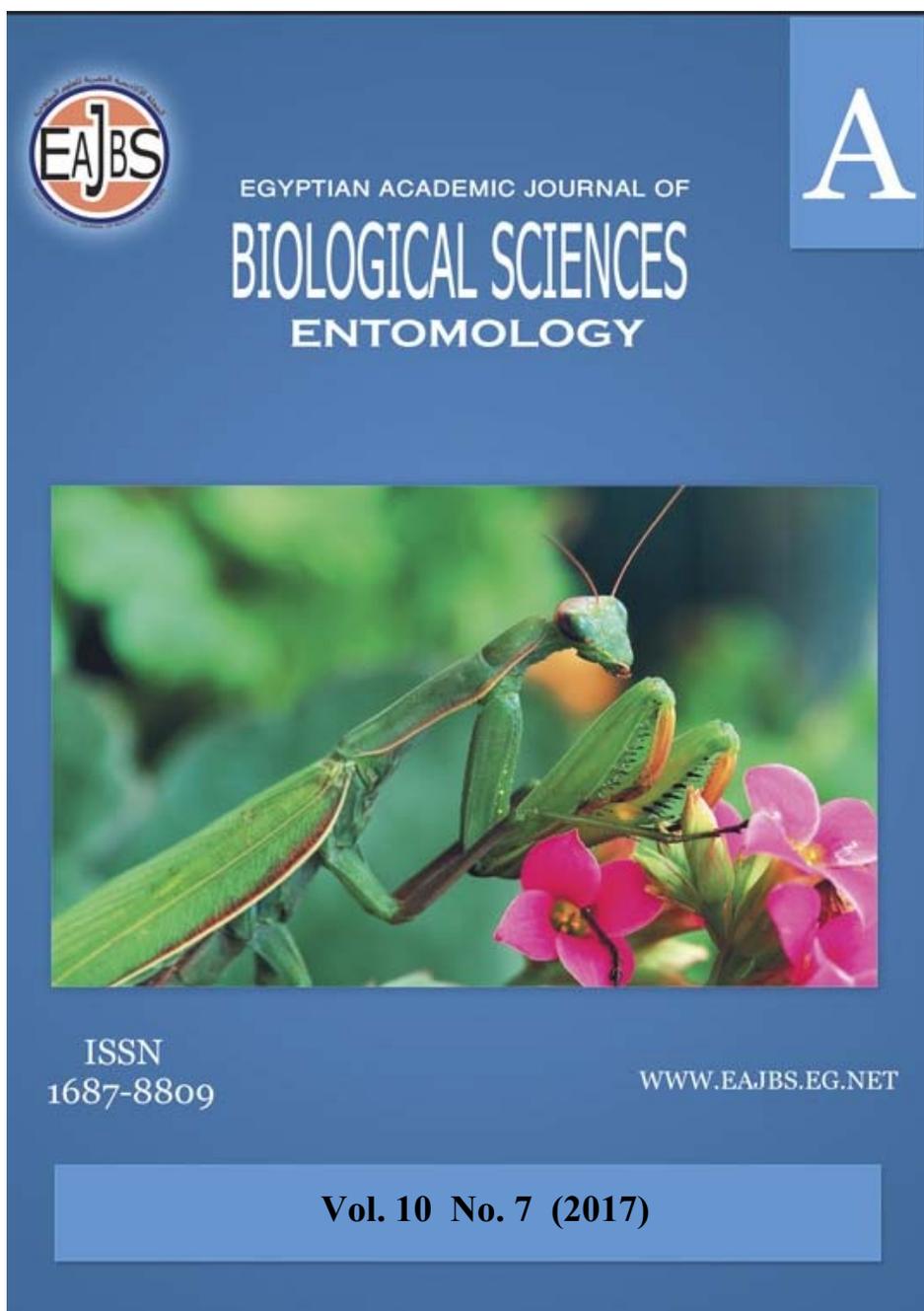


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Suitability of Two Sampling Methods for Determining the Population Trends of Certain Sap-Sucking Species Inhabiting Tomato and Cucumber Plantations

