

REVIEW OF LITERATURE

1. Ecological Studies:

a. Survey:

El-Okda (1979 a) recorded three land snails in Alexandria, *Eobania vermiculata* (Muller), *Helicella vestalis* (Pfiffer) and *Theba pisana* (Muller) on several ornamental plants, through the period of 1975 - 1976. In (1980), he recorded the three land snail species on 32 vegetable crops in Alexandria and Beheira governorates. Also, He recorded in (1984) two land snails; *Monacha sp* and *Oxychilus sp* on several orchards, field crops and ornamental gardens in Ismailia governorate.

Baker and Vegelzang (1988) recorded the land snail *T. pisana* on twenty six sites in South Australia, Victoria and Tasmani. They stated that, the large snails were found on short grass, soil surface, shrubs and tall herbs. On the other hand, small snails were rarely found on short grass and the soil surface in South-Eastern Australia.

Hashem et al. (1992) recorded *T. Pisana*, *H. vestalis* and *Cochlicella acuta* on citrus orchards at El-Amria, Alexandria Governorate.

Azzam (1995) recorded 15 snail species in ten governorates Alexandria, Beheira, Cairo, Fayoum, Giza, Ismailia, Kafr El-

Sheikh, Qalubia, Menofiya and Sharkia. These species are belonging to four families. The helicids; *C. acuta*, *E. vermiculata*, *Eremina desertorum*, *Eremina sp.* *Helicella sp.* *H. caperata*, *H. vestalis*, *H. aspersa*, *M. obstructa*, *Theba spp.*, and *T. Pisana*; the sublimed; *Rumina decollate*, the zonitid, *Oxychilus sp.*, the succinids *Oxyloma cleoptra* and *Succunea sp.*

El- Deeb et al. (1996 a) surveyed land snails in the field crops, vegetables, ornamental plants and orchards at Kafr El-Shiekh, Demietta and Dakahlia Governorates. They recorded the occurrence of *E. vermiculata*, *Succinea putris*, *Cepae nemoralis* at Kafr El-Shiekh. *Monacha cartusiana*, *C. nemoralis*, *Helicella sp.*, *C. acuta* and *Oxychilus alliarius*, at Demietta. While *M. cartusiana*, *S. putris*, *E. vermiculata*, *C. acuta* and *C. nemoralis* at Dakahlia governorate.

Ismail (1997) surveyed four species of land snails belonging to family Helicidae infesting different crops at 17 localities in Sharkia Governorate. These species were the glassy clover snail; *M. cartusiana*, the small sand snail; *H.vestalis*, the brown garden snail; *E. vermiculata* and the conical snail; *C. acuta*.

Lokma (1998) found that *M. cartusiana* was more abundant on date palm and alfalfa than other hosts in middle region of Saudi Arabia, while *E. vermiculata* was more abundant on washngtonia palm and two ornamental plants and

less abundant on date palm and fig trees. *M. cartusiana* reached its peak at March while *E. vermiculata* reached its peak at December.

Hegab et al. (1999) surveyed land snails, *M. cartusiana* and *E. vermiculata* on different crops in newly reclaimed lands and old lands in certain localities of Sharkia Governorate, during the two successive seasons (1996 / 1997 & 1997 / 1998).

Awad (2000) Surveyed the terrestrial gastropods in many different locations at Dakahlia Governorate on fruit orchards, field crops and ornamental nursery during the period from November 1997 to December 1998. The family Helicidae contained large number of species belonging to the genera *Cochlicella*, *Eobania*, *Helix*, *Helicigona*, *Euparypha* and *Theba*. *Theba* species were more abundant in most surveyed localities while the species of the Zonitid were found in limited localities.

Abd-El-Aal (2001) surveyed land snails in Sharkia Governorate. He detected five species of land snails in different localities. He reported that there were 12 districts containing 44 localities infested with land snails; *M. cartusiana*, *H. vestalis*, *C. acuta*, *E. vermiculata* and *Succinea sp.*

Mortada (2002) found that 13 species of terrestrial snails and slugs belonging to five families *Helicidae*, *Succineidae*, *Achatinidae*, *Zonitidae* and *Limacidae* were detected on different crops in 25 localities representing five districts of Dakahlia Governorate. These species were *E. vermiculata*, *H. aperta*, *Cepaea hortensis*, *M. cartusiana* and *C. acuta* (*Helicidae*). *S. oblonga*, *S. putris* (*Succineidae*). *O. alliarius* (*Zonitidae*) and *Rumina decollate* *Linnaeus* (*Achatinidae*). On the other hand, family: *Limacidae* contained four slug species, *Limax flavus*, *lehmannia marginata*, *Deroceras reticulatum* and *D. leave*.

Metwally et al. (2002) stated that six species of terrestrial mollusca belonging to families *Helicidae*, *Limacidae* were recorded on different crops at 23 localities representing 10 districts at Monoufia and Gharbia Governorates. These species were *M. cartusiana*, *E. vermiculata*, *C. acuta*, *O. alliarius*, the slugs, *L. flavus* and *D. reticulatum*.

Abd El- Wahab (2004) studied the surveyed land snails infesting fields of Clover, broad bean, Wheat, Sugar cane, vegetable crops, ornamental plants and orchards trees, in 25 localities representing five districts of Dakahlia Governorate, during the period of September to June at 2000 – 2002. He detected nine species of land snails; *E. vermiculata*, *M. cartusiana*, *H. aperta*, *C. nemoralis*, *C. acuta*, *S. putris*, *Succinea oblonga*, *O. alliarus* and *R. decollate*.

