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Impact of Gausho and Tiliton pesticides on some soil mites population in cotton fields

Heba M. Farid*, Ahmed I. Amer & El-Sayed G. Hamada

Plant Protection Research Institute, Agricultural Research Centre, Dokii, Giza, Egypt, Email: Bobaafify@gmail.com; drahmedamer26@gmail.com; dr_sayed97@yahoo.com
**Corresponding author Email: Bobaafify@gmail.com*

ABSTRACT

The present study was conducted to evaluate the environmental hazards of insecticides used as seed dressing by Gausho and leaf spraying by Tiliton on abundance and diversity of mites inhabiting soil in which they are useful in nutrient cycling in soil. Soil samples were collected monthly from cotton field during the vegetation period (April-September). Gausho caused a complete mortal effect on soil mite individuals over one month after the insecticide application. The mortal effect is suggested due to the fast leaching of insecticide into the soil by dipping technique method. Soil mites' population was maximum in June. Foliar spraying of Tiliton reduced the population density of soil mites compared with the control till the end of vegetative period. A reduction of 57.65% of soil mites was caused due to insecticides usage. Mortality may relate to the incidence dropping off some pesticides droplets into the soil during spraying method. Gausho reduced the species diversity (H'≤ 3) of oribatid mites 60 days after seed soaking, while exhibited a very low diversity (H'≤ 1) for prostigmatid, mesostigmatid, and astigmatid mites. Thus, the insecticide application in conventional fields had a significant effect on non-target beneficial arthropods and therefore reduced biological aspects in soil ecosystem that considered an indicator of soil quality and ensures its sustainability.

Keywords: ecotoxicology, oribatids, dominance, diversity index, soil micro-arthropods, soil fertility

INTRODUCTION

The soil is the source of nutrient elements needed for a diverse of organisms that play an important role in soil fertility and humus formation. Soil micro-arthropods are responsible for decomposition, nutrient cycling, and releasing of nutrients from organic matter for use by plants (Nakhron and Dkhar 2010).

Micro-arthropods populations in the soil are affected by a number of factors such as moisture, pH, and organic matter content of the soil (Wallwork 1970). Badejo and Akinyemiju (1993) reported that application of pesticide led to the reduction of micro-arthropods populations in soil. Therefore, the agricultural factors affecting the disappearance, dispersal and maintenance of mites in soil should be studied.

The herbicides applications cause significant reduction in species diversity and population density of soil micro-arthropods (Mitra et al. 1983; Badejo et al. 1997). Continual applications of herbicides cause reduction in the rate of decomposition of dead organic matter by micro-arthropods (Mathes and Schutz-Bernedt 1998). Atrazine, applied at high concentrations led to the chemical deterioration of the soil, which disrupted activity of micro-arthopods and prevented oviposition of the springtail *Orchesela cinta* (L.) (Entomobryidae) (Badejo and Van Straalen 1992). Edwards (1970) reported a decrease in prostigmatid, mesostigmatid, and oribatid mites, as well as Isotomidae.

This indicates, many pesticides compounds can contaminate the soil with toxic materials that effects on biological aspects of the soil and hence its fertility.

Gaucho is neonicotinoids insecticide (Imidacloprid 70% WG) used as seed treatment, ensuring protection of the plant against piercing and sucking pests from the time of sowing to the growing period. Its mode of action is effectiveness on the central nerve system of insects resulting in paralysis and death. In the soil, the active ingredient is released from the seed and forms a treatment-halo around the seed. Gaucho is absorbed very qualified by the germinating plant and is transported in the sap-flow to the stem and leaves. Gaucho controls thrips, aphids, termites and soil pests in cotton. Gaucho used as a seed dressing in different crops (e.g. rice, cotton, and cereals).

Tiltion is an organophosphorus insecticide (Profenofos 70% EC) pale yellow liquid with a garlic like odour, used to control *Spodoptera littoralis* (Boisduval) (Noctuidae) on cotton and other pests at 750 ml /feddan (4200 m^2) (Mann 2004).

Thus, the aim of the present study is to investigate the influence of two types of insecticides (used as foliar spraying and seed dressing) on diversity and population density of soil mites in cotton field in EL-Gemmiza Agricultural Research Station, Agricultural Research Centre, Egypt.

