

Evaluating of intercropping system onion with cabbage and insect predators for reducing insect pests infesting onion and cabbage plants

Aml B Abou El-Kassem^{1*}, HM Hassan², Aneesa S Sadek¹

¹ Department of Vegetables Crop Pests Research, Plant Protection Research Institute, Agric. Res. Center, Giza, Egypt

² Department of Economic Entomology, Faculty of Agriculture, Kafr El-Sheikh University 33516, Kafr El-Sheikh, Egypt

² Department of Biology, Faculty of Science at Yanbu, Taibah University, AL Amoedi, 46423 Yanbu El-Bahr, Saudi Arabia

Abstract

Agricultural practices such as intercropping and trap cropping are used to manipulate or reducing pest populations with less reliance on chemical means. The experiments were carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate during 2022/2023 and 2023/2024 seasons, to evaluate the effect of intercropping system on insect pests infesting cabbage intercropped with onion and their associated predators. In the first season, Population abundance of *Thrips tabaci*. on onion and cabbage crops exhibited three peaks on onion with 335, 757 and 1173 larvae and adults/10 plants on 13 February, 17 March, and 3 April, respectively. While on cabbage they were 475, 771 and 515 larvae and adults / 10 plants on 13 February, 9 March, and 3 April. Respectively. In the second one, the data took the same trend, while the total numbers of *T.tabaci* on onion plants was higher than cabbage plants the highest monthly average number on onion intercropping with cabbage was found in March in the first season. While in the second one, was in February and March. The least population of *T. tabaci* was noticed in plant density ratio of, 1onion: 4cabbage; 4249 and 3369 individuals in the first season, while 2217 and 1185 individuals in the second one. This is due to that onion intercropping system was found to have repellent effects and cabbage Plants physically impede the pest insect's movement. Also, ratio of 1 onion: 1 cabbage reduced the rate of infestation of cabbage by *Pieris rapae*, aphids, *Plutella maculipennis*, and *Nezara viridula*. Population density of insect predators was higher at intercropping system (polyculture) than in monoculture system.

Keywords: Intercropping system, pest control, onion, cabbage, insect pests and predators

Introduction

Vegetable crops are essential foods in the agricultural map all over the world. They occupy a distinguishable rank in agriculture in Egypt either in the old lands or in the newly reclaimed ones.

In Egypt, onion (*Allium cepa* L.) is an important field crop for both local consumption and for exportation. Onion plantations, as well as bulbs during the storage, are often subject to considerable insect infestations which affect the crop quality and quantity. (*Thrips tabaci* Lind.) is the major insect pests of onion and attacks the plants during several growth stages (Mahmoud, 2008 and Mahaffey and Cranshaw, 2010) [17, 18]. Cabbage (*Brassica oleracea* L.) is an important leafy vegetable crop which forms an important component of the diet in several countries. The nutritional value and succulent nature of cabbage attract many insect pests for feeding, including *Brevicoryne brassicae* L., *Pieris rapae* L., *Plutella maculipennis* (Curtis), *Nezara viridula* and *Thrips tabaci* Lind, which cause yield losses (Leite *et al.*, 2005 and 2006 Mahmoud *et al.*, 2009) [15, 16, 19]. Onion plants characterized by its repellent odour, small vegetative and rapid growth, is suitable for intensification with cabbage plants. Some patterns of crop intensifications may reduce the insect pest infestations. Sulvia *et al* (2016) indicated that the onion can be used as a useful tool to control the caterpillar, *Agrotis ipsilon* in lettuce in case of intercropping. Sidauruk and Sipayung (2018) [22] showed

that intercropping significantly decreased the numbers of *Myzus persicae* on potato, at 9th week after planting. Mohamed and Alyousuf (2021) showed the efficiency of intercropping system in decreasing the infestation of diamondback moth (*Plutella xylostella* L.) and turnip aphids. Gadzekpo *et al* (2020) [10] showed that intensification cabbage with cowpea is a successful pest control method of *Brevicoryne brassicae*, *Plutella xylostella*, *Aphis craccivora* and *Megaluruthrips sjostedi*. Sidauruk *et al* (2013) [23] reported that the pattern of intercropping significantly reduces the number of *Myzus persicae* in intercropping system. The lowest number of *M.persicae* was found by intercropping potatoes with mustard followed by potatoes and onions, and potatoes and celery, they added that the number of natural enemies significantly increased at intercropping system, these natural enemies are *Episyrphus balteatus*, *Chrysoperla carnea*, *Aphidius matricariae* and *Coccinella septempunctata*.

