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Population Dynamics of Pests Attacking Most Important Medicinal Plant, Coriander (*Coriandrum sativum* L.) Apiaceae, Along Two Seasons at Qalubiya and Menoufia Governorates, Egypt

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ABSTRACT

These experiments were carried out under field conditions on Coriander (*Coriandrum sativum* L.) plants along two seasons (2020–2021) and (2021–2022). Coriander seeds were sown at El-Qanater Research Station Farm in Qalubiya Governorate, as well as at a private farm in Menoufia Governorate, Egypt. The obtained results revealed the presence of 12 insect species belonging to order Hemiptera (*Bemisia tabaci*, *Hyadaphis coriandri*, and *Myzus persicae*), in addition to order Coleoptera (*Stegobium paniceum*, *Lasioderma serricorne*, *Anthrenus verbasci*, *Trogoderma granarium*, *Callosobruchus maculatus*, *Acanthoscelides obtectus*, and *Rhyzopertha dominica*), order Thysanoptera (*Thrips palmi*, and *Tetranychus urticae*). As well as the survey, it shows the existence of two parasites (*Lysiphlebus testaceipes* & *Laelius pedatus*) and five predators (*Coccinella undecimpunctata*, *Hippodamia* spp., *Hippodamia variegata*, *Tenebriodes* sp., and *Thaneroclerus* sp.) in addition to *Phytoseiulus* sp. as a predatory mite. Whiteflies, aphids, thrips, and two-spotted spider mites attacked coriander plants in the field during two seasons in two governorates. The highest numbers were recorded with aphid insects, followed by white flies, and there were no insect infestations during March between the two seasons. The coefficient of correlation between mean temperature and recorded insects was found to be positive, while it was negative for mean relative humidity. Many stored insect visitors, attacked the coriander plants especially at flowering and fertilization periods, such as *A. verbasci*, *S. paniceum*, *L. serricorne*, *C. maculatus*, and *A. obtectus*. It was noticed that all insect species infesting coriander plants always start with a few numbers, then gradually increase, reaching the highest numbers when the crop is dry. Results recorded that the insect species *S. paniceum*, *L. serricorne*, *C. maculatus*, *T. granarium*, *R. dominica*, and *T. castaneum* attacked coriander crops at stores along the two storage periods. The correlation between the carpet beetle, *Anthrenus verbasci*; the drug store beetle, *Stegobium paniceum*; the cigarette beetle, *Lasioderma serricorne*, cowpea beetle, *Callosobruchus maculatus*, the kidney bean beetle, *Acanthoscelides obtectus*, and minimum and maximum temperatures, relative humidity, and rainfall as abiotic factors was determined.

KEYWORDS: Sucking insects, Stored insects, Coriander, *Coriandrum sativum*, Climatic factors

1. INTRODUCTION

Coriander plants (*Coriandrum sativum* L.) belong to the Family Apiaceae (Umbelliferae). Its origin are in the Near East, mainly cultivated from its fruits (Mhemdi *et al.*, 2011) which a delicate culinary and used as medicinal plant, as well as it contains an essential oil (0.03 to 2.6%) Nadeem *et al*., 2013.

In all South-East Asian countries, coriander is grown as a culinary herb and vegetable for fruits and used as a spice. The herb has high economic value. It is also listed as a medicinal plant because of its ability to cure many diseases. The essential oils extracted from coriander have antibacterial, antioxidant, antidiabetic, anticancer, and antimutagenic activities due to the presence of various chemical compounds.

Coriander fruits are also used in the production of spirits, cosmetics, textiles, and printing materials (Nadeem *et al*., 2013; Zanetti *et al*., 2013). The spices are spread by seeds, which have been globally traded for both medicinal and food purposes since ancient Egyptian times.

Coriander plants are subjected to attack by many pest species, which cause serious damage to vegetative parts, seed quality, and quantity. Piercing sucking pests are the most destructive insects on these plants (Butani, 1984; Jain and Yadav., 1989; El-Sayed *et al*., 1990; El-Sayed, 1993; Upadhyay *et al*., 1996; El-Kordy *et al.*, 1999; and Chaudhary *et al*., 2009). The coriander aphid, *Hyadaphis coriandri,* is reported to be the main aphid species infesting coriander and causes about 19 percent of losses (Meena *et al*., 2011). On the other side, coriander fields may harbour beneficial insects, such as predators, parasitoids, which play an important role in controlling pests and improving the production of these plants (Rashad, 1976 and 1978; Hussein and Abd El-Aal, 1982; Al-Qarni, 2005). Insect pests are one of the major limiting factors for higher-quality production of coriander. The insect pests, *viz.*, *Hyadaphis coriandri* (Das), *Bemisia tabaci* (Genn.), *Myzus persicae* (Sulzer), and *Thrips tabaci* (Lind.), have been found infesting coriander crops, beside a mite, among the various insect pests, the coriander aphid, *Hyadaphis coriandri* (Das), has been reported as a regular and major pest of coriander. Both nymphs and adults cause both quantitative and qualitative losses to seed yield. They cause damage by sucking cell sap from inflorescences / umbels (Nayer *et al.*, 1982; Jain and Yadav, 1988; Jain and Yadav, 1989; Meena, 1999; Lekha, 2002; and Bana, 2007). The attack of insect pests depends on climatic conditions, crop growth stage, and the incidence of natural enemies at a particular time in the region.

The storage of post-harvest results is the last phase of the medicinal plant cultivation system. The storage and conservation of medicinal plants aim to prevent deterioration of their quality, maintaining the qualitative and quantitative aspects after drying by developing ideal conditions of temperature and relative humidity, avoiding the attack of microorganisms, fungi, and insects during the storage period. (Masand *et al*., 2014; Dinata and Jihad, 2021).

The medicinal plants are eventually stored for different periods depending on market demand, the size of production, and the farmer's needs. Storage is the crucial and significant post-harvest process postharvest operation. Pests are one of the most severe threats to food products, but they are often ignored by many manufacturers, which leads to a world-wide loss equivalent to thousands of millions of euros per year (Haff and Slaughter, 2004; Silva *et al*., 2013).

