ipomoea batatas* [7]. This study amid to determine the sensitivity of Abees and Beauregard Sweet potato cultivars to insect pest and their associated natural enemies.

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MATERIALS AND METHODS

Survey and Determination the Seasonal Abundance of Insect Pests and Their Associated Natural Enemies on Two Variety of Sweet Potato: The experimental trails were conducted at Baramoon Agriculture Research farm at, Dakahlia Governorate during two successive summer seasons 2021/2022 on Sweet potato, Ipomoea batatas (L.), the sweet potato variety were Abees and Beauregard. The two variety were cultivated on the 2nd of May 2021 and 21th of April 2022. An area of about quarter feddan was divided into two plots for each variety. The plants received the normal agricultural practices, with no insecticidal treatments. The following sampling techniques were used to survey the insect pests which infesting sweet potato varieties and their natural enemies and determination their seasonal abundance.

Sampling Technique

Visual Examination: All of the insect pests and natural enemies were counted on 20 plants of each variety chosen weekly at random from study area. The known insect species were counted and recorded, while the unknown species were counted and preserved for identification.

Sweep-net: Fifteen double strokes were taken weekly from Sweet potato cultivars and collected insects were put in plastic bags and transferred to the laboratory. The specimens were anesthetized with diethyl ether for identification, counting and recording.

Effect of Temperature and Relative Humidity on the Seasonal Abundance of Insect Pests and Their Natural Enemies: The daily temperature and relative humidity values were obtained monthly from the Agricultural meteorological Journal of Dakahlia Governorate. The weekly average degrees of these weather factors were calculated in each season to study these effects on the abundance of insect pests and their natural enemies of each variety Abees and Beauregard.

Analysis of Plant Components: Three months after sowing, leaflet samples of sweet potato varieties were picked and kept in paper bags. The leaflet specimens were sent to laboratory belonging to Soil, Water and Environment Research Institute, Agricultural Research Center Mansoura. Leaves Chlorophyll (a and b) was Measured using Methanol (100%) as described by Aminot and F. Rey [8]. Carotenoids were determined according to Lichtenthaler and Buschmann [9]. To digest the plant samples (either leaves or seeds) for determining the content of N.P.K. mixed of $HClO_4$+H_2So_4 was used as described by Peterburgski [10]. Nitrogen levels were determined using the Kjeldahl method, phosphorus levels were analyzed through the spectrophotometric method and potassium levels were ascertained using the flame photometer method [11].

Data Analysis: To reveal the apparent direct relationship between insect pests and natural enemies and between natural enemies and weather factors, statistical analysis was fulfilled. The correlation coefficient was obtained to describe the type of relationship among the studied variables were made with the Duncan's Multiple Range Test [12].

RESULTS AND DISCUSSIONS

Survey Mean Insect and Natural Enemies Infesting Sweet Potato Abees and Beauregard Cultivars in Dakahlia Governorate During 2021-2022

Insect Pests: Twelve insect pest species were surveyed in Abees variety have the potential for feeding on sweet potato foliage as belonging to eleven families and four orders; Hemiptera, Orthoptera, Lepidoptera and Diptera, each had four, two, five and one species respectively. Seven species are recognized as main sweet potato pests.

The most occurring insect pests were *E. decipiens* (22.55 % and 16.33 %), *S. littoralis* (17.37 % and 17.93%), *B. tabaci* (10.76 % and 22.64%), *A. convolvuli* (7.77 % and 10.66%), *S. exigua* (7.87% and 8.98%), *O. nubilalis* (7.64 % and 6.59%) and *H. hipponalis* (4.97% and 4.41%) in the first and second seasons, respectively. *N. viridula, M. subsultans* and *A. gossypii* Occurred at the rates of 4.54 & 5.47, 7.40 & 3.05 and 5.71& 1.17 % in the first and second seasons, respectively. However, the two remaining insect pests were found in very low numbers, ranging between 2.19 and 0.98% out of total surveyed insect pest's species (Table 1).

Meanwhile, the data presented in Table (2) indicated that eleven insect pest species were surveyed in Beauregard variety as belonging to nine families and three orders; Hemiptera, Orthoptera and Lepidoptera, each had five, two and four species respectively. The most occurring insect pests were *Ph. solenopsis* (36.73 % and 42.14 %), *B. tabaci* (24.16% and 13.81 %), *E. decipiens* (18.49 %and 10.52 %), *S. littoralis* (12.79 % and 9.90%), *S. exigua* (5.05 %4.75 %) and *A. convolvuli* (3.17 % and 8.06%) in the first and second seasons, respectively. *N. viridula, E. ventralis and H. hipponalis* Occurred at

Table 1: Insect pests and their associated natural enemies infesting sweet potato (Abees) variety by sweep-net and visual examination during 2020/2021-2021/2022 seasons

