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Population fluctuations of diamond back moth, *plutella xylostella* (l.) (lepidoptera: plutellidae) attacking some brassicae plants at menoufia governorate, Egypt

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Abstract
The experiments were carried out at Shebin Elkom center, Menoufia Governorate, Egypt under field conditions on some Brassicae vegetables along two seasons (2021/2022) and (2022/2023). Current study aimed to investigate the population dynamics of the Diamond back moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) and the impact of abiotic factors (high temperature, low temperature, relative humidity). Results revealed that Diamond back moth (DBM) was abundant infestation levels during autumn season and the beginning of winter season on cabbage, broccoli, cauliflower and red cabbage. Results indicated that the highest numbers of infestation were recorded at December2021 &October 2021 at the first season of study, while the lowest numbers of infestations were recorded on November 2021& January 2022. The highest number of infestations with (DBM) recorded on December 2022 & November 2022 at the second season of study, while the lowest numbers of infestations were recorded on October 2022 & January 2023.

Keywords: *Plutella xylostella*, brassicae, cabbage, red cabbage, cauliflower, broccoli, abiotic factors

Introduction

Diamond back moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) became a main and destructive insect pest of Brassica vegetables in Egypt. DBM has been direct losses and control costs (Talekar 1992, Talekar and Shelton 1993, Shelton 2004 [, Grzywacz *et al*. 2010, Zalucki *et al.* 2012) [6, 17, 19, 20, 25]. That is because the difficult control of this pest with the resistance to insecticides and the effect on natural enemies all these problems cause of *P. xylostella* outbreaks in most parts of the world (Lim 1986, Talekar and Shelton 1993) [10, 20] depending on the individual behavior against this insect has led to a continuous increase in the insecticide used rates, low effectiveness, the development of resistance to many insecticides (Gautam *et al.* 2018) [5]. Also, Diamond back moth reduces the yield quality and quantity every year (Embaby and Lotfy, 2015) [2]. *Plutella xylostella* has shown resistance to 91 active ingredients of insecticides worldwide which including 12 strains of *Bacillus thuringiensis* (Sakomoto *et al.* 2004).

DBM attack Brassica vegetables especially Brassica oleracea such as cabbage, cauliflower, broccoli, red cabbage. Damage of Brassica vegetables caused by the feeding of larvae even though they are small relative to other lepidopteran pests, the larval densities on leaves can reach levels that causing economic losses. Field experiment was conducted on four Cole crops, cabbage (Brassica oleracea var. capita), cauliflower (*B. oleracea* var. botrytis) and broccoli (*B. oleracea* var. Italica) and red cabbage Purple (*B. oleracea var. capitata F. rubra*). In Egypt cabbage is an important vegetable from the Brassicae and is widely grown. It is used as a cooked vegetable or as a raw salad in house and hotels. Cauliflower and broccoli are an important winter vegetable belonging to Brassicaceae with medicinal important having glucosinolates and anticancer substances are used for cancer (Cohen *et al.*, 2000; Lampe and Peterson, 2002; Keck and Finley, 2004) [1, 8, 9]. Which have an important component of human diet. Broccoli is the most widely used as a frozen vegetable and consider a high-quality vegetable for fresh consumption and contains vitamins A and C as well as minerals K, P, Ca, and Fe. Additionally, it includes thiamine, riboflavin, and niacin (McMurray 1999) [11]. Diamond back moth attacking broccoli and causes high damage (Satyagopal *et al.* 2015) [14]. DBM is the global pest of cauliflower and caused about 90% damage and the most important pest for Brassicaceae (Verkerk and Wright, 1996; Sarfraz *et al.*, 2006; Tufail *et al.*, 2008; Furlong *et al.*, 2013) [3, 15, 23, 24]. This pest was the main reason of low production (Talekar and Shelton, 1993; Sarfraz *et al.*, 2006 [15, 20]. Red cabbage have low in calories and has health advantages, it is used in, boiling and steamed foods, raw salads, and coleslaws. Its health benefits over cancer and diabetes. It also strengthens the immune system, aids in bodily purification, encourages weight loss, reduces inflammation, improves skin, and eases constipation. Important for understanding the factors that inhibit pest populations and their natural enemies, therefore essential for effective crop protection, relationship between the Diamond back moth and climatic factors (Gallo *et al.*).

Current study aimed to investigate the population dynamics of the Diamond back moth, *P. xylostella* and the impact of abiotic factors (high temperature, low temperature, relative humidity). Experiments were carried out at Shebin Elkom center, Menoufia Governorate, Egypt under field conditions on some Brassicae vegetables during two seasons (2021/2022) and (2022/2023).