During storage, medicinal and aromatic plants become infected with a variety of storage pests, which have an impact on their oil content as well as their weight and quality.

Coriander is regarded as one of the most important medicinal plants due to its multiple uses (Wangensteen *et al*., 2004), and it is infected with many pests during storage, such as *Stegobium paniceum* (L.), *Lasioderma serricorne* (F.), *Rhyzopertha dominica*, *Tribolium castaneum*, *Oryzaephilus surinamensis, Trogoderma granarium,* and *Corcyra cephenilca* (Butani, 1984; Singh and Anandra, 2019; Abdelghany *et al*., 2010), causing significant damage during storage.

From the previous preview, the present study was undertaken to light a spot on the economic insects attacking coriander plants in the field and stores, as well as the associated natural enemies, in addition to knowing the relation between some ecological factors and the population density of studied insects.

2. MATERIALS AND METHODS

Experiments were carried out under field conditions on Coriander (*Coriandrum sativum* L.) plants cultivated at mid-October along two seasons (2020–2021) and (2021–2022). Coriander seeds were sown at El-Qanater Research Station Farm in Qalubiya Governorate, affiliated with the Horticulture Research Institute, ARC Egypt, as well as at a private farm in Menoufia Governorate.

2.1. Survey and identification of insect pests under field conditions:

The experiments were carried out to identify as well as study the population fluctuations of pre- and post-harvest insect pests, in addition to the associated natural enemies of coriander plants in relation to biotic and abiotic factors. The experiments were arranged in a randomized complete block design with three replicates; there were 9 plots; each plot area was measured at 18 m^2 and divided into three rows, each 6 m long and 3 m wide. Seeds were sown in spot treatment on one side of each row at 30 cm distances. The total cultivated area was 175 m^2. Agricultural practices were followed as usual.

Weekly observations on insect pests and their natural enemies were conducted on coriander plants in the early morning. For this purpose, 10 plants were randomly selected and tagged in each plot, where the population of aphids and predators was counted visually (absolute counting), and after that, on the inflorescence /umbels on each randomly selected tagged plant. The population of mites and thrips was recorded by tapping them on a white paper sheet, whereas in the case of whiteflies, it was recorded by counting nymphs and adults.

Different types of stored beetles attacked coriander flowers. Ten plants of each plot were placed in one-liter glass jar, tightly covered well with a double cloth layer, and brought into a laboratory. Then, coriander plant samples were examined externally and internally to record the number of insects.

Different pest species and natural enemies collected from Coriandrum plants at Qalubiya and Menoufia Governorates, Egypt, were identified and arranged in tables, including orders, family, scientific, and English names of insect pests (Essam *et al.,* 2019).

The obtained data were subjected to statistical analysis to determine the correlation factor between insect pest population and abiotic factors like minimum and maximum temperature, relative humidity, and rainfall and study their influence on the population fluctuations of coriander pests.

2.2. Collecting aphids on Coriandrum plants:

Alate viviparous adult females were collected from different plants from Qalubiya and Menoufia Governorates in Egypt throughout two successive seasons, from 2020 to 2022, using a camel's hair brush, aspired off or by cutting ling the infested part of plants and putting them in a paper bag to transfer to the laboratory to push apterous adults to emerge wings. Alate viviparous females were preserved in sample tubes containing 70% ethanol alcohol with some drops of glycerol until preparing mounted microscopic slides for identification.

2.3. Survey and identification of insect pests attacking coriander seeds stored in the laboratory under natural conditions:

At the end of June, the coriander seeds from Qalubiya and Menoufia governorates were harvested and packed in jute bags; each bag contained 250 grams. The samples (100 bags) were stored at El-Qanater Research Station and the Biological control department at Menoufia University until October under natural conditions. Coriander samples were taken monthly, and transferred to the laboratory, where the samples were twice sieved with the aid of a 16 mesh per inch sieve. The obtained adult insects were recognized and counted. To estimate the immature stages, the plant samples containing seeds were kept in an incubator at 28°C and sieved

again after 2 and 4 weeks, and adult insects were recognized and counted. The high and low air temperatures were recorded every week during the five months in the two regions.

2.4. Effects of weather factors on the population density of insect pests infesting Coriander plants:

The effects of maximum & minimum temperatures, the mean percentage of relative humidity, and rainfall on the population density of insect pests were investigated during two seasons in two different ecosystems.

On the other hand, the obtained values of the four weather factors were taken as independent variables (x); i.e., mean minimum temperature (x_1), mean maximum temperature (x_2), mean percentage of relative humidity (x_3), and rain fall (x_4).

2.5. Statistical analysis:

The obtained data were subjected to analysis of variance (ANOVA) using Costat Software, Version 6.4 (2008). The mean differences were compared by Least Significant Difference (L.S.D. 5%).

3. RESULTS AND DISCUSSIONS

3.1. Survey of fauna inhabiting Coriander plants at two governorates:

The obtained results in Table (1) revealed the presence of 12 insect species belonging to order Hemiptera (*Bemisia tabaci*, *Hyadaphis coriandri, and Myzus persicae),* in addition to order Coleoptera (*Stegobium paniceum, Lasioderma serricorne, Anthrenus verbasci, Trogoderma granarium, Callosobruchus maculatus, Acanthoscelides obtectus, Rhyzopertha dominica* and *Tribolium castaneum*), Order Thysanoptera (*Thrips palmi),* and the two-spotted spider mite, *Tetranychus urticae).* As well, the survey shows the existence of two parasites (*Lysiphlebus testaceipes* and *Laelius pedatus*) and five predators (*Coccinella undecimpunctat*, *Hippodamia* spp., *Hippodamia variegata, Tenebriodes* sp., *Thaneroclerus* sp.) in addition to *Phytoseiulus* sp. as a predatory mite.