The present work aimed to study the effect of intercropping onion into cabbage for reducing of the cabbage infestation with some important insect pests and enhancing populations of insect predators.

Materials and methods

1. Experimental site and design

This investigation was conducted at the Sakha Agricultural Research Station's experimental farm during 2022/2023 and

2023/2024 seasons. An area of 1080 m² was divided into 18 plots (60 m² each) to act as six treatments and three replicates.

2. Intercropping patterns

Cabbage, *Brassica oleracea* Var. Balady seedlings and onion, *Allium cepa* local variety seedlings were transplanted on 30 and 20 December of 2022/ 2023 and 2023 /2024 seasons, respectively. Sole onion was usually transplanted on both ridges, while Sole cabbage was usually transplanted on one side.

The intercropping patterns were as follows:

- a. Sole onion and sole cabbage.
- b. One row onion with one row cabbage (1onion: 1Cabbage)
- c. One row onion with two rows cabbage (1onion: 2Cabbage)
- d. One row onion with three rows cabbage (1onion: 3Cabbage)
- e. One row onion with four rows cabbage (1onion: 4Cabbage)

3. Cultural practices

Normal cultural practices were adapted as recommended without insecticides.

4. Insect investigation

The first examination was practiced one month after crop transplanting, and examination continued weekly till harvest. At each sampling date, 10 whole plants of each of onion and cabbage were examined to record the numbers of occurring insect pests and their associated predators. Numbers of thrips (larvae and adults) *Pieris rapae* (larvae), Aphids (nymphs and adults), *Plutella maculipennis* (larvae

and pupae), and *Nezara veridula* (nymphs and adults), and predators; *Coccinella* spp. (larvae and adults), *Syrphus* spp. (larvae), *Scymnus* spp. (larvae and adults) and true spider (spiderlings and adults) were counted and recorded.

5. Statistical analysis

Data were subjected to ANOVA, and significant variable means were compared using Duncan's Multiple Range Test (1955) [6] at 5% level.

Results and discussion

1. Population dynamics of onion thrips, *Thrips tabaci* on onion and cabbage. Plants

Data presented in Table (1) & Fig: (1) indicated that during the first season (2022/ 2023), the numbers of onion thrips *T.tabaci* on onion plants began with a relatively low number (103 larvae and adults/ 10 plants) on February 6th then, the numbers increased and fluctuated to exhibit three peaks of 335, 757 and 1173 individuals/ 10 plants on February 13th, March 17th and April 3rd, respectively. Lower numbers of thrips were detected on cabbage compared to these on onion. The population density on cabbage was 63 individuals/ 10 plants on February 6th, then, formed three peaks of 475, 771, and 515 individuals/ 10 plants on February 13th, March 9th and April 3rd, respectively.

In the second (2023 / 2024) season,data in Table(1)and Fig (2) reported that the numbers of *T.tabaci* start by a few numbers of 15 individuals/ 10 plants on January 9th on onion crop, then, increased gradually to reach peaks of 49, 410 and 502 individuals/ 10 plants on January 23rd., February 20th, and March 20th, respectively. The numbers of *T.tabaci* on cabbage plants start by few numbers, with 15 individuals/ 10 plants on January 9th, and formed four peaks of 110, 123, 217 and 328 individuals/ 10 plants on January 23rd, February 6th, and 20th, and March 20th, respectively.

Table 1: Population dynamics of *Thrips tabaci* (larvae and adults) on sole onion and sole cabbage at the experimental farm of Sakha Agricultural research station during 2022/2023 and2023/2024seasons

2022/2023 season			2023/2024 season		
Sampling date	No. of thrips (larvae and adults)//10 plants		Sampling date	No. of thrips (larvae and adults)//10 plants	
	Onion	Cabbage		Onion	cabbage
February, 6	103	63	January, 9	15	15
13	335	475	16	32	87
20	271	281	23	49	110
28	412	602	30	37	93
March, 9	516	771	February, 6	195	123
17	757	753	13	310	102
25	723	476	20	410	217
April, 3	1173	515	27	334	131
10	594	327	March, 6	231	135
17	44	56	13	137	247
25	34	24	20	502	328
May, 1	0	0	27	271	148
			April, 3	70	21
			10	8	9
Total	4962	4343	Total	2601	1766
Average ± SE	413.50 ± 103.28	361.92 ± 80.86	Average	185.79 ± 43.10	126.14 ± 24.00

