Population dynamics of soil inhabiting mites in cucumber treated with granular insect growth regulators (IGRs)

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Summary. In small field trials, certain granular insect growth regulators (IGRs) induced significant reduction in soil inhabiting mites of cucumber plantation at a rate as low as 0.25 kg. a.i./acre. However, suborders specificity relationship could easily be detected.

In Egypt, soil arthropods faunal studies were first started during the last 2 decades[1,2]. Of the relatively large number of soil arthropodes, soil mites are the dominant group of animals inhabiting soils[3]. Studies and information about the soil micro-fauna in general and soil mites in particular are relatively limited. However, despite the fact that most of phytophagous species spend part of their life cycles on or in the ground[4], soile mites in general, and predatory species in particular, have recieved much less attention.

With the recent advent of chemical pesticides application either through soil treatment or indirectly from foliage treatments, much basic research is necessary to determine to what extent the soil mite fauna is influenced. The almost inadequate information on the specific response of the soil mites to different groups of chemicals, especially the newer ones, is rather serious since interest has been increased recently in using newer methods, such as insect growth regulators (IGRs), against many agricultural pests which spend either part of their life cycle, as in the case of some major lepidopterous cotton pests[5], or spend all their life-span, such as plant-parasitic nematodes[6,7], in the soil. Thus it was felt necessary to investigate the effect of a new class of chemicals against the soil acarine fauna in an effort to overcome the lack of information. Consequently studies were undertaken in 1978 in the Experimental Station of the Faculty of Agriculture at Shebin El-Kom, Menoufia Province, to explore the effectiveness of certain IGRs on natural abundance and population density of different sub-orders of mite associated with a truck crop such as cucumber. The findings of these studies are reported herein.

Materials and methods. The experimental work was carried out in an area of 1/200 acre cultivated cucumber on the farm of the Faculty of Agriculture Exp. Station. Soil type of the experimental area was loamy clay containing 1.36% organic matter and a mineral fraction containing 31.79% sand, 23.93% silt and 41.29% clay. The experimental area was divided into 6 square plots. 5 plots were treated with granular pesticides on May 25, 1978, while the 6th plot was left untreated for comparison.

3 insect growth regulators (IGRs) were tested to compare with chlorpyrifos as standard insecticide. All compounds formulated as granules 5% were tested at rate of 5 kg/acre.

Table 1. Natural population density of soil mites in cucumber plantation (May–July 1978)

Mite Sub-orders	Average number m^2 at indicated depths and days									
	10 cm					20 cm				
	2	7	15	30	45	2	7	15	30	45
	27.5.	1.6	9.6	24.6	9.7	27.5	1.6	9.6	24.6	9.7
Heterostigmata	900	600	1000	800	1200	3200	1200	3400	3500	3600
Cryptostigmata	1500	1800	1900	1600	1500	1900	2300	2400	1900	1800
Astigmata	100	200	100	200	300	300	200	300	400	500
Mesostigmata	800	500	300	700	900	1300	1500	1600	1000	1300
Prostigmata	300	700	900	1000	900	400	800	1300	1700	2200
Total Acari	3600	3800	4200	3400	4800	7100	6000	9000	8500	9400

Table 2. Average number of soil mites in cucumber plantation treated with certain IGRs

Treatments	Rate (kg/acre)	Average number of soil Acari/m^2 at indicated days post treatment						Reduction (%)
		2	7	15	30	45	Total	
RO-10-3108	5	300	1500	7200	6530	11000	26530	56.3
RO-08-9801	5	500	600	1000	7900	8600	18600	69.4
Diflubenzuron	5	2800	3100	4900	6400	11200	28400	53.2
Chlorpyrifos	5	1100	4800	10100	11600	11600	39200	35.4
Chlorpyrifos	20	700	600	900	3800	12500	18500	69.5
Control	–	10700	9800	13200	12800	14200	60700	–

LSD 5% 2669.08; 1% 3676.28.