The obtained results are confirmed by those of Essam *et al*., 2019, who reported nine aphid species belonging to six genera of the sub-family Aphidinae on 26 medicinal and aromatic host plants from different localities in Egypt.

In addition, Sagar and Kumar (1996) reported six species of insect predators (*Coccinella septempunctata*, *Chilomenes sexmaculata*, *Brumoides suturalis*, *Chrysoperla carnea*, *Episyrphus balteatus,* and *Ischioden scutellaris*) as the natural enemies of *Hyadaphis coriandri*. Of these, *C. septempunctata* was found to be the predominant species during the peak period of pest activity.

The obtained results are in the harmony of Suganthi *et al.*, 2022, who reported that Coriander aphid, whiteflies, thrips and tobacco caterpillar were infest coriander crop and coriander aphid is a major insect pest.

These results agree with that of Butani, 1984 and Kant *et al*., 2022, which reported that coriander plants infest with many storage pests such as *Stegobium paniceum*, *Lasioderma serricorne*, *Trogoderma granarium*, *Rhyzopertha dominica* and *Tribolium castaneum*.

Some stored insect visitors, found for the first time in the coriander plants especially at flowering and fertilization periods, such as *A. verbasci*, *C. maculatus*, and *A. obtectus* this may be due to their profuse branching and profuse flowering and this agree with the result obtained by Hashem *et al*., 2005 and Abdalla and Darwish (1996). In the harmony of this results (Razak and Ahmad 2020) found some insect species Anthrenus picturatus (Solskij, 1876) and Anthrenus latefasciatus (Reitter,1892) belong to the same family Dermestidae of *A. verbasci* found on aromatic plants from the same family of Coriander *Heracleum candicans* plants.

Table 1. Survey of pests and associated natural enemies inhabiting Coriander, *Coriandrum sativum* plants at Qalubiya and Menoufia governorates, Egypt along 2020 and 2022 seasons.

Pest Order Family	Scientific Name	Common name	Natural enemies	
			Parasites	Predators
White fly Hemiptera Aleyrodidae	*Bemisia tabaci* (Gennadius, 1889)	silver leaf white fly		
Aphids Hemiptera Aphididae	*Hyadaphis coriandri* (Das, B.C., 1918)	coriander aphid	Hymenoptera Braconidae *Lysiphlebus testaceipes* Cresson, 1880	Coleoptera Coccinellidae *Coccinella undecimpunctata* *Hippodamia* spp Chevrolat, 1836 *Hippodamia variegata* (Goeze, 1777)
	Myzus persicae (Sulzer, 1776)	green peach aphid		
Beetles Coleoptera Anobiidae	*Stegobium paniceum* (L.)	drugstore beetle		*Tenebriodes* sp. (Tenebrionidae), *Thaneroclerus* sp. (Cleridae)
	Lasioderma serricorne (Fabricius)	cigarette beetle		
Dermestidae Coleoptera	*Anthrenus verbasci* (Linnaeus)	Carpet beetle	Hymenoptera Bethylidae *Laelius pedatus* (Say,1836)	
	Trogoderma granarium (Everts)	khapra beetle		
Bruchidae Coleoptera	*Callosobruchus maculatus* (Fabricius)	cowpea beetle		
Chrysomelidae Coleoptera	*Acanthoscelides obtectus*(Say)	bean beetle (kidney bean)		
Bostrychidae Coleoptera	*Rhyzopertha dominica* (F.)	lesser grain borer		
Tenebrionidae Coleoptera	*Tribolium castaneum* Herbst,1797	flour beetle		
Thrips Thysanoptera Thripidae	*Thrips palmi* Karny, 1925	thunder flies		
Mite Trombidiformes Tetranychidae	*Tetranychus urticae* C. L. Koch, 1836	two spotted spider mite		Mesostigmata Phytoseiidae *Phytoseiulus* sp. Evans, 1952

The obtained results in Table (2) recorded the presence of whitefly, aphids, thrips, and two-spotted spider mites attacking coriander plants in the field over two seasons in two governorates. The highest numbers were recorded with aphid insects, followed by white flies. There were no insect infestations in March between the two seasons.

Statistical analysis of the data Table (2) indicated that, at the first season, the highest numbers of aphid insects were recorded in the second week of May at the two governorates, while they were in the third week of May at the second season of study. There were no infestations during March. The results of the first season are confirmed by those of the second.

Whitefly, *B. tabaci* occupied the second rank in this direction, followed by thrips and spider mite.

Table 2. Weekly average numbers of main pests attacking coriander plants in the field along two seasons at two governorates.