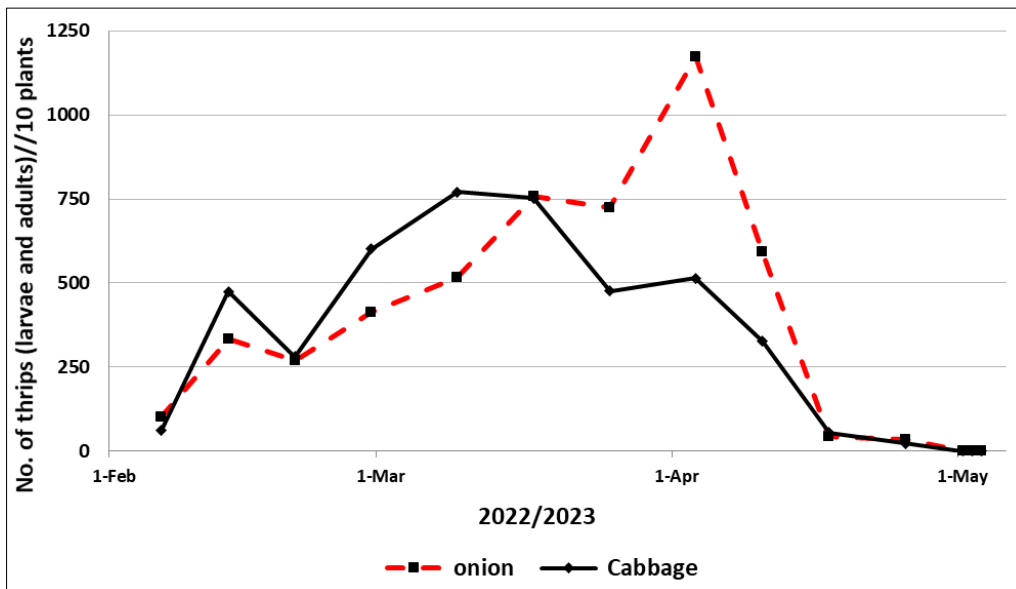


Fig 1: Population dynamics of *Thrips tabaci* on sole onion and sole cabbage at the experimental farm of Sakha Agricultural research station during 2022/ 2023 season

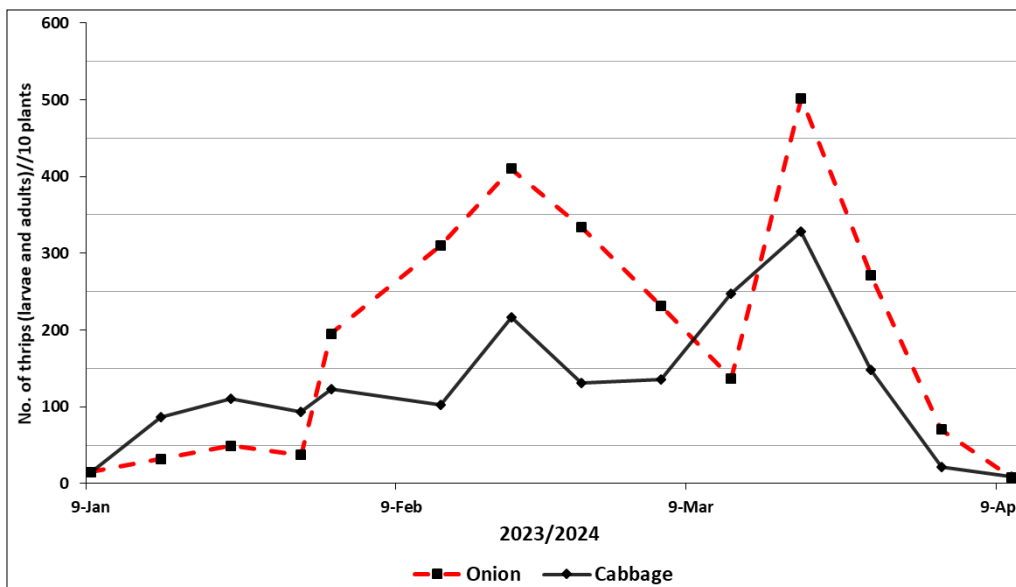


Fig 2: Population dynamics of *Thrips tabaci* on sole onion and sole cabbage at the experimental farm of Sakha Agricultural research station during 2023/2024 season

Data in Table(1) and Fig (1 &2) exhibit that mean numbers of thrips were 413.50 ± 103.28 and 185.79 ± 43.10 individuals /10 onion plants, compared to 361.92 ± 80.86 and 126.14 ± 24.00 individuals/ 10 cabbage plants, in the seasons, respectively.

