

Evaluation of urea fertilizer in comparison with some conventional pesticides against terrestrial snails in fruit orchards

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ABSTRACT

Terrestrial gastropods have become considerably as economic pests in Egypt. The control of these snails is of great importance. The present study was conducted to evaluate urea fertilizer in comparison with some conventional pesticides as alternative method against some land snails attacking certain crops. The results revealed the following remarks: LT₅₀ values with *Eobania vermiculata* snail were 2.68 and 1.61 days with urea concentrations of 10% and 20% respectively, followed by methomyl bait (1% and 2% a.i), and urea aqueous solution (7.5%) where the LT₅₀ values were 4.29, 1.70 and 4.24 days, respectively. The methomyl bait (2%) and urea sprays (10 & 15%) were found to be the most effective treatments against *Theba pisana* snail where they have % mortality values of 90, 90 and 100 followed by thiodicarb bait (2%) which gave 55% mortality, while both baits of Kocide 2000, Copper hydroxide (5% Cu) and Acrobat copper; copper oxychloride + dimethomorph (5% Cu) gave 37% mortality after 5 days of application in apple orchard. Urea solution alone (20%) or (10%) mixed with carbendazim (0.2%), and urea (10%) mixed with carbendazim (0.2%), aluminium potassium alum (2.5%) and sugarcane honey (2%) were evaluated against *E. vermiculata* and *T. pisana* in guava orchard. The % reduction values of molluscan population were 95.9, 87.2 and 97.2, respectively, 3 days of spray. On the other hand, evaluation of urea solution on citrus trunks, indicated that the % reduction values of molluscan population were 98.91, 94.30 and 85.2 after 3 days of spray with urea (20%), urea (10%) and urea 10% mixed with potash alum (2.5%) treatments, respectively. Trunk spray technique of 20% aqueous urea fertilizer in grape orchard against *E. vermiculata* and *T. pisana* snails reduced the infestation to 98.8% and 95.7% after 3 days of treatment, respectively. The high efficiency of urea treatment is extended to three weeks after spray. In all field experiments, urea solution must be avoided to be contact with the foliage system of trees to prevent the phytotoxicity, that occurred as burning of the leaves and flowers.

INTRODUCTION

It is well known that molluscs (gastropods); terrestrial snails and slugs inflict considerable damage attacking several agricultural vegetations in the Egyptian coastal areas. This damage includes leaves, flowers, fruits and stems of the agricultural plantation (El-Okda 1980, Gordan 1983 and Eshra, 2004). There are many several practices used for the control of these pests. The important one of these practices is a chemical control using certain traditional pesticides (El-Okda *et al.*, 1989, El-Shahaat and El-Okda, 1991, Abdallah *et al.*, 1992, Radwan *et al.*, 1992 and El-Shahaat *et al.*, 2005). However, these pesticides may have undesirable influences on the environment (Moran 2004). Therefore, it is will be benefit when the molluscan control achieved using non-hazardous compounds. So, the present study was conducted to evaluate urea fertilizer in comparison with some conventional pesticides as an alternative method against some terrestrial snails attacking certain fruit orchards.

MATERIALS AND METHODS

A. Snail collection: Adult terrestrial snails of *Eobania vermiculata* (Muller) and *Theba pisana* (Muller) snails (Order: Pulmonata, Family: Helicidae) were collected from some agricultural locations at Beheira Governorate during the late period of autumn season, 2006. The snails were kept in open-air glass aquarium cages and feeding on lettuce leaves for one week for acclimatization under laboratory conditions (20-25°C) prior to the experiments. Snails were starved for 48 hrs before the assays.