Mohamed A. Amro; Abd El-Raheem A. Abd El-Raheem and Alaa El-Deen A. A. Salem

Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt

Email Address: moamro1953@yahoo.com

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ABSTRACT

Faunistic composition and seasonal abundance of certain sap-sucking species inhabiting tomato and cucumber plantations were determined by using sweep net and direct count methods, during summer seasons of 2015 and 2016 in Assiut Governorate, Northern Upper Egypt. Twelve species belonging to 8 families and 3 orders in addition to the acarid mite were recorded. Heteropteran species were found to be constituted 69.24% of the gathered species. However, Homopteran species were found to be constituted 15.38%. Thysanoptera and Tetranychidae were presented by 7.69% for each. Concerning to the sampling method, 76.92% of the collected species were captured by the sweep net method, while 23.08% were gathered by the direct count method. The recovered species were classified as predominantly predaceous, predominantly phytophagous, predaceous in part and phytophagous in part species. Seasonal abundance of the recorded species was determined. The distinct predators, *Coranus aegyptius* (Fabricius, 1775) and *Orius* spp. showed relatively low abundance percentages. The predatory-phytophagous mirid species [*Campylomma unicolor* Poppius, 1914; *Nesidiocoris tenuis* (Reuter, 1895); *Creontiades pallidus* (Rambur, 1839). and *Deraeocoris serenus* (Douglas & Scott, 1868)], showed different abundance percentages. Amongst these taxa, *N. tenuis* revealed the highest abundance percentage on tomato plantations with an average of 63.00 and 75.00% during 2015 and 2016 seasons, respectively. The distinct phytophagous species, *Thrips tabaci* Lindeman, 1889; *Bemisia tabaci* (Gennadius, 1889) and *Tetranychus urticae* Koch, 1836 presented the greatest abundance percentages on cucumber when estimated by the direct count method. So, this work can be reflect the importance of sweep net as a suitable sampling method for determine the faunistic composition of the flight predatory insects inhabiting tomato and cucumber. However, direct count can be consider the most suitable method for determine the population trends of mobile or non-mobile arthropods inhabiting the same crops. Also, use of more than one sampling method could be successful to clarify the relation between useful and harmful arthropod species.

INTRODUCTION

In entomological experiments arthropods are often caught by traps to assess functional biodiversity of the targeted taxa. Sweep net, visual observation and other sampling methods were used to collect arthropods inhabiting the prevailing crops. In this approach, suitability of window and cornet traps for catching aphid antagonists and pollinators were tested by Eggenschwiler *et al.* (2012) in France.

They reported that, cornet traps appear to be suitable for collecting various insect groups than the window traps. In Upper Egypt, Amro *et al.* (2016) found that yellow sticky traps can predict the peak of (*Thrips tabaci* Lind.) on onion one week before the direct count method. On the other hand, publications dealing with the faunistic composition of sap-sucking species were done by several investigators e.g. Abdel-Galil and Amro (2002); Abdel-Galil *et al.* (2005) and Amro and Abdel-Galil (2012). By using different sampling methods, dominance and seasonal abundance of certain sap-sucking species were studied by Mahmoud (2005) and Temerak *et al.* (2014). Therefore, the present investigation was initiated to identify the suitable sampling method for determine the faunistic composition and the seasonal abundance of the prevalent sap-sucking species inhabiting tomato and cucumber. The population trends of the main sap sucking phytophagous species, was also, in consideration.

MATERIALS AND METHODS

The present investigation was carried out in a private farm in Abnoub province, Assiut Governorate, during two successive growing seasons of 2015 and 2016. An area of about 1/4 feddan (approximately 1/10 Hectare) was cultivated with the current tomato and cucumber cultivars which were obtained from the Horticulture Department, Faculty of Agriculture, Assiut University. The experiment was carried out in a completely randomized block design, with four replications (1/400 fed.). Regular conventional agricultural practices were performed. Insecticides were completely prevented.