MATERIALS AND METHODS

Pesticides used

Two pesticides, Gaucho and Tiltion were used. In that experiment, one carat (175 m^2) was sowed with 1.25 kg cotton seeds. Gausho was applied as 7g kg^{-1} seeds of cotton.

Study area: The study was carried out at the Research Farm of EL-Gemmiza Agricultural Research Station, Agricultural Research Centre, Egypt. Cotton seeds 'Giza 86' was cultivated on 01 Apr, 2019 in one carat for all treatments and check.

Field procedures: The experimental farmland was divided into plots, each of 6 x 7m and labeled for treated and check. These plots were interspersed by a space of 5m to avoid trans-boundary contamination. Treated seeds were prepared by mixing 7 g of Gaucho pesticide in 1 kg of cotton seeds (seed coating). Tiliton was applied as 31.25 cm /carat in July by spraying machine method on vegetation cover. Soil samples were taken monthly during the vegetation period (April-September); the first set of soil samples was collected 14 days post-treatment. The sampling method was conducted with an 8.5 cm diameter soil auger from (5–10 cm) depth, and four samples were collected from each plot per each treatment. Each sample was placed in a plastic bag, labeled and taken to the laboratory for further analyses i.e., extraction and identification of mites.

Laboratory Procedures: Mites were extracted from about 500 gm of soil sample using modified Tullgren funnels. Extraction lasted for five days where the mites were carefully removed, and the extracts were stored in the clearing medium lactic acid in closed vessels for 14 days for further examination under microscope. Slides were prepared for further identification (Krantz and Walter 2009). The identified mites were counted and recorded.

Statistical analysis

Factorial analysis was applied to compare the effect of pesticides, time variation per month and diversity of soil mites using Proc ANOVA in SAS (Anonymous 2003). Mean separation was followed using Tuckey's HSD in the same program.

Diversity index (H'): Describes the organism's population mathematically to analyze the number of individuals in each family group or species in a habitat community. The most commonly used diversity index is the Shannon-Weiner index (Odum 1971).

$$H' = \sum_{i=1}^{s} p_i \ln p_i ,$$

Where H` = Shannon-Weiner index

$$p_i = \frac{n_i}{N}$$

Where, n_i = Number of individuals of a species

N =Total individuals of all species

The diversity index criteria are as follows:

$H' \leq 1$ = Low diversity

$1 < H' \leq 3$ = Modrate diversity

$H' \geq 3$ = High diversity

Index of dominance (C): The dominance index indicates a high existence of a species against other species. The dominance index formula as follows (Odum 1971):

$$C = \sum_{i=1}^{s} p_i^2$$, Where C= Dominance Index

p_i = The proportion of individuals of a species, i= 1, 2…, n

Index values range from 0–1 by the following categories: $C \leq 0.05$ = Low Dominance

$0.05 < C \leq 0.1$ = Moderate Dominance

$C \geq 0.1$ = High Dominance.

K-Dominance curve: For the K-dominance abundance curve, species are ranked by order of importance on the x axis with percentage of dominance on the y axis cumulative scale (Warwick et al. 1987).

RESULTS AND DISCUSSION

Oribatid mites were significantly the dominate soil mites, presented by seven families (i.e., Haplozetidae, Oppiidae, Scheloribatidae, Euphthiracaridae, Lohmanniidae, Galumnidae and Northridae) (Table 1). Mesostigmatid, prostigmatid and astigmatid mites were occurred with a lower frequency. At the beginning of Guasho application, soil samples showed no individuals detected in treated plots. Gradually mite individuals appeared in trace numbers in May (mean 6.5). A reasonable increase was observed sixty days after Gausho treatment (mean 66.25). The total mite families in Jun. in untreated and treated plots was 13 families encountered, respectively 782 and 345 mite individuals. Clearly from obtained data, Gausho insecticides apparently caused toxicity to the beneficial non-target soil micro- arthropods such as Oribatida that ensures Gausho leaches fast and easily into the soil which effect on mite's community structure inhabiting treated soil (Table 2). This finding agrees with Badejo and Akinyemiju (1993) and Aktar et al. (2009) who reported that application of pesticide led to the reduction of micro-arthropods population in soil. It is also consistent with Badejo et al. (2004) who proved that herbicide Atrazine greatly reduced acarid species richness, abundance, and diversity in soil.

