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Population Density of Certain Piercing-Sucking Insects Infesting Wheat and its Associated Coccinellid Predator in Relation to Sampling Methods

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ABSTRACT

Population trends of certain piercing-sucking insects infesting wheat i.e. *Thrips* sp L., *Empoasca* spp and its associated coccinellid predator *Coccinella undecimpunctata* was determined by using yellow sticky traps (YST), direct count and sweep net methods on wheat fields. The tested taxa exhibited one seasonal peak only/each. By using YST both *Thrips* sp and *Empoasca* spp showed that their peaks at March 5 with a general average of 242.5 and 12.25 individuals/ 1 YST, respectively. No or very few numbers of *C. undecimpunctata* were collected by this method. Concerning the direct count method, *Thrips* sp and *C. undecimpunctata* exhibited their peaks at February 26 with a general average of 10.50 and 19.50 individuals/10 wheat tillers, respectively. However, *Empoasca* spp is completely disappeared. By using sweep net both *Thrips* sp and *Empoasca* spp revealed that semi-equal peaks at early and mid-February, while *C. undecimpunctata* peak was appeared one to four weeks later. Concerning the effectiveness of the used sampling methods it is appeared that yellow sticky traps can be used successfully to determine thrips populations. However, the direct count inspection can be considered as the most suitable method for determining coccinellid population trends. On the other hand, sweep net can be used as a successful method for determining *Thrips* sp, *Empoasca* spp and *C. undecimpunctata* in wheat fields.

Keywords: Population trends, thrips, leafhoppers, coccinellid predators**,** sampling methods**,** wheat.

INTRODUCTION

Cereals are the cheapest proteinaceous and starchy food. Cereal not only is an essential nutrient and important, but also has equaled or even superior politically importance compared with oil. Preserve cereal products against pests, diseases and weeds, is considered as one of the most important ways to increase production and achieve self-sufficiency (Behnia, 1997).

Some thrips types of the order Thysanoptera constitute one of the harmful groups found on grains. The most important thrips species in the world damaging ears of wheat and barley are *Haplothrips aculeatus* (Fabricius), *Haplothrips tritici* (Kurdjumov) and *Limothrips cerealium* (Haliday) (Minaei and Mound, 2008).

Although, leafhoppers could be considered as an occasional piercing-sucking insects in Egypt , they were considered as important pests worldwide, especially in Asia and these pests has spread in Europe, that they have completely economic importance (Bosco *et al*., 1997). In Egypt releasing the predatory coccinellid *Coccinella undecimpunctata* L. to evaluate its ability in suppressing piercing-sucking pests was performed by Ghanim *et al*., (2010).

Various sampling methods have been used to monitor arthropods inhabiting different crops. Sticky traps have been widely used to sample harmful and beneficial insects in wild and cultivated plants worldwide. Traps based on the response of insects to color have been widely used in integrated pest management programs in diverse cultivated crops. Also, sticky trap efficacy may depend on where traps are placed in relation to crop phenology (Hill and Hooper 1984, Meyerdirk and Oldfield 1985, El-Wakeil *et al*., 2015).

Although, sampling methods vary with different insect pests, sweep-net is a functional sampling technique for foliage insect pests. However, direct count is still used as effective sampling method for determining the population trends of onion thrips (Amro *et al*., 2016).

Determination the population trends of thrips, leafhoppers and their associated coccinellid predator inhabiting wheat by different sampling methods was the first goal of this investigation. Impact of sampling method to achieve this goal is the second.

MATERIALS AND METHODS

This work was conducted in the experimental farm of the Agricultural Research Station (Arab-Elawamer) Abnoub province Assiut Governorate during the two successive wheat growing seasons of 2013-2014 and 2014-2015. The experiment was conducted in an area of about 1/4 feddan. The experimental area divided into plots (50 meter square/each). The experimental area was cultivated by Mesr1 wheat cultivar at November 15 to evaluate thrips, leafhopper (complex) and associated coccinellid predator population trends.

