Advances in Applied Agricultural Sciences

Volume 03 (2015), Issue 04, 08-15

Journal homepage: www.aaasjournal.org

ISSN: 2383-4234

Research Article

Diversity and abundance of leafhoppers (Hemiptera, Cicadellidae) in different crops in Egypt

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ARTICLE INFO

Article history:
Received: December 01, 2014
Revised: March 30, 2015
Accepted: April 03, 2015
Available online April 23, 2015

Keywords:
Agronomic and vegetable crops
leafhoppers
virus
Identification

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ABSTRACT

Nowadays several viruses are known as pathogens able to trigger the dwarf syndrome of these viruses. Under natural conditions, the leafhopper species are detected as natural vectors. The infected plants fall behind in their development. Leafhoppers were collected from vegetable crops; potato, *Solanum tuberosum* (L.), egg plant, *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. The leafhopper species collected during 2013 season were identified using only the morphological methods. In vegetable crops, the leafhopper species collected were more than in the agronomic crops; on the other hand the leafhopper diversity in agronomic crops was greater than those in vegetable crops. Seven leafhopper species have been identified; the dominant species is *Empoasca decipiens* (82.5%), followed by *Balclutha incisa* and *Sogatella vibix*. In zucchini field, there was the highest leafhoppers (20%); followed by 15.3% in each of potato and pepper fields, while rice and alfalfa had the lowest leafhopper percents 7 and 6%, receptively. The present results provided the current knowledge and diversity of Cicadellidae populations in various crops in Egypt, which could be supportive to make a future management strategy for such insect.

Due to global warming longer periods of higher temperature in autumn and winter are expected which may result in an increasing importance of insect-transmitted viruses (Habekuss et al., 2009). The leafhoppers feed on stems and leaves, which can cause loss of sap material; but this injury is rarely noticeable and its economic impact has yet to be determined (Beckwith & Hutton, 1929; Mehner, (2005). Besides damage caused by direct feeding and definitely more importantly, these leafhoppers are vectors of diseases of many crops (Chen, 1971; Bisztray et al., 1989, 1991; Watkins & Lane, 2005). In their feeding

process, the leafhoppers act negatively on plants: a mechanical action by harming the vegetal tissue during feeding and egg laying, a toxic action due to the phytotoxicity of their saliva and an infectious action, some species being biological vectors (Brcak, 1979; Ceotto & Bourgoin, 2008). The diversity of the cicadas (Family Cicadellidae) of in Slovenia as well in North America recently has been determined (Gogala & Trilar, 2004; Sanborn & Phillips, 2013) which help in controlling of cicadas.

Economic damages caused by this kind of insect pests were registered in North Western and Central Europe, Japan and USA (Vacke, 1961; Chen, 1971; Manurung et al., 2004; Bressan et al., 2008). At least 160 genera of leafhoppers are known to be vectors for the majority of cereal viruses (Vacke, 1961; Vacke et al., 1980; Finger et al., 2012). Some Homoptera species were pointed out on cereal agrobiocoenosis by the importance as they are more abundant and produce fast growing populations and by losses produced of various Ciadellidae leafhoppers species (Witsack, 1999; Mehner, 2005; Finger et al., 2012; El-Wakeil et al., 2014). The virus vectors can propagate intensively in north Egypt in warm temperature and caused a big yield loss as reported by El-Nahal et al., (1979). Mehner (2005) noted that the leafhopper activities were affected by the weather conditions in their investigation periods.

Leafhoppers populate in different agronomic and vegetable crops and they are playing a key role in infesting many plants mainly rice, *O. sativa* alfalfa, *M. sativa*, and maize, *Z. mays* as well vegetables zucchini, *Cucurbita pepo* okra, *A. esculentus*, potato, *S. tuberosum*, pepper, *C. annuum* and egg plant, *S. melongena*. In Egypt, there is lack of taxonomic studies related to leafhoppers in this region. Therefore, our purpose here was to study presence and relative abundance analyzes of leafhopper species and finally to identify them morphologically.

Materials and Methods

Agronomic, vegetable crops and sampling sites

The experimental plots of different vegetable and agronomic fields (zucchini, potato, eggplant, pepper, okra, alfalfa, maize and rice) were designed as randomized complete block experiments. Different agronomic and vegetable crops fields were localized in El- Gharbyia governorate (30.881°N, 31.06°E, latitude, longitude), 90 km north Cairo, Egypt and in Assiut governorate (27.252°N, 31.09°E), ca. 400 km south of Cairo, each into three plots. Three replicates were performed randomly in each plot; the plot size was ca. 42m2 during summer 2013.

