Laboratory and Field Evaluation of New-Fort® as a Chemical Fertilizer against Some Land Snails

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Abstract: Molluscicidal efficacy of New-Fort® as a chemical fertilizer compared to methomyl as a recommended molluscicide was evaluated against some land snails under laboratory and field conditions. The obtained results in the laboratory exhibited that methomyl treatment was more toxic than that appeared with the fertilizer after 72 and 96 hrs of exposure whereLC_{50} as% values were 0.27 and 0.16,0.46 and 0.29 with methomyl and New-Fort against *Eobania vermiculata*, respectively. Also, methomyl treatment was more toxic than New-Fort against *Theba pisana*. On contrast, New-Fort was more toxic than methomyl against *Monacha obstructa* by 4.4, 3.2 and 3.3 fold after 48, 72 and 96 hrs. of assay. The field trial appeared that, the spray of New-fort® (2.5%) of guava trees gave the highest %reduction values of infestation where these values were 66.0, 86.9 after 7 and 21 days, while it were 46.3 and 72.8 with methomyl after the same exposure periods against *Eobania vermiculata*. Moreover, the percent reductions were 71.5 and 93.5 with fertilizer but they were 57.5 and 72.6 with methomyl after 7 and 21 days against *Theba pisana* respectively. The same trend was noticed with *Monacha obstructa*. This study is a promising approach to use of certain chemical fertilizer; NPK, in controlling molluscs to protect our environment from the conventional pesticides.

Keywords: Land snails, New-Fort®, methomyl

1. Introduction

Terrestrial snails have been known as destructive agricultural pests, causing damage to numerous orchard fruit trees, field and vegetable crops as well as ornamental plants **(Godan, 1983; Baker, 1989; El-Deeb *et al.*, 1996; Eshra, 2004 and Eshra *et al.*, 2015)**. The damage includes leaves, flowers, fruits and stems of the plants **(Eshra, 1997)**. They are distributed in different locations especially in the northern Governorates of Egypt.

The terrestrial snails; *Eobania vermiculata*, *Thepa pisana* and *Monacha obstructa* were recorded to be a harmful snails in many Egyptian Governorates attacking various plants **(El-Wakil *et al.*, 2000; Eshra, 2013)**. There are three common methods for controlling these pests: mechanical, biological and chemical. Although, chemical control is still the most effective methods, particularly over wide areas **(EL-Wakil and Attia1999; Moran *et al.*, 2004; El-Shahaat *et al.*, 2005)**, it causes many environmental problems. Therefore, searching for effective and safety agents for terrestrial snails control is very important. Using urea fertilizer for terrestrial snails control had been previously studied **(El-Shahaat *et al.*, 2009; Eshra, 2014)**. Therefore, this study is carried out to investigate the molluscicidal effects of New-Fort® as a chemical fertilizer under laboratory and field conditions compared to methomyl.

2. Materials and Methods

2.1. Land Snails

Adults of the brown garden snail, *E. vermiculata*, the white garden snail, *T. pisana* and the clover snail *M. obstructa* having approximately the same age and size were collected from some agricultural location at EL-Beheira Governorate during March, 2015 for laboratory evaluation. They were then transferred to plastic cups covered with cloth netting and maintained under laboratory conditions of 27 °C and 65% R.H. They were allowed to be acclimatized to these conditions for two weeks. Under these conditions, the snails were fed daily on lettuce leaves until the start of tests. Dead snails were removed immediately.

2.2. Chemicals and laboratory assays:

Methomyl (Neomyl®20% SL) as a potent molluscicides and New-Fort® as a chemical fertilizer; N.P.K (19, 19, 19) were used in the present study. This commercial product of the fertilizer contains total N(19.0%), P_2O_5(19.0%), K_2O(19.0%), in addition to, trace elements(in chelated form) produced by Kafr EL-Zyat Pesticides Chemicals Co, Egypt. Discs of lettuce leaves were dipped in series concentrations of methomyl or New-Fort® fertilizer for 1 minute and left for dryness. The treated lettuce discs were transferred into plastic cups and 10 adult snails were placed into each cup with three replicates for each concentration. Untreated lettuce discs were used as control treatment. Mortality percentages were recorded after 48, 72and 96hrs post-treatments. Snails' mortality values were corrected according to the Abbott equation **(Abbott, 1925)** and subjected to probit analysis **(Finney, 1971)**.

2.3. Field evaluation:

For each treatment a quarter feddan cultivated with infested guava trees by *E. vermiculata*, *T. pisana* and *M. obstructa* was exposed to spray application. Five guava trees were randomly chosen for each treatment and replicated five times. The fertilizer was applied as spray at the rate of 1.5%, 2.0% and 2.5% while methomyl treatment was sprayed as 2.0% only. In addition, untreated trees were left as a control. The treatments were distributed according to a complete randomized block design. Numbers of snails on the \\trees and around them were estimated before just treatment and after 1, 3, 7, 14 and 21 days of spraying application according to **Henderson and Tilitton (1955)**.The obtained results were statistically analyzed according to the method of **Snedecor and Cochran (1967)** and the differences between treatments were compared by LSD at the level of probability (0.05).

