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Original Research Article

Impact of using some new approaches on green onion (*Allium cepa* l.) Productivity and control land snails (*Monacha cantiana)*

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Abstract

Field experiments were carried out during the two successive seasons 2014 and 2015 at the farm of Sakha Horticulture Research Station, Kafrelsheikh Governorate, Egypt to study the efficiency of some approaches (silica nanoparticles, bio-insecticides (Dipel 2X), clove oil, peppermint oil and insecticide) on green onion growth, yield, mineral nutrients and controlling the land snails. Experimental treatments randomly arranged in randomized complete blocks design with three replicates. Obtained results showed that all treatment significantly promoted the growth and yield such as plant weight (g), plant height (cm), leaf area (cm^2), number of leaves, fresh and dry weight of leaves (g), total yield (ton $fed.^{-1}$), total soluble solids and protein (%) of green onion plants. Leaf photosynthetic pigment was increased especially in plants treated with chemical insecticide and silica nanoparticles in both seasons, which recorded 67.00, 65.90 and 64.17, 63.57 as compared control 54.57, 56.67, respectively. In addition, silica nanoparticles treatment increased leaf NPK % followed by clove and peppermint oil compared with control (tap water). On the other hand, silica nanoparticles was the highest efficiency treatment in controlling land snails in both seasons, the mean general reduction percent gave 90.73%followed by insecticide treatment which the mean general reduction percent gave 87.46%, respectively. Generally, it could be concluded that, silica nanoparticles is capable of using as a new approach to enhance growth and control land snails on of green onion plant.

Key words: Bio-insecticides (Dipel 2X), Clove oil, Green onion, Peppermint oil, Silica nanoparticles, Snails.

INTRODUCTION

Onion plant (*Allium cepa* L.) is a species of the *Alinaceae* family that has a great economic importance and the second most important vegetable crop in the world (FAO, 2006). Onion plant is cultivated for ultimate uses as green and bulbs. Additionally, it has medicinal properties in the treatment and prevention a number of serious diseases (Martinez *et al*., 2007 and Stajner *et al*., 2008) that attributed with onion biochemical constituents.

According to early book of economic and statistic of the Ministry of Agriculture, Egypt (2010), onion is one of the most important crops used for local consumption and also as exportation commodity. The area devoted for singe winter onion production was 112703 fed. With 13.5 ton fed^{-1}.

Land snails (Mollusca: Gastropoda) are serious pests in nurseries, greenhouses, orchards and filed crops in many parts of the world. In Egypt, the land snails became the most important agricultural pests causing substantial damage to different crops in Delta region (El-Okda, 1981 and Gabr *et al*., 2007). Control of snails on different crops

is heavily dependent on the use of pesticides that limit the effect of these pests below damaging level. Hence, the synthetic molluscicides or pesticides are the most effective measures available at present for the control of terrestrial gastropods (Heikal, 2015; Genena and Mostafa, 2008).

The terrestrial snails *Monachacantiana* (Montagu) became an important agricultural pest causing a great damage to crops indifferent localities in Egypt. It was recorded with a relatively high population density on major economic crops at Kafr El-Sheikh governorate (Sharsher *et al.*, 1996), since the percentage of infestations were 39.6, 73.1 and 74.2% on Egyptian clover, sugar beet and broad bean, respectively. These pests are controlled chemically by synthetic molluscicides insecticides (El-Okda, 1981). These chemical compounds cause environmental contamination giving rise to residues in food, fruits and water.

Nanotechnology is emerging as a highly attractive tool for formulation and delivery of pesticide active ingredients as well as enhancing and offering new active ingredients. Silica nanoparticle using as a new approach to control some insect pests in Egypt, such as aphids and leaf miner in *faba bean* fields and *Tuta absoluta* under greenhouse conditions (Derbalah *et al.,* 2012).

So, the present work was conducted on the land snail species which found in green onion fields at Kafrelsheikh governorate to examine the effect of some natural treatments like as silica nanoparticles, bio-insecticide, oil plant extracts (peppermint and clove oil) comparing with the chemical insecticide on growth, quality and safe control of snails in green onion plants.

MATERIALS AND METHODS

This study was carried out during 2014 and 2015 seasons on green onion (*Allium cepa*) at the Experimental Research Farm, Sakha Horticulture Station, Kafrelsheikh, Egypt to study safety methods for population management of common land snails (*Monacha cantiana*) and their effect on growth and quality of onion plants.