Surveying leafhoppers by sweep net

The sweep net is one method for monitoring insects in many crops especially in early stages (Cherry et al., 1977). Because of its low cost, speed, and simplicity, the sweep net is still the most common tool that growers use for decision making to control the insect pests (Schotzko & O'Keeffe, 1989). Sweep net sampling was used to collect the leafhopper species; it goes in the analysis of the collected individuals. (Fleischer et al. 1982; Kersting et al. 1997). A canvas sweep net with a fine mesh cloth end over a metal wire was used to sample the leafhoppers. The net was 38 cm in diameter, and was 75cm in length and the handle was a 1 m long wooden stick. Two weeks are intervals between different sample dates. Leafhoppers were swept (two 25 double strike net) to evenly sample most of the entire plot. Three replicates

were sampled from each plot/ crop/ date. All samples were transferred into small vials with 70% ethanol. The contents were then examined and species identified as described by Witsack (1999); Stöckmann et al. (2010) by helping Dr. Witsack in Martin Luther university- Halle, Germany.

Statistical analysis

The effect of different crops on leafhopper diversity were analysed using Statistix 9 (Statistix analysis Software) (Thomas & Maurice, 2008); which were performed with General Linear Model's procedure with different positions. The F test assumes that the within-group variances are the same for all groups. The null hypothesis of these tests is that different crops are equal. A large F test and corresponding small p-value (say, smaller than 0.05) is evidence that there are differences, by using LSD test to compare the means.

Results

The qualitative study of the structure of species collected from different vegetable crops as well agronomic crops revealed the presence of 7 species (Table 1) which captured from north and south of Egypt. Leafhopper numbers started highly in early of summer season then decreased slowly till the end of season.

Leafhoppers in vegetable fields

A. Zucchini: There are three leafhopper species were found in zucchini field. The most numerous Cicadellidae Typhlocybinae species was *Empoasca decipiens* (Paoli) (96%); while as *Balclutha incisa* (Matsumura) and *Exitianus taeniaticeps* (Kirschbaum) was the lowest populations (2% for each) as appeared in Fig. (1).

B. Eggplant: There were significant differences in leafhopper species; *E. decipiens* was recorded as dominate species with 86%; while the other species was *B. incisa* with 14% (Fig. 2).

C. Pepper: Two species were recorded in pepper field as shown in Fig. (3). The highest abundance species was *E. decipiens* (97%); on the other hand, Fulgoromorpha, Delphacidae *Sogatella vibix* (Haupt) was in rare numbers (3%).

D. Potato: Only *E. decipiens* was identified in potato with high numbers.

E. Okra: Only *E. decipiens* was identified in okra with moderate numbers.

Leafhoppers in agronomic crops

A. Maize: Five leafhopper species were identified in maize field; the highest numbers were recorded in species of *B. incisa* (40%), followed by *E. decipiens* (30%), then came *S. vibix* (20%), while both of *Sogatella nigeriensis* (Muir) and *Cicadulina bipunctata* (Melichar) were the lowest number of leafhopper species (10%) (Fig. 4).

B. Rice: The highest abundance species was *Sogatella vibix* (50%); *B. incisa* came in the second group with 37.5%. *E. decipiens* and *Nephotettix modulates* (Melichar) were equal with 6.25% for both of them: Four species were recorded in rice field as shown in Fig. (5).