Months	week	Pests (values are means/ plant)							
		whitefly	aphid	thrips	mite	whitefly	aphid	thrips	mite
First season 2020/2021									
		Qalubiya Governorate				**Menoufia Governorate**			
	1	0 h	0 i	0 g	0 i	0 h	0 i	0 g	0 h
March	2	0 h	0 i	0 g	0 i	0 h	0 i	0 g	0 h
2020	3	0 h	0 i	0 g	0 i	0 h	0 i	0 g	0 h
	4	0 h	30 h	0 g	0 i	0 h	0 i	0 g	0 h
	1	15 g	125 g	0 g	18 h	23 g	85 h	19 f	27 g
April	2	23 f	195 f	26 d	25 g	39 e	141 g	39 d	37 f
2020	3	58 a	230 e	52 a	34 f	69 a	192 f	59 b	45 d
	4	42 c	289 c	41 b	39 e	52 b	210 e	54 c	51 c
	1	54 b	311 b	32 c	54 c	43 d	267 c	79 a	46 d
May	2	43 c	349 a	27 d	59 b	49 c	340 a	54 c	53 b
2020	3	36 d	259 d	19 e	64 a	42 d	298 b	39 d	62 a
	4	26 e	126 g	17 f	43 d	33 f	254 d	32 e	40 e
Grand mean		24.75	159.5	18	28	29.16	149	33.78	30.08
LSD5%		1.37	1.45	1.28	1.37	1.37	1.37	1.37	1.37
Second season 2021/2022									
		Qalubiya Governorate				**Menoufia Governorate**			
	1	0 g	0 h	0 g	0 h	0 f	0 g	0 g	0 g
March	2	0 g	0 h	0 g	0 h	0 f	0 g	0 g	0 g
2021	3	0 g	0 h	0 g	0 h	0 f	0 g	0 g	0 g
	4	0 g	10 g	0 g	0 h	0 f	0 g	0 g	0 g
	1	0 g	0 h	0 g	0 h	0 f	0 g	0 g	0 g
April	2	0 g	0 h	0 g	13 g	0 f	0 g	0 g	0 g
2021	3	43 e	133 f	41 b	26 d	59 d	159 f	52 b	35 c
	4	59 c	272 e	49 a	30 b	89 c	257 d	57 a	38 b
	1	63 b	285 d	30 c	42 a	120 a	225 e	43 c	47 a
May	2	81 a	345 b	22 d	28 c	98 b	378 b	36 d	32 d
2021	3	52 d	389 a	16 f	21 f	60 d	452 a	31 f	23 e
	4	37 f	321 c	19 e	24 e	57 e	365 c	34 e	19 f
Grand mean		28	146.25	15	15.33	40.25	153	21.08	16.16
LSD5%		1.19	1.28	1.19	1.28	1.19	1.19	1.19	1.19

Means in each column followed by the same letter(s) did not differ at $p<0.05$ according to Duncan's multiple-range test.

Data in Tables 2, 3, and 4 revealed that the coefficient of correlation between mean temperature and recorded insects was found to be positive, while it was negative with mean relative humidity. These results are confirmed with those of Kumari and Yadav (2006), who reported that correlation and regression analysis of pooled data of two years revealed that the aphid population during its ascending phase showed positive correlation with the maximum, minimum, and mean temperatures while a negative association was achieved with the relative humidity; moreover, regression analysis showed that the combined effect of these meteorological parameters on the 71.3 to 99.4%, as well as, seed yield and quality were seriously affected by the coriander aphid, *Hyadaphis coriandri*.

Table 3. Monthly average of some physical factors at Qalubiya and Menoufia governorates, Egypt along 2020/2021 and 2021/2022 seasons.

Months	week	Temperatures (ºC)		R H (%)	Rain fall (mm)	Temperatures (ºC)		R H (%)	Rain fall (mm)
		Low	High			Low	High		
First season 2020/2021									
		Qalubiya Governorate				**Menoufia Governorate**			
	1	9.8 e	23.1 f	68.7 a	0 d	9.1 d	22.3 g	67.6 ab	0 b
March	2	8.4 e	28.3 d	55.4 e	0.1 cd	9.3 d	29.3 e	41.2 f	0 b
2020	3	9.2 e	24.2 ef	61.2 d	3.5 a	8.7 d	22.8 g	64.9 c	28.7 a
	4	9.6 e	20 g	64.0 c	2.7 ab	7.6 d	19.6 h	69.1 a	0 b
	1	8.1 e	21.4 g	61.9 d	0 d	8.4 d	20.5 h	61.2 d	0 b
April	2	10 e	25.8 e	66.0 b	0.2 bc	9.6 d	24.8 f	66.8 b	0.6 b
2020	3	14.3 d	36.1 bc	39.2 h	0.1 cd	14.7 c	34.1 cd	33.8 g	0 b
	4	14.4 d	37.7 b	37.5 i	0 d	14.6 c	36.3 bc	35.2 g	0 b
	1	17.3 bc	39.6 a	32.6 j	0 d	17.8 b	37.4 b	26.2 h	0 b
May	2	21.3 a	39.8 a	27.4 k	0 d	22.3 a	39.2 a	27 h	0 b
2020	3	18.9 b	34.8 c	47.8 f	0 d	18.3 b	33.6 d	46.6 e	0 b
	4	16.3 cd	37.4 b	45.1 g	0 d	15.8 c	35.8 bc	42.6 f	0 b
Grand mean		10.5	22.71	50.5	0.55	13	29.7	48.6	2.44
LSD 5%		1.68	1.66	1.68	1.08	1.68	1.68	1.68	0.48
Second season 2021/2022									
		Qalubiya Governorate				**Menoufia Governorate**			
	1	8.1 d	25.4 e	65 b	0 b	9.5 f	25.5 e	45 f	0 a
March	2	10.6 c	22 f	69.8 a	0.1 b	11.2 ef	23.2 f	61.3 a	0 a
2021	3	4.9 e	21.2 f	55.2 d	0 b	4.1 h	20.3 g	51.7 d	0 a
	4	7.6 d	20.8 f	58.4 c	0.1 b	6.9 g	20.1 g	58 b	0.1 a
	1	12 c	30.6 d	47.8 f	0.1 b	13.1 de	31.6 c	28.1 h	0 a
April	2	11.6 c	31.9 d	0.1 h	2.7 a	11.5 ef	31.2 c	54.7 c	0.1 a
2021	3	16.5 ab	42.5 a	26.6 g	0 b	17.4 ab	27.5 d	44.3 f	0 a
	4	16.3 ab	35.3 bc	50.7 e	0.2 b	15.6 bc	33.8 b	47.1 e	0 a
	1	14.8 b	33.4 c	50.1 e	0.1 b	14.2 cd	33 bc	45.1 f	0 a
May	2	17.6 a	36.8 b	27.2 g	0 b	18.7 a	35.9 a	20.9 i	0 a
2021	3	15 b	35.4 bc	46.8 f	0.1 b	14.5 cd	34.2 b	42.9 f	0 a
	4	18 a	37.3 b	46.6 f	0 b	17.4 ab	35.8 a	38.3 g	0 a
Grand mean		12.75	31.05	45.35	0.28	12	29.34	44.8	0.12
LSD 5%		1.68	1.63	1.61	0.88	1.68	1.68	1.72	0.12

Means in each column followed by the same letter(s) did not differ at $p<0.05$ according to Duncan's multiple range test.

