



Integrated Management for Controlling Terrestrial Snails in Certain Districts of Assiut Governorate

By

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5. Summary

The present studies were carried out in Assiut governorate during two seasons (2015/2016 – 2016/2017) in three localities. The first one is the Experimental Farm of the Faculty of Agriculture, Assiut University which cultivated with the ornamental plants, field crops and fruit trees. The second locality is a vegetated land in Bosra village, (It is located 7 km southeast of Assiut city) cultivated with Egyptian clover and wheat. The third locality is El-Ghorib village (25 km southeast of Assiut city), cultivated with wheat, Egyptian clover, onion, and garlic crops.

The present work aimed to:

1. Survey the terrestrial snail species inhabiting different types of soil in Assiut governorate, Egypt.
2. Investigate the seasonal fluctuations of the terrestrial snail populations and the effects of some ecological factors on terrestrial snail species in Assiut governorate.
3. Study the effects of some pesticides and plant extracts as a control method against the common snails.
4. Evaluate a combination of certain methods in suppressing the snail populations to be implemented as an IPM strategy.

The obtained results could be summarized as follows:

1. Ecological studies:

1.1. Survey of land snail species

The survey manifested three species of land snails and one species of slug for two years starting from March 2015. The snail species were identified as; *Monacha obstructa* (Montagu), *Eobania vermiculata* (Muller) and *Oxyloma elegans* (Montagu), while the slug species was *Limax flavus* (Muller).

The three land snail species were recorded at the Farm of the Faculty of Agriculture, Assiut University. In Bosra village and El-Ghorib village, only a single species of land snail, *M. obstructa* was recorded. The slug species, *L. fluvus* was recorded in the three studied areas.

1.2. Population densities of land snail species:

Data revealed that El-Ghorib village had about 45.44% of snails in both studied seasons. Bosra village came in the next rank (43.08 and 37.55%), meanwhile the farm of the Faculty of Agriculture, Assiut University acquired the lowest numbers (11.47 and 17.01%) of recorded snail species in the surveyed areas in 2015/2016 and 2016/2017 seasons.

Four land snail species were recorded at the farm of the Faculty of Agriculture, Assiut University. The highest density was recorded to *E. vermiculata* (52.82% and 46.34%), the *M. obstructa* recorded 31.60% and 36.88%. Meanwhile, *O. elegans* had the lowest density (11.74% and 8.98%). While, the slug, *L. fluvus* represented only by (3.84% and 7.80%) in both seasons 2015/2016 and 2016/2017.

It was noticed that a single slug and a single land snail species (*L. fluvus* and *M. obstructa*) were recorded in Bosra village. The *M. obstructa* was recorded by 95.19% and 95.07% of total land snail species during the two studied seasons. Whereas *L. fluvus* recorded by scarce numbers (4.81% and 4.93%) in both seasons.

In El-Gharib village only *L. fluvus* and *M. obstructa* was recorded. Data cleared that, *M. obstructa* gave the highest density (94.53% and 94.87%) as compared with *L. fluvus* (5.47% and 5.13%) in 2015/2016 and 2016/2017 seasons.

In general, the snail, *M. obstructa* was the predominant species in the Bosra village and El-Gharib village, meanwhile *E. vermiculata* was the predominant one in the farm of the Faculty of Agriculture, Assiut University.

1.3. Seasonal population fluctuations of land snail species:

a. The farm of the Faculty of Agriculture, Assiut University:

Data revealed that the highest populations of land snail species were observed during spring with 56.43 and 59.81%, followed by winter with 18.96 and 19.15% of the total catch, snails, while the lowest populations were observed during autumn season with 9.03 and 13.48% followed by summer season with 15.58 and 7.57% during, 2015/2016 and 2016/2017 seasons.

Results showed that *Eobania vermiculata* snail was the predominant species during the two studied seasons (2015/2016 and 2016/2017). The highest density of this species was recorded in the first season, through spring with 56.41%, followed by summer with 26.07% and autumn with 11.97%. The lowest population was observed during winter with 5.56% of the total population of this species. Meanwhile, spring season recorded the highest population in the second season with 66.33% followed by autumn and winter seasons with 12.76% and the summer season recorded the lowest population density (8.16%).