		Total number of insects and occurrence %				
		Season 1		Season 2		
Order/ Family	Scientific name	No	Occurrence %	No	Occurrence %	Pest status
Hemiptera						
Aphididae	*Aphis gossypii* (Glover)	216	5.71%	42	1.17%	Secondary
Aleyrodidae	*Bemisia tabaci* Genn	407	10.76%	807	22.64%	Main
Pentatomidae	*Nezara viridula* L.	172	4.54%	195	5.47%	Secondary
Cicadellidae	*Empoasca decipiens poli*	853	22.55%	582	16.33%	Main
Anthocoridae	*Orius laevigatus* (F.)	93	11.53%	73	8.21%	Beneficial
Orthoptera						
Acrididae	*Eyprepocnemis plorans*	83	2.19%	62	1.74%	Accidental
Trigonidiinae	*Trigonidium cicindeloides*	45	1.18%	35	0.98%	Accidental
Lepidoptera						
Sphingidae	*Agrius convolvuli* Linnaes	294	7.77%	380	10.66%	Main
Noctuidae	*Spodoptera littoralis* Boisd.	657	17.37%	639	17.93%	Main
Noctuidae	*Spodoptera exigua* (Hubner)	298	7.87%	320	8.98%	Main
Pyraustidae	*Ostrinia nubilalis*	289	7.64%	235	6.59%	Main
Pyralidae	*Herpetogramma hipponalis*	188	4.97%	157	4.41 %	Main
Coleoptera						
Coccinellidae	*Coccinella undecimpunctata* L	103	12.7%	206	23.17%	Beneficial
Coccinellidae	*Scymnus Syriacus*	74	9.18%	147	16.53%	Beneficial
Staphylinidae	*Paederus alfierii* Koch	49	6.07 %	30	3.37%	Beneficial
Hymenoptera						
Ichneumonidae	*Pimple roborattor*	33	4.09%	99	11.13%	Beneficial
Scelionidae	*Trissolcus basalis*	42	5.21%	43	4.83%	Beneficial
Braconidae	*Aphidius Colemani*	69	8.56%	52	5.84%	Beneficial
Braconidae	*Braconidae wasps*	93	11.53%	56	6.29%	Beneficial
Aphelinidae	*Encarsia formosa*	69	8.56 %	53	5.96%	Beneficial
Diptera						
Tachinidae	*Tachina larvarum*	115	14.26%	88	9.89%	Beneficial
Ephydridae	*Mosillus subsultans*	280	7.40%	109	3.05%	Secondary
Neuroptera						
Chrysopidae	*Chrysoperla carne* (steph.)	66	8.18 %	42	4.72 %	Beneficial

the rates of 3.19& 2.75, 1.96& 2.61 and 3.98&3.18 % in the first and second seasons, respectively. However, the two remaining insect pests were found in very low numbers, ranging between 1.26 to 0.97 % out of total surveyed insect pest's species.

From the survey illustrated in (Table 1 and 2) it was cleared that Abees variety was sensitive to *A. gossypii* and *O. nubilulis* than Beauregard cultivar while, Beauregard was sensitive to *ph. solenopsis* and E. *ventralis* than Abees cultivar. The primary foliage-damaging pests are noctuid and Sphingidae, moth larvae (Lepidoptera) occurred in both cultivars and *ph. solenopsis* (Hemiptera) in Bearegard variety. The same result is registered of Uwaidem *et al.,* [13] recorded that insects consisted of thirty four different species and approximately 80% were defoliators in sweet potato. Specifically economic damage was caused by sweet potato butterfly (*Acraea acerata*), leaf folders (Brachmia and sweet potato army worms (*Spodoptera spp*). John *et al.,* [14] noted that more than 50 insects belonging to several orders and at different stages of development infested sweet potato crop. About eight insect species caused major damage on the crop leaves, vines and tubers.

Natural Enemies (Beneficial Insect): The number of natural enemies increased one species in Abees variety than Beauregard variety this specie was *Aphidius colemani*, the species belonging to nine families and five order (Table 1 and 2). The most abundant predators were *C. undecimpunctata*, *S. syriacus* and *O. laevigatus* in Abees and Beauregard cultivars they were 12.7 and 23.17% & 7.64 and 17.32%, . 18 and 16.53 % & 4.72 and 14.09 %, 11.53 and 8.21 % & 5.06 and 7.78 % in the first

Table 2: Insect pests and their associated natural enemies infesting sweet potato (Beauregard) variety by sweep-net and visual examination during 2020/2021-2021/2022 seasons