Onion seeds cv. Giza 6 were sown in the nursery beds on the 3rd and 5th of November in both seasons, respectively. After two month from sowing the seedlings were transplanted into the field on both sides of the ridges at a spacing of 10 cm for each row on 2nd and 4th of January in both seasons. Experimental treatments randomly arranged in randomized complete blocks design with three replicates.

Examined Materials

1- **Insecticide:** Metaldehyed 5% (2, 4, 6, 8-tetramethyl-1, 3, 5, 7-tetraoxylcyclooctane) was applied at rate 2 Kg/200 L fed.$^{-1}$.

2- **Silica nanoparticles** were used at 300 ppm/200 Lfed.$^{-1}$**.** It obtained from Nanotech Egypt Company Limited, Cairo, Egypt. The size was 20 nm with a purity of 99.99%.

3- **Clove oil** (*Syzygium aromaticum* L.), it was used at rate 150 cm/200 Lfed.$^{-1}$.

4- **Peppermint oil** (*Mentha piperita* L.), it was used at rate 150 cm/200 Lfed.$^{-1}$.

The plant extract of peppermint and clove oil were obtained from Al-Badawia Company (commercial preparation).

5- **Bio- insecticides:** Dipel 2X (*Bacillus thuringiensis*), it was used at rate 300 g/200 Lfed.$^{-1}$

6- **Control** (foliar spray with tap water).

Plant analysis

Ten plant samples were taken randomly to measure the growth criteria such as plant weight (g), plant height (cm), leaf area (cm^2), number of leaves, fresh and dry weight of leaves (g). However, total yield (ton fed.$^{-1}$) and total soluble solids (%) were determined in fresh juice using Refract meter (A.O. A. C., 1965). Leaf chlorophyll content was estimated using SPAD-502 meter (Minolta Inc. Japan).

Onion plants were dried in oven at 70˚C and then finally ground to determine N, P, and K percentages, as described by Cottenie (1980). Total protein was also calculated by multiplying total nitrogen x 6.25.

Reduction percentage of snails resulted from treatments:

Snails were directly counted before treatment on leaves, and on soil surface from each plant. Also these samples were taken 1, 3,7,14 and 21 days post treatment (According to Agricultural Pesticides Committee Protocols). The reduction in snail's population due to treatments was calculated according to Henderson and Telton (1955) as follows

% Population reduction =

$$100 \times \left(1 - \frac{Ta \times Cb}{Tb \times Ca}\right)$$

Where:

Ta: Population in treated plots after treatment.

Tb: Population in treated plots before treatment.

Ca: Population in control after treatment.

Cb: Population in control before treatment.

Statistical analysis:

Analysis of variance was calculated, and the means of the treatments were compared using Duncan's Multiple Range Test (Duncan, 1955).

Table 1. Effect of some new approaches to control snails on plant weight, height and leaf area of green onion plants during 2014 and 2015 seasons.

Treatment	Plant weight(g)		Plant height (cm)		Leaf area (dm^2/plant)		Chlorophyll (SPAD)	
	2014	2015	2014	2015	2014	2015	2014	2015
Metaldehyed	43.17 a	41.33 a	37.5 a	36.67 a	24.96 a	24.22 a	67.oo a	65.9 a
Silica nanoparticles	40.83 b	39.00 b	35.67 a	35.67 ab	22.88 b	23.16 ab	64.17 b	63.57 b
Clove oil	38.83 c	38.00 b	33.5 b	34.33 b	21.62 bc	21.56 bc	63.83 b	62.4 bc
Peppermint oil	37.83 c	37.33 b	31.5 c	31.83 c	20.05 cd	20.08 cd	61.1 c	60.8 cd
Dipel 2 x	33.33 d	34.33 c	30.00 cd	29.33 d	18.85 d	18.69 de	59.1 c	59.57 d
Control	30.67 e	31.56 d	28.33 d	26.17 e	16.9 e	16.89 e	54.57 d	56.67 e
LSD 0.05	1.59	1.87	1.87	1.87	1.87	1.87	1.99	1.99

Table 2. Effect of some new approaches to control snails on number of leaves, fresh and dray weight of green onion leaves during 2014 and 2015 seasons.

