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Laboratory and field evaluation of certain chemicals comparing with methomyl against land snail *Monacha* sp. (Stylommatophora: Hygromiidae) infesting Egyptian clover plant

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Abstract:

The land snails feed on leaves, roots, tubers and seeds of of ornamental plants, , citrus, peach, plam , cabbage, carrot and bean as well as thses crops lose their marketability and hence their export potential in many countries. Efficacy of some chemicals as Potassium hydroxide, Ferrous sulphate and Sulphonic acid compared with Methomyl as standard pesticide was evaluated against *Monacha* sp. (Stylommatophora: Hygromiidae) under laboratory and field conditions infesting Egyptian clover plant. The obtained results in the laboratory exhibit the following ; the all tested chemicals exerted substantial mortality against *Monacha* sp. after one day of evaluation where the general mean of mortality percentage values was 63.3, 63.3, 25.8 and 21.6 for Methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid , respectively. Methomyl treatment was more toxic than that appeared with other tested treatments after 3 days of treatments where values were 87.5, 72.5, 36.6 and 31.6 for Methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid , respectively (values increased as concentration and time increased). According to mortality percentages, the descending order of the tested chemicals was Methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid where the general mean was 87.5, 74.1, 45.8 and 41.6 , respectively after 21 days. The field experiment appeared that, the spray of Methomyl (1%) gave the highest reduction percentages 93 and 83% after 7 and 15 days of treatments, respectively; while it was 73 and 49% with Potassium hydroxide and was 49 and 50 % with Ferrous sulphate and the least values were 43 and 42 % with Sulphonic acid .

Introduction

In Egypt, land snails have been increased and distributed rapidly in different locations especially in the northern Governorates (Eshra *et al.*, 2016). They caused considerable damage especially in most areas where they found the optimum conditions for survival and dispersion (Kassab and

Daoud, 1964; Glen and Wilson, 1997 and Glen *et al.*, 2000). These animals attack almost all crops reducing their yields, marketing values and cause severe damages to all plant parts (El-Okda, 1980) as a result of mucous secretion and the particular structure of their mouth parts enabling scratching and crushing. In addition, some of these animals work as intermediate hosts for parasite trematodes, cestodes and nematodes which cause worm diseases in man and domestic animals. Therefore, they attack the attention of the biologists because of the great economic damage they do in agriculture and horticulture (Godan, 1983). The land snails *Monacha* sp. (Stylommatophora: Hygromiidae) were recorded to be harmful snails in many Egyptian Governorates attacking various parts (El-Wakil *et al*., 2000 and Eshra, 2013). There are three common methods for controlling these pests (mechanical, biological and chemical). Nowadays the control with chemical pesticides is still one of the most effective methods (Radwan *et al.,* 1992; Eshra, 2004; Moran *et al*., 2004; El-Shahaat *et al*., 2005, 2009 and Ghamry, 1997) for elimination of different pests (Hilmy and Hegab, 2010). Many investigators have drawn the attention to control the land snails using chemical compounds (Ebenso, 2004; Hegab *et al.*, 2013 and Abdel-Rahman, 2017). Although that, it causes many environmental problems. Therefore, searching for effective and safety agents for terrestrial snails control is very important. Using safety agents as urea fertilizer and New-Fort® for terrestrial snails control had been previously studied (El-Shahaat *et al.*, 2009 and Eshra, 2014). Therefore, this study is carried out to investigate the molluscicidal effects of Potassium hydroxide, Ferrous sulphate and Sulphonic acid as safety chemicals against *Monacha* sp. under laboratory and field conditions comparing to Methomyl as standard pesticide.

Materials and methods

1. Experimental animals:

Adults of the land snail *Monacha* sp. having approximately the same age and size were collected from infested Egyptian clover (*Trifolium alexandrium*) field at Zawar Abo-Elliel village, Awlad-Sakr district, Sharkia Governorate for laboratory study. These snails were collected during November, 2018. They were then transferred to plastic cups covered with cloth netting and maintained under laboratory conditions of 20°C and 75% R.H. The snails were daily fed on clover plants for acclimatization two weeks. Dead snails were removed immediately (Eshra, 2014).

2.The tested chemicals:

2.1. Methomyl (Lannate ® 90% SP):

Chemical group: Carbamates

Trade name: Neomyl 90% WP

Common name: Methomyl

2.2. Ferrous sulphate:

Scientific name: Ferrous sulphate

Chemical formula: FeSO

The formulation: As crystalline powder

Source: Ferrous sulphate was obtained from El- Gamhouria

Company for chemicals, Zagazig branch, Egypt.