C. Alfalfa: Only *E. decipiens* was identified in alfalfa with moderate numbers.

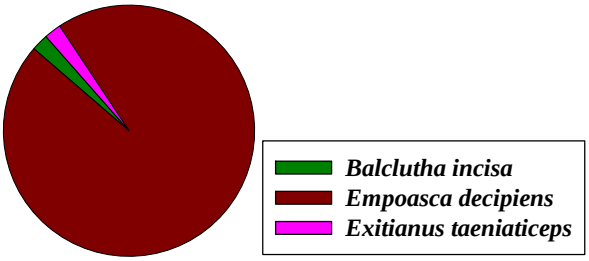

Fig. 1. Leafhoppers surveyed by sweep net of zucchini field

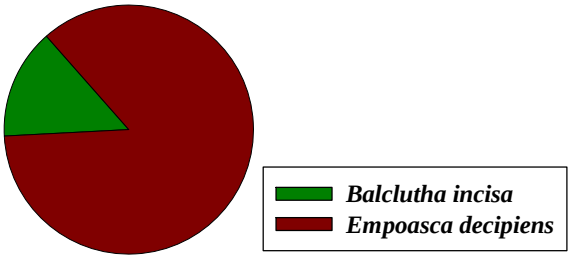

Fig. 2. Leafhoppers surveyed by sweep net of eggplant field

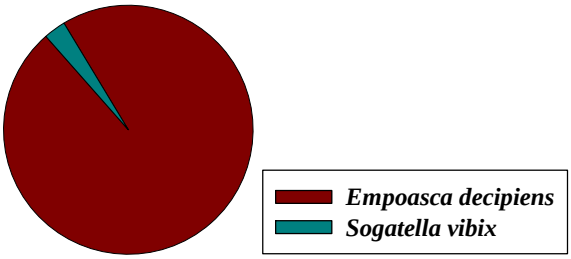

Fig. 3. Leafhoppers and planthopers surveyed by sweep net of pepper field

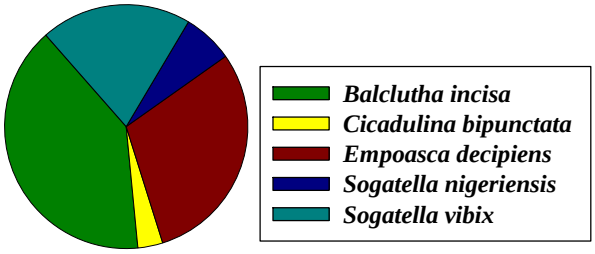

Fig. 4. Leafhoppers and plant hopers surveyed by sweep net of maize field

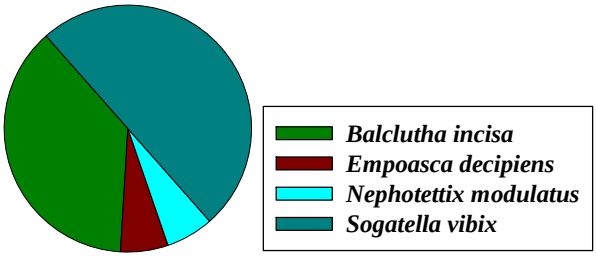

Fig. 5. Leafhoppers and plant hopers surveyed by sweep net of rice field

Diversity of leafhoppers and plant hoppers species

There were significant differences (P= 0.002) in diversity species of leafhoppers in the whole fields. *E. decipiens* was the highest species population (82.5%); followed by *B. incisa* (8.75%) while *S. vibix* was in the third level (6.5%). The other four leafhopper species (*S. nigeriensis, C. bipunctata, E. taeniaticeps* and *N. modulatus* were 2.25%, where each species is less than 1% caught by sweep net (Fig. (6); Tables 1 &2).

Leafhoppers and planthoppers in both agronomic and vegetable crops

The leafhopper diversity in agronomic crops was greater than those in vegetable crops. Diversity of leafhoppers was differed significantly (P= 0.014) among various agronomic and vegetable crops. In zucchini field, there was the highest leafhoppers (20%); followed by potato and pepper with the same ratio (15.3%) for each one. In the third group came maize and okra with percents (13 and 12.4%), respectively. Eggplant had a moderate leafhopper numbers (11%); while rice and alfalfa had the lowest leafhopper percents 7 and 6%, receptively as shown in Table (2) and Fig. (7).

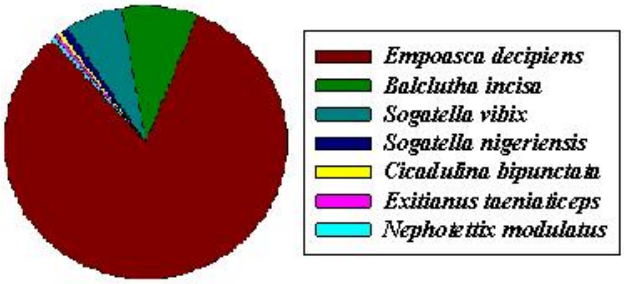

Fig. 6. Diversity of leafhoppers and plant hopers surveyed by sweep net in different crops