Our results are in agreement with those obtained by El-Fakharany (2010) [7] who indicated that population fluctuation of *T.tabaci* reached maximal abundance in March and early April. Similar results were reported by Leite *et al.* (2005 and 2006) [15, 16], Ibrahim and Adesiyun (2009) [13] and Hendawy *et al* (2011) [12] as they showed that the population density of *T.tabaci* peaked in March and April.

2. Monthly average number of *Thrips tabaci* on onion and cabbage intercropping

Results in Table (2) indicated that total numbers of *T. tabaci*

infesting onion intercropped with cabbage in 2022/ 2023 season. The densities were highest on both crops during March compared to February and April, whatever the intercropping pattern practiced. Averages of *T.tabaci* were 1038.67 & 650.00, 893.00& 736.67, 1116.67& 897.33 and 1031.67& 653.33 larvae and adults /10 onion or cabbage plants for 1:1, 1:2, 1:3 and 1:4 (onion: cabbage) cropping patterns, respectively. The second rank of thrips density was found during February, while the lowest was in April.

Monthly average of *T. tabaci* in control treatment was higher 665.33 and 666.67 individuals. / 10 plants on onion and cabbage respectively during March 2022/ 2023 season.

Average population density of thrips on onion ranged between 437.80 and 464.31 larvae and adults / 10 plants according to the intercropping pattern, while average density on cabbage ranged between 335.19 and 443.94 larvae and adults / 10 plants.

Table 2: Monthly average number of *Thrips tabaci* on onion and cabbage intercropping at the experimental farm of Sakha Agricultural Research station, during 2022/ 2023 season

Month	No. of thrips (larvae and adults)/ 10 plants as indicated by intercropping system									
	Onion	Cabbage	Onion	Cabbage	Onion	Cabbage	Onion	Cabbage	Control	
	1	1	1	2	1	3	1	4	onion	Cabbage
Feb. 2023	238.75	328.25	210.25	317.10	137.00	291.25	181.00	222.25	280.25	355.25
Mar.	1038.67	650.00	893.00	736.67	1116.67	897.33	1031.67	653.33	665.33	666.67
Apr	115.50	50.00	230.25	99.50	120.25	143.25	100.75	130.00	461.25	230.50
Total	1392.92	1028.25	1333.50	1153.27	1373.92	1331.83	1313.42	1005.58	1406.83	1252.42
Mean ± SE	464.31± 289.38	342.75± 173.36	444.50 ± 224.32	384.42± 186.99	457.97± 329.38	443.94± 230.68	437.80± 297.83	335.19± 161.28	468.94±111.23	417.47±129.70

In the second season 2023/2024, Table (3), the highest monthly average numbers of *T. tabaci* on onion plants intercropped with cabbage plants was found with 1:1 was 311.50 and 169.00 individuals/10 plants in February and March on onion and cabbage plants, respectively. The

highest monthly average number of *T. tabaci* on onion and cabbage plants was found with plant density 1:2 was 274.50 and 273.00 individuals/ 10 plants, respectively in March 2023/2024.

Table 3: Monthly average number of *Thrips tabaci* on onion and cabbage intercropping at the experimental farm of Sakha Agricultural Research station, during 2023/ 2024 season

Month	No. of thrips (larvae and adults)/10 plants as indicated by intercropping system									
	Onion	Cabbage	Onion	Cabbage	Onion	Cabbage	Onion	Cabbage	Control	
	1	1	1	2	1	3	1	4	Onion	Cabbage
Jan. 2024	38.50	56.00	45.00	55.50	33.75	76.25	47.25	47.75	33.25	76.25
Feb.	311.50	104.50	243.50	164.75	304.00	189.50	297.50	74.50	312.25	143.25
Mar.	267.25	169.00	273.00	274.50	238.50	234.75	204.00	171.00	285.25	214.50
Apr	29.50	2.00	19.00	8.50	17.50	25.00	98.5.00	6.00	39.00	15.00
Total	646.75	179.40	589.50	503.00	593.75	525.50	647.25	299.25	669.75	449.00
Average ± SE	161.68±74.2 9	82.87± 35.53	145.12±65.8 0	125.81± 59.39	148.43±71.2 3	131.37 ±48.66	161.81±55.7 7	74.81± 35.02	167.43±76.0 2	112.25± 42.98