The *Monacha obstructa* snail came in the second rank. In spring season, it recorded the highest density with 50.71 and 63.46%, followed by winter season with 43.57 and 18.59%; whereas the lowest numbers were recorded in autumn (5.71 and 17.31%) and summer (0.00 and 0.64%) in both studied years.

b. Bosra Village Farms:

The *L. flavus* recorded the highest numbers (18 and 14 snails/25 cm²) in spring during the two studied years. The density of *L. flavus* were low in winter of both studied season (11 and 8 snails/25 cm²).

As well as *M. obstructa* snail in wheat fields took the same trend, this species recorded the highest number during spring followed by winter

season. The numbers were 233 and 101 snails/25 cm² in 2015/2016, and 150 and 23/25 cm² in 2016/2017 seasons.

In clover fields, the highest numbers of *L. flavus* and *M. obstructa* snails were recorded during spring season. The numbers were 29 and 730 snails/25 cm² in the first season and 21 and 625 snails/25 cm² in the second season. Winter season came in the second rank with 15 and 497 snails/25 cm² in 2016 and 2 and 53/25 cm² snails in 2017. The last rank was recorded during autumn season with 7 and 23 snails/25 cm² in the first season and 1 and 37 snails/25 cm² in the second one.

Snail density at Bosra village showed that *M. obstructa* snail was the predominant species as compared to *L. flavus* slug during both studied seasons.

c. El-Ghorib Village Farms:

The *M. obstructa* recorded the highest densities during spring season, where these populations were 257 and 153 snails/25 cm² for wheat; 805 and 564 snails/25 cm² for clover; 23 and 17 snails/25 cm² for onion; 22 and 14 snails/25 cm² for garlic in 2015/2016 and 2016/2017 seasons. Data also revealed that winter season came in the second rank, where *M. obstructa* was observed under wheat, clover, onion, and garlic crops in this season. The populations were 88 and 45 snails/25 cm² for wheat; 492 and 145 snails/25 cm² for clover; 9 and 8 snails/25 cm² for onion; 6 and 4 snails/25 cm² for garlic in both studied seasons. In autumn *M. obstructa* was recorded in clover fields only with 39 and 24 snails/25 cm² in both seasons.

Obtained data show that, *L. flavus* in wheat and clover fields recorded the highest densities during spring followed by winter. Their populations were 25 and 33 snails/25 cm²; 16 and 14 snails/25 cm² for wheat and clover during spring in first year. In spring season, its densities were 17 and 19 snails/25 cm², while in winter 5 and 15 snails/25 cm² were recorded for wheat and clover in the second year.

In general, seasonal fluctuations showed that the highest numbers of *Monacha obstructa*, *Eobania vermiculata*, *Oxyloma elegans* and *Limax flavus* were recorded during spring during the study period.

1.4. Effect of weather factors on the population density of land snail species:

Results showed that some weather factors gave a significant correlation, while some factors showed in significant one with the studied populations of the land snails. Also, the correlation coefficient between the studied weather factors and populations of the land snail species gave negative or positive correlations.

In the Faculty of Agriculture farm, the *M. obstructa* snail population showed significant negative correlation with the maximum, minimum, diurnal, and night temperature in 2015/2016 season, where the correlation values were: -0.815, -0.852, -0.789, and -0.789, respectively, but all-weather factors gave insignificant correlation values in the second season. In contrary, the *L. flavus* slug population had insignificant negative correlation in the first season and significant negative correlation with the same factors in the second year.

The *L. flavus* slug population had significant negative correlation with maximum, minimum, diurnal, and night temperature in both seasons of El-Ghorib village and in the first season of Bosra village. The *M. obstructa* snail population showed significant negative correlation with the maximum, minimum, diurnal, and night temperature in the first season in both farms, and insignificant negative correlation in the second season in both farms too.

2. Control studies:

2.1. Laboratory studies:

The toxic effect of Lannate 90% SP, Protrecto (BT) 9.4% WP, Gaucho 70% WS, Lannate 90% SP plus acetyl salicylic acid, Maximic 8%

SC, and Alum and the ethanolic extracts of *Calotropis procera*, *Citrullus lanatus* and *Ambrosia maritima* against *M. obstructa* snail were assayed as follows:

2.1.1. Efficiency of Lannate 90% SP against *M. obstructa*:

- The percentages of mortality of the land snail species, *M. obstructa*, treated directly with lanate hardly reached 50% at 1500 ppm concentration and reached 100% at 3000 and 4500 ppm in 19 and 23 days, respectively. In case of treating lettuce as food source for the snail, the percentages of mortality reached 50, 60 and 70% at 1500, 3000 and 4500 ppm at the end of the experiment (23days).
- The LT_{50} values with lettuce were 13.38, 6.98 and 4.32 days, respectively. However, the lannate LT_{90} values were 61.91, 22.28 and 13.25 days.
- The LT_{50} values without lettuce were 19.62, 15.18 and 9.26 days, respectively. However, the methomyl LT_{90} values were 92.59, 67.28 and 43.75 days.