Zedan et al. (2005) studied the survey of land snails and slugs as well as damage and losses estimation caused by *M. cartusiana*, *E. vermiculata* and *C. nemoralis* on some vegetable crops and fruit trees in Dakahlia, Sharkia and Demiat Governorates, during the period from October, 2003 to September, 2004 seasons. They recorded thirteen land snail and slug species (nine snail and four slug species) in Dakahlia Governorate. While eight species (six snail and two slug species) were surveyed in Sharkia Governorate. In addition to, nine species (seven snails and two slug species) were found in Demmiatta Governorate. The mean reduction caused by *M. cartusiana* in fresh weight of shoots for three cutting of Egyptian clover were 38.22, 33.59, 35.12 % and the general mean loss was 35.65 %. While losses percentages were estimated with 10.9, 14.2 and 17.25 % in leafs of mandarin, cabbage and lettuce crops, respectively. Also, *M. cartusiana* snail was responsible the damage in cucumber fruit with 6 %, *E. vermiculata* and *C. nemoralis* caused damaged to leafs of orange and guava trees with 14.7 and 9.6 %.

Mohamed (2006) surveyed land snail species; *M. cartusiana* and *E. vermiculata* in seven districts belonging to three Governorates, Fayoum, Giza and Sharkia. on different host plants during November 2003 till June 2004. Survey study revealed the occurrence of *M. cartusiana* inhabiting 38 different host plants, from these; seven field crops (Barley, Berseem, Broad bean, Cotton, Maize, Sudan grass and Wheat), eleven weeds. While *E.*

vermiculata was recorded on seventeen ornamental plants and two fruit trees.

b. Population Dynamics:

El-okda (1979 a) studied the mean numbers of adult land snails on ornamental plants in Alexandria Governorate at different times. He found that three land snails were active throughout the year. However, this activity was enhanced during periods of decreased temperature and increased humidity. The snail *Eobania vermiculata* was more abundant (43%) than *Theba pisana* (35%) and *Helicella vestalis* (22%), throughout the period of 1975-1976.

Kady et al. (1983) reported that, population of *M. obstructa* in the Egyptian clover field in Mansoura began to increase gradually from the end of March to the middle of April. It reached the highest value during spring, snail numbers were greatly localized at the margins of the field rather than at its middle and low numbers of snails were observed during December, January and February months.

Baker and Vogelzang (1988) studied the population dynamics of *T. pisana* snails in different sites. The snails were most abundant in the pasture at Mt-Benson, South Australia, in Spring especially near its edge, and rare in Summer. Snails were common well into the pasture aggregated within the pasture where suitable aestivation sites were available. Small snails (<12 mm diameter)

were more restricted in microhabitat than large snails. They found that in Tasamaniatss, density was 240 snail, in Victoria it began 893 snails in four different sites and in south Australia it was 1349 snail on ten different sites in South Eastern Australia.

Hassanein and Hamed (1989) studied the land snails infesting pear trees in Northern coast of Egypt. They reported that, the number of *Helicella sp.* increased during late Summer and Autumn consequently, it represented 87.6 and 89.6% of the collected samples during October 1987, respectively. On the other hand, 70.1 and 31% of the total number of collected snail were reported for *Euparpha pisana* during June and December 1987, while 31.9 and 23.9% were recorded in June and December 1987 respectively, *C. acuta* was represented by the lowest population during Summer months but it become more abundant than the other two species during February 1987.

El- Okda et al. (1989) reported that, infestation of *T. pisana*, *H. vestalis*, *Eobania sp*, *Cochlicella sp* and *Monacha sp.* were occurred during May till November on fences. While it was present through the year on the inner plantation. They added that the highest population density of these species were noticed in the neglected and weedy orchards.

Statikou et al. (1990) Studied The life cycle, population dynamics, growth and secondary production of the land snail *M. cartusiana* in northern Greece. Demographic analysis of the

populations of *M. cartusiana* revealed that 2-3 cohorts existed in the field throughout the year; the reproductive period started in early, mid- or late Autumn, depending on Weather conditions; and growth of newly hatched individuals was also influenced by Weather conditions.

Baker and Hawake (1990) studied population dynamics of *T. pisana* in cereal pasture rotation in Australia. They found that, the snail (>6mm shell diameter) were most abundant during Spring and Summer in pastures. During Summer, snails were aggregated within pastures, especially on weeds and many snails were killed by burning the old pastures in Australia, prior to sowing crops. In the hottest Summer, snail numbers decreased prior to burning.

Ali and Suleman (1992) studied seasonal variation in population density of the land snail *M. obstructa* in citrus orchard in Pakistan during the period from November, 1985 to March, 1987. They noticed that the snail remained active most months of the year except Summer months; when densities of both adults and immature stages declined to zero. The snail was active during the wet days of Spring when temperature was around 25°C. During the Spring season a large number of snails were often noticed crawling about on the grassy lawns and along the road-side leaving behind shiny tracks formed by the mucous secretions. As the green vegetation was abundant, in this season the snails were found in large numbers feeding up on the leaves of various plants, high feeding activity was

noticed during the crepuscular period. Maximum population densities of immatures were observed during late Spring (April and early May), and it was followed by peak density of adults in October to November. As the hot dry weather approached both the adult and immature stages become scarce, and ultimately disappeared even from shady places. During the Summer months the snails were totally inactive.