Table 4. Correlation SE and probability between population of white fly, aphid species, thrips, spider mite and some environmental factors along two seasons at two governorates

	Qalubiya governorate			Menoufia governorate		
Factor	**r**	**SE.r of r**	**p(r=o)**	**r**	**SE.r of r**	**p(r=o)**
Whitefly first season 2020/2021						
Low Temp.	0.75	0.208	.0048 ns	0.739	0.212	.0059**
High Temp.	0.85	0.163	.0004***	0.749	0.209	.0050**
R.H %	-0.273	0.304	.3903 ns	-0.679	0.232	.0152*
Rainfall	-0.0377	0.316	.9073 ns	-0.380	0.292	.2224 ns
Whitefly second season 2021/2022						
Low Temp.	0.816	0.182	.0012**	0.725	0.217	.0076**
High Temp.	0.730	0.215	.0070**	0.693	0.227	.0124*
R.H %	-0.233	0.307	.4659 ns	-0.450	0.282	.1418 ns
Rainfall	-0.0346	0.316	-9148 ns	1.0000	0000	0.0000***
Aphid species first season 2020/2021						
Low Temp.	0.80	0.18	.0015**	0.947	0.101	.000***
High Temp.	0.811	0.184	.0013**	0.876	0.151	.0002***
R.H %	-0.292	0.302	.3562 ns	-0.735	0.214	.0064**
Rainfall	-0.518	0.270	.0839 ns	-0.364	0.294	.2442 ns
Aphid species second season 2021/2022						
Low Temp.	0.80	0.189	.0017**	0.752	0.208	.0047**
High Temp.	0.68	0.231	.0146*	0.762	0.204	.0039**
R.H %	-0.138	0.313	.6685 ns	-0.518	0.270	.0842 ns
Rainfall	-0.229	0.307	.4730 ns	1.0000	0000	0.0000***
Thrips first season 2020/2021						
Low Temp.	0.58	0.25	.0457*	0.795	0.191	.0020**
High Temp.	0.77	0.199	.0031**	0.798	0.190	.0019**
R.H %	-0.233	0.307	.4650 ns	-0.766	0.203	.0036**
Rainfall	-0.451	0.282	.1402 ns	-0.359	0.295	.2517 ns
Thrips second season 2021/2022						
Low Temp.	0.741	0.212	.0057**	0.765	0.203	.0037**
High Temp.	0.752	0.208	.0048**	0.620	0.247	.0313*
R.H %	-0.185	0.310	.5645 ns	-0.366	0.294	.2411 ns
Rainfall	0.151	0.312	6391 ns	1.0000	0000	0.0000***
Spider mite first season 2020/2021						
Low Temp.	0.923	0.12	.0000***	0.83	0.173	.0007***
High Temp.	0.85	0.16	.0003***	0.789	0.194	.0023**
R.H %	-0.236	0.307	.4594 ns	-0.653	0.239	.0211*
Rainfall	-0.529	0.268	.0769 ns	1.0000	0000	0.0000***
Spider mite second season 2021/2022						
Low Temp.	0.819	0.181	.0011**	0.715	0.220	.0089**
High Temp.	0.77	0.199	.0030**	0.629	0.245	.0283*
R.H %	-0.363	0.294	.2452 ns	-0.350	0.296	.2645 ns
Rainfall	0.129	0.313	.6886 ns	1.0000	0000	0.0000***

ns= not significant *= significant **= high significant ***= very high significant
r= correlation coefficient p= probability SE= standard error

The present findings recorded the highest aphid population on coriander crop during February, which is in harmony with those of Paurti *et al*., (2017) and Swami *et al*., (2018), who found that aphid population and maximum temperature exhibit a positive significant correlation. Similar results were obtained by Kumari and Yadav (2006) and Meena *et al.*, (2009), who reported that the mean atmospheric temperature showed a significant positive correlation, while the mean relative humidity exhibited a significant negative correlation with the aphid population.

In addition, Meena *et al*., (2011) studied the correlation between each of the biotic (the coriander aphid, *Hyadaphis coriandri*, and their natural enemies) and abiotic (minimum and maximum temperature, relative humidity, wind speed, sunshine hours, and rainfall) factors and revealed that the maximum temperature and relative humidity (morning) had a positive effect on the population of aphids, moreover, the minimum temperature, relative humidity (evening), wind speed, and sunshine hours had no significant effect on the population of aphids.

Data in Table (5) revealed that the first sign of coriander seed infestation appeared in early April for *A. verbasci*, whether in Qalubiya and Menoufia Governorates, at the beginning of the first season (2020/2021), and a few numbers of insects had developed earlier in coriander seeds. Coriander seed development was accompanied by an increase in numbers of *S. paniceum* during the second week of April at two governorates, while *L. serricorne* appeared during the third week of April and *C. maculatus* appeared during the first week of May at two governorates and gradually increased, reaching its maximum population during the period of dry crop. *A. obtectus* was appeared during the fourth week of April in Qalubiya, whereas in Menoufia Governorate, it appeared during the third week of April. At the second season 2021/2022, *A. verbasci* was observed in the field on coriander seeds during the fourth week of April, while *S. paniceum* was appeared on coriander seeds during the third week of May, whether in Qalubiya and Menoufia Governorate, while *L. serricorne* was seen in Qalubiya during the fourth week of May and in the third week of May at Menoufia Governorate. *C. maculatus* and *A. obtectus* appeared on coriander seeds during the first week of May at Qalubiya and in the third week of April at Menoufia Governorate.

From previous results, it was noticed that all insect species infesting coriander plants always start with a few numbers, then gradually increase, reaching the highest numbers when the crop is dry. These results are confirmed with those of Abdelghany *et al.*, (2010) who studied the population density of stored product pest in six aromatic plants over 12 month and reported that there was a low level of infestation at the beginning of infestation then increased gradually until reached the maximum level.