		Total number of insects and occurrence %				
		Season 1		Season 2		
Order/ Family	Scientific name	N	Occurrence %	N	Occurrence %	Pest status
Hemiptera						
Aleyrodidae	*Bemisia tabaci* Genn	861	24.16%	512	13.81%	Main
Pentatomidae	*Nezara viridula* L.	114	3.19%	102	2.75%	Secondary
Pentatomidae	*Eysarcoris ventralis* (H.-S.)	70	1.96%	97	2.61%	Secondary
Pseudococcidae	*Phenacoccus solenopsis Tinsley*	1309	36.73%	1562	42.14%	Main
Cicadellidae	*Empoasca decipiens Paoli*	659	18.49%	390	10.52%	Main
Anthocoridae	*Orius laevigatus*(F.)	45	5.06%	53	7.78 %	Beneficial
Orthoptera						
Acrididae	*Eyprepocnemis plorans*	43	1.21%	36	0.97%	Accidental
Trigonidiinae	*Trigonidium cicindeloides*	43	1.21%	47	1.26%	Accidental
Lepidoptera						
Sphingidae	*Agrius convolvuli* Linnaes	113	3.17%	299	8.06%	Main
Noctuidae	*Spodoptera littoralis* Boisd	456	12.79%	367	9.90%	Main
Noctuidae	*Spodoptera exigua* (Hubner)	180	5.05%	176	4.75%	Main
Pyralidae	*Herpetogramma hipponalis*	142	3.98%	118	3.18 %	Secondary
Coleoptera						
Coccinellidae	*Coccinella undecimpunctata*	68	7.64%	118	17.32%	Beneficial
Coccinellidae	*Scymnus Syriacus*	42	4.72%	96	14.09%	Beneficial
Staphylinidae	*Paederus alfierii*	35	3.93%	38	5.58%	Beneficial
Hymenoptera						
Ichneumonidae	*Pimple roborattor*	43	4.83%	32	4.69%	Beneficial
Scelionidae	*Trissolcus basalis* Wollaston	35	3.93%	52	7.63%	Beneficial
Aphelinidae	Encarsia formosa	43	4.83%	89	13.06%	Beneficial
Braconidae	*Braconid wasps*	58	6.52%	73	10.71%	Beneficial
Diptera						
Tachinidae	*Tachina larvarum*	41	4.61 %	86	12.62 %	Beneficial
Neuroptera						
Chrysopidae	*Chrysoperla carnea (steph.)*	25	2.81 %	44	6.46 %	Beneficial

and second seasons, respectively. The most occurring parasitoids in Abees and Beauregard cultivars were *T. larvarum*, *Braconidae sp*. and *E. formosa* they were 14.26 and 9.89% & 4.61 and 12.62 %, 11.53 and 6.29 & 6.52 and 10.71% and 8.56 and 5.96 %& 4.83 and 13.06% in the first and second seasons, respectively. Moreover, *A. colemani* was most occurring just in Abees variety it was 8.56% and 5.84% in the first and second seasons, respectively. John *et al.,* [14] mentioned that seven insect species were found to be beneficial as predators or parasitoids of the insect pests, implying that any management practice employed for control of the major pests should consider conservation of the natural enemies on sweet potato plant. The production of sweet potatoes could be affected by several biotic constraints such as viral diseases, insect pests and weeds [15].

Seasonal Abundances of Main Insect Infecting Abees and Beauregard Varieties in Season 2021/2022: The seasonal abundance of the major insect pests attacking sweet potato plantations were monitored for the two seasons of investigation in (Table 3). The population density of *B. tabaci* during the two years of study on Abees cultivar showed three peaks per a year. These peaks were occurred in 3rd week of June, first week of July and first week of September, during the first year While, in the second year these peaks were occurred in 3rd week of Jun, 3rd week of August and first week of September. *Empoasca decipiens* had four peaks these peaks were occurred in 4th week of Jun, 2nd week of July, 3rd week of August and first week of September during the first year Meanwhile, these peaks occurred in 2nd week of Jun, first week of July and 4th week of August in the

Table 3: Seasonal abundance of main insect infesting Abees variety during 2021 and 2022 seasons at Baramoon Agriculture Research farm, Dakahlia Governorate

	Mean No./ 20 leaflets											
	2021						2022					
Sampling dates	*B. tabaci* N. A.	*E. decipiens* N. A.	*A. convolvuli* L. stage	*S. littoralis* L. stage	*S. exigua* L.	*H. hipponalis* L.	*B. tabaci* N. A.	*E. decipiens* N. A.	*A. convolvuli L.*.	*S. littoralis* L.	*S. exigua* L.	*H. hipponalis* L.
7/6	20	22	4	29	18	0	10	33	0	23	22	0
14/6	27	23	2	40	23	0	40	73	0	38	37	0
21/6	56	42	3	47	27	3	100	20	8	48	30	2
28/6	43	87	8	59	32	4	82	35	6	53	27	3
5/7	52	73	15	43	30	5	47	64	17	42	21	4
12/7	10	98	25	32	27	0	18	20	29	37	26	0
18/7	8	92	30	30	24	6	25	10	33	57	37	7
25/7	10	43	34	22	35	11	28	18	37	59	20	11
1/8	16	40	42	45	37	18	30	40	46	63	27	16
8/8	19	39	53	33	15	24	76	50	40	52	19	20
16/8	26	82	22	54	10	35	84	64	52	47	20	23
23/8	30	62	13	63	8	30	72	72	50	42	10	16
31/8	40	65	25	85	5	35	95	50	34	45	15	30
6/9	50	85	18	75	7	17	100	33	28	33	9	25
Average	29.07	60.92	21.0	46.9	21.2	13.42	57.6	41.57	27.14	45.64	22.8	11.21

N: nymph, L: larvae, A: adult

Table 4: Seasonal abundance of main insect attacking Beauregard variety during 2021 and 2022 seasons at Baramoon Agriculture Research farm, Dakahlia Governerat