Ghamry *et al.* (1993) studied the Ecology and morphology of land snails *C. acuta*, *E. vermiculata* and *M. cantiana* on certain orchard trees; ornamental plants and field vegetable crops at Sharkia Governorate. Results showed that these pests were more active during Spring and Autumn months whereas temperature and humidity degrees are suitable for their development and reproductive. However snail *Monacha cantiana* on field and vegetable crops during May and June months were 390, 175, 225 and 9 individual per m². On wheat, broad been, Egyptian clover, squash and tomato, respectively.

Hashem *et al.* (1993) carried out monitoring of land snail population on sweet orange trees during two successive years (1990 and 1991) in Behera Governorate. These land snails were *T.pisana*, *H. vestalis*, *C. acuta* and *E.vermiculata*. Snail were noticed on citrus trees from January to December for *E. vermiculata*, from February to December for *H. vestalis*, from March to November for *T. pisana*

and from March to October for *C. acuta*. Generally, Spring and Autumn months showed the maximum number of snails per tree.

Nakhla et al. (1993 a) studied the population dynamics of land snails in banana orchards at Beheira Governorate during the two successive year, 1989 and 1990. They found that *E. vermiculata*, *H. vestalis* and *C. acuta* were the dominating land snails in banana orchards. Snails were observed on the plants almost throughout the whole year round (from January to December). Snail infestation almost doubled throughout only one generally Autumn and Spring months showed the maximum snail abundance per plant and snail activity variably affected with temperature and relative humidity.

Nakhla and Tadros (1993) studied on the seasonal abundance of land snails in Sharkia governorate on date palm shoots. They found that date palm shoots are subjected to severe infestation with the three dominating land snail species, *H. vestalis*, *C. acuta* and *T. pisana* , Monitoring land snail population was carried out during the two successive years, 1991 and 1992, and commencement dates and peaks of snail activity were recorded and the seasonal broods were approximated. Snails were noticed on data palm shoots from January to December for *H. vestalis* and *C.acuta* and from February to November for *T. pisana* and *H. vestalis* was the most abundant snail on date palm shoots all over the whole year round where the commulative mean number being 564 - 597 individuals per shoots,

followed by *C. acuta* (495.7 - 523.9 individuals) then *T. pisana* (303.0 - 346.9 individuals) for 1991 and 1992, respectively.

Mohamed (1994) studied the population dynamics of mollusca species on ornamental plants in Helwan. She found that, the highest numbers of three tested snail species; *H. vestalis*, *E. vermiculata* and *M. obstructa* were occurred during the months of Autumn and Spring seasons; while the lowest were in Winter. Also, in Masr El-Kadima, the highest population density of *H. vestalis*, *M. obstructa*, *E. vermiculata* and *H. aspersa* were recorded during May, November, October and February months. In El-Mohandsen nursery, the highest number of *M. obstructa* was occurred on coaches palm plants during May; while the lowest was in January during November.

El-Deeb et al. (1996 a) studied the population dynamics of some land snails at three Delta Governorates of Egypt (Kafr El-Sheikh, Demietta and Dakahlia), from July 1994 to June 1995. They found that, *M. cartusiana* snail was abundantly found on Egyptian clover; while *E. vermiculata* snail severely infested fruit trees and ornamental plants through out the different seasons. The relative abundance of the common land snails species was cleared at *M. cartusiana* reached its peak during April month, while *E. vermiculata* snail reached during Autumn and Spring seasons. On the other hand, *Helicella sp.* and *C. acuta* appeared with high numbers during May and January months.

Ismail (1997) studied the population density of *M.cartusiana* on field and vegetable crops in certain localities of Sharkia Governorate. it was obviously increased during Spring months as compared to the population density during Winter and Autumn months. While the infestation did not appear during Summer months. Moreover, Egyptian clover harbored the highest numbers of *M .cartusiana* followed by cabbage and wheat, while broad bean and pea showed the lowest number.

Hegab et al. (1999) found that population densities of *M.cartusiana* and *E.vermiculata* were higher during March, April, May and June months. The land snails were found on different crops at nine localities representing four localities of Sharkia Governorate. They added that Egyptian clover harbored the highest numbers of *M. cartusiana* followed by wheat, while broad bean showed the lowest numbers. Mandarin orange sustained the highest of *E. vermiculata*, while the olive trees showed the lowest numbers.

El-Deeb et al. (1999) indicated that, *E.vermiculata*, *T.pisana* and *H.vestalis* were prevailed all species on field crops, vegetable crops and fruit trees orchards at Behera governorate. The population density of land snail species could be arranged in descending order as follows: *T.pisana* > *E.vermiculata* > *H.vestalis* > *M.abstructa* > *Oxychillus sp.* The relative abundance of land snail species considerably differed according to snail species, year season, location and plant species.

Abd-El-Karim (2000) recorded the population dynamics of *E. vermiculata* snails at Kafr-El-Sheikh Governorate in five study locations namely; Biala, Hamool, Desok, Balteem and Kafr-El-Sheikh. Duranta plants were the most vulnerable for this species all year, guava in Balteem and Banana in Biala were also studied among different year months. Number of collected snails fluctuated from month to another and two population peaks were recorded during April and December (27 and 25 snails / tree on guava in Balteem) and (66 and 75 snails / tree during March and December on Banana in Biala).

Abd El-Aal (2001) illustrated that Egyptian clover harbored the highest numbers of *M. cartusiana* followed by cabbage while broad bean contained the lowest number. The population density of *M. cartusiana* was obviously increased during Spring months (March, April and May) as compared to low or moderate values during Winter and Autumn months. The infestation did not appear during Summer months. Also, navel orange harbored a relatively high numbers of *H. vestalis* followed by mango and guava was the least one in this respect. *H. vestalis* was gradually increased after Winter months to reach the maximum values during Summer months.