Data showed application of Tiliton pesticide as foliar application on cotton plants in Jul. decreased the total mite individuals in treated plots to 89 individuals compared with 176 in the untreated (Table 1). Finally number of soil mites was decreased until the end of experiment in Sept. to 12 individuals for all families groups. A reduction of 57.65% of soil mites was caused due to insecticides usage.

The results on Tilton spraying pesticide are corresponding to Anbarashan and Gopalsamy (2013) who reported that pesticides/insecticides had a significant effect on non-targeted arthropods in soil such as Collembola, Arachinida, Hymenoptera and Thysonoptera that were suppressed after pesticides/insecticides spraying. Results are also confirmed that of Cortet et al. (2002) who studied the impact of different insecticides on soil mites.

Results showed that oribatid mites had a moderate diversity index (H´) ranging from (1.24–1.72) during May to August (H´ $\geq$ 1), while Mesostigmata showed a lower diversity rate during May to September (0–0.27). Finally, Prostigmatid and astigmatid mites showed a very low diversity rate ranging from (0–0.38) with expressed (H´ $\leq$ 1). All mite groups not exhibited in April due to the leaching effect of Guasho pesticide (Figure 1).

There were fluctuations in variability of mites detected according to influence of insecticide on mite species in soil (Figure 2). Data showed a higher dominance rate (C $\geq$ 0.1) of oribatid mite species than others, exhibited (0.11–0.29), while mesostigmatid, prostigmatid, and astigmatid mites showed a lower dominance rate (C $<$ 0.05) along the experimental period.

Evaluation of species richness of oribatid mites among different times showed K-dominance curve for the percentage of dominant oribatid mites inhabit tested soil samples (Figure 3). The present study revealed that Haplozetidae is numerically the most dominant group of oribatids inhabits soil samples among the tested period (25.9%). Secondly is Oppiidae (18.6%), then Scheloribatidae representing (17.5%), and lastly is Northridae representing (4.7%) from all mites recorded.

Data confirms that Haplozetidae, Oppiidae, Scheloribatidae, and Euphthiracaridae are numerically the most dominant oribatid mites extracted from studied area after the exposure to pesticide residues, which indicates that these species are more refractory to tested insecticides and more resistant to their toxic effect. This finding resembles to Murvanidze et al. (2019) who reported also *Protoribates capucinus* (Haplozetidae) was stress-resistant species and dominant in tested soil. Presence or absence of these species in conventional field can determine if the fields are under environmental stress like soil pollution. That agrees with findings of Gbarakoro and Zabbey (2013) who deduced that some Oribatids like *Galumna* spp., *Scheloribates* spp. and *Crptophagus* spp. were ubiquitous and refractory to atrazine and gramoxone individually, but were all susceptible to mortal effects of both herbicides. Furthermore, density result of soil micro-arthropods below 0–10 cm in the treated plots agrees with Gbarakoro et al. (2012) who reported that pollution is significantly reduces mesofaunal assemblages in the upper 10.0 cm layer of soil.

Table 1. Total abundance of soil mites per plot samples under impact of different pesticides in cotton field , in El Gemmiza Agricultural Research Station during Apr. to Sept. 2019.

Mite family	April		May		June		July		August		September	
	Ga.†	Co.‡	Ga.	Co.	Ga.	Co.	Ga.+Ti.§	Co.	Ga.+Ti.	Co.	Ga.+Ti.	Co.
Oribatida												
Haplozetidae	0	10	7	11	72	224	8	17	5	16	0	12
Oppiidae	0	1	1	1	35	81	15	31	10	15	5	13
Scheloribatidae	0	1	1	1	41	77	10	22	6	17	4	9
Euphthiracaridae	0	4	2	2	42	63	13	19	3	6	0	4
Lohmanniidae	0	1	5	1	23	54	4	10	2	16	0	7
Galumnidae	0	2	0	3	18	33	2	9	3	5	1	4
Northridae	0	2	1	2	11	15	3	5	2	6	0	3
Juveniles	0	8	3	10	80	189	23	41	7	13	0	6
Mesostigmata												
Uropodidae	0	3	2	4	1	3	2	3	0	1	0	2
Macrochellidae	0	3	1	2	3	10	2	3	0	0	0	1
Parasitidae	0	2	1	2	2	5	1	1	0	0	0	0
Laelapidae	0	1	0	0	1	3	0	0	0	0	0	0
Prostigmata												
Trombiididae	0	1	0	0	1	2	3	8	0	0	0	0
Astigmata												
Acaridae	0	8	5	9	15	23	3	7	2	4	2	3
Total mites	**0**	**47**	**29**	**48**	**345**	**782**	**89**	**176**	**40**	**99**	**12**	**64**