Treatment	No. of leaves / plant		Fresh weight of leaves (g/plant)		Dry weight of leaves (g/plant)	
	2014	2015	2014	2015	2014	2015
Metaldehyed	6.67 a	7 a	12.93 a	12.58 a	9.03 a	9.16 a
Silica nanoparticles	6.67 a	7 a	11.92 ab	11.19 ab	9 a	8.97 a
Clove oil	6 a	6.33 a	11.16 bc	10.52 bc	7.33 ab	8.27 ab
Peppermint oil	6 a	6.33 a	10.03 c	10.30 bc	6.40 b	7.93 ab
Dipel 2 x	5.67 a	6 a	9.69 cd	9.16 cd	6.30 b	6.77 bc
Control	5 a	5.67 a	8.47 d	8.26 d	5.70 b	6.1 c
LSD 0.05	1.87	1.99	1.48	1.77	1.77	1.77

RESULTS AND DISCUSSION

Vegetative growth parameters

The effects of silica nanoparticles, peppermint oil, clove oil extract, Dipel 2x and chemical insecticide, metaldehyde (recommended rate) on vegetative growth including plant weight, height, , leaf area per plant, chlorophyll content (SPAD green color reading), number of leaves per plant, fresh and dry weight of leaves were determined after harvest as shown in Tables 1 and 2. The results in Table 1 indicated that plant weight, height, leaf area and chlorophyll content were significantly increased with all application treatments comparing with control treatment. The highest values obtained by metaldehyde followed in decreasing order silica nanoparticles, clove oil extract and Dip ell 2x in both seasons. The results in Table 2 declared that green onion plants treated with chemical insecticide or silica nanoparticles gave the highest number of leaves per plant, fresh and dry weight of leaves with non-significant differences between them compared with the lowest values obtained by control, while the other treatments gave intermediate values in both seasons. The results indicated that chemical insecticide or silica nanoparticles followed by plant extracts treatments had positive effects on vegetative growth of cucumber supporting earlier results by Gao *et al*., 2006*;* Kalteh *et al.,* 2014, thy declared that the vegetative growth parameters of basil or maize plants significantly increased with silicon nanoparticles application. This could be due to many advantages of nanofertilizers such as more efficient absorption by plants and fast releasing (Wurth, 2007). Nanotechnology has been used in nanofertilizers as an instrument to synchronize the releasing and absorption of phosphorous and nitrogen in plant and also inhibit the interaction between nutrients, microorganisms, water and air.

Silica nanoparticles produce a layer in cell wall which helps to tolerate stresses and improve growth and yield in plants (Derosa *et al*., 2012). Also Fathy *et al*. (2008) and Shafeek *et al. (*2015) showed that the bio-stimulants (plant extracts) able to promote vegetative growth, mineral nutrient uptake and improve the productivity of many plants.

Yield, TSS% and Protein %

Date illustrated in Figure 1, 2 and 3 show that, yield as ton/

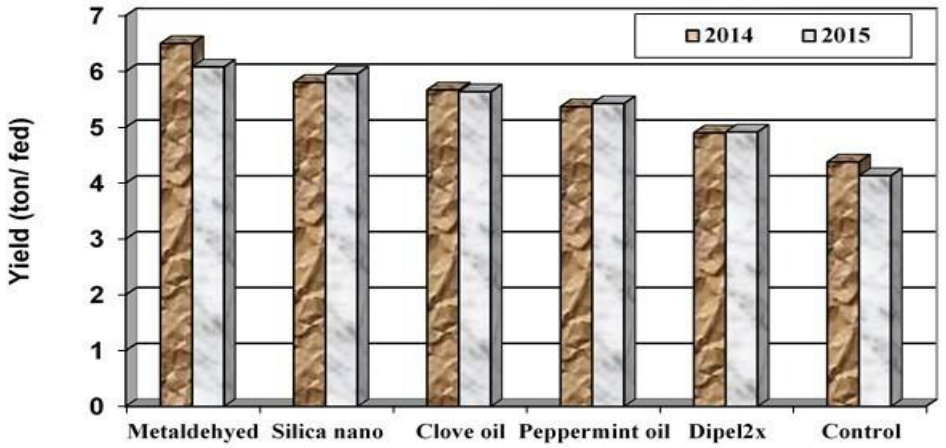

Figure 1. Effect of some new approaches to control nails on yield of green onion during 2014 and 2015 seasons.