Mortada (2002) found that the initial infestations of *M. cartusiana* were recorded in the beginning of October on Egyptian clover and broad bean while wheat, the initial infestation was

appeared later in the beginning of November. He mentioned that the initial infestations of *M. cartusiana* were detected as adult stage on all field crops, while Juveniles were observed later. The population density of *M. cartusiana* was obviously increased during Spring months as compared to low or moderate values during Winter and Autumn months.

Metwally *et al.* (2002) studied the seasonal population growth of *M. cartusiana* land snail on certain field and vegetable crops and *E. vermiculate* snail on certain ornamental plants at Monofia and Gharbia Governorates. At Monofia Governorate, they found the total counted *M. cartusiana* snails on the tested crops (cabbage, pea, lettuce, cauliflower, broad bean, Egyptian clover and wheat) in the two seasons were (10.3-91.8), (32.6-32.6), (63.2-61), (141-138.4), (93.2-94.6), (146.2-143) and (139-129.8) respectively. While at Gharbia Governorate, were (161-136.2), (44,8-48.6), (46.2-37), (110.2-95), (104-95.6), (155.6-155.6) and (117.2-107.8) respectively. Concerning *E. vermiculata* snails, the mean number of snails on (onions, sansveria, pertchardia, garonia, gladules, duranta and nastartuim) at Monofia Governorate during the two seasons were (29.03-29.6), (13.38-13.8), (15.95-16.08), (12.05-15.6), (33.7-41.38), (15.78-18.78) and (49.05-49.08) individuals / quadrate respectively while at Gharbia Governorate, the mean numbers / host were (30.23-26.47), (16.9-18.33), (19.19-22.4), (23.25-25), (22.43-23.73), (20.87-1945) and (38.78-49.2) respectively.

Mahrous et al. (2002) recorded that population density of land snails differed according to host plant and locality. They found on field crops. The highest population density of *M.cartusiana* per 50 × 50 cm was detected on Egyptian clover with range of 20.1-42.6 followed by broad bean (11.4-29.7), wheat (11.1-19.4) maize (6.1-12.3) and sugar-cane 6.6 individuals. On the other hand, the population density of *E.vermiculata* on Egyptian clover, wheat, broad bean and maize were 10.1, 8.4, 6.2 and 3.2 individuals respectively. On vegetables the highest population densities of *M.cartusiana* per 50 X50 cm were recorded on cabbage (18.9-28.2) and lettuce (14.2-22.2) individuals. On the other hand. *E.vermiculata* was estimated on cabbage and lettuce with population density ranged from 10.4 to 18.1 snails. *M.cartusiana* was detected on all fruit trees with a relatively low population density; while *E.vermiculata* population density on navel orange, mango and guava ranged from 4.9 to 29.1 individuals.

Nakhla et al. (2002): studied the population activity of the clover land snail, *M. obstructa*, which is a destructive pest to field vegetable and ornamental crops as well as some fruit orchards. Monitoring studies were carried out in an apple orchard interplanted with Egyptian clover at El-Saff, Giza Governorate, during two successive years from October (1997) to September (1999). *M. obstructa* was found on apple trees all the year round with peaks during June and July up to September, 1998 and 1999. The maximum abundance took place during Summer (54%) followed by

Spring (26%), while they were 15 and 5% during Autumn and Winter, respectively. *M. obstructa* attacked the Egyptian clover fields from October and increased during the following months to reach maximum abundance at the end of the season in May of the next year. The two highest seasonal activities were achieved during Winter (46%) and Spring (43%) seasons. Accordingly, it is preferred not to inter plant apple orchards with Egyptian clover since the later is a preferable host to *M. obstructa*.

Idrees (2003) studied the population dynamics of *M. cantiana*, *C. acuta* and *T. pisana* species on Guava and orange trees during 1999/2000. *C.acuta* recorded the highest population during April (342 individual / tree) followed by *M. cantiana* that recorded (299.6 individuals / tree) during May month, while *T.pisana* recorded (126.7 individual / tree) during March. The lowest population for the previous species recorded (8.7, 2.3 and 5.1 individuals / tree) during October, January and October, respectively. On the other hand, orange trees were highly infested with *M. cantiana* recorded 113.1 individuals tree during June while *C.acuta* infestation was 57.6 individuals tree during April. Also, *T. pisana* was recorded 16.6 individuals tree during April.

Abd El-Wahab (2004) studied the population dynamics of land snail species, *E. vermiculata* at Dakahlia Governorate on ornamental plants at El-Mansoura district and *S. putris* on Egyptian clover at two successive growing seasons 2000 – 2002. Data

revealed that the population density of *E. vermiculata* snails reached their minimum values on Jasmine, Alocasia and Thuja ornamental plants during two successive seasons at (September and February). While *S. putris* exhibited their minimum numbers on Egyptian clover, broad bean and Wheat during the two seasons at [(October and February), (November and February), (November and March) and (January and March)], respectively.

Mohamed (2006) studied the population density of land snail *M. cartusiana* on Egyptian clover fields in three different Governorates (Fayoum, Giza and Sharkia) during November 2003 to June 2004. She stated that the infestation by *M. cartusiana* was found early with an average low population density (7.1 individuals per quadrat 50 x 50) cm in November on soil of clover field at Sannoris district. While the maximum population density of this species was recorded in April at Fayoum and Giza with an average of 90.1 & 14.2 individuals for the former location and 58.0 & 21.2 individuals for the later; on soil and plant respectively.