B. Chemical Used: 1. Lannate 90% SP (methomyl); as an oxime carbamate insecticide, Larvin 80% DF (thiodicarb); as an oxime carbamate insecticide, Lambada plus 5% EC (lambda cyhalothrin) as a synthetic pyrethroid insecticide, Kocide 2000, 53.8% DF (copper hydroxide); as a fungicide, Acrobat copper 46% WP (copper oxychloride + dimethomorph); as a fungicide, Kemazed 50% WP (carbendazim); as a fungicide, Endo 50% EC (ethion); as organophosphate insecticide- acaricide potash alum $[Al.K(SO_4)_2.12H_2O]$ and urea fertilizer (46.5% N). 2. Toxic baits preparation: The evaluated pesticide that were prepared in bait formulations at different concentrations where bran-sawdust mixture (1+1 w/w) was used as food attractant to snails. The baits were prepared using an appropriate volume of acetone-ethanol mixture (1:1 v/v) and blue colored painting substance (1%) dissolved in a suitable amount of water. Moreover, the evaluation of baits

was conducted using glass containers, each closed tightly by perforated cloth cover.

C. Experiments: 1. The 1st experiment was carried out under laboratory conditions to evaluate the efficacy of urea aqueous solutions at the concentrations of 7.5, 10.0 and 20%, aqueous preparation of ethion at the concentrations of 0.5% and 1.0%, and lambda cyhalothrin at 0.25% while Lannate methomyl baits were prepared at the concentration of 1.0% and 2.0% as a.i, against *E. vermiculata* snail using a feeding technique on lettuce leaves sprayed with the chosen aqueous treatment. LT₅₀ values in days were estimated after 5 days of evaluation. 2. The 2nd experiment was done to evaluate the poison baits of some pesticides and urea treatments against *T. pisana* snail in apple orchard. The 2% a.i baits of Lannate or Larvin were prepared as previously described, while the baits of Kocide 2000 and Acrobat copper contained 5% Cu metal were also prepared to the evaluation. On the other hand, urea treatments were applied as aqueous preparations contain 10% and 15% urea mixed with aluminium potassium alum (2.5%), polyethylene glycol 600 di-oleate as a non-ionic emulsifier (0.25%) and sugarcane honey (5%). The urea preparations were sprayed on snails stuck on tree trunks using a knapsack sprayer, while the baits were distributed in heaps, each about 50 g on the moistened soil around the trees. The cumulative mortality percentages were recorded up to 5 days after application. 3. The 3rd experiment was conducted to evaluate the efficacy of some treatments applied as trunk spray at the aestivation period of *E. vermiculata* and *T. pisana* snails; where they were the most abundant snails in guava orchard, Aug.-Sept., 2006. These treatments were urea (20%), urea (10%) mixed with Kemazed carbendazim (0.2%), aluminium potassium alum (2.5%) and sugarcane honey (2%), and urea (10%) mixed with carbendazim (0.2%). Mean counts of snails per tree trunk were counted before just spray and 3 days post spray then the % reduction values were estimated up to 2 weeks. 4. The 4th experiment was conducted as trunk spray technique in citrus orchard in April, 2007. The evaluated treatments were urea solution (20%), (10%) and urea (10%) mixed with AlK alum (2.5%) The infestation reduction % values were recorded after 3 days of treatment. 5. The 5th experiment was established to evaluate the urea aqueous preparation (20%) in grape orchard during spring, 2007.

In the part of field experiment, each treatment had 20 trees as replicates for the spray technique while it had 10 replicates in the spot application of baits where each spot was 25 x 25 cm beside tree. The populations of snails

was conducted using glass containers, each closed tightly by perforated cloth cover.

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In the part of field experiment, each treatment had 20 trees as replicates for the spray technique while it had 10 replicates in the spot application of baits where each spot was 25 x 25 cm beside tree. The populations of snails

were recorded either on trunk or on baits before and post treatments. The % reduction values were estimated using the equation of Hinderson and Tilton (1955). All data were subjected to one-way analysis of variance (ANOVA) followed by Student-Newman-Keuls (SNK) test (Cohort software Inc., 1985) to determine the significant differences among means values at the probability level of 0.05.