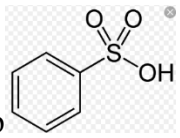
2.3. Potassium hydroxide :

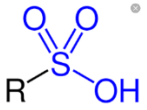
Chemical name: Potassium hydroxide

Molecular formula: KOH

Formulation: (WP) or (WC)

2.4.Sulphonic acid



General formula:  , where R is an organic alkyl or aryl group and the S (=O)2-OH group is a sulphonyl hydroxide .

3.Laboratory evaluation:

Toxicity of the tested chemicals against *Monacha* sp. was evaluated as a spray with concentrations (1, 2, 3, and 4) % of Potassium hydroxide , Ferrous sulphate and Sulphonic acid and (0.125, 0.25, 0.5 and 1) % of Methomyl that were prepared as solutions. Acclimatized adult snails were transferred into plastic cups where 10 healthy adult snails were placed into each cup. Each concentration had three replicates and untreated cups were used as a check treatment. Replicates were sprayed with the tested chemicals a single time. The cups were covered with muslin clothes and secured with rubber band to prevent snails from escaping (El-Okda, 1981). Mortality number was recorded after 1, 3, 7 and 21 days post-treatments according to Ghamry (1997). The means of died snails were calculated at the end of the experiment.

4. Field evaluation:

Field experiments were performed at Zawar Abo-Elliel village, Awlad-Sakr district, Sharkia Governorate. For each treatment, a quarter 3x3.5m at an area of about one feddan cultivated with Egyptian clover (*Trifolium alexandrium*) heavy infested with land snail *Monacha* sp . The field was irrigated only day before any treatment. The tested materials were applied as solution spray with one concentration (4%) and methomyl with (1%) by incorporating the tested material with tap water. Number of snails inside each quarter was estimated before just treatment and after 1, 3,7,15 and 21 days of spraying application. Reduction percentages were statistically calculated according to the formula of Henderson and Tillton (1955) as follows: % Reduction = 100 [1- t2r1/ t1r2] where r1 and r2 are the number of the alive snails before and after treatment respectively in untreated plots (control), t1 and t2 are the number of the alive snails before and after treatment respectively, in treated plots. Statistical analyses were designed using Costat statistical software, 2005 Version 6.311.

Results and discussion

1. Laboratory evaluation:

Mortality percentages of snail *Monacha* sp. sprayed with different concentrations of Methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid under laboratory conditions presented in Table (1). It can be seen that the all tested chemicals exerted substantial mortar effect against *Monacha* sp. after 1 day of evaluation where the general mean of mortality percentage values were (63.3, 63.3, 25.8 and 21.6) for methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid , respectively. Methomyl was the most effective one where, there were no survivals (100% mortality) at highest concentration (1%) after one day post-treatment. The corresponding values were 87, 30 and 30% at highest concentration (4%) of Potassium hydroxide , Ferrous sulphate and Sulphonic acid , respectively. The mortality percentages increased as time increased where the general mean was 63.3, 87.5, 87.5, 87.5 and 87.5 for Methomyl; 63.3, 72.5, 72.5, 73.3 and 74.1 for Potassium hydroxide ; 25.8, 36.6, 42.5, 45 and 45.8 for Ferrous sulphate and 21.6, 31.6, 39.1, 39.1 and 41.6 for Sulphonic acid after 1,3,7,15 and 21 days respectively. The mortality percentages increased as increasing concentration (20, 53. 3, 80 and 100) % mortality at concentration 0.125, 0.25, 0.5 and 1% of methomyl respectively. The descending order of the tested chemicals was Methomyl, Potassium hydroxide , Ferrous sulphate and Sulphonic acid according to mortality percentages where the general mean of % mortality was 87.5, 74.1, 45.8 and 41.6, respectively after 21 days. Table (2) revealed that there were significant differences between the treated and untreated *Monacha* sp. The differences

between the tested chemicals were significant.

2. Field evaluation:

Table (3) showed that the same trend was observed when the tested chemicals were applied under field conditions. The reduction percentages of *Monacha* sp. infesting Egyptian clover plant treated with Methomyl, Potassium hydroxide, Ferrous sulphate and Sulphonic acid increased gradually with time till 7 days then decreased. Methomyl exhibited higher molluscicidal efficiency than Potassium hydroxide, Ferrous sulphate and Sulphonic acid. After 7-days post-treatments, reduction percentages were, 93, 73, 49 and 43 consecutively. F.test showed significant differences between values of the reduction percentages at the four tested chemicals (Table,4).