2. Toxicological Studies:

a. Effect of Pesticides, oils and mineral salts on land snails.

Godan (1965) studied the repellent effect of carbamate compounds at high concentration 2.0% and attractiveness at low concentrations 0.1%. Data indicated that mexacarbate had the strongest repellent effect followed by carbaryl and Zectran while

isolan was the lowest one. **The same author in (1967)** tested the molluscicidal effects of carbaryl, isolan and mexacarbate as contact and anti-feeding against snails *Cepaea nemoralis* (L.) *Helicigona arbustorum* (L.) and *Helix pomatia*. Carbaryl was found to be less effective and unsuitable for practical application, since 100% mortality was achieved only with the most sensitive species (*C. nemoralis*), and only at a concentration of 1%. However, lethal dose of other carbamate, isolan and mexacarbate were toxic for *C. nemoralis* at concentrations of only 0.12% and 0.05%, respectively.

Anonymous (1971) it was found by Bayer company at west Germany that a wheat bran bait containing 2% Mesurol gave 83% mortality of European black slug and brown garden snails. Control ranged between 50% and 100% and Mesurol provided equal or superior control in almost cases. Test data was counted 84 hours later and indicated that Mesurol gave longer control than Metaldehyde.

This study proved that when land mollusca treated with a contact spray or dust they secrete immediate copious mucous secretion which often carries away any chemical before it can do its job.

El-Okda (1976) found that baits which contained 0.1 % (100 PPM) Lannate did not prevent *Theba pisana* snails from feeding for two days without any mortality. While snails fed on 0.5 % Lannate in baits and contacted for 4 days gave 100 % mortality.

Issa et al. (1977) used Rogor 40% as contact and bait on two different species of land snails; *T. pisana* and *Cochilcella*

acuta. Data showed that LC₅₀ values were 3512 and 4006 ppm for *T. Pisana* and *C. acuta*, respectively.

El-Okda (1979) evaluated the molluscicidal action of Methomyl and Aldicarb at 1.0 % concentration against snails *H. vestalis*, *T. pisana* and *E. vermiculata*. Results showed that Aldicarb was more toxic than Methomyl against *H. vestalis* and *T. pisana* but Methomyl showed higher mortality percentage than aldicarb against *E. vermiculata* whereas methomyl gave 100.0 % mortality after 4 and 6 days for *H. vestalis* and *T. pisana* while it occurred post 3 and 4 days in case of aldicarb. Concerning, *E. vermiculata*, methomyl caused 100.0 % mortality after 6 days but aldicarb gave the same result after 8 days from the treatment.

El-Sebae et al. (1982) tested Methomyl (du pont-1642) and Aldicarb against the land snails *H. vestalis*, *E. vermiculata* and *T. pisana* as bait containing 0.5% methomyl or aldicarb. The result revealed high-attracted action and toxicity for land snails. Bran bait containing aldicarb gave higher mortality than Methomyl after 5 days. Also, data revealed that the presence of 0.15% Methylene blue in bran baits increased the mortality percentage. It was suggested that methylen blue could be used in increasing the toxic potency through its effect as an attractant.

El-Okda (1983) evaluated the toxicity of five pesticides; Metaldehyd, Aldicarb, Methomyl (Du pont-1642), Vydate and Mesurol as bran bait 0.5 % on the beneficial snails *Oxychilus sp.*,

under laboratory condition. All tested compounds gave high mortality percentages after 5 days baiting except metaldehyde, which revealed lower toxicity.

Godan (1983) observed a shock reaction of gastropods on contact with metaldehyde. The animals at first crawled around energetically, to escape from the treated area: in the experimental dishes, they were collected along the molluscicide free edge. They subsequently tried to avoid contact with the metaldehyde by using their own mucus trail or that made by another member of the same species. In addition, data showed different sensitivity levels at different times in the lifespan of a gastropod and have determined the length of each of these phases.

El-Okda (1984) studied the molluscicidal effect of Methomyl bait against *Monacha sp.* It gave 90 % mortality in clover field, wheat, vegetables and orchards. On the other hand, it exhibited a poor results against *Oxychilus sp* (12-35 % mortality).

El-Okda et al. (1989) studied the efficacy of the formulated local 0.5% Aldicarb, Oxamyl, Methiocarb, Lannate and Metaldehyde in controlling the land snails *H.aspersa*, *E.vermiculata*, *T.pisana*, *R.decollata*, *Limax sp.* and *Oxychillus sp.*, The results indicated that, Aldicarb, Methomyl, Oxamyl and Lannate gave the highest toxicity against the most snail and slug species, while Methiocarb and Metaldehyde were less toxic. They also reported that *Limax sp.*,

T.pisana and *Monacha sp.* showed unexpected inverse response towards almost toxicants.

Radwan et al. (1992) tested five molluscicides as 0.5% bran baits against *T.pisana* under laboratory conditions. The LT_{50} for Aldicarb, Aldoxycarb, Methomyl, Oxamyl and Thiofanox were 5.77, 4.69, 2.31, 3.97 and 6.67, respectively.

El-Bahi et al. (1992) studied the molluscicidal action of Diazinon 4%, Dimethoate 40%, Baylaucide and Copper sulphate against terrestrial snail *Pleurodonte orbiculata*. Results showed that dimethoate was the most safe and efficient in controlling these snails even when used in its recommended dose in the field. Copper sulphate and baylauscide gave low effect at 30 PPM and 1 PPM, respectively, where only 40% and 30% from the exposed snail died after 3 hours exposure, respectively. Diazinon gave 45% mortality after 2 hours when used at rate 4ml/liter, while exposure of snails to Dimethoate used as spray on the fruit trees was found to be more efficient and gave 50% mortality after one hour and reached 100.0% after 3 hours.