Faunistic composition and seasonal abundance of the prevalent sap-sucking species inhabiting tomato and cucumber

Faunistic composition of the collected sap-sucking species:

Sweep net (10 double strokes / replicate) and direct count methods (5 leaves / replicate) were taken weekly (4 replicates) during the main active period of sucking pests on tomato and cucumber through both of 2015 and 2016 summer seasons. Each collected sample was emptied into a labeled collecting muslin bag, transferred to the laboratory and examined under stereomicroscope. Numbers of sap-sucking species were recorded. A taxonomic list of the recovered species has been prepared. The collected heteropteran species were previously identified by R. C. Froeschner, U. S. National Museum (January 16, 1980). The rest of species were identified by the specialists of the insect classification department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Egypt.

Seasonal abundance of the collected sap-sucking species:

Numbers of the recovered sap-sucking species inhabiting tomato and cucumber plantations were monitored weekly by using the abovementioned sampling methods. Seasonal abundance of the recovered species has been determined. The formula of Facylate (1971) has been used to measure the abundance percentage as follows:

$$A = \frac{n}{N} \times 100, \text{ where:}$$

A = Abundance percentage.

n = Total number of samples in which each species appeared.

N = Total number of samples taken all over the study period.

Population trend of the main sap-sucking species:

Numbers of mobile and non-mobile species i.e. thrips (nymphs and adults), whitefly (nymphs), and the two spotted spider mite (mobile stages) were counted by the direct count method on cucumber leaves. Data were statistically analyzed by

using F test; means were compared according to Duncan's multiple range tests as described by Steel and Torrie (1982).

RESULTS AND DISCUSSION

Faunistic composition and seasonal abundance of the prevalent sap-sucking species inhabiting tomato and cucumber

Faunistic composition of the collected sap-sucking species:

A partial taxonomic list of the gathered sap-sucking species inhabiting tomato and cucumber is presented in Table (1). Twelve species belonging to 8 families and 3 orders in addition to the acarid mite were found in association with one or both of the examined crop plantations. Heteropteran species were found to be constituted 69.24% of the gathered species. However, Homopteran species were found to be constituted 15.38%. Thysanoptera and Tetranychidae were presented by 7.69% for each.

Table 1: A partial taxonomic list of sap-sucking species collected by sweep net and direct count methods from tomato and cucumber plantations and their abundance percentage in Assiut during 2015-2016 seasons.

Order & Family	Scientific name	Status	Stage	Host plant	Sampling method	Abundance percentage			
						Tomato		Cucumber	
						2015	2016	2015	2016
Order: Thysanoptera Thripidae (Thrips)	<i>Thrips tabaci</i> Lindeman	2	A&N	C	DC	0.00	0.00	100	100
Order: Hemiptera- Heteroptera Pentatomidae (Stink Bugs)	<i>Nezara viridula</i> (Linnaeus)	2	A	T	SN	13.00	13.00	0.00	0.00
Lygaeidae (Seed Bugs)	<i>Nysius graminicola</i> (Kolenate)	2	A	T&C	SN	13.00	13.00	38.00	25.00
	<i>Oxycarenus hyalinipennis</i> (Costa)	2	A	T	SN	13.00	13.00	0.00	0.00
Reduviidae (Assassin bugs)	<i>Coranus aegyptius</i> (Fabricius)	1	A	T	SN	13.00	13.00	0.00	0.00
Anthoridae (Flower bugs)	<i>Orius</i> spp.	1	A	T&C	SN	25.00	38.00	25.00	13.00
Miridae (Plant bugs)	<i>Campylomma unicolor</i> Poppius	3&4	A	T&C	SN	25.00	38.00	25.00	13.00
	<i>Creontiades pallidus</i> Rambur.	3&4	A	T	SN	13.00	13.00	0.00	0.00
	<i>Nesidiocoris tenuis</i> (Reuter)	3&4	A	T	SN	63.00	75.00	0.00	0.00
	<i>Deraeocoris serenus</i> (D. & S.)	3&4	A	T	SN	13.00	13.00	0.00	0.00
Order: Homoptera Cicadellidae (Leafhoppers) Alyerodidae (Whiteflies)	<i>Empoasca fabae</i> Harris	2	A	T&C	SN	13.00	13.00	63.00	75.00
	<i>Bemisia tabaci</i> (Gennadius)	2	N	T&C	DC	50.00	38.00	100	88.00
Order: Acari Tetranychidae (Spider mite)	<i>Tetranychus urticae</i> Koch	2	M	C	DC	0.00	0.00	75.00	88.00