1-Population trends of thrips, leafhoppers and its associated coccinellid predator

Three sampling methods have been used to determine the population trends of certain piercing-sucking insects attacking wheat plants and their associated coccinellid predator. Population trends of the examined taxa were monitored by using: 1- yellow sticky traps (YST) (22 x10 cm) painted with ICI Dulux, which sat up in the field 8 weeks post cultivation at 80 cm height until late season. Traps were distributed in the field randomly with four replicates and renewed weekly. The collected traps were transferred to the laboratory and examined under stereomicroscope. Thrips, leafhoppers and the its associated coccinellid predator were counted.2- Direct count method was investigated by examined 10 wheat tillers in the field during the same period.3- A standard sweep net (35 cm. diam.) as described by Borror *et al*., (1979) was used. Samples of 10 double sweeps, were taken weekly at random (four replicates). Samples were kept in polyethylene bags until examined in the laboratory by using

stereomicroscope. Collected specimens were preserved and identified. Data were statistically analyzed by F test as described by Steel and Torrie (1982).

2-Impact of sampling method on the population trend evaluation

According to the obtained data, a comparison between the population trends of thrips, leafhoppers and the associated coccinellid predator inhabiting wheat was determined.

RESULTS AND DISCUSSION

1-Population trends of thrips , leafhoppers and its associated coccinellid predator

Data presented in Table (1) and fig (1), expressed about the population trends of *Thrips* sp, *Empoasca* spp and *C. undecimpunctata* captured by yellow sticky traps (YST) on wheat fields during 2014 and 2015 growing seasons at Assiut Governorate. Three unidentified leafhopper species were calculated as leafhopper complex (*Empoasca* spp). Data revealed that, both of *Thrips* sp and *Empoasca* spp showed that one seasonal peak only at March 5 and plant age of 109 days old with an average of 217.5, 11.75 and 267.5 , 12.75 individuals/ one YST during 2014 and 2015 seasons, respectively. During the entire study period *Thrips* sp showed 19.80 fold of *Empoasca* spp. Approximately no and/or very few individuals of the lady bird beetle *C. undecimpunctata* were collected by YST method. Differences between the examined taxa showed significant value (F= 4.49*). However, correlation coefficient (r) between *C. undecimpunctata* and both of *Thrips* sp, *Empoasca* spp showed no values. This result is attributed to the absence of *C. undecimpunctata* inspected by YST method.

Table 1. Population trends of *Thrips* sp ; *Empoasca* spp and *Coccinella undecimpunctata* captured by yellow sticky traps on wheat fields during 2014 and 2015 growing seasons at Assiut Governorate.

Sampling date	Plant age (days)	Mean numbers of individuals / 1 yellow sticky trap 2014			2015			Average 2014&2015		
		Thrips sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*
Jan.15	60	27.00	2.25	0.00	18.75	1.50	0.00	22.88	1.88	0.00
22	67	34.75	4.00	0.00	15.75	2.25	0.00	25.25	3.13	0.00
29	74	37.25	4.00	0.50	26.75	3.50	0.00	32.00	3.75	0.25
Feb.5	81	25.00	2.00	0.00	16.50	2.00	0.00	20.75	2.00	0.00
12	88	38.00	9.00	2.50	34.50	9.00	0.00	36.25	9.00	1.25
19	95	27.50	2.50	0.00	24.00	1.75	0.00	25.75	2.13	0.00
26	102	53.50	3.25	0.00	61.00	3.25	0.00	57.25	3.25	0.00
March 5	109	217.50	11.75	1.00	267.50	12.75	0.00	242.50	12.25	0.50
12	116	29.00	3.55	0.00	31.75	6.00	0.00	30.38	4.78	0.00
19	123	2.75	6.25	0.00	4.00	2.75	0.00	3.38	4.50	0.00
26	130	2.50	4.00	0.00	6.50	4.00	0.00	4.50	4.00	0.00
Apr.6	137	1.75	4.00	0.00	4.00	3.25	0.00	2.88	3.63	0.00
Total		496.50	56.50	4.00	511.0	52.00	0.00	503.75	54.25	2.00
Mean		41.38 A	4.71 B	0.33 C	42.58 A	4.33 B	0.00 C	41.98 A	4.52 B	0.17 C
F value		480.77**			13.059**			4.49*		
(r)		------	------		------	------		------	------	