† = Gaucho, ‡ = Control, § = Tiltion

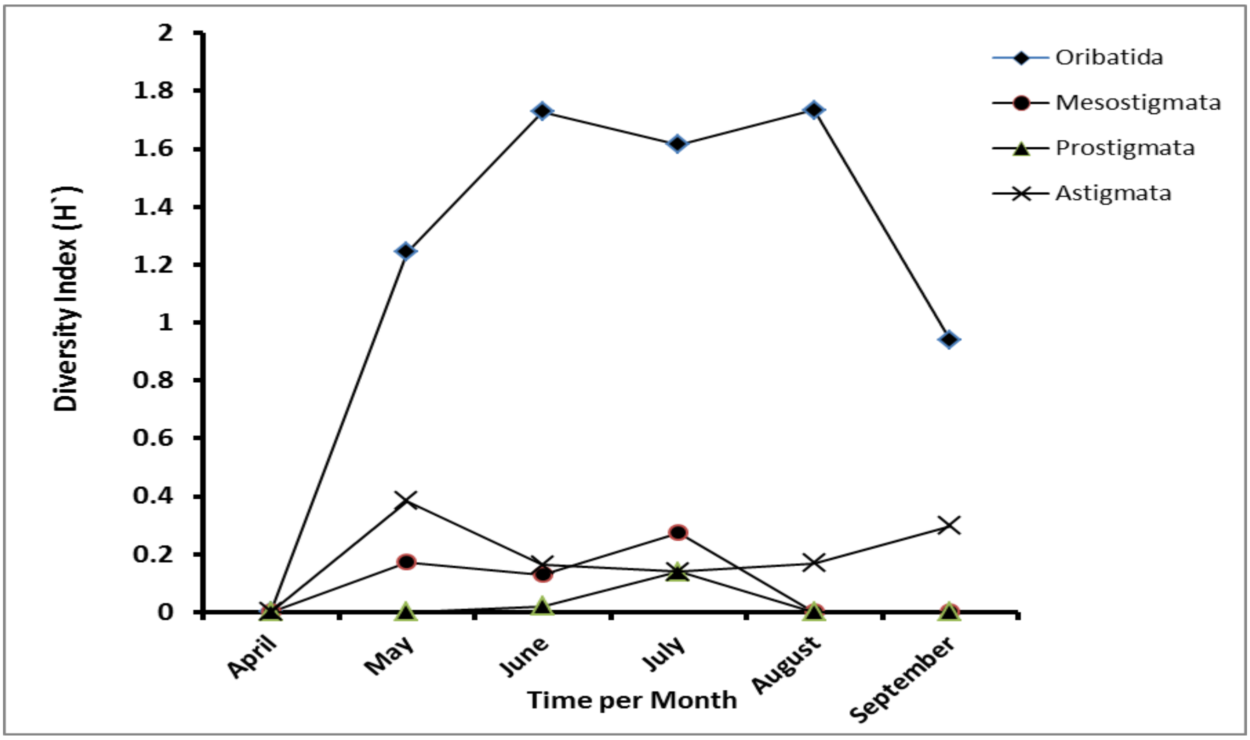

Figure 1. Diversity index for the population of mite individuals in each group during Apr. to Sep. 2019. H` ≤ 1= Low diversity, 1< H` ≤3= Modrate diversity, H` ≥ 3= High diversity

Table 2. Factorial analysis of data presented in Table (1) as means for families, months and treatments per plot samples during Apr. to Sep. 2019.