Status: 1- Predominantly predaceous; 2- Predominantly phytophagous; 3- Predaceous in part; 4- Phytophagous in part **Stage:** A= Adult N= Nymph M= Mobile stage
Host plant: T= Tomato C= Cucumber **Sampling method:** SN= Sweep net
DC= Direct count

In respect to the sampling methods, 76.92% of the collected species were captured by the sweep net method, while 23.08% were gathered by the direct count on host plant leaves. It is important to note that, flight species were collected predominantly by sweeping net. However, mobile and/or non-mobile arthropods were collected by direct count. The recovered species were classified as reported by Amro and Abdel-Galil (2012) into predominantly predaceous; predominantly phytophagous; predaceous in part and phytophagous in part species. Clarify the behavior of the collected predatory-phytophagous mirid species [*Campylomma unicolor* Poppius, 1914; *Nesidiocoris tenuis* (Reuter, 1895); *Creontiades pallidus* (Rambur, 1839). and *Deraeocoris serenus* (Douglas & Scott, 1868)], could be reflect their importance as biological control agents. The collected mirid species were previously identified by (Amro, 1983) as phytophagous species appeared as partly

predaceous when their host plants were absent or rare. The mirid *N. tenuis* is classified as primarily phytophagous-predaceous in part by El-Minshawy *et al.* (1977) in Alexandria. Also, Fernandez *et al.* (1995) considered *N. tenuis* as a predatory-phytophagous species and also refer to its ability to be used as an important control agent against fruit worm *Heliocovera armigera*, whereas it preys on its eggs and first instar larvae. In a similar study, Perdakis *et al.* (2009) stated that the mirid *N. tenuis* is an important natural enemy of whiteflies in Mediterranean field and protected tomato crops. On the other hand, they reported that, its feeding on tomato plants may cause the development of necrotic rings on the stems and flower abortion. In Upper Egypt, Amro and Abdel-Galil (2012) reported that mirid species can be appear as exclusively phytophagous in nature and in few cases as a consumer of lepidopterous and coleopterous larvae. In order to update the presence of species of mirid predators and their impact on solanaceous crops of interest, samples were taken from tomato and tobacco in open fields and from tomato in covered crops of selected locations by Martinez *et al.* (2014). Their results showed the presence of the species *N. tenuis* and *Macrolophus praeclarus* (Distant, 1884). Also, they reported that, those mirids were presented in most samples taken, while the incidence remained over 40% in both crops.

Seasonal abundance of the collected sap-sucking species:

By using the sweep net, data presented in Table (1) revealed that the reduviid, *Coranus aegyptius* (Fabricius, 1775) and the anthocorid *Orius* spp. showed relatively low abundance percentages. However, the recovered mirid species showed differential abundance percentages. The predatory-phytophagous mirid *N. tenuis* revealed the highest abundance percentage on tomato plantations with an average of 63.00 and 75.00% during 2015 and 2016 seasons, respectively. The other predatory-phytophagous mirid species, *C. unicolor*; *C. pallidus* and *D. serenus* showed less abundance percentages as compared with *N. tenuis*. By using the direct count method, absence of the distinct phytophagous species, *Thrips tabaci* Lindeman; *Tetranychus urticae* Koch and low abundance of *Bemisia tabaci* (Gennadius) on tomato plantations could be attributed to the presence of the above mentioned distinct and/or primarily predaceous species which collected by sweep net method. So, it can be stated that, use of more than one sampling method is more useful for clarify the situation on crop foliage.