In case of plant density ratio 1 onion: 3 cabbage, monthly average numbers of *T.tabaci* were higher 304.00 and 234.75 individuals/ 10 plants in February, March on onion and cabbage plants, respectively. While the pattern 1 onion:4 cabbage induced the highest monthly average number of *T.tabaci*, 297,50 and 171.00 individuals/ 10 plants in February and March on onion and cabbage plants, respectively. In sole crops, the highest monthly averages of *T.tabaci* were 312.25 and 214.50 individuals/ 10 plants in February and March, respectively in 2023/2024.

Our results are in agreement with those of Hamid (2011) [11] who recorded that the highest average number of *T.tabaci* adults on onion was in March, while the highest average of larvae was in April El-Fakharany (2018) [21] showed that the highest monthly average number of *T.tabaci* was higher in March on sole onion plants and on onion intensification with lettuce.

Sole crops had the higher number of *T. tabaci* than intercropping with cabbage 4962.8 and 4343 individuals, respectively. Grand average of first

3. Population density of *Thrips tabaci* on onion and cabbage intercropping

In the season 2022/ 2023,Table (4) the highest total number of *T. tabaci* on onion intercropped with cabbage plants was recorded with the ratio of 1onion: 1 cabbage; 4544 and 3467 individuals respectively, Followed by total number of *T.*

tabaci with the ratio of 1onion: 2 cabbage, 4451 and 3900 individuals respectively. The least population density of *T. tabaci* was recorded on onion intercropped with cabbage at 1onion: 4 cabbage, 4249 and 3369 individuals, respectively. Results first season showed that the mean number of *T. tabaci* on onion plants was 4522.8 individuals, while was higher than mean number of insects on cabbage plants 3777.8 individuals. Also, results showed that sole crops had the higher number of *T.tabaci* than intercropping with cabbage 4962.8 and 4343 individuals, respectively. Grand average of first season showed that the mean number of *T.tabaci* on onion plants was 4522.8 individuals, while was higher than mean number of insects on cabbage plants (3777.8 individuals). Also, results showed that 1 onion:4 cabbage had the least average number of *T. tabaci* on both crops.This may be due to that onion intercropping system resulted in repellent effects as well as cabbage Plants physically impede the pest insect's movement (Hongjiao *et al*, 2011).

In the season 2023/ 2024, Data presented inTable (4) reported the least number of *T. tabaci* was found at 1onion: 4 cabbage, with 2217 and 1185 individuals. Respectively. Grand average of the second season clarifies that the mean number of *T. tabaci* on onion plants 2394 individuals. Was higher than mean number of that insect of cabbage plants was 1664.2 individuals.

Table 4: Effect of intercropping onion with cabbage plants on total numbers of *Thrips tabaci* at Sakha Agricultural Research station during two seasons 2022/2023 and 2023/24

Cropping system Onion: Cabbage	Total no. of thrips (larvae and adults)//120plants2022/ 23		Total no. of thrips(larvae and adults)//140plants 2023/24	
	Onion	Cabbage	Onion	Cabbage
1Onion:1 Cabbage	4544±5.7b	3467±11.5d	2528±17.3a	1322±11.5d
1Onion:2 Cabbage	4451±17.3c	3900±5.7b	2284±5.7bc	1996±13.3b
1Onion:3 Cabbage	4408±16.0c	3810±23.0c	2340±23.0b	2052±17.3a
1Onion:4 Cabbage	4249±29.0d	3369±11.5e	2217±19.3c	1185±8.6e
Control	4962±5.7a	4343±10.3a	2601±17.3a	1766±5.7c
Total	22614	18889	11970	8321
Average ± SE	4522.8±119.72	3777.8±173.08	2394± 73.19	1664.2±175.72

Means followed by the same letter are not significantly different at 0.05 level of probability (Duncan's Multiple Range Test 1955

Baidoo *et al.* (2012) [3] indicated that intercropping 1 row of onion with 4 rows of cabbage has served as an effective pest management strategy and effective land use, and onion can be used as an intercrop in the management of cabbage pests. Debra and Misheck (2014) [5] showed that garlic and onion intercropping can repels insect pests. In cabbage plants, it was noted that onion intercropped with cabbage has a higher repellent effect than the garlic and onion intercropping. El-Sadany and El-Shamy (2016) [8] showed that intercropping faba bean–tomato reduces the load of insect pests on the main crop tomato and reduces the dependence on chemical control of insects and leads to the production of healthy crops. So, intercropping could be used in integrated management environment program as a safe component to pests control and preserves from pollution.