The current study shows stored insect pests attacking coriander seeds under natural store room condition along two seasons at two governorates. Results presented in Table (6) recorded the insect species of *S. paniceum, L. serricorne*, *C. maculatus*, *T. granarium*, *R. dominica*, and *T. castaneum* within two seasons. In the first season (2020/2021), data showed that coriander seeds were highly infested with *S. paniceum* beetle with means of 250.6 individuals, followed by *L. serricorne*, *R. dominica*, *T. granarium*, *T. castaneum*, and *C. maculatus* with means of 141.6, 41.4, 30.2, 20.4, and 17.6 individuals, respectively, during five storage months at Qalubiya Governorate. While, in Menoufia Governorate, coriander seeds were highly infested with *L. serricorne* beetles, recording means of 136.6 individuals, followed by *S. paniceum*, *T. castaneum*, *T. granarium*, *C. maculatus*, and *R. dominica*, with means of 69, 36.6, 30.8, 28, and 25.6 individuals, respectively, during the same previously mentioned duration.

At the second season (2021/022), the obtained results reported the presence of six insect species: *S. paniceum, L. serricorne*, *C. maculatus*, *T. granarium*, *R. dominica*, and *T. castaneum*, with lower numbers of individuals than the first one, where coriander seeds were highly infested by *S. paniceum* beetle with means of 156.4 individuals, followed by *L. serricorne*, *T. granarium*, *R. dominica*, *C. maculatus*, and *T. castaneum*, with means of 79, 18.2, 14.8, 13.2 and 9.6 individuals, respectively, along the five

Table 5. Weekly average numbers of beetle species attacking coriander plants under field conditions along two seasons at Qalubiya and Menoufia governorates.

Month	week	Pests (values are means/ plant)									
		carpet beetle	drug store beetle	cigarette beetle	cowpea beetle	kidney bean beetle	carpet beetle	drug store beetle	cigarette beetle	owpea beetle	kidney bean beetle
First season 2020/2021											
		Qalubiya Governorate					**Menoufia Governorate**				
March 2020	1	0 f	0 g	0 g	0 d	0 e	0 f	0 f	0 f	0 e	0 f
	2	0 f	0 g	0 g	0 d	0 e	0 f	0 f	0 f	0 e	0 f
	3	0 f	0 g	0 g	0 d	0 e	0 f	0 f	0 f	0 e	0 f
	4	0 f	0 g	0 g	0 d	0 e	0 f	0 f	0 f	0 e	0 f
April 2020	1	1 f	0 g	0 g	0 d	0 e	10 c	0 f	0 f	0 e	0 f
	2	3 e	6 f	0 g	0 d	0 e	8 d	2 e	0 f	0 e	0 f
	3	5 d	20 e	8 f	0 d	0 e	7 d	3 de	3 e	0 e	5 de
	4	2 ef	23 d	12 e	0 d	5 d	4 e	4 d	17 c	0 e	7 bc
May 2020	1	10 c	26 c	28 d	10 a	10 b	10 c	10 b	22 b	10 a	6 cd
	2	9 c	27 bc	36 c	6 b	8 c	12 b	15 a	11 d	7 c	10 a
	3	17 b	28 b	50 b	5 c	7 c	21 a	9 bc	29 a	8 b	8 b
	4	22 a	30 a	61 a	10 a	15 a	5 e	8 c	30 a	5 d	4 e
Grand mean		5.75	13.33	16.25	2.58	3.75	6.41	4.25	9.33	2.5	3.33
LSD5%		1.37	1.28	1.19	0.97	1.08	1.37	1.28	1.19	1.72	1.19
Second season 2021/2022											
		Qalubiya Governorate					**Menoufia Governorate**				
March 2021	1	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
	2	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
	3	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
	4	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
April 2021	1	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
	2	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	0 c	0 e
	3	0 e	0 c	0 b	0 d	0 e	0 d	0 c	0 c	3 b	2 d
	4	6 d	0 c	0 b	0 d	0 e	6 b	0 c	0 c	4 b	4 c
May 2021	1	5 d	0 c	0 b	4 b	5 d	3 c	0 c	0 c	6 a	6 b
	2	8 c	0 c	0 b	6 a	8 c	5 b	0 c	0 c	0 c	7 ab
	3	10 b	5 b	0 b	3 c	12 b	8 a	9 b	10 a	6 a	8 a
	4	12 a	10 a	9 a	1 d	14 a	9 a	19 a	15 b	4 b	0 e
Grand mean		3.41	1.25	0.75	1.16	3.25	2.58	2.33	2.08	1.91	2.25
LSD5%		1.08	0.68	0.48	0.97	0.97	1.08	0.68	0.68	1.08	1.08

Means in each column followed by the same letter(s) did not differ at $p<0.05$ according to Duncan's multiple range test.

Table 6. Monthly average numbers of beetle species attacking coriander seeds of Qalubiya and Menoufia governorates stored in laboratory along two seasons at two governorates.