Materials and Methods

Experimental design

Current study was conducted into during two successive seasons; 2021-2022 and 2022-2023 at a private farm in Shebin Elkom center, Menoufia governorate. In first September under field conditions on some Brassicae vegetables cabbage, broccoli, cauliflower and red cabbage, the experiments were arranged in a randomized complete block design with three replicates; there were 9 plots; each plot area was measured at 18 m2 and divided into three

rows, each 6 m long and 3 m wide for 175m2. Seedlings were sown in spot treatment on one side of each row at 30-40 cm distances. The total cultivated area was 700 m2. Agricultural practices applied as usual normally, no fertilizer and no chemical control were used. After one month from cultivated weekly observations on insect DBM (Larvae-Pupae) were conducted on Brassicae vegetables in the early morning. 15 plants were randomly selected and tagged in each plot, where the population of DBM was counted visually (absolute counting).

Statistical analysis

Current study contained estimating the related between population fluctuation of Diamond back moth, *P. xylostella* and the weather factors during study. Weather factors were recorded; maximum, minimum mean temperatures and mean percentage of relative humidity obtained from Central Laboratory of Agriculture Climate (C.L.A.C.) Giza, Egypt. Mean daily weather factors were recorded and calculated as weekly means presenting. Results obtained both of the mean population numbers of *P. xylostella* and mean population percentages were statistically analyses by using (ANOVA)-analysis of variance- in SAS program (SAS Institute, 1988) [16].

Results and Discussion

1. Population fluctuations of Diamond back moth (DBM)

The obtained data tabulated in Table (1) and Fig. (1) show that the population density of (DBM) attacking Brassicae vegetables under field conditions from Oct.2021, Nov. 2021, Dec. 2021 to Jan. 2022 at Menoufia governorate.

Data obtained and tabulated in Table (1) and Fig. (1) revealed that the highest number of infestations with (DBM) recorded on Dec. 2021&Oct. 2022 at the first season of study while the lowest numbers of infestations were recorded in Nov.2021& Jan. 2022.

a. Population fluctuation of the diamond back moth larvae

Data obtained indicated to that high numbers of population were on Cauliflower, Cabbage, Broccoli and Red cabbage which (290,269,250 and 170) respectively on September. While at December month the population numbers on Cauliflower, Broccoli, Red cabbage and Cabbage were (310,267, 199 and 176) respectively, and the lowest numbers of population were recorded in November & January. Cauliflower, Broccoli, Cabbage and Red cabbage which (285, 284,272 and 152) - Cabbage, Cauliflower, Broccoli and Red cabbage (102,95,86 and 40) respectively.

2. Population fluctuation of the Diamond back moth Pupae

Data revealed that high numbers of population were on Cauliflower, Broccoli, Cabbage and Red cabbage which (157,149,141 and 116) respectively on September. While at December month thepopulation numbers on Cauliflower, Broccoli, Red cabbage and Cabbage were (353,334,293 and 238) respectively. and the lowest numbers of population were recorded in November & January. Cauliflower, Cabbage, Broccoli and Red cabbage which (167, 165, 272 and 82) -Cauliflower, Broccoli, Red cabbage and Cabbage (81,61,53 and 52) respectively.

Statically analysis at the first successive season 2021/2022 showed also that there were highly significant effects (differences) between mean population numbers of the successive insect *P. xylostella* and maximum, minimum temperatures and relative humidity percentage.

Table 1: Weekly average numbers of the Diamond back moth attacking some Brassicae vegetables during season 2021-2022 at Menoufia governorate.

Months	Week	Total numbers of Diamond back moth (DBM) individuals 2021-2022								Weather Factors		
		Cabbage		Red cabbage		Broccoli		Cauliflower				
		Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Max. T	Min. T	R.H.
October 2021	1	53	28	30	25	47	39	61	40	33.2	18.8	56.1
	2	62	29	42	31	57	36	73	35	34.7	18.7	57.9
	3	75	39	43	27	67	39	79	43	32.2	18.3	53.0
	4	79	45	55	33	79	35	77	39	31.4	17.3	57.7
November 2021	1	67	42	25	13	75	32	82	50	31.6	18.1	59.8
	2	65	38	32	20	60	26	62	39	31.0	16.8	61.2
	3	59	32	30	17	77	37	72	46	25.4	15.4	72.3
	4	81	53	65	32	72	36	69	32	26.5	13.7	67.9
December 2021	1	43	56	53	66	63	86	68	82	22.3	12.1	64.9
	2	37	49	44	69	55	80	75	86	22.4	11.1	71.1
	3	41	60	52	75	72	75	79	95	18.4	8.4	67.5
	4	55	73	50	83	77	93	88	90	18.8	8.5	76.1
January 2022	1	23	14	10	15	28	16	31	27	20.3	7.8	75.6
	2	32	15	12	18	20	14	22	18	18.9	7.3	58.5
	3	25	13	10	13	17	16	25	19	16.4	5.6	66.2
	4	22	10	8	7	21	15	17	17	14.9	4.7	74.1
Mean		51.18	37.25	35.06	34	55.43	42.18	61.25	47.37	24.9	12.7	64.9
F (0.05)		275.51	311.34	412.52	374.21	239.71	311.32	225.74	327.92	375.21	392.76	371.44
LSD 5%		3.64	3.85	4.29	4.01	4.24	4.13	3.79	3.86	3.22	3.75	3.91