4. Effect of intercropping systems on insect pests infesting cabbage plants intercropped with onion

Data presented in (Tables 5&6) show total numbers of insect pests infesting cabbage plants intercropped with onion at different patterns of intercropping.

4.1. *Pieris rapae*

In season 2022/2023, data in (Table 5) indicated that *Pieris rapae* was recorded at the highest total number of 38 individuals. /10 plants forming 25.85% of the total number of *P.rapae* at the ratio of 1 onion: 4 cabbage, while plant density ratio 1 onion:1 cabbage recorded the least total number (15 individuals /10 plants), respectively, with 10.20 % out of total. On the other hand, ratio of 1 onion: 2

cabbage and 1 onion: 3 cabbage came in between with total numbers 25 (17.01%) and 31 (21.09%) individuals. /10 plants, respectively.

In season 2023/2024, results in (Table 6) indicated that *Pieris rapae* was recorded by the lowest total number intercropping onion on cabbage plants with 17 and 18 individuals /10 plants forming (14.70 and 15.00%) at ratio 1onion: 1cabbage and 1 onion: 2 cabbage, respectively. However, the highest total numbers were recorded in control treatment (sole cabbage) with 31 individuals /10 plants forming 25.83% of the total number of *P.rapae*.

4.2. *Aphis* spp.

Data in table (5) showed that intercropping onion on cabbage plants at ratio of 1 onion: 2 cabbage harbored the highest total numbers of Aphids 1134 individuals /10 plants on cabbage plants and represented by (28.68%) of the total number of Aphids followed by 1 onion:3 cabbage with total numbers 1071(27.09%) individuals /10 plants. While the lowest total numbers of Aphids were recorded 372 (9.41%) individuals /10 plants in case plant density ratio 1onion: 1cabbage followed by control treatment 408(10.32%) individuals /10 plants.

Data in Table (6) explain that at ratio of 1onion: 1 cabbage and sole cabbage were the lowest total numbers of Aphids by 12 (5.97%) and 16 (7.96%) individuals /10 plants respectively, followed by 1onion:4 cabbage (PDR) with 35 (17.41%) individuals /10 plants, while 1 onion: 3 cabbage had the highest number of insects with 98 (48.76%) individuals /10 plants.

Table 5: Population densities of certain insect pests infesting cabbage plants intercropped with onion, at Sakha Agricultural Research station during2022/ 2023 season

Intercropping pattern	Total No.of insects/10plants 2022/2023							
	<i>pierris rapae</i>		Aphids.		<i>Plutella.maculipennis</i>		<i>Nezara viridula</i>	
	No.	%	No.	%	No.	%	No.	%
1Onion:1 Cabbage	15	10.20	372	9.41	146	16.61	27	8.23
1Onion:2 Cabbage	25	17.01	1134	28.68	184	20.93	91	27.74
1Onion:3 Cabbage	31	21.09	1071	27.09	202	22.98	77	23.48
1Onion:4 Cabbage	38	25.85	969	24.501	216	24.57	69	21.04
Sole cabbage	38	25.85	408	10.32	131	14.90	64	19.51
Total	147		3954		879		328	
Average ± SE	29.40±4.34		65.83±790.80		±175.8016.23		±10.68 65.60	

4.3. *Plutella maculipennis*

In 2022/2023season (Table5) data clarify that treatment 1 onion: 1 cabbage had the least total number of *P. maculipennis* (146 individuals. /10 plants forming 16.61 % of the total number of insects, followed by a ratio of 1onion: 2cabbage and 1onion:3 cabbage with 184 and 202

individuals /10 plants, respectively. which represented (20.93% and 22.98 %) of the total number, respectively. The ratio of 1 onion: 4 cabbage recorded the highest numbers of *P. maculipennis* 216 individuals /10 plants, forming 24. 57 % of the insect.

In the second season, (Table 6), showed that treatments 1 onion: 2 cabbage and 1 onion: 4 cabbage had the least numbers 59 and 79 individuals /10 plants, respectively, for mine 11.32% and 15.16% of the total numbers of insect.

Sole cabbage had 209 individuals/ 10 plants, which constituted 40.12 %out of total population of *P.maculipennis*.