	Mean No./ 20 leaflets											
	2021						2022					
Sampling Dates	*B. tabaci* N. A.	*E. decipiens* N. A.	*A. convolvuli* L. stage	*S. littoralis* L. stage	*S. exigua* L.	*Ph. solenopsis* L. A.	*B. tabaci* N. A.	*E. decipiens* N. A.	*A. convolvuli L.*.	*S. littoralis* L.	*S. exigua* L.	*Ph. solenopsis* N. A
7/6	64	10	1	25	4	0	32	20	0	18	0	0
14/6	76	32	2	35	9	0	50	47	0	26	2	0
21/6	70	48	2	44	7	92	74	18	9	25	18	85
28/6	73	43	3	48	10	240	42	22	5	32	15	122
5/7	64	52	5	30	25	180	31	45	22	23	20	134
12/7	20	71	7	20	19	105	10	18	23	16	18	122
18/7	18	46	10	18	12	91	23	7	29	28	15	110
25/7	7	35	14	25	19	82	25	10	26	22	20	118
1/8	19	30	21	22	20	93	30	29	21	21	25	202
8/8	125	47	22	41	18	92	47	38	35	43	19	213
16/8	71	50	13	34	15	102	53	45	30	45	10	186
23/8	80	97	10	24	10	95	31	52	33	38	8	98
31/8	84	40	5	48	9	82	28	32	32	20	4	92
6/9	90	58	0	42	3	55	36	17	34	10	2	80
Average	61.5	47.0	8.07	32.5	12.8	93.5	36.5	27.8	21.3	26.2	12.5	111.5

N: nymph, L: larvae, A: adult

second year. The population density of *A. convolvuli* during the period of study recorded two peaks these peaks were in the first and last week of August in 2021 while, in the second season the highly peaks were in the first and 3rd week of August. The obtained results in Table (3) referred that the population density of *S. littoralis* had three peaks in the first and second years of study these peaks were in 4th week of June, first week of August and 4th week of August. Moreover, the population of *S. exigua* was different on Abees cultivar which increased gradually until reached the 4th week of June and decreased for four week then increased in the first week of August in the first year of study. Meanwhile, in the second season it had three peaks in 4th week of June, 3rd week of July and decreased for one week then increased in the 1st week of August. The population of *H. hipponalis* was different than another main insect which increased gradually until reached the 3rd week of August and decreased for one week then increased in 4th week of August in both of the two years of study.

The obtained results in Table (4) showed that seasonal abundance of the major insect pests attacking Beauregard cultivar was monitored for the two seasons of investigation. The population density of *B. tabaci* in Beauregard cultivar during the period of study had three peaks these peaks were occurred in 2nd week of June, 2nd week of July and first week of September during the first year. While in the second year these peaks were occurred in 3rd week of June and 3rd week of August. Data illustrated in Table (4) cleared that the population density of *E. decipiens* had three peaks in the first and second season the highest number 97 and 52 individual of *E. decipiens* was coughted in the last week of August in 2021 and 2022 season. Population of *A. convolvuli* on

Table 5: Correlation Coefficient between the population densities of Main insects associated natural enemies that infested the Abees varieties and weather factor during 2021 and 2022 season at Mansoura district

	Simple correlation coefficient (r)							
	2021				2022			
	Average Temperature		Average R.H.		Average Temperature		Average R.H.	
Main insect Natural enemies	r±S.E	P	r±S.E	P	r±S.E	P	r±S.E	P
B. tabaci	0.04±0.15	0.77 ns	-0.26±0.15	0.093 ns	0.14±0.15	0.368 ns	0.07±0.15	0.618 ns
E. decipiens	0.35±0.15	0.023*	0.22±0.15	0.15 ns	0.24±0.13	0.111ns	-0.24±0.15	0.123ns-
A. convolvuli	0.60±0.12	0.0***	0.50±0.13	0.007***	0.46±0.13	0.001**	0.38± 0.14	0.012*
S. littoralis	-0.28±0.15	0.068 ns	0.12±0.15	0.412 ns	0.37±0.14	0.014*	-0.007±0.15	0.96 ns
S. exigua	-0.03±0.15	0.823 ns	-0.28± 015	0.072 ns	-0.28±0.15	0.06 ns	-0.16±0.15	0.299 ns
O. nubilalis	0.43±0.14	0.003**	0.08±0.15	0.583 ns	0.43±0.14	0.004**	0.29±0.15	0.05 ns
H. hipponalis	0.47±0.13	0.017**	0.52±0.13	0.004***	0.30±0.15	0.046*	0.580.12	3.95***
Natural enemies								
C. undecimpunctata	0.07±0.15	0.63 ns	0.07±0.15	0.64 ns	-0.29±0.15	0.577 ns	-0.27±0.15	0.800ns
S. Syriacus	-0.48±0.13	0.001**	0.01±0.15	0.91 ns	-0.07±0.15	0.622 ns	-0.32±014	0.033*
O. laevigatus	0.38± 0.14	0.012*	-0.09±0.15	0.53 ns	0.19±0.15	0.219 ns	-0.14±0.15	0.35 ns
P. alfierii	0.46±014	0.002**	0.26±0.15	0.08 ns	0.36±0.14	0.185*	0.07±0.15	0.649 ns
P. roborattor	0.34±0.14	0.024 *	0.12±0.15	0.42 ns	0.52±0.13	3.95***	0.39±0.14	0.010*
E. formosa	0.46±014	0.002**	0.26±0.15	0.08 ns	0.33±0.14	0.029*	-0.09±0.15	0.55 ns
T. larvarum	-0.22±0.15	0.15 ns	0.045±0.15	0.77 ns	-0.14±0.15	0.36 ns	-0.04±0.15	0.77 ns
Braconid wasps	0.27±0.15	0.076 ns	-0.08±0.15	0.58 ns	0.17±0.15	0.26 ns	-0.28±0.15	0.063 ns
C. carnea	0.043±0.15	0.78 ns	0.12±0.15	0.43 ns	0.63±0.12	0.0***	-0.3±0.15	0.0456*