Mite Family	Mean		Month	Mean		Treatment	Mean	
Haplozetidae	31.833	A	Apr.	1.679	b	Pesticide	6.131	B
Immature	31.667	A	May	2.75	b	Control	14.476	A
Oppiidae	17.333	Ab	June	40.25	a	-	-	
Scheloribatidae	15.75	Ab	July	9.464	b	-	-	
Euphthiracaridae	13.167	Ab	Aug.	4.964	b	-	-	
Lohmanniidae	10.25	Ab	Sep.	2.714	b	-	-	
Acaridae	6.75	Ab	-	-		-	-	
Galumnidae	6.667	ab	-	-		-	-	
Northridae	4.167	ab	-	-		-	-	
Macrochellidae	2.083	b	-	-		-	-	
Uropodidae	1.75	b	-	-		-	-	
Trombiididae	1.25	b	-	-		-	-	
Parasitidae	1.167	b	-	-		-	-	
Laelapidae	0.417	b	-	-		-	-	
F	3.19			14.63			6.85	
P	0.0003			0.0001			0.0098	
Tuckey's HSD	28.768			15.945			6.3004	

*Means with the same letters in the same column are not significantly different at P≤0.05

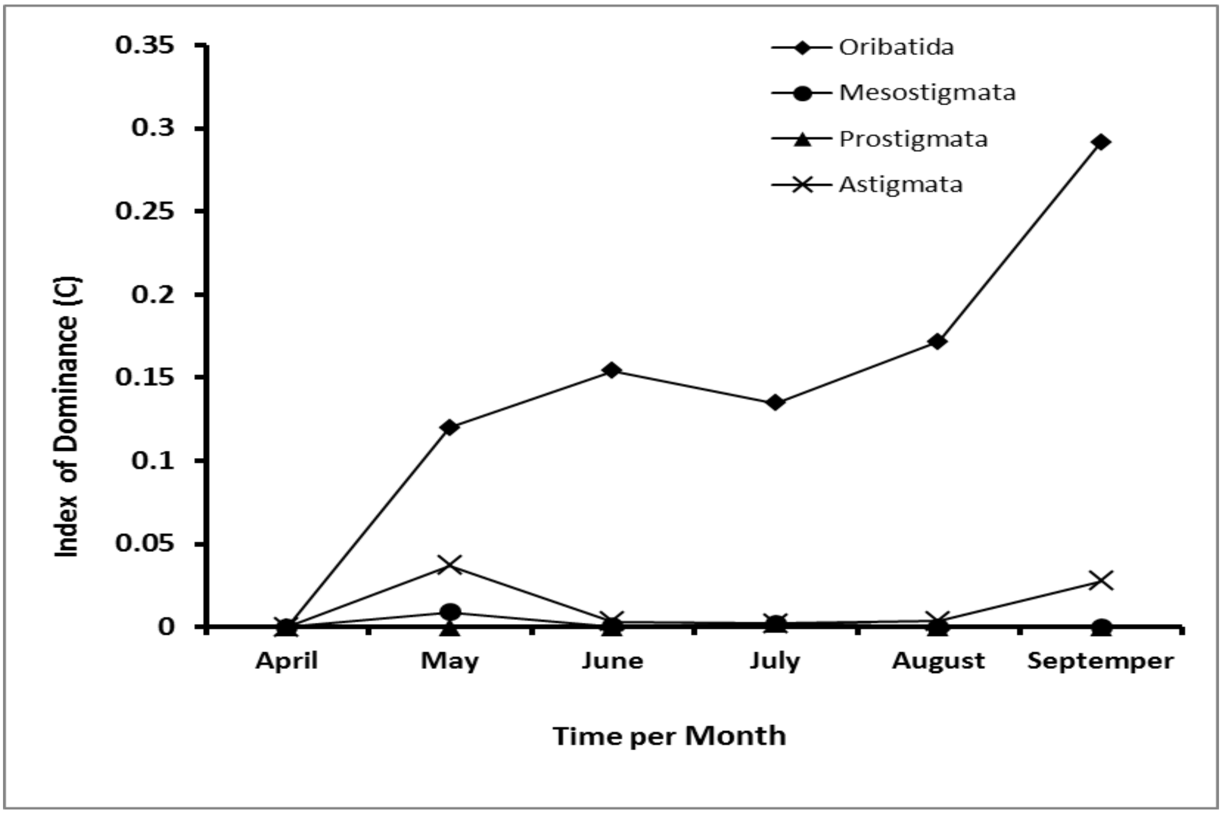

Figure 2. The index of dominance of mite groups extracted from a cotton field during Apr. to Sep. 2019. Index values range from 0–1 as following categories C ≤ 0.05 = Low, 0.05 < C ≤ 0.1 = Moderate, C ≥ 0.1 = High.