RESULTS AND DISCUSSION

Laboratory and field trials were conducted to evaluate certain pesticides and urea fertilizer against terrestrial snails attacking different fruit orchards. Laboratory evaluation was carried to evaluate urea solutions of 7.5, 10.0 and 20% against the garden snail; *E. vermiculata*. The urea treatments were compared with Endo (ethion) as an organophosphorous insecticide, Lambada cyhalothrin as a synthetic pyrethroid insecticide and Lannate (methomyl) bait (2% a.i) that is well known as a high effective molluscicide. The urea treatments were assessed by direct spraying the snail individuals, while the other treatments, except methomyl bait, were evaluated according to feeding technique using lettuce leaves sprayed by each concentration of the treatment. According to the results in Table (1), the LT_{50} values revealed that urea at 10% and 20% gave the highest efficiency with values of 2.68 and 1.61 days with urea, respectively. The 2nd highest efficient treatment was Lannate (methomyl) bait 2% (1.77 days) followed by Lannate (methomyl) bait (1.0%) and urea aqueous solution (7.5%) where the LT_{50} values were 4.29 and 4.24 days, respectively. The remaining treatments had LT_{50} values ranged from 5.22 and 5.27 days. These results showed that the urea treatments were found to be the most effective against the tested snail compared with other treatments. This result suggests that the urea can be used as a candidate molluscicide.

Evaluation of some pesticides baits and urea solutions against *T. pisana* was carried out in apple orchard during the activity period of spring season. The baits were distributed in heaps on soil surface near the trees while the urea solutions were sprayed on snails stucked on trunk of trees. The obtained results as shown in Table (2) indicate that Lannate (methomyl) bait and urea treatments (10 & 15%) appeared to be the most effective treatments where they have % mortality values of 90, 90 and 100 after 5 days of application, respectively. On the other hand, both baits of Kocide (5% Cu) and Acrobate copper (5% Cu) gave 37% mortality, while Larvin (thiodicarb) bait (2% a.i) gave 55% mortality. These findings demonstrate that urea fertilizer gave a

high promising effect on snails when sprayed on tree trunks as well as weeds and grasses found in the orchard. Unfortunately, a phytotoxic effect was appeared on leaves in burning form when urea solution is in contact with the foliage of trees. However, this fertilizer had no dramatic effect on the environment in comparison to the conventional pesticides which are much more expensive.

Table (1): LT₅₀ value of urea fertilizer and certain pesticides against *Eobania vermiculata* snails using feeding technique under laboratory conditions

Treatments	Concentration (%)	LT ₅₀ (Days)	95% Fiducial limits			
			Lower	Upper	Slope	χ ²
Urea*	7.5	4.24	3.88	4.55	4.01 ± 0.19	1.1
	10	2.68	2.46	2.92	3.40±0.01	4.3
	20	1.61	1.48	1.74	5.02±0.14	52.3
Endo	0.5	5.57	4.97	6.26	5.40±0.62	2.1
	1.0	5.56	4.77	6.51	3.27±0.19	4.8
Lambada plus	0.25	5.27	4.71	5.91	4.52±0.36	7.3
	0.5	5.22	4.57	5.99	3.46±0.19	2.7
Lannate	1.0	4.29	4.01	4.58	5.43±0.34	10.7
	2	1.77	1.62	1.93	4.09±0.01	33.4

χ² = Chi square values

* Urea preparation were sprayed on the snail

A Guava orchard located at Sabaheia region, Regional Research Station, Alexandria Governorate was highly attacked by *E. vermiculata* and *T. pisana* land snails during Aug – Sept period. During this time, the snails are at an aestivation period and therefore stucked by mucus substance on stems of trees. This orchard also was suffered from weeds that are considered as host for gastropods. Urea solution at different concentrations either alone or mixed with Kemazed carbendazim, aluminium potassium alum and sugarcan honey were evaluated against these animal pests. The % reduction values of molluscan population were 95.9, 87.2 and 97.2 with urea solution

Table (2): Evaluation of some pesticides and urea fertilizer against *Theba pisana* snails in apple orchard during spring season.