r = correlation coefficient ns= insignificant * = significant with varied degree

Beauregard cultivar increased gradually until reached the 2nd week of August then decreased in the first year of study. Meanwhile, in the second season *A. convolvuli* recorded two peaks in the 3rd week of June and 2nd week of August. The population density of *S. littoralis* had four peaks in the first and second years of study these peaks were 4th week of June, 4th week of July, 2nd week of August and 4th week of August in the first year. While, the population of *S. littoralis* in 2022 was different it increased gradually till the 2nd week of June and decreased for one week then increased gradually again until reached the highest peak for it in the 3rd week of August. *Spodoptera exigua* had two peaks in the first and second season; the highest peak was at the 1st week of August in 2021 and 2022 seasons. The population fluctuations of *Ph. solenopsis* revealed that this insect had three peaks in the first season; the highest number 240 Adult and nymph was recorded by visual examination in the last week of June, in 2021. While in season 2022, the highest number 213 adults were recorded in the 2nd week of August.

Effect of Some Weather Factors on the Population Fluctuation of Main Insects Infected Abees and Beauregard Varieties and Their Associated Natural Enemies: Results arranged in Table (5) assured that the values of correlation coefficient between the average temperature, relative humidity and the population density of the main insects attacking Abees cultivar and their associated natural enemies during investigation (2021 and 2022). The relation between temperature parameters and population size of *A. convolvuli*, *O. nubilalis* and *H. hipponalis* cleared highly significant Positive correlation during 2021and 2022 years. Meanwhile, *E. decipiens* had only highly significant Positive correlation in 2021 while; *S. littoralis had* significant Positive correlation in 2022. The values of correlation coefficient between the relative humidity and the population density of *S. littoralis and H. hipponalis* cleared highly significant Positive correlation during 2021and 2022 years.

In the first Season, the relationship between the natural enemies and certain weather components referred that there were a significant correlation between population size of *S. syriacus*, *O. laevigatus*, *P. alfierii*, *P. roborattor*, *E. formosa* and average temperature. While, there were no significant correlation between the population density of natural enemies and the average of relative humidity. Meanwhile, in the second season, there was a Positive significant between *P. alfierii*, *P. roborattor*, *E. formosa*, *C. carnea* and average temperature. In the second season there were significant negative correlations between *S. Syriacus, C. carnea* and average of relative humidity.

Table 6: Correlation Coefficient between the population densities of Main insects associated natural enemies that infested the Beauregard variety and weather factor during 2021 and 2022 season at Mansoura district

	Simple correlation coefficient (r)							
	2021				2022			
	Average Temperature		Average R.H.		Average Temperature		Average R.H.	
Main insect Natural enemies	r±S.E	P	r±S.E	P	r±S.E	P	r±S.E	P
B. tabaci	-0.03±0.15	0.818 ns	4.21±0.15	0.99 ns	-0.18±0.15	0.23 ns	-0.29±0.15	0.06 ns
E. decipiens	0.26±0.15	0.085 ns	0.14±0.15	0.34 ns	0.34±0.14	0.026*	-0.30±0.15	0.052 ns
Ph. solenopsis	0.28±0.15	0.065ns	-0.3±0.15	0.048*	0.47±0.13	0.001**	-0.01±0.15	0.92ns
A. convolvuli	0.68±0.11	0.00***	0.36±0.14	0.016*	0.49±0.13	0.00**	0.38±0.14	0.012*
S. littoralis	0.11±0.15	0.487ns	-0.08±0.15	0.577ns	0.37±0.14	0.014*	-0.38±0.14	0.012*
S. exigua	0.47±0.13	0.016**	0.22±0.15	0.156 ns	0.38±0.14	0.011*	-0.29±0.15	0.05ns
Natural enemies								
C. undecimpunctata	0.20±0.15	0.194 ns	-0.57±0.12	6.22***	-0.14±0.15	0.37 ns	-0.50±0.13	5.77**
S. Syriacus	-0.21±0.15	0.175 ns	-0.34±0.14	0.024*	0.11±0.15	0.476ns	-0.34±0.14	0.023*
O. laevigatus	0.46±0.13	0.001**	0.55±0.13	0.00***	0.53±0.13	0.0***	0.07±0.15	0.63 ns
P. alfierii	0.33±0.14	0.027 *	0.11±0.15	0.46 ns	0.07±0.15	0.63 ns	0.32±0.14	0.035*
P. roborattor	0.33±0.14	0.032*	-0.08±0.15	0.57 ns	0.17±0.15	0.28 ns	-0.17±0.15	0.256 ns
E. formosa	0.17±0.15	0.254ns	0.12±0.15	0.42ns	-0.46±0.14	0.002**	0.07±0.15	0.63 ns
T. larvarum	0.51±0.13	0.00***	-0.04±0.15	0.78ns	0.01±0.15	0.93 ns	-0.12±0.15	0.44 ns
Braconid wasps	0.37±0.14	0.013*	0.10±0.15	0.51 ns	0.59±0.12	0.00***	-0.14±0.15	0.37 ns
C. carnea	0.35±0.14	0.020*	0.21±0.15	0.17 ns	0.58±0.12	0.00***	-0.25±0.15	0.16 ns