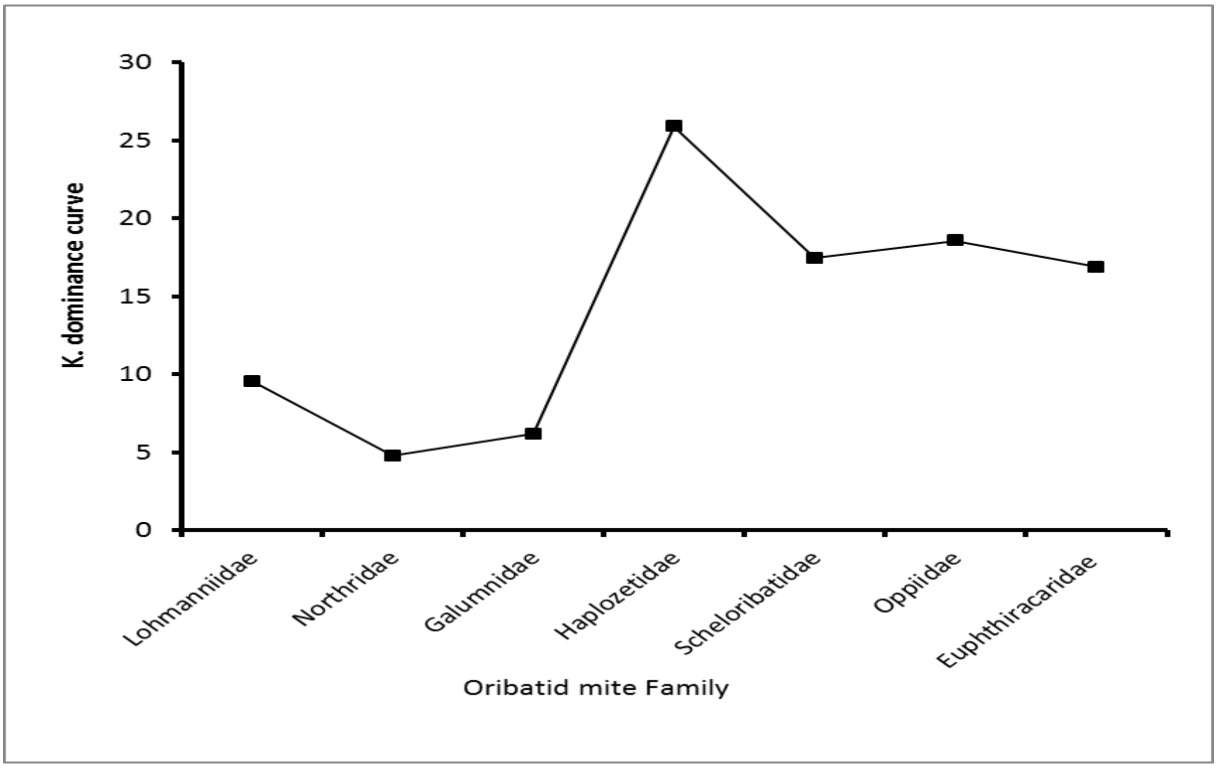

Figure 3. K-dominance curve for the percentage abundance of dominant oribatid mites recorded during Apr. to Sep. 2019.

Conclusion

Gausho insecticides applications in a cotton field cause total mortal effect on soil mites during the first month after sowing the dressed cotton seeds due to its fast leaching into soil. While, the leaf spraying Tiliton reduced the population density of soil mites due to the toxicity effect of pesticide run off. The species diversity and population density of oribatid mites were reduced after Gausho application, and expressed very low rates for prostigmatid, mesostigmatid, and astigmatid mites.

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