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

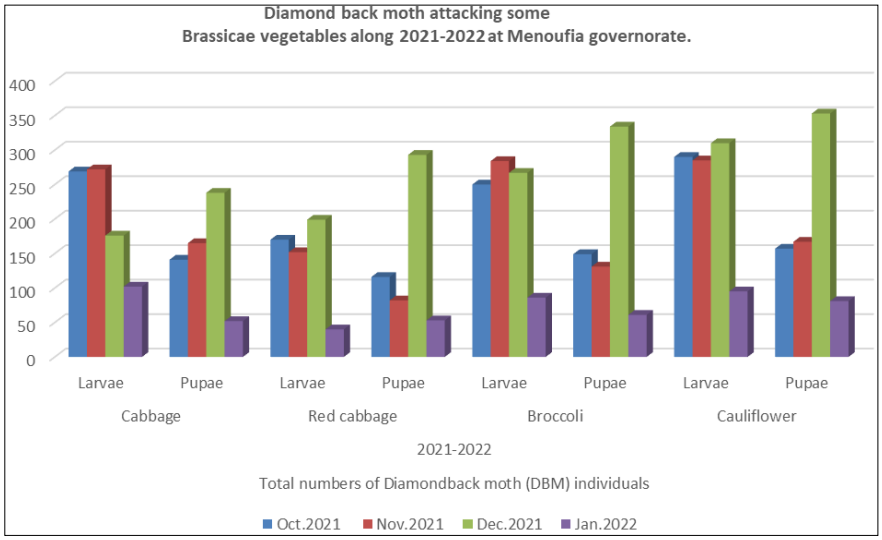

Fig 1: Population fluctuations of the Diamond back moth attacking some Brassicae vegetables during season 2021-2022 at Menoufia governorate.

Data obtained and tabulated in Table (2) and Fig (2) showed that the population density of (DBM) attacking Brassicae vegetables under field conditions from Sep.2022, Nov. 2022, Dec.2022 to Jan. 2023 at Menoufia governorate.
Data obtained and tabulated in Table (2) and Fig (2) revealed that the highest number of infestations with (DBM) recorded on Dec. 2022& Nov.2022 at the second season of study, while the lowest number of infestations were recorded in Sep. 2022& Jan. 2023.

3. Population fluctuation of the Diamond back moth larvae

Data obtained indicated to that high population numbers on Cauliflower, Broccoli, Cabbage and Red cabbage were (302,276,257 and 168) respectively on December. While at November month population numbers on Cabbage, Broccoli, Cauliflower and Red cabbage were (325,299,298 and 175) respectively. And the lowest population numbers were recorded in September & January. Cauliflower, Cabbage, Broccoli and Red cabbage which (313, 292, 267and 168) - Cabbage, Cauliflower, Broccoli and Red cabbage (134, 118, 79 and 78) respectively.

Table 2: Weekly average numbers of the Diamond back moth attacking some Brassicae vegetables during season 2022-2023 at Menoufia governorate.

Months	Week	Total numbers of Diamond back moth (DBM) individuals 2022-2023								Weather Factors		
		Cabbage		Red cabbage		Broccoli		Cauliflower				
		Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Max. T	Min. T	R.H.
October 2022	1	59	28	33	26	58	40	69	48	35.8	20.8	54.5
	2	75	47	40	30	61	41	77	49	31.9	18.3	57.8
	3	73	42	44	29	73	42	80	60	31.7	18.6	56.8
	4	85	59	51	36	75	44	87	70	29.9	18.2	61.6
November 2022	1	72	46	33	21	70	33	70	48	28.3	15.5	58.1
	2	79	51	34	23	73	36	74	54	27.6	15.9	62.3
	3	86	58	46	30	75	37	76	58	27.3	14.4	59.1
	4	88	69	62	34	81	39	78	61	24.8	13.4	60.3
December 2022	1	52	38	53	66	63	86	68	82	25.3	13.5	61.2
	2	62	45	44	69	55	80	75	86	25.8	12.5	50.9
	3	68	56	52	75	72	75	79	95	25.7	12.6	70.2
	4	75	58	50	83	77	93	88	90	21.1	10.9	74.7
January 2023	1	23	14	10	15	28	16	31	27	21.7	10.3	74.8
	2	32	15	12	18	20	14	22	18	20.3	9.3	69.4
	3	25	13	10	13	17	16	25	19	21.4	7.4	68.6
	4	22	10	8	7	21	15	17	17	22.9	9.2	70.3
Mean		61	40.56	36.73	35.93	57.43	44.18	63.5	55.12	26.3	13.8	63.2
F(0.05)		326.11	345.71	421.34	276.84	364.82	329.11	288.75	321.44	311.72	267.99	312.33
LSD 5%		3.11	3.25	4.52	2.76	4.87	3.52	3.85	3.21	3.25	3.82	3.73