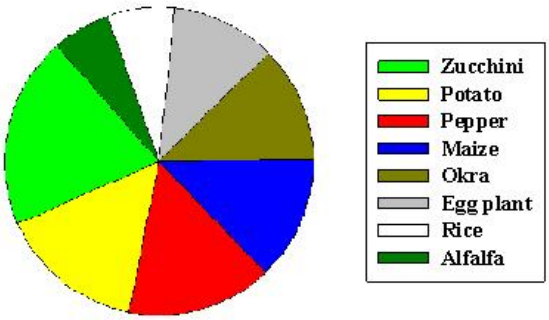

Fig. 7. Total leafhopper and plant hoppers species surveyed by sweep net in different crops

Table 1: *Name of leafhopper and planthoppers species and their photos*

Balclutha incisa (Matsumura, 1902) 	*Cicadulina bipunctata* (Melichar, 1904) 
Empoasca decipiens (Paoli, 1930) 	*Exitianus taeniaticeps* (Kirschbaum, 1868) 
Nephotettix modulates (Melichar, 1912) 	*Sogatella nigeriensis* (Muir, 1920) 
Sogatella vibix (Haupt, 1927) 	

Table 2: *Leafhopper species extracted from different crops and governorates in Egypt*

Leafhopper and planthoppers species	***Oryza sativa***	***Zea mays***	***Medicago sativa***	***Solanum tuberosum***	***Cucurbita pepo***	***Capsicum annuum***	***Abelmoschus esculentus***	***Solanum melongena***
	Rice	**Maize**	**Alfalfa**	**Potato**	**Zucchini**	**Pepper**	**Okra**	**Egg plant**
Balclutha incisa **(Matsumura, 1902)**	+	+			+			+
Cicadulina bipunctata **(Melichar, 1904)**		+						
Empoasca decipiens **(Paoli, 1930)**	+	+	+	+	+	+	+	+
Exitianus taeniaticeps **(Kirschbaum, 1868)**					+			
Nephotettix modulatus **(Melichar, 1912)**	+							
Sogatella nigeriensis **(Muir, 1920)**		+						
Sogatella vibix **(Haupt, 1927)**	+	+				+		
Places	**North Egypt**				**South Egypt**	**North Egypt**		

Discussion

Leafhopper numbers in the early of season (warm) was higher than in the rest of season (hot), this may be due to the weather condition which affected on mobility of leafhoppers as reported by Habekuss et al. (2009); El-Wakeil et al. (2014). Such as preliminary results give hint that due to global warming not only insects themselves will become more important, but also insects like leafhoppers may migrate from southern regions northward as stated by Chmielewski et al. (2007) in their study with Russian wheat aphid (*Diuraphis noxia*), but that with rising temperatures also insect transmitted viruses will gain evident importance.

The presence of Cicadellidae in the adult and all nymph stages during the entire experimental period and in all plots, with very high densities has suggested the economic importance of this group of insects as pest and biological vectors for continuous potential source of virus infestation of various agronomic and vegetable crops. It is known that Cicadellidae have the capacity to transmit different viruses from the infected plants in all stages of the insect (adult and nymph) as reported by Baniţã et al. (1996); Bisztray et al. (1989).

Zucchini is infested with Cicadellidae in a proportion of 20% from the total harmful insects captured during the vegetation period; on the other hand, rice is infected with a proportion of 7%. The size of the populations is favourably influenced particularly by the growing stages of the host plants as confirmed by Baniţã et al. (1996) in their studies on wheat. Qualitative structure of the populations is represented by 7 species but the basic nucleus encompasses one species: *E. decipiens* (82.5%); while the other six species included 17.5% from the population of Cicadellidaeas. Similar results were mentioned by Biedermann & Niedringhaus (2009); Finger et al. (2012); El-Wakeil et al. (2014), who said that one of the found species are always the dominant, while the others comprise small percents.

For polyphagous insect pests, investigations of the seasonal occurrence on each host plant are indispensable for understanding the population dynamics throughout the study time. *E. decipiens*, *B. incisa* and *S. vibix* can feed on many plants, such results were stated by Catindig et al. (1995); Matsukura et al. (2009, 2011) in their researches in rice and maize crops in north Egypt.

The results on the diversity of leafhopper populations in different crops and their function as virus vectors in north and south of Egypt still requires further research. Finally, the sweep net method based on ease of use, and the fact that they are commonly used tools available for growers is considered as monitoring tool to start in applying one of the suitable management strategies.

Acknowledgements

The authors are greatly indebted to Dr. W. Witsack, Martin- Luther University for leafhoppers identification.

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