Table 3. Vertical distribution of Acarina in cucumber plantation following treatment with certain granular IGRs

Treatments	Rate kg/ acre	Average number of soil Acari/mc at indicated days for depth of													
		2	7	15	30	45	Total	Reduction (%)	2	7	15	30	45	Total	Reduction (%)
		10 cm							20 cm						
RO-10-3108	5	0	900	1500	1900	3600	7900	61.9	300	600	5700	4630	7400	18630	53.3
RO-08-9801	5	300	100	600	2600	2800	6400	69.1	200	500	400	5300	5800	12200	69.5
Diflubenzuron	5	700	700	1900	2300	3800	9400	54.1	2100	2400	3000	4100	7400	19000	52.5
Chlorpyrifos	5	200	1400	2800	3500	3400	11300	45.4	900	3400	7300	8100	8200	27900	30.3
Chlorpyrifos	20	0	200	800	1600	4100	6700	67.7	200	900	100	2200	8400	11800	70.5
Control	–	3600	3800	4200	4300	4800	20700	–	7100	6000	9000	8500	9400	40000	–

Table 4. Effect of different IGRs on different sub-orders of soil mites/m^2 (0-20 cm)

Mite Sub-orders	Reduction in mite population at indicated days (%) 2	7	15	30	45	Average
RO-10-3108 (5 kg/acre)						
Heterostigmata	100.0	100.0	15.9	20.9	20.8	51.5
Cryptostigmata	100.0	87.8	69.8	68.6	27.2	70.7
Astigmata	100.0	100.0	50.0	61.7	12.5	64.8
Mesostigmata	85.7	70.0	47.3	82.3	31.8	63.4
Prostigmata	100.0	73.3	54.5	44.4	16.1	57.7
RO-18-9801 (5 kg/acre)						
Heterostigmata	100.0	100.0	93.2	14.0	11.6	61.4
Cryptostigmata	100.0	95.1	93.0	14.3	33.3	67.1
Astigmata	100.0	100.0	100.0	83.3	25.0	81.7
Mesostigmata	100.0	85.0	78.9	76.5	63.6	80.8
Prostigmata	71.4	73.3	100.0	74.1	61.2	76.0
Diflubenzuron (5 kg/acre)						
Heterostigmata	90.2	77.8	70.5	60.4	41.7	68.1
Cryptostigmata	47.1	70.3	51.1	40.0	12.1	44.1
Astigmata	100.0	100.0	100.0	66.7	37.5	80.8
Mesostigmata	76.2	70.0	47.3	5.9	4.5	40.8
Prostigmata	100.0	40.0	77.2	70.3	6.5	58.8
Chlorpyrifos (5 kg/acre)						
Heterostigmata	100.0	11.1	25.0	9.2	18.8	32.8
Cryptostigmata	73.5	36.5	7.0	5.7	18.2	28.1
Astigmata	100.0	75.0	25.0	16.7	37.5	50.8
Mesostigmata	100.0	90.0	47.3	5.9	9.1	50.4
Prostigmata	71.4	80.0	31.8	14.8	19.3	43.5
Chlorpyrifos (20 kg/acre)						
Heterostigmata	100.0	94.4	97.7	100.0	6.3	79.7
Cryptostigmata	100.0	92.7	93.0	45.7	9.1	68.1
Astigmata	100.0	100.0	100.0	75.0	12.5	77.5
Mesostigmata	90.5	75.0	84.2	23.4	18.2	58.3
Prostigmata	100.0	86.7	90.9	81.4	19.3	75.7