Table 6: Population densities of certain insect pests infesting cabbage plants intercropped with onion, at Sakha Agricultural Research station during 2023/24 season

Intercropping pattern	Total No.of insects/10plants 2023/24							
	<i>Pieris rapae</i>		Aphids.		<i>Plutella.maculipennis</i>		<i>Nezara viridula</i>	
	No.	%	No.	%	No.	%	No.	%
1Onion:1 Cabbage	17	14.17	12	5.97	82	15.74	14	6.22
1Onion:2 Cabbage	18	15.00	40	19.90	59	11.33	80	35.56
1Onion:3 Cabbage	24	20.00	98	48.76	92	17.66	63	28.00
1Onion:4 Cabbage	30	25.00	35	17.41	79	15.216	49	21.78
Sole cabbage	31	25.83	16	7.96	209	40.12	39	17.33
Total	120		201		521		225	
Average ± SE	2.92 ±24.00		40.20±15.41		104.20±26.74		11.14±45.00	

4.4. Nezara viridula

Data in (Table 5) indicated that treatment with ratio 1onion:1cabbage recorded the lowest total numbers of *N.veridula* were 27 individuals /10 plants forming (8.23%) of insect. followed by the ratio of 1onion: 4 cabbage with total numbers of insect was 69 individuals /10 plants forming (21.04%) of the total number of *N. viridula*. While the highest total numbers of insect were 91 individuals /10 plants in plant density ratio 1onion:2cabbage and represented by (27.74%) of the total the insect.

In the second season, (Table 6) show that total numbers of *N. viridula* in treatments of intercropping onion on cabbage plants with 1onion:1cabbage recorded the lowest total number 14 individuals /10 plants and forming (6.22 %) of insect, while 1onion:2 cabbage received the highest total numbers 80 individuals /10 plants and forming (35.56%) of the insect.

Hongjiao *et al* (2011) clarify that onion and garlic intensification systems were recorded to have repellent effects on diamond back moth to lowering pests numbers because the a combined plants physically impede the pest insect's movement These findings agree with those obtained by Abo-Shanab *et al* (2013) [2] who found that intercropping tomato with coriander leads to a reduction in population of sucking pests in tomato, hence coriander crop was more attractive to the pests than tomato as trap crop.

Laxman *et al* (2019) [14] noticed that the cabbage plots intercropped with alfalfa was effective in reducing the population density of *Plutella xylostella* larvae, *Pieris brassicae* and aphids, as well as the attraction of natural enemies as pollinators to flowering intercropped plants, Debra and Misheck (2014) [5] showed that intercropping of cabbage with onion or garlic reduced the infestation of *Brevicoryne brassicae* L. and *Bemisia tabaci* and aphids.Mohammed and Alyousuf (2021) [20] showed that the effectiveness of intercropping systems of cabbage on decreasing the number of aphids, the low numbers was

recorded in the treatments of 3 cabbage: 1 alfalfa and 3 cabbage: 1 broad bean compared to the monoculture cabbage system. Abdul khaliq *et al.*, (2016) [1] show that minimum thrips density was recorded in the onion plots which were intercropped with cotton followed by tomato, chilli and okra respectively. The maximum thrips density was recorded in control plots and significant difference was found in the thrips densities among treatments.

5. Effect of intercropping onion with cabbage plants on insect predators associated with insect pests infesting cabbage plants

Results presented in (Table7) indicated total numbers of insect predators associated with insect pests infesting cabbage plants intercropped with onion

5.1. Coccinella undecimpunctatu

Results presented in (Table7) indicated total numbers of *C. undecimpunctatu* were lowest (13 and 19 individuals / 10 plants) at 1onion:4 cabbage and 1 onion: 3 cabbage, respectively. With (7.93% and 11.59%) of the insect, respectively. The highest numbers were (63 and 38 individuals 10 plants) forming (38.41 % and 23.17%) of the insect, at ratio of 1onion: 1cabbage and 1onion: 2cabbage respectively.

5.2. Syrphus SPP

Results inTable (7) indicated that the lowest total numbers of *Syrphus* SPP were 8, 13 and 17 individuals / 10 plants, forming (5.06 %-8.23 and 10.75%) at ration of 1onion: 2 cabbage, 1onion: 1 cabbage and control (sole cabbage),respectively.While the highest numbers were79 individuals / 10 plants, forming (50.00%) of the insect with plant density ratio 1onion:3 cabbage followed by 1onion: 4 cabbage with total number of insect 41 individuals / 10 plants forming (25.95%) of the insect.