Months	Drug store beetle	Cigarette beetle	Cowpea beetle	Khapra beetle	Lesser grain borer	Flour beetle
Qalubiya Governorate						
June 1st season	260 b	114 b	30 b	24 c	15 ef	0 f
June 2nd season	120 d	55 f	9 f	20 d	5 g	0 f
July 1st season	300 a	212 a	36 a	48 a	40 b	0 f
July 2nd season	207 c	79 de	23 c	24 c	7 g	5 ef
Aug. 1st season	261 b	91 cd	19 d	38 b	44 b	10 de
Aug. 2nd season	251 b	92 cd	14 e	36 b	10 fg	12 de
Sept. 1st season	304 a	206 a	3 g	27 c	58 a	25 c
Sept. 2nd season	109 de	98 c	10 f	9 f	22 d	18 cd
Oct. 1st season	128 d	85 cde	0 g	14 e	20 de	67 a
Oct. 2nd season	95 e	71 e	10 f	2 g	30 c	49 b
Grand mean	203.5	110.3	15.4	24.2	28.1	18.6
LSD 5%	20.6	14.86	3.14	3.57	6.57	8.26
Menoufia Governorate						
June 1st season	53 d	100 c	10 ef	29 c	2 ef	0 g
June 2nd season	11 f	27 e	5 g	20 d	0 f	0 g
July 1st season	94 b	201 a	42 b	40 b	23 c	15 f
July 2nd season	33 e	42 e	24 c	31 c	1 ef	0 g
Aug. 1st season	107 a	157 b	50 a	60 a	35 b	37 c
Aug. 2nd season	50 d	77 d	15 d	22 d	5 e	24 e
Sept. 1st season	66 c	78 d	26 c	15 e	47 a	55 b
Sept. 2nd season	48 d	90 cd	9 ef	7 fg	10 d	29 de
Oct. 1st season	25 e	147 b	12 de	10 f	21 c	76 a
Oct. 2nd season	24 e	102 c	8 fg	3 g	4 ef	33 cd
Grand mean	51.1	102.1	20.1	23.7	14.8	26.9
LSD5%	11.48	20.74	3.88	4.24	4.17	7.39

Means in each column followed by the same letter(s) did not differ at $p<0.05$ according to Duncan's multiple-range test.
Grand mean of Low ºC =21.3, 21.4 High ºC =37.9, 37.3 at the 1st, 2nd season of Qalubiya governorate
Grand mean of Low ºC =20.1, 21.3 High ºC = 36.4, 37.7 at the 1st, 2nd season of Menoufia governorate

storage months at Qalubiya Governorate. While, at Menoufia Governorate, coriander seeds were highly infested by *L. serricorne* insects with a mean of 67.6 individuals, followed by *S. paniceum, T. castaneum, T. granarium, C. maculatus,* and *R. dominica* with means of 33.2, 17.2, 16.6, 12.2, and 4 individuals, respectively, during the storage months. *S. paniceum* recorded the highest population number compared with the other insect species, recording 304 individuals in September and 251 individuals in August during the second season, followed by *L. serricorne,* 212 individuals in July during the first season 2020/2021, and 98 individuals in September during the second season at Qalubiya Governorate.

According to the present results in Tables (5, 6) it could be concluded that the most of stored insects attacked Coriander crop in both field and stores are: *S. paniceum* and *L. serricorne* beetles are among the most common pests of coriander plants, during the two seasons in the two governorates. This finding are similar to Lal, 2018 who reported that the major pests in all aromatic and spice plant are *S. paniceum* and *L. serricorne*. Also, (Kalra, 2006, Singh and Kumar, 2019, Magd El-Din, 2003) reported that *S. paniceum* and *L. serricorne* are main pests of coriander and fennel plant during storage. Recently, the results are in harmony with El-Gamal *et al*., 2020 who reported that drugstore beetle is an important pest causing damage to coriander dried fruits during storage. At the same direction (Thanushree, 2019) found that *Lasioderma serricorne* cause high infestation to coriander seed 45 days of storage.

Moreover, *A. obtectus* and *C. maculatus* adult insects were rarely found for the first time in the field and may be recorded as plant visitor due to the shortage of their numbers in both regions under investigation. Also, the obtained results recorded some store insects in the field and stores such as *T. granarium, R. dominica, T. castaneum* and confirmed with that obtained by (Abdelghany *et al*., 2010) who reported that the beetles of *T. castaneum, T. confusum, T.granarium* and *Cryptolestes ferrugineus* infested six stored aromatic plants in the botanical warehouses in Egypt.

The obtained results in Table (7) revealed the correlation of the carpet beetle, *A.verbasci,* drug store beetle, *S. paniceum,* Cigarette beetle, *L. serricorne*, Cowpea beetle, *C. maculatus*, Kidney bean beetle, *A. obtectus* and minimum and maximum temperatures, relative humidity, rainfall as abiotic factors.

The statistical analysis of the data in Table (7) reported that there were positive significant differences in the relation between minimum and maximum temperatures and the population density of all recorded insects, while there were negative significant differences in the relation between both of relative humidity & rainfall factors and the population density of all previous mentioned insects. This result are in harmony with Hashem *et al.,* (2005) who reported positive and highly significance in correlation and regression values between daily mean minimum temperature and weekly infested bean seeds with bean beetle *Bruchus rufimanus.* In addition, Angilletta, 2009 reported that temperature is the most influential factor on insect population dynamics and biological aspects. According to Parvatha Reddy (2013), global warming and climate changes will result in extension of geographical range of pests and pathogens, in cooler latitudes, global warming brings new species.

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Table 7. Correlation SE and probability between population of carpet, drug store, cigarette, cowpea and kidney bean beetles and some environmental factors along two seasons at two governorates.