In addition, Chlorpyrifos was tested also at the recommended rate for controlling cotton and clover pests; i.e. 20 kg/acre. The experimental granules were broadcasted as soil surface treatment and thenafter all plots were irrigated within 24 h post-treatment.
The chemical names of the tested compounds are: RO-10-3108 (6,7-epoxy-3-ethyl-1-(p-ethylphenoxy)-7-methylnonane); RO-08-9801 (1-(4-ethylphenoxy) 6-7-epoxy-3, 7-dimethyl-2-Octene); Diflubenzuron (1-(4-Chlorophenyl)-3-(2,6-difluoro-benzoyl)urea); Chlorpyrifos (0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorthioate).
During the experimental period (May-July 1978), sampling was carried out at 5 schedules. The first sampling date was 2 days post-treatment for the assessment of the initial efficacy. For studying the long-term activity of the experimental compounds, 4 other samples were also collected at intervals of 7/15/30 and 45 days post-treatment. On each sampling date, 4 soil samples were taken randomly from 4 sites in each experimental plot. Sites of previous corings, rocks and other objects were avoided. An iron tool of $10\times 10\times 10$ cm was used for obtaining the soil samples for faunal examination. Since the soil mites groups differ significantly in their vertical distribution, each sample was collected to represent 2 levels, the surface stratum, from the surface down to 10 cm and the subsurface stratum from 10 to 20 cm below the soil surface. Special care was taken to close the sampling polyethylene bag tightly during its transport to the laboratory.
The mites were carefully sorted out from the soil by means of modified Berlese-Tullgren funnels. The required time for complete extraction of the fauna was approximately 3 days[8].
Identification and classification of different mite suborders was worked out with the aid of a steroscopic binocular microscope, according to different authors[9-12].

Results and discussion. For precise information, soil mites were recognized and differentiated in 5 sub-orders as follow: Heterostigmata, Cryptostigmata, Astigmata, Mesostigmata and Prostigmata. The data in table 1 indicate the trends in population changes throughout the experimentation period as well as the period between collections. Considerable fluctuations were easily noticed in total community of mites either at 10 or 20 cm depth. However, the maximum population of mites took place at collections of 9th June and 9th July in both levels which may be due to natural causes such as, timing of irrigation or change in organic matter levels due to fertilization.
Detailed data of the abundance of different sub-orders revealed that Heterostigmata, Cryptostigmata and Prostigmata had the highest density respectively at both levels where they exceeded in total number than the other 2 sub-orders. However, regarding the vertical natural distribution, it is clear that the identified sub-orders seem to be more abundant at subsurface stratum (10-20 cm), regardless of sampling date, which might be due to the high temperature at soil surface (0-10 cm) and subsequently to lack of humidity. However, Madge[13] has pointed out that the humidity seemed to be the main factor that regulates the distribution of soil Oribatids (Cryptostigmata).
Changes in soil mite population, following application of granular pesticides throughout the duration of the study (45 days), are presented in table 2. It is a evident in treated plots that there was a significant reduction at the 5% level in the mixed population of soil mites, when compared with the natural population in untreated plots throughout the whole study period. The highest reduction in total soil mite population was achieved with the use of Ro-08-9801 at the rate of 5 kg/acre and Chlorpyrifos at rate of 20 kg/acre. Ro-10-3108 and Diflubenzuron both at a rate of 5 kg/acre came next, showing 56.3% and 53.2% reduction respective-

ly. However, the least pesticide performance was associated with the insecticide compound Chloropyrifos when used at the same level of the tested IGRs (5 kg/acre). In general the soil mites are more susceptible to the tested IGRs than chlorpyrifos at 5 kg/acre which was reported as a high potent soil pesticide[14].

Closer examination of the detailed data (table 3) of treated plots revealed that the reduction percentages in natural population of mite was slightly different in both levels of vertical distribution, which could be explained in view of the behaviour of the pesticide used. However, RO-10-3108 and Chlorpyrifos at the rate of 5 kg/acre performed better in the surface stratum than in the subsurface-stratum which means more adsorption in this layer and less leaching. Increasing the rate of Chlorpyrifos 4 times did permit slight leaching to the subsurface stratum only and a subsequent slight increase in efficacy (70.5%) reduction as compared with 67.7% reduction in the surface stratum).

Such findings could lead us to make some restrictions in chosing the soil pesticides to fit with our requirements. The main tool in this respect must be the behaviour of soil pesticides under different environmental conditions, including soil type, in relation to behaviouristic abundance of the target organisms.