r = correlation coefficient ns= insignificant * = significant with varied degree

The data summarized in Table (6) indicated the values of correlation coefficient between the average temperature, relative humidity and the population density of the main insects infected Beauregard cultivar and their associated natural enemies during investigation (2021 and 2022). There were highly significant positive correlations between the population densities of *A. convolvuli*, *S. exigua* and average of temperature in the first season of study while, there was significant positive correlations between *Ph. solenopsis*, *A. convolvuli* and average of relative humidity. Whereas, during the second season of study there were significant positive correlations between the population densities of *E. decipiens*, *Ph. solenopsis*, *A. convolvuli*, *S. littoralis*, *S. exigua* and average temperature. Average of relative humidity had only significant correlations between the population densities of *A. convolvuli* and *S. littoralis*.

In the first Season, the relationship between the natural enemies and certain weather components referred that all natural enemies had significant correlations with average temperature, with the exception of *C. undecimpunctata, S. Syriacus* and *E. formosa*. Meanwhile, all natural enemies had no significant correlations with average of relative humidity with the exception of *C. undecimpunctata, S. Syriacus* and *O. laevigatus*. During the second season of study there were highly significant correlations between the population densities of *O. laevigatus*, *E. formosa*, *Braconid wasps, C. carnea* and average of temperature. Whereas, average of relative humidity had only significant correlations between the population densities of *C. undecimpunctata, S. Syriacus* and *P. alfierii.*

The Relationship Between Main Insects That Infested Abees and Beauregard Varieties and Their Associated Natural Enemies: Data represented in Table (7 and 8) indicated that the relationship between the main insect of sweet potato varieties and its natural enemies during the two seasons 2021 and 2022. Data in Table (7) showed a highly significant relationship between *B. tabaci* and *O. laevigatus*, *E. formosa* in the first season of study while, in the second season there were significant relationship between *B. tabaci* and *S. syriacus*, *P. alfierii.* It may be noticed that *S. syriacus* and *O. laevigatus* exerted highly significant effect on the numbers of *E. decipiens* on Abees variety during the first and second season of study. The data summarized in Table (7) indicated that populations of *A. convolvuli* had only highly significant effect with *O. laevigatus* during season 2021 while, in the second season there was a negative correlated between the population of *A. convolvuli* and *C. undecimpunctata*, *S. syriacus*, *P. roborattor* and *T. larvarum*. *Pimple roborattor* and *T. larvarum* exerted a highly negative significant effect on the population of

Table 7: Correlation Coefficient between the population density of Main insects, that infesting the Abees variety and their associated natural enemies during 2021 and 2022 season at Mansoura district