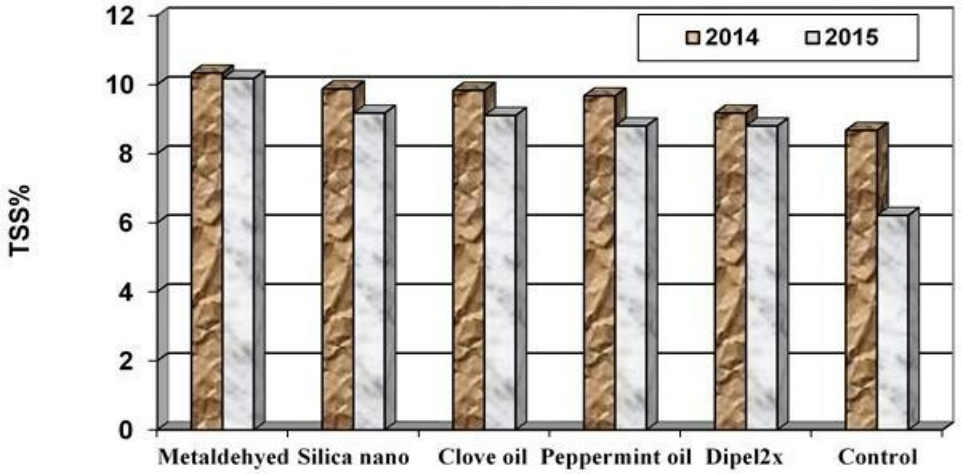

Figure 2. Effect of some new approaches to control snails on TSS% of green onion during 2014 and 2015 seasons

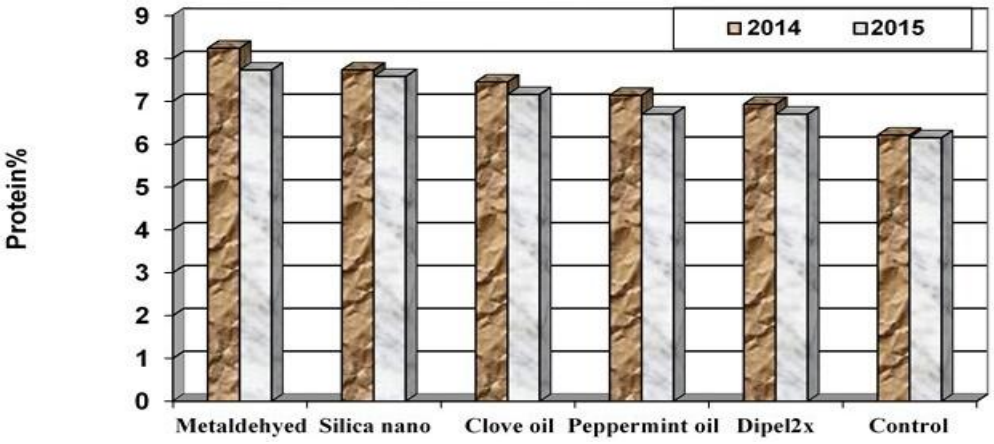

Figure 3. Effect of some new approaches to control snails on protein% of green onion during 2014 and 2015 seasons.

Table 3. Effect of some new approaches to control nails on leaf macronutrient concentrations of green onion plants during 2014 and 2015 seasons.

Treatment	N		P		K	
	2014	2015	2014	2015	2014	2015
Metaldehyed	1.45 a	1.36 a	0.35 a	0.34 a	1.55 a	1.48 a
Silica nanoparticles	1.36 b	1.33 b	0.33 b	0.32 b	1.45 b	1.40 b
Clove oil	1.31 c	1.26 c	0.31 c	0.32 b	1.36 c	1.30 c
Peppermint oil	1.25 d	1.18 d	0.29 d	0.31 c	1.21 d	1.21 d
Dipel 2x	1.22 e	1.18 d	0.26 e	0.29 d	1.16 e	1.09 e
Control	1.09 f	1.08 e	0.21 f	0.22 e	1.01 f	1.04 f
LSD 0.05	0.01	0.01	0.01	5.35	0.01	0.01

fed, T.S.S and portion % of green onion as affected by some new approaches to control nails in 2014 and 2015 seasons. Total yield was significantly affected by different treatments. Chemical insecticide, Silica and plant extracts (clove and peppermint oil) treatments gave the highest total yield especially metaldehyed and silica treatments compared to control in both seasons (Figure 1). As for, TSS% data in Figure 2 showed that all treatments increased TSS% compared with untreated plants without significant differences among them compared with the lowest values recoded with control treatment in both seasons. The highest protein % (8.24 and 7.73%) and (7.95 and 7.58%) obtained by metaldehyed and silica treatments compared with the lowest values (6.2 and 6.15) recorded with control in both seasons, respectively (Figure 3). In this concern, El-Samahy *et al*. (2014) showed a significant increase in the yield TSS of tomato fruits as a result of the silica nanoparticles followed by neem oil extract compared with check (without any treatments), Fathy and Kheder (2005) indicated that, foliar spraying with limonene oil increased, fruit setting and tomato total yield ,also Shafeek *et al*. (2015) concluded that the heaviest bulbs yield and its best values of some physical properties which resulted may be attributed to the best vigor of plant growth characters which obtained by foliar ornamental plant extracts.