The obtained results supported the findings mentioned before by other researches where the current data agree with Gouth *et al.* (1968); El-Okda *et al.* (1989); El-Shahaat *et al.* (1995, 2005 and 2007) and Abdel-Rahman and Al Akra (2012). They found that Oxime Carbamates Methomyl appeared to be an efficient chemical against land snails. Bailey (2002) said that the carbamates are feeding inhibitors leading to death. Godan (1983) said that the increasing of the mucous secretion is one of the first reaction of gastropods to many stressors including mechanical irritation caused by molluscicidal chemicals leading to death. Abdel-Rahman (2017) found that Ferrous sulphate appeared to be the most toxic in comparison with natural extracts against *Monacha cartusiana* under both field and laboratory conditions. .

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. It is well known that the important way for controlling terrestrial mollusks (snails and slugs) is chemical control using certain traditional pesticides that 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 need to evaluate certain chemical fertilizers and understand their effects on molluscs.

Table (1): Mean values of mortality percentages of snail (*Monacha* sp.) treated with different concentrations of Methomyl, Potassium hydroxide, Ferrous sulphate and Sulphonic acid after indicated days under laboratory conditions.

Mean values of % Mortality of snail (*Monacha* sp.) after indicated days						
Compound	**Treatment conc. %**	**1 day**	**3 days**	**7 days**	**15 days**	**21 days**
Methomyl	0.125	20	50	50	50	50
	0.25	53.3	100	100	100	100
	0.5	80	100	100	100	100
	1	100	100	100	100	100
	General mean	63.3	87.5	87.5	87.5	87.5
Potassium hydroxide	1	37	43	43	43	47
	2	67	70	70	70	70
	3	63	90	90	90	90
	4	87	87	87	87	87
	General mean	63.3	72.5	72.5	73.3	74.1
Ferrous sulphate	1	10	13.3	13.3	13.3	13.3
	2	20	33	50	50	50
	3	43	43	43	43	43
	4	30	57	57	63	67
	General mean	25.8	36.6	42.5	45	45.8
Sulphonic acid	1	17	20	33	33	33
	2	10	30	30	30	30
	3	30	30	37	37	47
	4	30	47	57	57	57
	General mean	21.6	31.6	39.1	39.1	41.6
Control	General mean	0	0	0	0	0

Table (2): Statistical analysis of the general means of mortality percentages of snail (*Monacha* sp.) treated with different concentrations of Methomyl, Potassium hydroxide, Ferrous sulphate and Sulphonic acid after for 21 days under laboratory conditions.

Compound	The general means of % mortality of snails after indicated days				
	1 d.	3 d.	7 d.	15 d.	21 d.
Methomyl	63.3a	87.5a	87.5a	87.5a	87.5a
Potassium hydroxide	63.3a	72.5b	72.5b	73.3b	74.1b
Ferrous sulphate	25.8b	36.6c	42.5c	45c	45.8c
Sulphonic acid	21.6b	31.6c	39.1cd	39.1c	41.6c
Control	20b	20c	20d	16.6d	10d
F.test	***	***	***	***	***
L.S.D 0.05	2.939	2.358	2.587	2.392	2.167

Table (3) Population reduction percentages of *Monacha* sp. infesting Egyptian clover plant exposed to the tested compounds with one concentration as sprays for 21 days under field conditions.

Compound	After after indicated days population reduction%					
	Replicate	**1 day**	**3 days**	**7 days**	**15 days**	**21 days**
Methomyl (1%)	1	89	82	92	93	61
	2	77	73	94	83	54
	3	65	83	94	72	71
	Mean	77	79.33	93.33	82.66	62
Potassium hydroxide (4%)	1	54	42	98	71	60
	2	41	69	67	56	36
	3	57	71	55	20	22
	Mean	50.66	60.66	73.33	49	39.33
Ferrous sulphate (4%)	1	62	51	72	65	36
	2	26	56	64	68	36
	3	20	29	12	18	16
	Mean	36	45.33	49.33	50.33	29.33
Sulphonic acid (4%)	1	30	23	53	21	19
	2	31	41	56	69	15
	3	29	30	19	36	23
	Mean	30	31.33	42.66	42	19

Table (4): Statistical analysis of the general means of population reduction percentages of *Monacha* sp. infesting Egyptian clover plant exposed to the tested compounds with one concentration as sprays for 21 days under field conditions.

Compound	General means of % population reduction percentages of snails after indicated days				
	1 day	**3 days**	**7 days**	**15 days**	**21 days**
Methomyl	77 a	79.33 a	93.33 a	82.66	62 a
Potassium hydroxide	50.66 b	60.66 ab	73.33 ab	49	39.33 ab
Ferrous sulphate	36 b	45.33 bc	49.33 b	50.33	29.33 b
Sulphonic acid	30 b	31.33 c	42.66 b	42	19 b
F.test	* 0.0117	** 0.0066	* 0.0801	N.S 0.2237	*
L.S.D 0.05	25.49	22.69	41.86	44.02	22.82

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