	Simple correlation coefficient (r)						
	Season 2021						
Natural enemies	*B. tabaci* r±S.E P	*E. decipiens* r±S.E P	*A. convolvuli* r±S.E P	*S. littoralis* r±S.E P	*S. exigua* r±S.E P	*O. nubilalis* r±S.E P	*H. hipponalis* r±S.E P
C.undecimpunctata	0.15±0.15 0.32 ns	0.42±0.14 0.004**	0.26±0.15 0.093ns	-0.11±0.15 0.487 ns	-0.11±0.15 0.475	0.16±0.15 0.31 ns	0.34±0.14 0.243*
S. Syriacus	0.10±0.15 0.50ns	-0.61±0.12 1.496 ***	-0.21±0.15 0.175 ns	-0.08±0.15 0.572 ns	0.3±0.15 0.05 ns	0.09±0.15 0.555 ns	-0.24±0.15 0.114ns
O. laevigatus	-0.3±0.14 0.012*	-0.42±0.14 0.005**	0.50±0.13 0.000***	0.19±0.15 0.16 ns	-0.2±0.15 0.157ns	-0.44±0.15 0.003**	0.07±0.15 0.653ns
P. roborattor	--------	------	-0.02±0.15 0.871ns	-0.56±0.13 0.0001***	0.29±0.15 0.054 ns	0.44±0.14 0.003**	0.14±0.15 0.375ns
E. formosa	-0.43±0.15 0.003**	---------	-------	---------	----------	-------	----------
T. larvarum	--------	--------	0.05±0.15 0.723ns	-0.60±0.12 2.53***	0.42±0.15 0.004**	0.11±0.15 0.450 ns	-0.5±0.12 0.000***
Braconid wasps	----------	--------	0.06±0.15 0.668ns	-0.19±0.15 0.215 ns	0.025±0.15 0.87 ns	0.11±0.15 0.46 ns	0.27±0.15 0.729ns
C. carnea	-0.46±0.13 0.001**	----------	---------	----------	----------	-------	---------
Season 2022							
C.undecimpunctata	-0.12±0.15 0.434 ns	0.27±0.15 0.073 ns	-0.77±0.10 2.20***	-0.27±0.15 0.07 ns	0.45±0.14 0.002**	-0.64±0.12 4.11***	-0.56 ±0.13 1.11***
S. Syriacus	0.40±0.14 0.007**	0.26±0.11 0.039*	-0.32±0.14 0.037*	0.33±0.14 0.02*	0.42±0.14 0.005**	0.084±0.15 0.59 ns	-0.36±0.14 0.016*
O. laevigatus	-0.10±0.12 0.39 ns	0.36±0.14 0.18*	-0.12 ±0.15 0.41 ns	0.20±0.15 0.20 ns	0.62±0.12 8.01***	0.32±0.14 0.03*	0.37±0.14 0.013*
P. alfierii	0.32±0.14 0..037*	0.27±0.15 0.080 ns	-0.02±0.15 0.88 ns	0.19±0.15 0.21 ns	0.21±0.15 0.165 ns	0.04±0.15 0.97 ns	0.25±0.15 0.103 ns
P. roborattor	----------	----------	0.78±0.09 9.76***	0.50±0.13 6.55***	-0.35±0.14 0.021*	0.56±0.12 8.20***	0.81±0.09 3.11***
E. formosa	0.075±0.15 0.635 ns	-0.15±0.15 0.320 ns	---------	----------	-------	------	-------
T. larvarum	----------	----------	-0.44±0.14 0.002**	0.35±0.14 0.02*	0.03±0.15 0.848 ns	-0.28±0.15 0.06 ns	-0.22±0.15 0.161 ns
Braconid wasps	----------	----------	-0.10±0.15 0.51 ns	0.50±0.13 5.96***	0.08±0.15 0.606 ns	0.15±0.15 0.32 ns	0.014±0.15 0.927 ns
C. carnea	-0.14±0.15 0.362 ns	-0.11±0.15 0.465 ns	--------	--------	----------	----------	--------

r = correlation coefficient ns= insignificant * = significant with varied degree

S. littoralis during the first season. Meanwhile, during the season of 2022 the population of *S. syriacus*, *P. roborattor*, *T. larvarum* and Braconid sp. showed a positive significant relationship with this insect. *Tachina larvarum* exerted a highly significant positive effect on the population of *S. exigua* during season 2021.Whereas during the season of 2022, the population of *C. undecimpunctata*, *S. syriacus*, *O. laevigatus* and *P. roborattor* showed significant relationship with this insect. Data in Table (7) showed a highly significant relationship between *O. nubilalis* population and the predators, *O. laevigatus* and *P. roborattor* on Abees variety during the two seasons of study. During the season 2021 there was a significant relationship between *H. hipponalis* population and *C. undecimpunctata, T. larvarum.* While, in the second season *C. undecimpunctata*, *S. syriacus*, *O. laevigatus* and *P. roborattor* showed significant relationship with this insect.

The data presented in Table (8) revered that a highly significant relationship between *B. tabaci* population and the predators *S. syriacus* and *P. alfierii* on Beauregard variety during the first season. Meanwhile, Data indicated that there was no correlation coefficient value between

Table 8: Correlation Coefficient between the population density of Main insects, that attacking the Beauregard cultivar and their associated natural enemies during 2021 and 2022 season at Mansoura district.