Treatments	**Mean cumulative mortality (%) at indicated days		
	(0-1)	(0-3)	(0-5)
Lannate 2% a.i bait	15	57	90 ^b
Larvin 2% a.i bait	10	33	55 ^c
Kocide 2000 5% Cu bait	0.0	17	37 ^d
Acrobate copper 5% Cu bait	0.0	17	37 ^d
Urea 10%* trunk spray on snail	50	70	90 ^b
Urea 15%* trunk spray on snail	60	90	100 ^a

* urea treatment contains urea fertilizer + Al.K alum (2.5%) + polyethylene glycol as an emulsifier (0.25%) + Sugarcane honey (5%) then diluted with H₂O

** Means having the same letter are not significantly different at $P \leq 0.05$

(20%), urea (10%) + Kemazed carbendazim (0.2%) and urea (10%) mixed with Kemazed carbendazim (0.2%), alum (2.5%) and sugarcane honey (5%), respectively, 3 days after spray. However, the infestation values were reduced to 21.3, 37.5 and 8.98, respectively, after 2 weeks of evaluation (Table 3). These findings exhibited that the urea. Preparations have no long residual effect according to the unsatisfactory control levels after 2 weeks of spray. Therefore, the treatments should be applied again after that period where the snails can locomote from herbaceous plants to reach the guava trees. The 3rd urea mixture appeared to be the most efficient treatment without adverse effects on non – target organisms, mammals, birds and others. In contrast, the traditional pesticides- based baits as molluscicides have deleterious influence on the environment as reported by Martin (1993). Due to the phytotoxic action of urea solutions on foliage, these treatments should be directed to trunks only.

The stucked terrestrial snails on citrus stems on daylong during April were sprayed by aqueous urea fertilizer at concentration of 20%, 10% and 10% mixed with aluminum - potassium alum (2.5%). The % reduction values of snail populations were 98.91, 94.30 and 85.2, respectively after 3 days of spray (Table 4).

Trunk spray technique of 20% aqueous urea was evaluated in grape orchard during spring season at Abees region, Alexandria Governorate, against *E. vermiculata* and *T. pisana* snails stucked on trunks during daylong

period. Table (5) showed that the alive snails had count values per grape shrub as 64.8 and 68.2 during March and April periods, respectively.

Table (3): Trunk sprays of some treatments against *E. vermiculata* and *T. pisana* snails at their aestivation period in guava orchard, Aug- Sept, 2006.

Treatments	Mean count of snails per tree $\pm$ SD before just spray*	% Reduction of snails 3 days post spray	% Infestation reduction 2 weeks after treatment
Urea solution (20%)	147.5 $\pm$ 8.8	95.9 $\pm$ 6.7 ^b	21.36 $\pm$ 4.7
Urea (10%) + kemazed carbendazim (0.2%)	40.8 $\pm$ 6.7	87.2 $\pm$ 5.4 ^c	37.5 $\pm$ 7.8
Urea (10%) + kemazed carbendazim (0.2%) + potash alum (2.5%) + sugarcane honey (2%)	33.4 $\pm$ 5.2	97.2 $\pm$ 2.3 ^a	8.98 $\pm$ 4.7

*: Each value is an average of 20 trees $\pm$ standard deviation.

** Means having the same letter are not significantly different at $P \leq 0.05$

Table (4): Evaluation of urea solutions sprayed on citrus trunk against terrestrial snails at Nubareia province, Beheira Governorate during April, 2007.