3. Results and Discussion

3.1. Toxicity of the commercial fertilizer product of New-Fort® against *E. vermiculata*, *T. pisana* and *M. obstructa* under laboratory conditions:

Results in Table (1) shows the toxicity of New-Fort® compared to methomyl against adult of *E. vermiculata* under laboratory conditions. After 48 hrs of exposure, methomyl and New-Fort® were comparable in their toxicity against *E. vermiculata* where the LC_{50} values were 0.75% and 0.87%, respectively. After 72 and 96 hrs of exposure, methomyl (LC_{50} values were 0.27% and 0.16%) was 1.7 and 1.8 more toxic than New-Fort® (LC_{50} values were 0.46% and 0.29%).Generally, toxicity of both methomyl and New-Fort® is increased with increasing the exposure time.

The same trend was also, observed with *T. pisana*. There is no significant difference between the toxicity of methomyl and New-Fort® after 48 hrs of exposure where LC_{50} values were 0.64% and 0.75%, respectively (confidence limits were overlapped). Methomyl (LC_{50}values were 0.20% and 0.15%) was 2.3 and 2.9 fold more toxic than New-Fort® (LC_{50} values were 0.46% and 0.43%) after 72 and 96 hrs, respectively (Table 2).

On the other hand, New-Fort® was more toxic than methomyl on *M. obstructa* by 4.4, 3.2 and 3.3 fold after 48, 72 and 96 hrs, respectively. WhereLC_{50} values of New-Fort® values of methomyl were 0.40% , 0.16% and 0.10%, after 48, 72 and 96 hrs, respectively (Table 3).

Table (1): Toxicity of New-Fort® and methomyl against *E. vermiculata* under laboratory conditions:

Treatments	Time after exposure (hr)	LC_{50} (%)	Confidence limits (%)		Slope ± SE
			Lower limit	Upper limit	
New-Fort®	48	0.87	0.69	1.07	1.53 ± 0.203
	72	0.46	0.37	0.59	1.62 ± 0.183
	96	0.29	0.23	0.36	1.72 ± 0.142
Methomyl	24	1.18	0.84	2.15	1.26 ± 0.168
	48	0.75	0.54	1.23	0.98 ± 0.214
	72	0.27	0.22	0.33	1.25 ± 0.143
	96	0.16	0.13	0.20	1.50 ± 0.150

Table (2): Toxicity of New-Fort® and methomyl against *T. pisana* under laboratory conditions:

Treatments	Time after exposure (hr)	LC_{50} (%)	Confidence limits (%)		Slope ± SE
			Lower limit	Upper limit	
New-Fort®	48	0.75	0.63	0.93	1.64 ± 0.198
	72	0.46	0.40	0.53	1.95 ± 0.192
	96	0.43	0.37	0.51	1.88 ± 0.215
Methomyl	24	1.00	0.70	1.75	1.05 ± 0.15
	48	0.64	0.46	1.08	0.88 ± 0.14
	72	0.20	0.17	0.25	1.49 ± 0.148
	96	0.15	0.12	0.19	1.42 ± 0.197

Table (3): Toxicity of New-Fort® and methomyl against *M. obstructa* under laboratory conditions:

Treatments	Time after exposure (hr)	LC_{50} (%)	Confidence limit (%)		Slope ± SE
			Lower limit	Upper limit	
New-Fort®	48	0.09	0.07	0.11	1.49 ± 0.194
	72	0.05	0.04	0.05	1.94 ± 0.190
	96	0.03	0.03	0.04	2.13 ± 0.187
Methomyl	24	2.68	1.43	9.15	0.90 ± 0.162
	48	0.40	0.32	0.53	1.18 ± 0.143
	72	0.16	0.12	0.20	1.21 ± 0.143
	96	0.10	0.07	0.13	1.18 ± 0.195

3.2. Field evaluation of a product of chemical fertilizer New-Fort® in comparing with methomyl against *E. vermiculata*, *T. pisana* and *M. obstructa*:

Field evaluation of New-Fort® and methomyl was carried out in guava orchard at EL-Beheira Governorate according to spray technique against some serious terrestrial snails. Results were presented in Tables (4, 5 and 6). New-Fort® at the rate of 2.5% achieved the highest reduction percentages in *E. vermiculata* numbers, where reduction percentages were 26.9, 50.9, 66.0, 77.9 and 86.9% after 1, 3, 7, 14 and 21days of treatment, respectively. New-Fort and methomyl achieved statistically comparable snail reductions percentages. While New-Fort® at 2% reduced *E. vermiculata* numbers by 21.6, 40.8, 50.5, 65.6 and 78.2% after 1, 3, 7, 14 and 21days of treatment, consecutively, Methomyl at 2% reduced *E. vermiculata* numbers by 16.5, 33.9, 46.3, 57.7 and 72.8% after 1, 3, 7, 14 and 21days of treatment, respectively. On the other hand, there is no significant difference between New-Fort® at 1.5% and methomyl at 2%, where New-Fort® at 1.5% reduced *E. vermiculata* numbers by 15.9, 31.0, 38.9, 52.8 and 66.2% after 1, 3, 7, 14 and 21days of treatment, consecutively (Table 4).

Results presented in Table (5) revealed that, New-Fort® at the rate of 2.5% significantly achieved the highest efficiency against *T. pisana*, followed by New-Fort® and at 2% methomyl and then by New-Fort® at 1.5%.New-Fort®at 2.5% caused 32.3, 54.0, 71.5, 86.6 and 93.5% reduction in *T. pisana* numbers after 1, 3, 7, 14 and 21-days of treatment, respectively. Concerning *M. obstructa*, New-Fort® at the rate of 2.0 and 2.5% significantly achieved the highest efficiency followed by methomyl at 2% and New-Fort® at 1.5%. The reduction percentages of *M. obstructa* numbers were 50.1, 65.5, 81.7, 92.2 and 95.7% after 1, 3, 7, 14 and 21days of treatment, respectively, in plots treated with New-Fort® at 2.5%. (Table6).

The pooled results appeared that the New-Fort® as a chemical fertilizer, NPK, have a promising effect to be applied against certain terrestrial snails which are considered as serious pest to agricultural vegetation. Moreover, the use of the fertilizer against terrestrial snails is safer for the environment and human health when compared with the conventional pesticides besides its lower coast of application. The obtained results supported the findings mentioned before by other researchers where the current data agree with **Gouch *et al.* (1968), EL-Okda *el al*. (1989), EL-Shahaat *et al*. (1995), (2005) and (2007)**. They found that oxime carbamate methomyl appeared to be an efficient chemical against land snails. Also, **EL-Shahaat *et al.* (2009)** found that urea as a chemical fertilizer was highly successful agent when sprayed directly on terrestrial snails at the resting or aestivation period, this fertilizer, also could be sprayed on weeds around trees for controlling snail. However, urea solution at the concentration ranged from 10-12% had a high adverse effect or phytotoxicity action when reached to the foliage organs of plants; leaves, fruits and buds. **Eshra (2014)** showed that the land snails controlled by urea fertilizer at the concentration of 8%, and gave mortality percentages ranged from 67 to 100 %. In the present study, no phytotoxicity was observed in guava trees due to the application of the fertilizer product at the tested rates. Other experiment conducted by **EL-Shahaat *et.al.* (2009)** found that the nitrogenous fertilizer “Urea” had phytotoxicity influence on tree foliage when sprayed for mollusca control.

It is well known that the important way for controlling terrestrial mollusks (snails and slugs) is chemical control using certain traditional pesticides. However, these pesticides have undesirable or detrimental effects on the environment and non-target organisms **(Moran *et al.* 2004)**. Finally, it is necessary to show that more research and attention are needed to evaluate certain chemical fertilizers and understand their effects on molluscs.

Table (4): Reduction percentages of *E. vermiculata* on the Guava orchard after different times of treatment with New-Fort® and methomyl application at EL- Beheira Governorate:

Treatments	Con (%)	%Reduction ± SD				
		1-day	3-days	7-days	14-days	21-days
New-Fort®	1.5	15.9[c] ± 3.0	31.0[c] ± 4.3	38.9[c] ± 4.3	52.8[c] ± 7.7	66.2[c] ± 9.1
	2.0	21.6[b] ± 4.7	40.8[b] ± 5.9	50.5[b] ± 5.9	65.6[b] ± 8.9	78.2[b] ± 5.9
	2.5	26.9[a] ± 2.4	50.9[a] ± 2.7	66.0[a] ± 4.5	77.9[a] ± 6.2	86.9[a] ± 5.4
Methomyl	2.0	16.5[bc] ± 4.6	33.9[bc] ± 7.9	46.3[bc] ± 8.1	57.7[bc] ± 7.5	72.8[bc] ± 2.6

Numbers within the same column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Table (5): Reduction percentages of *T. pisana* on the Guava orchard after different times of treatment with New-Fort® and methomyl application at EL- Beheira Governorate:

Treatments	Con. (%)	%Reduction ± SD				
		1-day	3-days	7-days	14-days	21-days
New-Fort®	1.5	17.7[b] ± 7.7	29.2[c] ± 9.4	43.2[c] ± 7.8	60.7[c] ± 8.1	71.9[b] ± 6.4
	2.0	26.3[ab] ± 6.6	41.2[b] ± 8.8	60.0[b] ± 10.1	75.8[b] ± 7.8	86.6[a] ± 6.4
	2.5	32.3[a] ± 8.4	54.0[a] ± 4.4	71.5[a] ± 4.7	86.6[a] ± 5.9	93.5[a] ± 4.3
Methomyl	2.0	17.7[b] ± 3.9	44.1[ab] ± 9.8	57.5[b] ± 6.5	66.4[c] ± 5.6	72.6[b] ± 5.3

Numbers within the same column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Table (6): Reduction percentages of *M. obstructa* on the Guava orchard after different times of treatment with New-Fort® and methomyl application at EL- Beheira Governorate:

Treatments	Con. (%)	%Reduction ± SD				
		1- day	3-days	7-days	14-days	21-days
New-Fort®	1.5	$33.8^{c} \pm 3.0$	$48.8^{c} \pm 4.9$	$68.0^{bc} \pm 7.8$	$77.6^{c} \pm 7.3$	$87.3^{bc} \pm 6.0$
	2.0	$42.7^{b} \pm 4.1$	$58.7^{ab} \pm 9.0$	$75.6^{ab} \pm 8.1$	$85.0^{b} \pm 5.8$	$90.9^{ab} \pm 3.2$
	2.5	$50.1^{a} \pm 6.3$	$65.5^{a} \pm 6.6$	$81.7^{a} \pm 3.4$	$92.2^{a} \pm 3.9$	$95.7^{a} \pm 2.1$
Methomyl	2.0	$36.1^{c} \pm 2.6$	$51.6^{bc} \pm 5.5$	$66.1^{c} \pm 2.4$	$75.8^{c} \pm 3.4$	$82.3^{c} \pm 4.0$

Numbers within the same column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

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الملخص العربى

التقييم المعملى والحقلى للسماد الكيماوى (نيوفورت) ضد بعض القواقع الأرضية

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أجريت هذه الدراسة معمليا وحقليا لتقييم فعالية السماد الكيماوى المعروف باسم نيوفورت المحتوى على نيتروجين وفوسفور وبوتاسيوم ضد بعض القواقع الأرضية ومقارنة ذلك بمبيد ميثوميل الموصى به فى مصر كمبيد ضد رخويات التربة. وأظهرت النتائج المعملية، أن تعرض القواقع للمعاملات بعد ٧٢، ٩٦ ساعة يوضح السميه الأعلى للميثوميل حيث كانت قيم LC_{50} ٠,٢٧%،٠,١٦% ضد قوقع *E. vermiculata* وكانت ٠,٤٦%،٠,٢٩% لسماد نيوفورت على الترتيب. من ناحية أخرى، فأن قيم LC_{50} كانت ٠,٢%،٠,١٥% للمبيد،٠,٤٦%،٠,٤٣% للسماد ضد قوقع *T. pisana* على الترتيب. وقد أوضحت النتائج أن فعالية السماد كانت أكثر من فعالية المبيد ضد قوقع *M. obstructa* حيث كانت قيم LC_{50} للسماد كنسبة مئوية تساوى ٠,٠٩،٠,.٥، ٠,.٣ بعد ٤٨، ٧٢، ٩٦ ساعة،من المعاملة بينما كانت ١٦,٤، ٠,٠١٠، ٠,٠ لمبيد ميثوميل على الترتيب. أظهرت النتائج الحقلية أن الرش بالسماد بتركيز ٢,٥% فوق أشجار الجوافة يظهر أعلى كفاءة ضد كل أنواع القواقع الموجودة حيث كانت نسب خفض الأصابة ٦٦ للسماد، ٤٦,٣للمبيد (بتركيز٢%) بعد ٧ أيام من الرش، بينما كانت القيم ٨٦,٩، ٧٢,٨ بعد٢١ يوما من الرش للسماد والمبيد على الترتيب ضد قوقع *E. vermiculata*. وبعد ٧، ٢١يوما من المعاملة فأن نسب خفض الأصابة بقوقع *T. Pisana* كانت أعلى مع السماد (٧١ ،٥ ,٩٣) ثم المبيد (٥٧,٥، ٧٢,٦) على الترتيب. ونفس الأتجاه بالنسبة لقوقع *M. obstructa* حيث كانت نسب الخفض ٨١,٧ ، ٩٥,٧ للسماد ،٦٦,١ ، ٨٢,٣ للمبيد.

توضح الدراسة أنه يمكن استخدام الأسمدة الكيماويه من نوع (NPK) لمكافحة رخويات التربة حفاظا على البيئة من أستخدام المبيدات التقليدية.