Concerning the above mentioned predators, life span and feeding habits of certain *Orius* species was evaluated, by El-Husseini *et al.* (2000) and Gomaa and Ibrahim (2001). Release of different stages of *Coranus africana* El-Sebaey in tomato fields revealed 92-100% suppression on the whitefly *B. tabaci* numbers (El-Sebaey and Abd El-Wahab, 2011). Also, the potential of the mirid *D. serenus* in consuming the aphid species *Therioaphis trifolii* (Monell) is measured in the laboratory by Amro and Abdel-Galil (2012). Their results showed that this mirid predator consumed more numbers of the prey as it aged. Also, the continuous supplement by the prey individuals increased the ability of the predator consumption. Five days old predator is found to be able to consume more than 80-100% of the introduced preys. Evaluation the effectiveness of the predatory bug *Deraeocoris lutescens* Schilling for the green peach aphid control in greenhouse conditions and its economic justification was studied by Zadeh and Parvar (2014). They reported that, the mean number of the aphid individuals per each sugar beet plant was significantly higher in the control treatment than in the treatments with *D. lutescens*. This finding could be reflecting the importance of the collected predatory-phytophagous sap-sucking species and introduce a beam of light on their ability to use as biological control agents in the future.

Population trend of the main sap-sucking species:

According to the obtained results thrips, whiteflies and the two spotted spider mite were found to be more active on cucumber than on tomato. By using the direct count method data in Table (2) revealed that numbers of thrips *T. tabaci* exhibited gradual increase during both seasons. The peak of this insect pest is recorded one week before harvesting in July 8 with an average of 10.05 individuals/leaf. High variation between the inspection dates was recorded ($f = 9.562^{**}$). Population trend of the whitefly *B. tabaci* nymphal stages revealed gradual increase until the appearance of its peak at June 18 with an average of 30.25 individuals/leaf. One week later suddenly decrease in the pest numbers was recorded (17.13 individuals/leaf) and continued until the completely absence of the pest, when plant leaves became unsuitable for the pest feeding.

Table 2: Population trends of *Thrips tabaci*; *Bemisia tabaci* and *Tetranychus urticae* estimated by direct count on cucumber during 2015 and 2016 growing seasons at Assiut governorate.

Sampling date	Mean numbers of individuals / 1 leaf								
	<i>Thrips tabaci</i>			<i>Bemisia tabaci</i>			<i>Tetranychus urticae</i>		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
May,28	3.30	3.93	3.62 d	1.00	1.00	1.00 e	0.00	0.00	0.00 f
June,4	5.65	5.65	5.65 cd	5.85	7.35	6.60 d	0.00	0.00	0.00 f
11	5.73	5.90	5.82 cd	10.70	11.95	11.33 c	4.35	6.85	5.60 e
18	6.05	6.80	6.43 c	29.00	31.50	30.25 a	10.60	12.10	11.35 d
25	6.25	7.71	6.98 c	15.25	19.00	17.13 b	20.75	25.75	23.25 b
July,2	8.15	9.10	8.63 b	8.05	8.25	8.15 d	45.50	46.00	45.75 a
8	9.55	10.55	10.05 a	7.00	7.80	7.40 d	16.90	19.40	18.15 c
15	9.05	9.70	9.38 b	0.00	0.00	0.00 e	11.15	11.90	11.53 d
Mean	6.72	7.42	7.07	9.61	10.86	10.23	13.66	15.25	14.45
F value between dates	---	---	9.562**	---	---	30.685**	---		16.329**
	C			B			A		

F value between species = 21.063**

Means followed by the same letter are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