(r) Correlation coefficient between *Coccinella undecimpunctata* and each of *Thrips* sp and *Empoasca* spp
Means followed by the same letter in each column and/or row are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

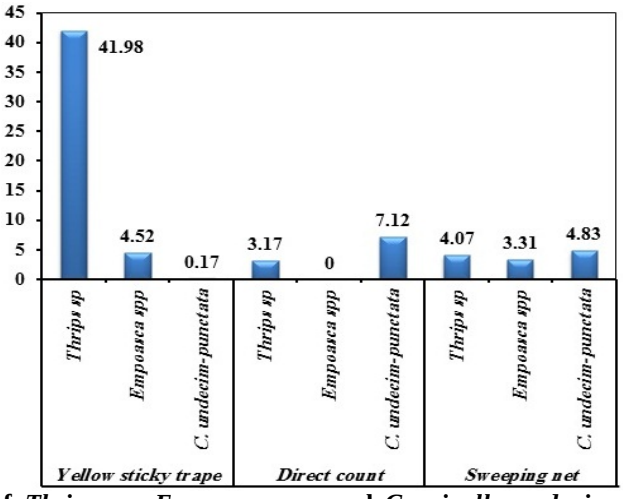

Figure 1. Seasonal mean of *Thrips* sp, *Empoasca* spp and *Coccinella undecimpunctata* captured by yellow sticky traps (1 YST), direct count (10 wheat tillers) and sweep net (10 double strokes) on wheat fields during 2014 and 2015 growing seasons at Assiut Governorate.

In this approach, yellow sticky traps hanging at 60, 80,100 and 120 cm above the ground level were assessed for monitoring cotton insect pests by Atakan and Canhilal (2004) in Turkey. They recorded tow leafhopper species i.e. *Asymetresca decedens* Paoli, *Empoasca decipens* Paoli, in addition to the western flower thrips *Frankliniella occidentalis* (Pergande).

Results obtained by El-Wakeil and Volkmar (2013) showed that the sticky traps are effective in the collection of some insect pests and natural enemies inhabiting wheat. Their results showed that sticky traps as a monitoring method is appropriate for both thrips and leafhoppers while it was suitable partially for coccinellids.

Concerning the direct count method, the obtained data in Table (2) showed that both *Thrips* sp and the coccinellid predator *C. undecimpunctata* exhibited one seasonal peak at February 26 and plant age of 102 days old post cultivation. Although, *Thrips* sp recorded 10.00 and 11.00 individuals, *C. undecimpunctata* recorded 21.00 and 18.00 individuals/ 10 wheat tillers during 2014 and 2015 seasons, respectively. It is important to note that, *C. undecimpunctata* general numbers is equal 2.25 fold of those recorded by *Thrips* sp during the entire study period. This finding proved the theory stated that predators increasing their numbers dependent on the increase of prey numbers. Completely absence of the leafhopper *Empoasca* spp by using this method referring to the unsuitability of the direct count method to identify the leafhopper population trends on wheat plantations. This behavior could be attributed to the insect pest escaping and/or disappearance during the inspection period or to its non - preference to feed between wheat leaves sheaths. Differences between the examined taxa showed highly significant values (F= 8.117**). However, correlation coefficient (r) between *C. undecimpunctata* and *Thrips* sp showed positive values (r = 0.486, 0.362, 0.429) during 2014, 2015 and the entire study period, respectively.