	Qalubiya governorate			Menoufia governorate		
Carpet beetle 1st 2020/2021 2nd 2021/2022						
Factor	**r**	**SE. r of r**	**p(r=o)**	**r**	**SE. r of r**	**p(r=o)**
Low temp.	0.752	0.208	.0047**	0.672	0.234	.0166*
	0.831	0.175	.0008***	0.611	0.250	.0348*
High temp.	0.661	0.237	.0192*	0.462	0.280	.129 ns
	0.739	0.212	.0060**	0.746	0.210	.0053**
R.H %	-0.135	0.313	.6739 ns	-0.376	0.293	.2283 ns
	-0.233	0.307	.4645 ns	-0.396	0.290	.2020ns
Rainfall	-0.377	0.292	.226 ns	-0.316	0.299	.3160 ns
	-0.372	0.293	.2325 ns	-0.344	0.296	.2727ns
Drug store beetle 1st 2020/2021 2nd 2021/2022						
Low temp.	0.956	0.092	.0000***	0.964	0.0831	.0000***
	0.433	0.284	.1589 ns	0.356	0.295	.2556ns
High temp.	0.825	0.178	.0009***	0.832	0.175	.0008***
	0.344	0.296	.2727 ns	0.443	0.283	.1483ns
R.H %	-0.291	0.302	.3572 ns	-0.729	0.216	.0071**
	0.029	0.316	.9264	-0.186	0.310	.5610ns
Rainfall	-0.172	0.311	.5922 ns	-0.267	0.304	.4004 ns
	-0.143	0.312	.6561 ns	-0.186	0.311	.5622ns
Cigarette beetle 1st 2020/2021 2nd 2021/2022						
Low temp.	0.832	0.175	.0008***	0.738	0.213	.0061**
	0.384	0.291	.2171 ns	0.350	0.296	.2643ns
High temp.	0.718	0.2198	.0085**	0.727	0.216	0073**
	0.275	0.304	.3866 ns	0.455	0.281	.1364ns
R.H %	-0.215	0.308	.5005 ns	-0.562	0.261	.0570 ns
	0.020	0.316	.9498 ns	-0.118	0.311	.5717ns
Rainfall	-0.364	0.294	.2440 ns	-0.249	0.306	.4345 ns
	-0.116	0.314	.7177 ns	-0.195	0.310	.5429ns
Cowpea beetle 1st 2020/2021 2nd 2021/2022						
Low temp.	0.746	0.211	.0053**	0.820	0.180	.0011**
	0.512	0.271	.0890 ns	0.500	0.273	.0972ns
High temp.	0.684	0.230	.0140*	0.673	0.233	0.162*
	0.394	0.290	.2047 ns	0.556	0.262	.0602ns
R.H %	-0.255	0.305	.4230 ns	-0.598	0.253	.0396*
	-0.196	0.310	.5404 ns	-0.085	0.315	.7910ns
Rainfall	-0.317	0.299	.3151 ns	-0.209	0.3092	.5142
	-0.190	0.310	.5524 ns	-0.357	0.295	.2537ns
Kidney bean beetle 1st 2020/2021 2nd 2021/2022						
Low temp.	0.778	0.198	.0028**	0.963	0.085	.0000***
	0.603	0.252	.0378*	0.540	0.266	.0696ns
High temp.	0.757	0.206	.0043**	0.889	0.144	.0001***
	0.478	0.277	.1153 ns	0.601	0.252	.0386ns
R.H %	-0.263	0.305	0.315	-0.809	0.185	.0014**
	-0.078	0.315	.4080 ns	-0.427	.0014**	.1653ns
Rainfall	-0.361	0.294	.2489 ns	-0.284	0.303	.3702 ns
	-0.212	0.309	.5077 ns	-0.335	0.297	.2871ns

ns= not significant *= significant **= high significant ***= very high significant
r= correlation coefficient p= probability SE= standard error

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الملخص العربي

الكثافة العددية للآفات التي تصيب الكزبرة كأحد أهم النباتات الطبية على مدى موسمين متتاليين في محافظتي القليوبية والمنوفية، مصر

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أجريت تجربة تحت ظروف الحقل المفتوح على نبات الكزبرة لموسمين متتالين ٢٠٢٠/٢٠٢١، ٢٠٢١/٢٠٢٢ بمحطة بحوث البساتين بالقناطر الخيرية التابعة لمركز البحوث الزراعية بمحافظة القليوبية ومزرعة خاصة بمحافظة المنوفية - مصر وذلك لعمل حصر للآفات التي تصيب نبات الكزبرة والاعداء الحيوية المصاحبة في الحقل والمخزن.

أشارت النتائج المتحصل عليها تواجد ١٢ نوع من الآفات التي تصيب نبات الكزبرة، والتي تتبع رتبة نصفية الأجنحة (الذبابة البيضاء- من الكزبرة- من الخوخ الخضر)، بالإضافة إلى رتبة غمدية الأجنحة (خنفساء العقاقير، خنفساء السجائر، خنفساء السجاد، خنفساء الصعيد، خنفساء اللوبيا، خنفساء الفاصوليا الجافة، ثاقبة الحبوب الصغرى، خنفساء الدقيق)، وكذلك رتبة هدبية الأجنحة والتابع لها حشرة التربس بالإضافة إلى العنكبوت الأحمر العادي ذو البقعتين والتابع لرتبة العناكب. كما اظهرت نتائج الحصر تواجد نوعين من الطفيليات وخمسة أنواع من المفترسات بالإضافة إلى نوع من الأكاروس المفترس. حقليا تصاب نباتات الكزبرة بحشرات الذبابة البيضاء والمن والتربس والعنكبوت الحمر في كلتا المحافظتين خلال عامي الدراسة، حيث سجلت حشرات المن أعلى نسبة إصابة تليها حشرة الذبابة البيضاء مع ملاحظة عدم ظهور إصابة خلال شهر مارس في كلتا المحافظتين خلال موسمي الدراسة. أثرت العوامل المناخية (درجات الحرارة) إيجابيا على تعداد الحشرات وكان التأثير سلبيا للرطوبة والأمطار.

أظهرت نتائج البحث إصابة ثمار الكزبرة بالعديد من آفات المخازن في الحقل أثناء مرحلتي التزهير والإخصاب وهي (خنفساء السجاد- خنفساء العقاقير- خنفساء السجائر- خنفساء اللوبيا- خنفساء الفاصوليا الجافة) حيث لوحظت الإصابة في الحقل ثم إزدادت تدريجيا حتى وصلت لأعلى نسبة إصابة على المحصول الجاف في المخزن. كما أظهرت النتائج إصابة المحصول الجاف للكزبرة بالمخزن بخنافس العقاقير والسجاد واللوبيا والصعيد وثاقبة الحبوب الصغرى وخنفساء الحبوب في كلتا المحافظتين خلال موسمي الدراسة طوال فترة التخزين، كما أظهر التحليل الإحصائي للنتائج وجود ارتباط معنوي موجب بين تعداد الآفات ودرجات الحرارة بينما كان الارتباط سلبيا بين تعداد الآفات والرطوبة النسبية.