Also, high variation between the inspection dates was recorded ($f = 30.685^{**}$). Appearance of the acarid *T. urtica* was recorded two weeks later than both of *T. tabaci* and *B. tabaci*, while its disappearance was recorded one week before both taxa. In addition its peak (45.75 individuals/leaf) was recorded in July, 2. Competition between the targeted species could be responsible for the appearance of their peaks at different times. It is important to note that, *T. urtica* seasonal peak was equal 4.55 and 1.51 fold of *T. tabaci* and *B. tabaci*, respectively. Although, Amro (2008) recorded the same pests on cucumber, different results were obtained in the same area of study. He reported that peaks of *T. urtica* on cucumber were less than those of *T. tabaci* and *B. tabaci* peaks. This finding could be attributed to diverse reasons which need more studies in the future. So, this work can be reflect the importance of sweep net as a suitable sampling method for determine the faunistic composition of the flight predatory insects inhabiting tomato and cucumber. However, direct count can be consider the most suitable method for determine the population trends of mobile and non-mobile arthropods inhabiting the same crops.

Also, use of more than one sampling method could be successful to clear the relation between useful and harmful arthropod species.

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ARABIC SUMMARY

ملاءمة طريقتين من طرق جمع الحشرات لتقدير اتجاه مجاميع بعض الأنواع الثاقبة الماصة التي تقطن زراعات الطماطم و الخيار

محمد عبد الرحمن محمد عمرو، عبد الرحيم أحمد عبد الرحيم و علاء الدين عبد القادر أحمد سالم
معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي- الجيزة

تم تقدير التركيب النوعي و الوفرة الموسمية لبعض أنواع مفصليات الأرجل الثاقبة الماصة التي تقطن زراعات الطماطم و الخيار باستخدام الشبكة الكانسة لجمع الحشرات و العد المباشر خلال موسمي 2015 و 2016 بمحافظة أسيوط. تم تسجيل 12 نوع تتبع 8 عائلات و 3 رتب حشرية بالإضافة إلي أكاروس العنكبوت الأحمر. مثلت أنواع نصفية الأجنحة 24.69% من المجموع الكلي للأنواع التي تم تسجيلها. بينما مثلت أنواع متجانسة الأجنحة 38.15%. كما مثلت أنواع هديبة الأجنحة و الأكاروس 69.7% لكل منهما. بالنسبة لطرق أخذ العينات فقد تم جمع 92.76% من الأنواع باستخدام الشبكة الكانسة لجمع الحشرات و 08.23% بالعد المباشر. تم تقسيم الأنواع التي تم جمعها الي أنواع يغلب عليها الأفتراس و أنواع يغلب عليها التغذية النباتية و أخرى حيوانية و نباتية التغذية. تم تقدير الوفرة الموسمية للأنواع التي تم تسجيلها. المفترسين *Coranus aegyptius* (Fabricius) and *Orius* spp. أظهرت درجة متوسطة من الوفرة. أما الأنواع التي أظهرت سلوك الأفتراس و الضرر معا مثل *Campylomma unicolor* Poppius; *Nesidiocoris tenuis* (Reuter); *Creontiades pallidus* Rambur and *Deraeocoris serenus* (Douglas & Scott), فقد أظهرت درجات مختلفة من الوفرة. من بين تلك المصنفات أظهر بق النبات *N. tenuis* أعلى وفرة موسمية علي زراعات الطماطم بمتوسط عام 63% و 75% خلال موسمي 2015 و 2016 علي التوالي. أما الأنواع الضارة مثل *Tetranychus urticae* و *Thrips tabaci* Bemisia tabaci (Gennadius) Lindeman فقد أظهرت أعلى نسبة من الوفرة علي الخيار عندما تم تقدير أعدادها باستخدام طريقة العد المباشر. وهكذا فإن هذا العمل يعكس أهمية شبكة جمع الحشرات في تقدير مجاميع الحشرات الطائرة التي تقطن محصولي الطماطم و الخيار. أما طريقة العد المباشر فقد كانت هي الأفضل في التعبير عن اتجاه مجاميع الأطوار الثابتة و المتحركة لمفصليات الأرجل ذات أجزاء الفم الثاقب الماص التي تقطن نفس المحاصيل. و لهذا فإن استخدام أكثر من طريقة لجمع الحشرات قد تكون الأفضل في التعرف علي العلاقة بين كلا من مفصليات الأرجل النافعة و الضارة التي تقطن محصول ما.