	Simple correlation coefficient (r)						
	Season 2021						
Natural enemies	*B. tabaci* r±S.E P	*E. decipiens* r±S.E P	*A. convolvuli* r±S.E P	*S. littoralis* r±S.E P	*S. exigua* r±S.E P	*Ph. solenopsis* r±S.E P	*H. hipponalis* r±S.E P
C.undecimpunctata	0.23±0.15 0.126 ns	-0.14±0.15 0.37 ns	0.19±0.15 0.226 ns	0.26±0.15 0.955 ns	0.04±0.15 0.785ns	0.05±0.15 0.729 ns	0.06±0.15 0.676 ns
S. Syriacus	-0.49±0.13 7.51***	-0.48±0.13 0.001**	-0.14±0.15 0.374 ns	0.00±0.15 0.980 ns	-0.09±0.15 0.539 ns	-0.30±0.15 0.047*	-0.21±0.15 0.167 ns
O. laevigatus	0.03±0.15 0.802 ns	0.049±0.15 0.75 ns	0.57±0.12 0.00***	0.08±0.15 0.583 ns	0.24±0.15 0.111 ns	-0.33±0.14 0.031*	0.67±0.11 0.000***
P. alfierii	0.41±0.14 0.006**	0.03±0.15 0.803 ns	0.62±0.12 0.00***	0.13±0.15 0.379 ns	0.32±0.14 0.035*	0.04±0.15 0.792 ns	0.50±0.13 0.000***
P. roborattor	------	------	0.47±0.13 0.001**	0.11±0.15 0.487 ns	0.55±0.13 0.0001***	0.37±0.14 0.014*	0.19±0.15 0.206 ns
E. formosa	0.02±0.15 0.894 ns	------	------	-----	------	-------	------
T. larvarum	------	------	0.29±0.15 0.058 ns	-0.17±0.15 0278 ns	0.62±0.12 0.000***	-------	0.28±0.15 0.063 ns
Braconid wasps	------	------	0.20±0.15 0.187 ns	0.19±0.15 0.223 ns	0.47±0.13 0.001**	--------	0.13±0.15 0.401 ns
C. carnea	0.22±0.15 0.14 ns	-0.07±0.15 0.637 ns	-------	--------	------	------	------
Season 2022							
C.undecimpunctata	0.25±0.15 0.107 ns	0.12±0.15 0.435 ns	-0.7±0.09 0.00***	-0.02±0.15 0.854 ns	-0.16±0.15 0.303 ns	-0.5±0.13 0.006*	-0.78±0.15 0.00***
S. Syriacus	0.09±0.15 0.56 ns	-0.37±0.15 0.015*	- 0.3±0.14 0.036*	-0.04±0.15 0.787 ns	0.15±0.15 0.314 ns	-0.17 ±0.15 0.00*	-0.45±0.14 0.0026 **
O. laevigatus	-0.06±0.15 0.677ns	0.25±0.15 0.099ns	0.28±0.15 0.063 ns	0.13±0.15 0.403 ns	-0.04±0.15 0.775 ns	0.09±0.15 0.55 ns	0.17±0.15 0.272 ns
P. alfierii	-0.04±0.15 0.763ns	0.23±0.15 0.129 ns	0.13±0.15 0.389 ns	-0.00±0.15 0.099 ns	0.31±0.15 0.0453*	0.31±0.15 0.044 *	0.01±0.15 0.932 ns
P. roborattor	-------	--------	-0.02±0.15 0.85 ns	0.43±0.14 0.004**	0.35±0.14 0.019*	------	-0.02 ±0.15 0.871 ns
E. formosa	0.015±0.15 0.92 ns	-------	----------	-------	------	--------	-------
T. larvarum	--------	--------	-0.54±0.13 0.0002***	0.25±0.15 0.100ns	0.07±0.15 0.646ns	--------	-0.36±0.14 0.016*
Braconid wasps	----------	--------	0.70±0.11 0.00***	0.43±0.14 0.003**	0.47±0.13 0.005*	----------	0.70±0.11 0.00***
C. carnea	-0.05±0.15 0.732 ns	-0.09±0.15 0.542 ns	--------	-------	--------	----------	-------

r = correlation coefficient ns= insignificant * = significant with varied degree

Table 9: Leaflet chemical composition of sweet potato varieties.

Varieties	N %	P%	K%	ChlorophyII a, mg/g F.W	ChlorophyII b, mg/g F.W	Carotene (Mg/100g)
Abees	3.42	2.98	3.98	0.726	0.445	27.22
Beauregard	3.20	3.00	3.0	0.602	0.440	26.99

B. tabaci and its natural enemies on Beauregard variety during the second season of the study. *Scymnus syriacus* exerted highly significant effect on the numbers of *E. decipiens* on Beauregard variety during the first and second season of study. The data summarized in Table (8) indicated that populations of *S. littoralis* had only highly significant effect with *P. roborattor* and *Braconid sp.* during the second season of study Moreover, *Spodopter exigua* had only highly significant effect with *P. roborattor* and *Braconid sp.* during the first season of study. *Agrius convolvuli* and *H. hipponalis* had a highly significant effect with *O. laevigatus* and *P. alfierii* during the first season of study Moreover, *C. undecimpunctata*, *S. syriacus*, *T. larvarum* and *Braconid sp.* showed a positive significant relationship with the two insect on Beauregard variety during 2022 season. These results

were agreement with Ames *et al.* [16] detected that Predatory bugs, carabid beetles, vespid wasps and spiders attack the larvae of *S. littoralis* and *Spodopter exigua* and more than 40 species of scelionid, braconid, ichneumonid and tachinid parasites are known [16] Also mentioned that a high rate of parasitism by braconid wasps is common in control of *H. hipponalis* also earwigs and other generalist predators are also important in maintaining natural control. If natural enemy action is not disrupted by pesticide use, control is rarely needed.

Leaflet Chemical Compositions of Two Sweet Potato Varieties and Their Relation with Insect Infestation: Data presented in Table (9) showed that the chemical analysis of sweet potato leaflet Abees cultivar was higher than Beauregard in N%, K%, chlorophyII a, chlorophyII b and carotene which explains the sensitivity of Abees variety to infection with sucking insect pests *B. tabaci, N.viridula, E. decipiens* with a higher occurrence than Beauregard variety.

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