Chemical composition of leaves

The effects of some new approaches to control snails on leaf macronutrient concentrations (NPK) of green onion are shown in Table 3. There were significantly differences due to foliar treatments for leaf macronutrient concentrations in both seasons. All treatments significantly increased leaf N, P and K concentrations compared to control. Chemical insecticide treatment (metaldehyed) or silica nanoparticles treatment tended to increase leaf NPK content followed by clove and peppermint oil comparing with the lowest values obtained by control treatments. In this concern, Liang, 1999, Kamenidou and Cavins 2008 and Tahir *et al*. (2011). They found that addition of Si to wheat genotypes irrigated with saline water significantly improved N, P and K uptake.

Efficacy of different applied treatments against *M. cantiana* in green onion under field Conditions

Data in Tables (4 and 5) show the reduction percentage resulted from five treatments; Nano silica, peppermint oil, clove oil extract, Dip ell 2x and chemical insecticide, metaldehayed (recommended rate) during two seasons 2014 and 2015.The results obtained that most of the tested treatments were effective against *M. cantiana* in onion plants under field conditions The most effective treatment was silica nanoparticles (91.11 and 90.35%) followed in decreasing order by metaldehayed (87.62 and 87.30%), Peppermint oil (82.21 and 84.97%), Clove oil (69.17 and 68.7%) and finally Dipel 2x treatment (24.5 and 23.95 %) in both seasons, respectively. The results showed that silica nanoparticles was the most effective treatment against *M. cantiana* in treated onion plants. This agrees with the finding of (Debnath *et al*. (2010) who reported that Silica nanoparticles showed entomotoxic potential and has no negative effect on plant growth. In addition, the silica enhances structural rigidity and strength of the plant cells (Epstein, 1994). Also, the high efficacy of silica nanoparticles against *M. cantiana* may be due to the absorbance of silica nanoparticles into the cuticle lipids resulting in damage to the protective wax layer (made of various fatty acids and lipids that act as an effective barrier to water loss) and induces death by desiccation (Ebeling, 1971, Rahman, 2009 and Derbalah *et al*., 2012). The use of such nanomaterial's is more acceptable as they are safe for plants and causes less environmental pollution compared to conventional chemicals (Barik *et al*., 2008). Moreover, application of nanoparticles on the leaf and stem surface does not alter either photosynthesis or respiration in several groups of horticultural and crop plants. Therefore, Silica nanoparticles and other nanomaterials may offer an important role in improving the

Table 4. Reduction percentage of snails on green onion plants under field conditions during 2014 season

Treatment	Period after treated / day					General Reduction (%)
	1	3	7	14	21	
Metaldehayed	79.25	89.33	99.50	89.75	80.25	87.62
Silica nanoparticles	89.50	95.30	99.75	93.25	77.75	91.11
Clove oil	52.00	65.33	72.25	80.50	75.75	69.17
Peppermint oil	65.50	77.33	89.50	95.20	83.50	82.21
Dipel 2x	0.00	15.00	24.75	49.25	33.50	24.50

Table 5. Reduction percentage of snails on green onion plants under field conditions during 2015 season

Treatment	Period after treated / day					General Reduction (%)
	1	3	7	14	21	
Metaldehayed	79.00	88.75	98.90	89.00	79.50	87.30
Silica nanoparticles	89.00	94.25	99.00	92.50	76.99	90.35
Clove oil	51.50	65.00	71.75	80.00	75.25	68.70
Peppermint oil	69.50	80.00	98.75	94.25	82.35	84.97
Dipel 2x	0.00	14.50	24.00	48.50	32.75	23.95

pest management techniques for crops (Derbalah *et al*., 2012). The tested insecticide showed high efficacy against snails and this agrees with the findings of (Mostafa, 2008). However, using some plant extracts as safety control increased reduction in snail's population this agrees with the finding of Sharshir *et al*., 1996, Shahawy, 1998 and 2013 found that plant extracts against *M. cantiana* showed that the most effective against snail when compared with control. However, Napoleon (2015) found that combined plant extracts of Malasantol (*Sandoricum vidalii*) fruit, barks of *Harpulia arborea* (Blanco) Radlk., and Parkia species either in two or three species combinations are highly effective in controlling giant earthworm and golden apple snail under laboratory and field conditions.

CONCLUSION

In the present work we report that silica nanoparticles was used for safe control of land snails and improve growth and quality of green onion plants.

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