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

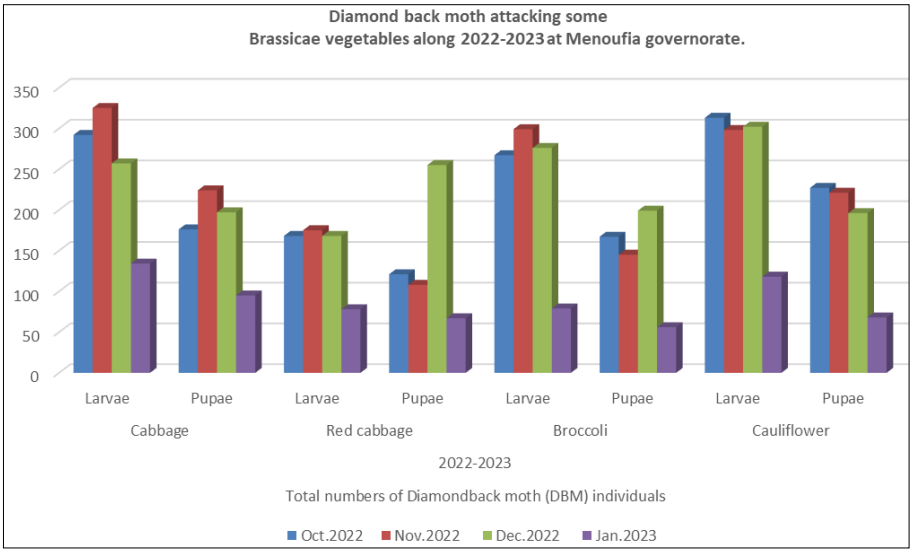

Fig 2: Population fluctuations of the Diamond back moth attacking some Brassicae vegetables during season 2022-2023 at Menoufia governorate.

4. Population fluctuation of the Diamond back moth Pupae

Data indicated that high numbers of population were on Red cabbage, Broccoli, Cabbage and Cauliflower which (255,199,197 and 196) respectively on December. While at November, numbers of population were on Cabbage, Cauliflower, Broccoli and Red cabbage, which (224, 221, 145 and 108) respectively and the lowest numbers of population were recorded in October 2019 & January 2020. Cauliflower, Cabbage, Broccoli and Red cabbage which (227, 176, 167 and 121) - Cabbage, Cauliflower, Red cabbage and Broccoli (95, 68, 67 and 56) respectively.

According to Kamel (2003) [7] the Diamond back moth was abundant during kharif and the beginning of winter along the two seasons of study. Diamond back moth remains a major and the most destructive insect pest in Brassica vegetables worldwide Zalucki *et al*. (2012).

Statically analysis at the second successive season 2022/2023 showed also that there were highly significant effects (differences) between mean population numbers of the successive insect *P. xylostella* and maximum, minimum temperatures and relative humidity percentage.

Conclusion

Current study aimed to investigate the population dynamics of the Diamond back moth, *Plutella xylostella* (L.) and the impact of abiotic factors (high temperature, low temperature, relative humidity). Results revealed that Diamond back moth (DBM) was abundant infestation levels during autumn season and the beginning of winter season on cabbage, broccoli, cauliflower and red cabbage. Results indicated that the highest numbers of infestation were recorded at December 2021 &October 2021 at the first season of study, while the lowest numbers of infestations were recorded on November 2021& January 2022. The highest number of infestations with (DBM) recorded on December 2022 & November 2022at the second season of study, while the lowest number of infestations were recorded on October 2022 & January 2023.

In this study understanding of factors affecting DBM population dynamics and the relationship between them help making IPM program to control DBM. Recommended for control should use some bacterial insecticides because these products have no effect on Brassicae plants and natural enemies.

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