Table 2. Population trends of *Thrips* sp ; *Empoasca* spp and *Coccinella undecimpunctata* captured by direct count on wheat fields during 2014 and 2015 growing seasons at Assiut Governorate.

Sampling date	Plant age (days)	Mean numbers of individuals / 10 wheat tillers								
		2014			2015			Average 2014&2015		
		Thrips sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*
Jan.15	60	0.50	0.00	1.00	0.00	0.00	2.00	0.25	0.00	1.50
22	67	1.00	0.00	3.00	0.00	0.00	3.50	0.50	0.00	3.25
29	74	1.00	0.00	7.00	0.00	0.00	8.50	0.50	0.00	7.75
Feb.5	81	1.50	0.00	2.00	0.00	0.00	2.00	0.75	0.00	2.00
12	88	10.00	0.00	2.00	10.00	0.00	3.50	10.00	0.00	2.75
19	95	5.50	0.00	2.50	5.00	0.00	1.00	5.25	0.00	1.75
26	102	10.00	0.00	21.00	11.00	0.00	18.00	10.50	0.00	19.50
March 5	109	5.50	0.00	16.50	4.50	0.00	17.00	5.00	0.00	16.75
12	116	4.50	0.00	14.00	3.00	0.00	12.00	3.75	0.00	13.00
19	123	1.00	0.00	9.00	0.00	0.00	12.50	0.50	0.00	10.75
26	130	0.50	0.00	6.00	0.00	0.00	1.50	0.25	0.00	3.75
Apr.6	137	0.00	0.00	1.75	0.00	0.00	3.50	0.00	0.00	2.63
Total		41.00	0.00	85.75	35.00	0.00	85.00	38.00	0.00	85.38
Mean		3.42 B	0 C	7.15 A	2.79B	0.00 C	7.08 A	3.17 B	0.00 C	7.12 A
F value			323.86**			243.22**			8.117**	
(r)		0.486	-----		0.362	------		0.429	-----	

(r) Correlation coefficient between *Coccinella undecimpunctata* and each of *Thrips* sp and *Empoasca* spp
Means followed by the same letter in each column and/or row are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

In similar results, Bereś *et al*., (2013) detected a single population peak of thrips on sweet corn in southeastern Poland. Initially, the highest number of individuals was found on the bottom side of leaves, and later in sheaths, on fresh silk, under the cob husk, and on tassels.

Results obtained by using sweep net method showed real differences between the examined taxa population trends. Data in Table (3) showed that the three examined taxa were presented until late season. Thrips and leafhoppers appeared in small numbers at early and late season, while showed one seasonal peak only with semi-equal values, and general average of 12.50 and 11.25 individuals /10 double sweep net strokes during the entire study period, respectively. However, the coccinellid predator showed its peak, one to four weeks later than thrips and leafhoppers peaks. This finding prove the aforementioned theory discussed the predatory – prey relationship. Variations between the examined taxa populations showed non-significant value (F= 0.57ns), while correlation coefficient (r) between *C. undecimpunctata* and both of *Thrips* sp and *Empoasca* spp numbers showed negative values (r = -0.687* and -0.539) during the entire study period, respectively.

Table 3. Population trends of *Thrips* sp ; *Empoasca* spp and *Coccinella undecimpunctata* captured by sweeping net on wheat fields during 2014 and 2015 growing seasons at Assiut Governorate.