Table 7: Effect of intercropping onion with cabbage for insect predators associated with insect pests infesting cabbage at Sakha Agricultural Research station

Predators /intercropping system	Total No. of predators /10 plants 2022/ 2023-2023/24							
	<i>Coccinellid sp</i>		<i>Syrphus sp.</i>		<i>Scymnus sp.</i>		True spider	
	No	%	No	%	No	%	No	%
1Onion: 1 Cabbage	63	38.41	13	8.23	25	18.94	44	18.88
1Onion: 2 Cabbage	38	23.17	8	5.06	36	27.27	69	29.61
1Onion: 3 Cabbage	19	11.59	79	50.00	21	15.91	55	23.61
1Onion: 4 Cabbage	13	7.93	41	25.95	22	16.67	26	11.16
Sole cabbage	31	18.90	17	10.75	28	21.21	39	16.74
Total	164		158		132		233	
Means ± SE	32.8±8.73		31.60±13.14		26.4±3.47		46.6±7.28	

5.3. *Scymnus* SPP.

Results in (Table 7) show that *Scymnus* numbers were lowest at 1onion:3 cabbage had recorded (21 individuals / 10 plants) forming (15.91%) of the insect.while the highest total number of insects was recorded (36 individuals /10 plants) forming (27.27%) of the insect with plant density ratio of 1 onion: 2cabbage.

5.4. True spider

Data in Table (7) explain the lowest total numbers of true spider (26 and 39) individuals /10 plants, forming (11.16 % and 16.74%) of the insect were recorded in plant density ratio 1onion: 4 cabbage and sole cabbage, respectively. While the highest total numbers of true spiders (69&55 and 44) individuals / 10 plants, forming (29.61% -23.6 1% and 18.88%) of the insect with plant density ratio 1onion:2 cabbage follow by 1 onion: 3cabbage and 1 onion: 1 cabbage respectively. Fening *et al.*, (2020) [9] reported that the intensification system between cabbage and onion crops, led to an increase in the natural enemies of predators such as the *Paragus borbonicu* fly and *Cheilomenes* spp. and the number of Araneae spiders increased significantly during the growing seasons. Sidauruk *et al.*, (2013) [23] showed that the number of natural enemies significantly increase at intercropping system, as found with *Episyrphus balteatus*, *Chrysoperla carnea*, *Aphidius matricariae* and *Coccinella septempunctata*, the population density of all of the natural enemies was highest at polyculture than in monoculture pattern.

Zereabruk *et al.*, (2018) [25] clarify the population of bonded thrips (*Aeolothrips* spp.) was significantly higher on onion in the intercropped compared to onion treated with insecticide. The number of onion thrips on onion was decreased by intercropping and natural enemies of thrips.

6. Correlation coefficient values among predators and insect pests on cabbage plants

Correlation among predators and certain insect pests were determined (Table 8).Coccinellid populations correlated with significant negative correlations with *Pieris rapae* ($r=-.982^*$) and highly significant negative with *Plutella maculipennis* ($r=-.994^{**}$) while insignificant negative correlation with Aphids and *Nezara viridula* ($r=-.780$ and $-.677$) respectively.

Syrphus spp. correlated with insignificant positive correlations with *P.rapae*, Aphids, *Plutella maculipennis* and *Nezara viridula* ($r=.588,.388,.613$ and $.254$) respectively.*Scymnus* spp. correlated with insignificant negative correlation with *Pieris rapae* and *Plutella maculipennis* ($r=-.358$ and $-.288$) respectively, while insignificant positive correlations with Aphids and *Nezara viridula* ($r=.241$ and $.391$) respectively. True spider correlated with insignificant negative correlation with *Pieris rapae* and *Plutella maculipennis* ($r=-.393$ and $-.262$) respectively, while insignificant positive correlations with Aphids and *Nezara viridula* ($r=.353$ and $.461$) respectively.

Table 8: Correlation coefficient values between predators and insect numbers on cabbage plants at season 2022/ 2023

	pieris rapae	Aphids.	Plutella.maculipennis	Nezara viridula
Coccinellid spp	-.982*	-.780	-.994**	-.677
Syrphus spp	.588	.388	.613	.254
Scymnus spp	-.358	.241	-.288	.391
True spider	-.393	.353	-.262	.461
*. Correlation is significant at the 0.05 level (2-tailed).				
**. Correlation is significant at the 0.01 level (2-tailed).				

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