Nakhla et al. (1993 b) studied the effect of some inorganic salts against the small garden snail, *T.pisana* during 1992 activity season. Copper sulfate, Sodium fluoride, Sodium chlorate, Sodium pyrophosphate and Potassium cyanate were tested as bran at concentration of 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 6.0 and 8.0 %. Copper sulfate showed the highest percent mortality (95-100 %) at

concentration of 0.5 and 1.0%, while the LC_{50} was 0.2554 and LC_{95} was 0.496. On the contrary, potassium cyanate was the least effective compound that until concentration of 80 % the mortality was only 45%. Sodium fluoride, Sodium chlorate and Sodium pyrophosphate showed 93.3 & 100, 91.0 & 100 and 88.0 & 100% mortality, respectively, at concentrations of 6.0 and 8.0% respectively. The LC_{50} & LC_{95} values were 1.130 & 6.673, 22.404 & 6.456 and 2.325 & 6.834 for these compounds respectively.

Awad (1994) evaluated four pesticides i.e., Temik, Furadan, Skipper and Mesurol under laboratory conditions against *Succinea putris* and *M. cartusina*. Results revealed that adult snails were more sensitive to pesticidal action than young stages. Temik and Furadan had significant potency exceeded to the pesticidal activities than *M. cartusina*. The mean mortality percentage of Temik and Furadan averaged 92.0 & 84.9 and 87.4 & 90.86 % for adults of *M. cartusiana* and *S. putris*, respectively. For young stages, these values averaged 84.3 & 80.29 and 70.7 & 81.43 % respectively.

Ghamry *et al.* (1994) evaluated nine insecticides namely Chloropyrifose, Dimethoate, Triazphos, Profenos, Fenthion, Methamidophos, Fenitrothion, Alphamethrin and Cyfluthrin as bait at 0.5, 1.0 and 2.0% against two land snails *M. contiana* and *E. vermiculata*. Chloropyrifos and dimethoate only exhibited pronounced effect on the two tested species, *Monacha sp.* was more susceptible than the other specie. Results from bait tests revealed

that Chloropyrifos and Dimethoate were effective for killing snails after 12 day of exposure under laboratory condition. On the other hand, the same trend was observed with these insecticides when used at 2.0 % bait after 9 days under the field condition.

Nakhla and El-Sisi (1995) evaluated some inorganic salts as bran bait formulation at the rate of (0.125, 0.50, 1.0, 2.0, 4.0, 6.0 and 8.0%) for controlling the small garden snail, *T. pisana* in laboratory. The results indicated that: Copper sulfate showed high mortality percentages (95-100%) at the concentration 0.5 and 1.0%. the LC_{50} was 0.2554 and LC_{95} was 0.4964. Potassium cyanate was the least effective and the concentration 8.0% produced 45% mortality. Sodium fluoride, Sodium chlorate and Sodium pyrophosphate each at the concentrations 6.0 and 8.0% gave 93.3 and 100, 91.0 and 100, 88.3 and 100% mortality, respectively. The LC_{50} and LC_{95} reached 1.130 and 6.073, 2.404 and 6.456, 2.325 and 6.834 respectively.

El-Wakil and Mesbah (1995) studied the effect of spraying Copper sulfate solutions on the infestation rate of *T. pisana* snails in broad bean field. There was a significant decrease in the number of snails among different treatments as compared to the control group. Moreover, there were significant differences in the productivity of treated plants as well as on decreasing the number of snails infesting plants. The concentrations of 1.5gm/L. Copper sulfate solution gave the highest productivity of the plants and exhibited a significant

decrease in the number of infested snails as compared to control group.

Mourad and Zedan (1996) tested the molluscicidal efficiency of four pesticides. Nudrin (belong to carbamates) in addition to 3 organophosphorous (methamidophos, profenofos and chlorpyrifos methyl) against the land snail, *M.obstructa*, using leaf dipping technique. Also, Nudrin was tested as a bait. The effect of sublethal concentration, LC_{50} and LC_{25} of Nudrin and methamidophos on the activity of transaminase enzymes (ALT and AST) in the soft tissue of snails *M. obstructa* colorimetrically. Their results indicated that LC_{25} and LC_{50} of Nudrin and methamidophos caused a variable increase levels in the activity of ALT, while for AST activity it was clear that methamidophos increased its activity except at LC_{50} at seven days interval, also LC_{50} of Nudrin showed marked increase in activity of AST, while LC_{25} showed slight decrease.

Okka et al. (1996) tested the effect of methiocarb as a bait or spray against land snail *M. contiana* under laboratory condition. Results revealed that methiocarb as a spray at a rate of (2.0kg/fed) was effective and mortality percentage was 80.0% after three days of exposure. While it gave 90% mortality after six days of application when used as bait.

Ismail (1997) evaluated eight pesticides i.e Aldicarb, Carbofuran, Oxamyl granules, Oxamyl EC, Fenamiphos, Fenthion, Ethoprop and Brmoxynil against *M.cartusiana* under

laboratory and field conditions. Data revealed that under laboratory conditions oxamyl EC proved to be the highest toxic one followed by aldicarb, fenthion, ethoprop, oxamyl granules, bromoxynil and carbofuran, while fenamiphos showed the lowest effectiveness. However, under field conditions, the organophosphorous compounds induced the highest potency in this respect. Percentage of snail reduction during the first three days after treatment were 75.9, 73.5 and 83.5% for fenamiphos, fenthion and ethoprop, respectively.