Sampling date	Plant age (days)	Mean numbers of individuals / 10 sweeping net double strokes								
		2014			2015			Average 2014&2015		
		Thrips sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*	*Thrips* sp	*Empoasca* spp	*Coccinella undecim-punctata*
Jan.15	60	2.50	1.75	0.25	9.00	3.00	1.00	5.75	2.38	0.63
22	67	5.75	3.00	0.50	9.00	5.00	1.50	7.38	4.00	1.00
29	74	3.00	2.50	1.50	3.50	6.50	2.00	3.25	4.50	1.75
Feb.5	81	12.00	4.00	1.00	13.00	7.50	1.00	12.50	5.75	1.00
12	88	6.50	8.50	1.00	8.50	14.00	0.50	7.50	11.25	0.75
19	95	3.50	5.50	11.00	1.50	3.50	9.50	2.50	4.50	10.25
26	102	8.50	3.50	7.00	2.00	2.00	7.00	5.25	2.75	7.00
March 5	109	2.00	0.00	12.50	2.50	2.50	6.50	2.25	1.25	9.50
12	116	5.00	0.00	5.50	0.00	2.50	6.50	2.50	1.25	6.00
19	123	0.00	0.00	6.00	0.00	0.50	6.00	0.00	0.25	6.00
26	130	0.00	0.50	8.00	0.00	2.50	5.50	0.00	1.50	6.75
Apr.6	137	0.00	0.00	8.50	0.00	0.50	6.00	0.00	0.25	7.25
Total		48.75	29.25	62.75	49.00	50.00	53.00	48.88	39.63	57.88
Mean		4.06	2.44	5.23	4.08	4.17	4.42	4.07	3.31	4.83
F value			10.121**			0.215ns			0.57ns	
(r)		-0.444	-0.362		-0.827**	-0.667*		-0.687*	-0.539	

(r) Correlation coefficient between *Coccinella undecimpunctata* and each of *Thrips* sp and *Empoasca* spp
Means followed by the same letter in each column and/or row are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

In conclusion, the examined three taxa showed one seasonal peak on wheat plantations. Approximately no and/or very few individuals of the lady bird beetle*C. undecimpunctata* were collected by using YST method. Completely absence of the leafhopper *Empoasca* spp by using the direct count method referring to the unsuitability of this method to identify the leafhopper population trends on wheat plantations. Peaks of both thrips and leafhoppers showed semi-equal values by using sweep net method. However, the coccinellid predator showed its peak one to four weeks later than thrips and leafhoppers peaks. So, it is important to note that, sampling methodology could be taking a role in the population determination of any arthropod pest.

Although, scarce information have been collected about leafhoppers presence on cereals, these insect pests were collected from vegetable crops; potato, *Solanum tuberosum* (L.), eggplant, *Solanum melongena* (L.), pepper, *Capsicum annuum* (L) zucchini, *Cucurbita pepo* okra, *Abelmoschus esculentus* (L.), as well as from agronomic crops (alfalfa, *Medicago sativa* (L.) maize, *Zea mays* (L.) and rice, *Oryza sativa* (L.) in North and south Egypt as reported by El-Wakeil *et al*., (2015).

2-Impact of sampling methods on the population trend evaluation

Presence of thrips in so high numbers (41.98 individuals/ one YST trap) by using this method refers to its role as the most preferred method that expressed about the population density of thrips in wheat fields. In the same time, it can be used as a suitable method for determine *Empoasca* population trends. Because yellow sticky traps capture the least *Coccinella* numbers (0.17 individuals/ 1 YST) as compared with the other tested methods, it can be consider as unsuitable method to determine Coccinellid population trends. These results could be due to the impact of sticky traps coloration which plays an important role in the arthropod attraction to diverse colors.

Concerning the direct count method, appearance of *C. undecimpunctata* in high numbers (7.12 individuals/10 wheat tillers) refer to the fact that, this method can be consider as the most suitable method for evaluating the population trend of *Coccinella*. This method could be express about the real incidence of thrips and the lady bird beetle inhabiting wheat plantations. It is clear that, zero numbers of *Empoasca* spp collected by using the direct count method refer to its unsuitability to determine leafhopper population trends.

In respect to sweep net method, data revealed that it is the most suitable method for determining the population trend of all of the tested arthropods. It showed 4.07, 3.31 and 4.83 individuals/10 sweeping net double strokes for *Thrips* sp, *Empoasca* spp and *C. undecimpunctata*, respectively. So, it is important to note that *C. undecimpunctata* recorded 1.46 and 1.19 fold of *Thrips* sp and *Empoasca* spp during the entire study period, respectively.