Treatments	Snail number / tree* $\pm$ SD		Infestation reduction (%)
	Before just treatment	3 days, post treatment	
Urea solution (20%)	75.40 $\pm$ 3.1	0.82 $\pm$ 0.77	98.91 ^a
Urea solution (10%)	62.17 $\pm$ 5.2	9.20 $\pm$ 4.10	85.20 ^c
Urea (10%) + Al.k. alum (2.5%)	56.49 $\pm$ 7.2	3.22 $\pm$ 5.7	94.30 ^b

*The most abundant snails were *Eobania vermiculata* and *Theba pisana*

** Each value is an average of 10 tree $\pm$ SD.

*** Means having the same letter are not significantly different at $P \leq 0.05$

Table (5): Trunk spray technique of 20% urea fertilizer solution for controlling terrestrial snails* in grape orchard in the spring season at 2007

Time of treatments	Snails count / tree before spray	Snails reduction (%), 3 days post – spray	Snails reduction (%) at indicating week after treatment***	
			1	3
March	64.8 $\pm$ 7.5**	98.8 $\pm$ 4.98	96.30 $\pm$ 5.7	91.36 $\pm$ 7.5
April	68.2 $\pm$ 6.2	95.7 $\pm$ 2.67	91.64 $\pm$ 8.2	81.67 $\pm$ 5.1

** Each value is an average of 20 trunk shrub $\pm$ SD.

***: The dead snails were counted on trunk and around the shrub.

The reduction of these values was 98.8% and 95.7 % after 3 days of trunk spray, respectively. The efficiency of the treatments was still high after one and three weeks of spray. The % reduction values were 96.3 and 91.36 during the period of February-March then reduced to 91.64 and 81.67 during the 2nd period. The prolonged efficacy of urea treatment up to 3 weeks may be due to the absent of weeds and grasses in this orchard because these herbaceous plants are well known considerable as preferable host for terrestrial molluscs. This explanation means that the weeds and grasses should be removed or sprayed by urea treatment to reduce snail population.

In the present study, the obtained results are in agreement with those reported by other investigators. Moran *et al* (2004) found that copper hydroxide gave promising efficiency against land gastropods. Also, copper compounds such as oxides and salts are effective repellents (Godan, 1983) and copper-complex compounds containing mainly copper silicates, which has been registered in Australia for management of land snails, has been demonstrated to have significant repellency (Davis *et al.*, 1996). The efficacy of copperous fungicides and urea compounds against gastropods was also reported by Glen *et al.* (1986), Chandiwana *et al* (1987) and Liao and Wange (1999). They found that copper ammonium and urea formaldehyde were effective for controlling molluscs. In our study, the high effectiveness of oxime carbamate compounds as molluscicides was noticed. These compounds have been used with varying degrees of success for snail control (El-Sebae, *et al* 1982). Copper metal and copper-based pesticides are known to have important role in this manner; copper attacks the epithelial cells of the foot, and is not taken into the haemolymph and poisons other organs or biological systems (Ryder and Bowen, 1977). This explanation is related to that described by Moran *et al.* (2004). Copper ammonium carbonate, garlic, aluminium, copper foil and urea formaldehyde fertilizer (6%) had irritant, antifeedant, physical, chemical repellent or molluscicidal effect or showed a combination of more than one. This conclusion was accordance with that reviewed by Judge (1969), Mohamed (1994), El-Shahaat *et al.* (1995), Beshr (2000), Schuder *et al.* (2003) and Eshra (2004). Moreover, the potential effect of oxime carbamate compounds and copperous fungicides as molluscicides was indicated by Mohamed (2007). She found that urea solution spray if come in contact with the foliage, it causes phytotoxicity. However, further investigations are needed to understand the mode of action of urea on gastropods. On the other hand, this present work, exhibited that

the urea treatments had no dramatic impact on the environment while the conventional chemical pesticides may have detrimental hazards to the domestic animals as well as wild life and they are more expensive than urea fertilizer.

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تقييم فعالية سماد اليوريا مقارنة ببعض المبيدات التقليدية ضد القواقع الارضية في بساتين الفاكهة

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أجريت تجربة معملية وعدة تجارب حقلية بغرض تقييم فعالية سماد اليوريا مقارنة ببعض المبيدات التقليدية ضد رخويات التربة الصدفية والتي تهاجم زراعات الفاكهة بالاسكندرية ومناطق غرب الاسكندرية بمحافظة البحيرة.