Zedan (1999) evaluated the efficacy of Niclosamida 70 % WP as land snail molluscicide against *M. obstructa* under laboratory and field conditions. He showed that a spray concentration of 1 gm / m² (384 PPM) gave 93.33 % mortality after 24 h. and as a dusting with 2 gm /m² gave 93.3 % mortality. As a bait, Niclosamide 70 % WP was the most effective one followed by Temik granules 10 %, Niclosamide granules 21 % and Skipper granules 4 % mortality % were 90, 86.7, 63.3 and 43.3 respectively . He stated that niclosamide 70 % WP as a spray with rates of 0.1, 0.2 and 0.3 gm /m² gave 54, 80.8 and 86.3 % reduction of snails population infesting pea field during 1997 & 1998 seasons.

El-Zemity et al (2001) studied the molluscicidal activity and repellent properties of thirteen monoterpenoidal compounds against the snail, *H. aspersa*. Camphoe, thymol, (R)- Carvone and Carvacrol proved to be potent molluscicides. Of the compounds tested, only citronellol, geraniol, (+ or -) menthol and thymol were

highly effective as repellents. The use of piperonyl butoxide and triton x-100 to improve the efficacy of the highest contact active compounds was also investigated. All combinations of the tested monoterpenoids with triton x-100 in 1:2 ratio notably increased the molluscicidal activity over methiocarb. However, piperonyl butoxide only enhanced the molluscicidal activity of terpinene-4-ol.

Ismail *et al.* (2001) studied the effect of four chemicals namely (Aldicarb 15 %, Copper sulfate, Aluminium sulfate and Magnesium sulfate) and four dry leaf powders of herbs namely (*Malabar nut tree*, *Adhatoda vasica* Ness, *lamb's quarter*, *Chenopodium album* L., *common flea bane*, *pulicaria dysenterica* Gaertn and *Marsh flea bane*, *Conyza dioscoroidis* Desf.) as poisonous baits against land snail adults of *E.vermiculata* under laboratory and field conditions. Results revealed that Aldicarb showed highly efficacy than the tested inorganic salts (Copper sulfate, aluminium sulfate and magnesium sulfate) under laboratory and field conditions. Copper sulfate appeared to be the most effective salt than the other two inorganic salts (aluminium sulfate and magnesium sulfate). As for herbs, dry leaf baits of *Malabar nut tree* was the most effective, while dry leaf baits of *common flea bane* recorded the lowest effective under laboratory and field condition.

Abd-El-All (2005) studied the efficacy of both five screening methods and four molluscicides against the two land snail species,

M. cartusiana and *Succinea putris*. The screening methods were dry soil, wet soil, lettuce leaves either sprayed or dipped for 10 seconds in the toxicant and Petri dish glass, all applied with 2% methiocarb 75% wp. The molluscicides used were methiocarb, aldicarb, carbofuran and thiodicarb. The experiment was conducted under laboratory conditions of 18-25 degrees C° and 48 to 60 RH%. The results revealed that the controlling the chartreuse snail. *M. cartusiana*. This might be due to the high frequency probabilities for snails individuals to contact the toxicant during their increased motional activities. Adults snails were more sensitive to molluscicidal action than young snails. The potency of aldicarb and carbofuran significantly exceeded that of methiocarb or thiodicarb. *S. putris* snail seemed to be more susceptible to the molluscicides than *M. cartusiana*. The molluscicidal potency for each of the tested materials was negatively correlated with their potencies. The response of *M. cartusiana* to aldicarb was faster than that of *S. putris* showing LT₅₀ of 3.19 and 4.90 for each of the two snail species, respectively.

Salem et al. (2006) studied the application of certain pesticides including the biopesticide Protecto as poisonous baits in April during the activity period of land snails. In this respect, the highest values of percent reduction were detected with methomyl and glyphosate with general means of 61.35 and 52.70 % for *E. vermiculata* and 67.25 and 57.55 % for *M. cartusiana* respectively,

while fenamiphos, sethoxydim and malathion gave moderate effect. However, Protecto was the least effective one in this respect.

b. Effect of plant Extracts.

Hamdy and El-Wakil (1993) studied the molluscicidal and the antifeeding activity of the cardenolide extract isolated from the latex of *C. procera*, *T. pisana* (Muller) and *H. vestalis* and it was compared to that of Lannate. The results showed that the extract was 28 times more toxic to *T.pisana* than Lannate. (LD₅₀ for the extract was 3.8 µg/snail, while Lannate was 105.8 µg/snail). The extract was also highly toxic to *H.vestalis* (its LD₅₀ was 4.4 µg/snail). Addition, the extract was also found to have strong antifeeding activity. Where the concentrations of 0.52 µg/cm² and 1.3 µg/cm² gave 100% protection to lettuce leaves against the mentioned species, respectively, while Lannate up to 19.5 µg/cm² did not protect the plant. The results assert the presence of highly effective and selective natural products, that may replace the synthetic organic pesticides, which cause serious environmental hazards.