So, it can be concluded that, yellow sticky traps can be used successfully to determine thrips populations. However, the direct count inspection can be considered as the most suitable method for determining coccinellid population trends. On the other hand, sweep net can be used as a successful method for determining *Thrips* sp, *Empoasca* spp and *C. undecimpunctata* in wheat fields.

A similar conclusion was reached by Kucharczyk (1998) who found that using the method of colored traps was more successful than the method of collecting thrips by sweep net. Surveying the piercing-sucking insects and their predatory insects in cotton fields was done by using yellow sticky traps and direct counting by Ghanim *et al*., (2010) in Egypt. The predator prey ratio in this study was 4.56, in 2008 season, while it was 4.64 in 2009 season at the beginning of study, then these ratios increased gradually and reached their maximum 1: 19.6 in 2008 and 1: 16.78 in 2009.

Three sampling methods (Pheromone traps, inspection of ear insects and water traps) were used by Gafaar and Volkmar (2010) in central Germany to determine population densities and damage of wheat midges and thrips. They recorded thrips, *Limothrips cerealium* (Haliday) and *Haplothrips tritici* (Kurdjumov) in winter wheat scale fields. Their results recorded significant difference between the tested traps in thrips populations. Also, three sampling methods-sweep-net, hand-vacuum modified from a leaf vacuum blower, and a wheeled, blower-vacuum designed to blow insects from the foliage into the vacuum port of a leaf vacuum-were compared as methods for sampling insects in sweet potatoes, *Ipomoea batatas* L. (Reed *et al*., 2010). The results obtained by Rezaei *et al*., (2014) showed that species of leafhoppers *Macrosteles laevis, Psammotettix alienus, Empoasca decipiens* and *Laodelphax striatellus* collected by sweep net were recorded as the dominant leafhoppers of cereal fields in Shahrekord city, Iran.

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الكثافة العددية لبعض الأفات الثاقبة الماصة التى تصيب القمح وعلاقته بالعدو الحيوي (أبو العيد) المصاحب لها مع طرق أخذ العينات

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معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي- الجيزة

تم تقدير تذبذب أعداد بعض الأفات الثاقبة الماصة التى تصيب القمح (التربس و الجاسيد) و مفترس أبو العيد المصاحب لهما علي محصول القمح بإستخدام المصائد الصفراء اللاصقة و الفحص المباشر و شبكة صيد الحشرات. أظهر كل مصنف قمة واحدة علي القمح. بإستخدام المصائد الصفراء اللاصقة أظهر كل من التربس و الجاسيد ذروة واحدة فى ٥ مارس بمتوسط عام ٢٤٢.٥ و ١٢.٢٥ فرد/ مصيدة. بينما تواجد أبو العيد باعداد قليلة جدا عند إستخدام هذه الطريقة. بإستخدام طريقة الفحص المباشر إختفي الجاسيد تماما بينما أظهر كل من التربس و أبو العيد قمتيهما بتاريخ ٢٦ فبراير بمتوسط عام ١٠.٥٠ و ١٩.٥٠ فرد/ ١٠ تيللر. عند إستخدام شبكة صيد الحشرات أظهرت قمتي التربس و الجاسيد قيم متساوية في بداية و منتصف فبراير بينما أظهر أبو العيد قمته بعد أسبوع إلي أربعة أسابيع. و من النتائج يتضح أن المصائد الصفراء اللاصقة يمكن إستخدامها كطريقة ناجحة لتقدير الكثافة العددية للتربس. بينما طريقة الفحص المباشر ستكون هي الأفضل لتقدير الكثافة العددية لأبو العيد. من جهة أخري فإن شبكة صيد الحشرات يمكن أن تكون هي الطريقة الناجحة لتقدير الكثافة العددية لبعض الآفات الثاقبة الماصة لعصارة النبات (التربس و الجاسيد) ومفترس أبو العيد المصاحب لهما علي محصول القمح.