تم تطبيق اليوريا في صورة محاليل مائية بتركيزات مختلفة عن طريق التغذية على أوراق الخس - معمليا- أو رش جذوع الاشجار وقت التصاق القواقع عليها. أما المبيدات التقليدية فاشتملت على

مبيد الميثوميل والثيوديكارب (مبيدات تابعة لمجموعة الاوكسيم كاربامات) ومبيد الاثيون (مبيد حشرات واكلاروسات تابعا لمجموعة الفوسفور العضوي) ومبيدي الكوسيد واكلروبات النحاس (كمبيدات فطريات) . وقد طبقت المبيدات في صورة طعوم تحتوي مواد جاذبة غذائية وبطريقة التغذية على أوراق الخس. وقد أوضحت الدراسات النتائج الآتية :-

1. قيم الزمن اللازم لقتل 50% من القواقع معمليا كانت 2.68 ، 1.61 يوما مع محلول اليوريا 10% ، 20% على الترتيب ضد قوقع الحدائق البني ايويانيا فرميكيولاتا ويلي ذلك طعم كل من الميثوميل و اليوريا (7.5%) حيث كانت قيم LT_{50} هي على الترتيب 1.77 ، 4.29 ، 4.24 يوما.
2. اكثر المعاملات كفاءة في مزارع التفاح كان طعم الميثوميل (2%) ، اليوريا (10%) ، اليوريا (15%) وذلك ضد قوقع الحدائق الابيض "تيا بيساننا" حيث كانت قيم نسب الموت 90% ، 90% ، 100% على الترتيب ويلي ذلك طعم الثيوديكارب (55%) اما طعم كل من الكوسيد 2000 (5% نحاس) ، اكلروبات النحاس (5% نحاس) قد اعطيا نسب موت منخفضة (37%) بعد خمسة ايام من التطبيق.
3. اثبتت معاملات اليوريا بمفردها (20%) او مخلوطة بتركيز (10%) مع مبيد الفطريات كربندازيم وبتركيز (10%) مخلوطة مع الكاربندازيم وكبريتات الالومنيوم والبيوتاسيوم وعسل قصب السكر ، كفاءة ضد نوعي القواقع السابق ذكرهما وذلك عند التطبيق في مزارع الجوافة حيث كانت قيم نسب الموت هي على الترتيب : 87.2 ، 95.9 ، 97.2 بعد ثلاثة ايام.
4. رش محلول اليوريا على جذوع اشجار البرتقال اوضح ان نسب خفض الاصابة بالقواقع كانت 98.91 ، 85.2 ، 94.3 باستخدام محلول يوريا 20% ويوريا 10% بمفردهما ، 10% مخلوطا مع مركب شب الالومنيوم والبيوتاسيوم على الترتيب وذلك بعد ثلاثة ايام من رش القواقع الملتصقة فوق الجذوع.
5. تم رش محلول يوريا 20% فوق جذوع شجيرات العنب وذلك لمكافحة قوقعي ايويانيا فرميكيولاتا وتيا بيساننا أثناء التصاق كل منهما خلال النهار. انخفضت نسبة الاصابة الي 98.8% ، 95.7% بعد ثلاثة ايام من الرش خلال مارس وابريل على الترتيب. ومن جهة اخرى فان نسب خفض الاصابة ظلت عالية بعد اسبوع وثلاثة اسابيع من رش الجذوع بسبب عدم وجود حشائش بين شجيرات العنب.

بشكل عام فان تعرض اوراق اشجار الفاكهة لمحلول اليوريا قد أدى إلى حدوث حرق في اجزاء او كل الأوراق مما يعني ضرورة الحرص نحو عدم وصول محلول الرش إلى المجموع الخضري.