It is impossible to make generalizations about the efficacy of the different tested pesticides with regard to the mite sub-orders under investigation. However, sub-orders specificity relationships could easily be detected. For example, although Astigmata was the most susceptible sub-order to all tested compounds, its rank of susceptibility could be arranged in descending order as follow: RO-08-9801, Diflubenzuron, Chlorpyrifos (20 kg), RO-10-3108 and Chlorpyrifos (5 kg) respectively. Other sub-order, such as the Heterostigmata, exhibited a different rank of response, revealing Chlorpyrifos (20 kg), Diflubenzuron, RO-08-9801, RO-10-3108, and Chlorpyrifos (5 kg) to be the most effective. However, it is of interest to note here that the 3 IGRs RO-08-3108, RO-10-3108 and Diflubenzuron at 5 kg/acre induced significant reduction, comparable with that obtained by the organophosphorous compound Chlorpyrifos at 20 kg/acre especially against the sub-orders Astigmata, Mesostigmata and Prostigmata. Furthermore, in particular the Heterostigmata were highly susceptible to the juvenoids RO-08-3108 and RO-10-3108 and to the disruptor of the chitin biosynthesis, Diflubenzuron if short-term (0-7 days posttreatment) efficiacy was considered (table 4). Our results indicate clearly the important role which IGRs could play in depressing the population of soil mites. However, much higher dosages must be tested in order to obtain a high degree of control. Also special care must be taken to consider the specific response of the predaceous species of soil mites (belonging to different groups) to such class of chemicals.

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Specific inhibition of a calcium dependent activation of brain cyclic AMP phosphodiesterase activity by vinblastine

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Summary. Vinblastine selectively inhibits the activation of brain cyclic AMP phosphodiesterase activity by Ca^{++}-protein activator (50% inhibition by 2×10^{-5} M). This inhibitory effect was reversed by excessive amounts of the activator, whereas large quantities of Ca^{++} caused only a slight suppression of the vinblastine effect. This result of vinblastine suggests a new site of its action and also suggests the possible role of protein activator, phosphodiesterase proteins or cyclic nucleotides in the previously known effects of vinblastine in vivo and in vitro.

Vinblastine (VB) inhibits the assembly of microtubules and is also known to interact with systems affected by Ca^{++}[2,3]. High concentrations of Ca^{++} or VB precipitate tubulin, a subunit of microtubules, as well as other acidic proteins[2,4]. In the presence of Ca^{++}, dose-effect curve for precipitation of protein by VB shifted toward lower values[2]. VB was reported to inhibit Ca^{++}-induced release of catecholamine from adrenal gland[3]. Therefore, it is possible that Ca^{++} and VB may act at the same binding site on certain proteins[2,3].

Recently, we observed that brain supernatant protein(s) precipitated by a high concentration of VB has cyclic AMP phosphodiesterase (PDE) activity and this specific activity is about 3 times as high as that found in the original supernatant[5]. The predominant PDE in the brain supernatant is the activity which can be stimulated by an endogenous calcium dependent protein activator (PA), a heat stable acidic protein[6,7]. Following binding of Ca^{++} to PA, this complex binds to PDE with subsequent activation[8,9]. We have investigated in this paper the effect of VB on the Ca^{++}-PA regulated PDE activity of brain supernatant with special reference to the possible site of its action.

Materials and methods. VB was a generous gift from Eli Lilly Co., Indianapolis, Indiana (Dr R.J. Hosley). The crude brain supernatant PDE activity was prepared from rat brain. The rat brain was homogenized with 2 vol. of 10 mM imidazole buffer, pH 6.9, containing 1.5 mM $MgCl_2$, and following centrifugation at $70{,}000\times g$ for 30 min, the supernatant was used as a source of enzyme activity. PA-free PDE was prepared from bovine brain by a slight modification of the method of Cheung and Lin[10]. Purification of PA was done as reported by Teo et al.[11].