2.1.2. Efficiency of Protrecto (BT) 9.4% WP against *M. obstructa*:

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 46.67, 76.67 and 80.00 % without lettuce at 2500, 5000 and 7500 ppm, respectively; and decreased to be 33.33, 36.67 and 56.67 with lettuce at the same concentrations.
- The LT_{50} values with lettuce were 25.51, 13.48 and 11.83 days while the LT_{90} values were 135.31, 49.67 and 46.84 days, respectively.
- The LT_{50} values without lettuce were 35.23, 33.12 and 17.09 days while the LT_{90} values were 225.12, 234.83 and 75.91 days, respectively.

2.1.3. Efficiency of Gaucho 70% WS against *M. obstructa*:

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 60.00, 80.00 and 90.00 % without lettuce at 500, 1000 and 1500 ppm, respectively; and decreased to be 40.00, 50.00 and 63.33 with lettuce at the same concentrations.
- The LT_{50} values with lettuce were 18.93, 11.06 and 7.06 days, respectively. However, the gaucho LT_{90} values were 94.44, 53.83 and 30.36 days.
- The LT_{50} values without lettuce were 29.34, 19.59 and 13.17 days, respectively. However, the gaucho LT_{90} values were 154.88, 117.04 and 55.21 days.

2.1.4. Efficiency of Lannate 90% SP plus acetyl salicylic against *M. obstructa*:

- At the end of the treatment (23 days) without lettuce, the mortality percentage was 76.67% at 1500 ppm, while a complete death was at 15 days with 3000 and 4500 ppm. But in case of using lettuce, the mortality percentages were 60.00, 70.00 and 76.67% at 1500, 3000 and 4500, respectively.
- LT_{50} values with lettuce were 12.15, 6.98 and 4.05 days while the LT_{90} values were 40.39, 16.98 and 13.56 days, respectively.
- LT_{50} values without lettuce were 14.23, 12.11 and 7.40 days while the LT_{90} values were 63.61, 54.56 and 35.72 days, respectively.

2.1.5. Efficiency of Maximic 8% SC against *M. obstructa*

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 70.00, 70.00 and 100.00 % without lettuce at 250, 500 and 750 ppm, respectively; and decreased to be 36.67, 50.00 and 63.00 with lettuce at the same concentrations.

- LT_{50} values with lettuce were 16.08, 12.51 and 5.76 days while the LT_{90} values were 68.32, 49.01 and 20.67 days, at concentrations of 250, 500 and 750 ppm, respectively.
- The LT_{50} values without lettuce were 29.15, 17.98 and 12.45 days, respectively. However, the maximic 8% SC LT_{90} values were 183.39, 91.96 and 80.67 days at concentrations of 250, 500 and 750 ppm, respectively.

2.1.6. Efficiency of Alum against *M. obstructa*:

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 50.00, 26.67 and 26.67 % without lettuce at 1250, 2500 and 5000 ppm, respectively; and decreased to be 36.67, 16.67 and 20.00 with lettuce at the same concentrations.
- The LT_{50} values with lettuce were 27.28, 32.59 and 34.89 days, respectively. However, the Alum LT_{90} values were 186.15, 245.99 and 24.40 days at concentrations of 1250, 2500 and 5000 ppm, respectively.
- The LT_{50} values without lettuce were 20.91, 23.02 and 25.43 days, respectively. However, the Alum LT_{90} values were 145.73, 151.57 and 152.42 days at concentrations of 1250, 2500 and 5000 ppm, respectively.

2.1.7. Efficiency of *Calotropis procera* ethanolic extract against *M. obstructa*

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 16.67, 43.33 and 63.33% without lettuce at 4000, 6000 and 8000 ppm, respectively; and decreased to be 13.33, 36.67 and 40.00 with lettuce at the same concentrations.

2.1.8. Efficiency of *Citrullus lanatus* ethanolic extract against *M. obstructa*:

- At the end of the experiment (23 days), the mortality percentages of *M. obstructa* were 43.33, 40.00 and 13.33% without lettuce at 4000, 6000 and 8000 ppm, respectively; and decreased to be 20.00, 16.67 and 12.33 with lettuce at the same concentrations.

2.1.9. Efficiency of *Ambrosia maritima* ethanolic extract against *M. obstructa*:

- At the end of the experiment (23 days), there was no mortality for *M. obstructa* without or with lettuce at 4000, 6000 and 8000 ppm, concentrations.

In general, the chemical compounds can be ascendingly arranged based on their killing potency as follows: lannate 90% SP plus acetyl salicylic acid > lannate 90% SP > maximic 8% SC > gaucho 70% WS > protrecto 9.4% WP > alum, while the ethanolic plant extracts as follows: *Calotropis procera* extract > *Citrullus lanatus* extract > *Ambrosia maritima* extract.

2.2. Field studies:

2.2.1. Effect of plowing method of soil on the population density of *M. obstructa*:

- The P2 (Deep plowing > 25 cm) method gave a low population density of *M. obstructa* in the Egyptian clover field in Bosra and El-Ghorib farms as compared with P0 (without plowing) and P1 (surface plowing < 20 cm) after 3, 7, 11 and 15 days of treatment. The population density after these periods were: 83.71, 67.57, 57.43 and 54.29 in Bosra farm; and 90.00, 81.71, 75.00 and 66.71 in El-Ghorib farm.

2.2.2. Evaluation of some different treatments against *M. obstructa* population density:

- The results indicated that T4 (*Calotropis procera* extract + Lannate 90% SP plus acetyl salicylic acid + wet sackcloth) was the best treatment for reducing the population density of *M. obstructa* in the field followed by T3 (Lannate 90% SP plus acetyl salicylic acid + wet sackcloth), T2 (*Calotropis procera* extract + wet sackcloth), T5 (Lannate 90% SP plus acetyl salicylic acid), T7 (Wet Sackcloth), and T6 (*Calotropis procera* extract) at Bosra and El-Ghorib farms in Assiut governorate during 2016/2017 season.

2.2.3. Reduction ratios of *M. obstructa* population density after applying some IPM programs under field conditions:

- The IPM treatment combinations could be arranged according to their reduction ratio after 15 days of applying against the snails in the Egyptian clover field in Bosra village in a descending order as follows: P2 T4 > P1 T4 > P2 T3 > P0 T4 > P2 T2 > P1 T3 > P2 T5 > P1 T2 > P2 T7 > P0 T3 > P2 T6 > P1 T5 > P1 T7 > P1 T6 > P0 T2 > P0 T5 > P0 T7 > P0 T6; and in El-Ghorib village as follows: P2 T4 > P1 T4 > P2 T3 > P0 T4 > P1 T3 > P2 T2 > P2 T5 > P2 T6 > P0 T3 > P2 T7 > P1 T2 > P1 T5 > P1 T6 > P1 T7 > P0 T2 > P0 T5 > P0 T6 > P0 T7 .

where :

P0= without plowing,

P1= Surface plowing (<20 cm),

P2= Deep plowing (>25 cm),

T1= without treatment,

T2= *Calotropis procera* extract + wet sackcloth,

T3= Lannate 90% SP plus acetyl salicylic acid + wet sackcloth, T4= *Calotropis procera* extract + Lannate 90% SP plus acetyl salicylic acid + wet sackcloth,

T5= Lannate 90% SP plus acetyl salicylic acid,

T6= *Calotropis procera* extract,

T7= Wet Sackcloth.

- In general, IPM program contained *Calotropis procera* extract + Lannate 90% SP plus acetyl salicylic acid + wet sackcloth (T4) gave the highest reduction ratios under deep and surface plowing.

2.2.4. The loss rate of wheat yield resulting from land snails in Bosra and El-Ghorib villages:

- The rates of loss in the wheat yield were 5.37 % and 5.35 % in Bosra and El-Ghorib villages, with a mean weight of 5.36 %.
- The reduction percentage caused by the land snails reduced the Egyptian clover fodder yield by 5.19, 6.98, 1.31, 7.52, 9.53 and 20.10% with an average of 8.06% in Bosra village. Meanwhile in El-Ghorib village, the reduction percentage were 1.62, 4.87, 0.88, 7.11, 15.64 and 17.66% for 1st, 2nd, 3rd, 4th, 5th and 6th cut with an average of 8.58%, respectively.

Finally, it might be mentioned that the data given in the present study may be of great value and can be used as a base for developing an integrated pest management program for controlling snails and slugs in Upper Egypt.