Ghamry (1994) tested Five cruciferous seeds powder from cabbage (*Brassica oleraces*), cauliflower (*Brassica oleracea botrytis*), garden rocket (*Eurica sativa*), radish (*Rophanus sativus*) and turnip (*Brassica napus*), in a screening study against three land snail species, i.e. (*E. vermiculata*, *M. obstructa* and *Cepaea nemoralis*) in laboratory. Cabbage and cauliflower seeds powder

only gave pronounced effect, so they were extracted by ethanol, acetone, cold or boiled water. Crude extracts were tested by three different methods: as baits, or topically on the animal body through the shell mouth or as water pool at 0.5 ml depth level. Results revealed that powders and crude extracts of cabbage and cauliflower seeds were the most effective natural products for killing snail after 3-10 days. Ethanol or acetone extracts into bait were effective only, against the snails *M. contiana* and *C. nemoralis*. Topical application test of cabbage seeds extract by ethanol and acetone gave high percentage mortality reached 100%, while cauliflower seeds extracts occupied the second categories. The same trend was observed by water pool test, otherwise all boiled seeds extracts in water were not effective.

Ghamry et al. (1994) studied the effect of five plant leaf extracts; *Hyoscyomus nuticus*, *Digitaria sanguinalis*, *Bitter apple*, *Safir* and *Canna indica* in screening test against two land snail species i.e. *E. vermiculata* and *M. contiana* in the laboratory. *Hyoscyomus nuticus* extracts gave only pronounced effect. Their ethanolic crude extracts were tested by two different methods; as bait or topically on the animal body through the shell mouth. Results revealed that when crude ethanolic extract of *Hyoscyomus nuticus* incorporated into baits gave latent effect for killing the two snails after 9 days 75.0% and 88.0% of mortality for *Eobania sp.*, and *Monacha sp.*, respectively. While topical application test of the same extract of *Hyoscyomus nuticus* gave 100.0% mortality to

Monacha sp., and 90.0% to *Eobania sp.*, *Canna indica* extracts had no effect.

Ghamry (1997) tested leaves powder of pimpernel plants (*Anagallis arevensis*) and cortexes of fruits pomegranate (*Punica granatum*) as baits against the two land snails i.e. *E. vermiculata* and *M. cartusiana*. Also, they extracted the same plants by using methanol, ethanol and boiled water and tested in baits or applied topically direct on the animal body through its shell mouth. Results revealed that these powders and crude extracts as baits of pimpernel leaves and pomegranate fruits cortexes, mostly, effective for killing the land snail species after 1-19 day from treatment. Topical application test, for methanol, ethanol and water extracts of pimpernel leaves and ethanolic extracts of pomegranate fruits cortexes gave highly percent mortality reached 100%. On the other hand, boiled water extracts either from pimpernel leaves or fruits extracts came next after methanol and ethanol extracts. Under the field condition, powder bait of leaves caused 64 and 74% mortality for *Monacha sp.*, after 25 days from the beginning of treatment during the growing seasons of (1996 and 1997), respectively.

Morsy et al. (1998) tested four solvent extracts of each of Lemongrass (*Symbopogon citratus*), Santonica (*Artemisia cinae*) and Pomegranate (*Punica granatum*) against the 3rd instar larvae of *Chrysomya albiceps*. The pomegranate extracts showed the larvicidal activity with LC₅₀ ranging between 25 ppm

(acetone extract) and 280 ppm (chloroform extract). The Santonica showed larvicidal activity with LC_{50} ranging between 48 ppm (ethanol extract) and 380 ppm (acetone extract). The Lemongrass showed activity with LC_{50} ranging between 135 ppm (ethanol extract) and 570 ppm (chloroform extract). So, the most effective action in accordance to LC_{50} was the acetone extract of pomegranate, followed by ethanol extract of Santonica and lastly ethanol extract of Lemongrass. The slope functions of these three extracts were 4.6, 2.8 and 8.22 respectively. The shift to insect control by plant extracts have the way to a some what healthy environment.

Okka (1998) studied the effect of fifteen plant extracts to control land snail *T.pisana*. The plant parts (leaves of five species, roots of one species and seeds of the other nine species) were grinded to powder. The crude extracts of these fifteen materials were tested as baits against the land snail *T. pisana*) under laboratory conditions. The effective materials were extracted by commercial alcohol 75%. The results showed that crude extracts of Olives, Roseberry, kloquat, tamarind, celery and thyme were showed the highest toxic, followed by fleabane, liquorice, parsley and fennel, while, garden rocket came at least category of natural products for killing snail after one day exposure. On the other hand, the crude extracts of castor beans, carob, spearmint and nigella gave percentage mortality (60 to 65%) mortality after one day from treatment.

Hussein et al. (1999) tested the molluscicidal activity of Methomyl, Methiocarb and Cardenolide (Cardiac glycoside) extract against the land snail *M. obstructa* as contact test. The results revealed that the LD₅₀ values of the extract after 24h of treatment was 60.9 µg/snail whereas the LD₅₀ values of two tested carbamate pesticides after 72h of treatment were 11.9 and 27.4µg/snail, respectively.

Zedan et al. (2001) studied the repellency potential of some crude plant extracts i.e., neem, spotted gum, oshar, cauliflower, santonica, radish, peppermint, khilla, alocasia and cabbage, when extracted with hexane and ethanol on three land snail species, i.e., *E.vermiculata*, *M.obstructa* and *T. Pisana*. All tested ethanolic extracts exhibited high repellency effects, while hexane extracts failed to gain satisfactory repellency against the three tested snails. The repellency percentage ranged between 71.48 and 100.0% for khilla against *E. vermiculata*, and from 75.0 to 100.0% for oshar and khella against *T. Pisana*.

Ebenso (2004) studied the effect of 350, 500 and 700 mg kg⁻¹ of crude extracts of Neem, *Azadirachta indica* A Juss, on edible tropical land snails *Archachatina marginata* and *limicolaria aurora* (Jay) as bait. Responses were measured through normal feeding, cessation of food intake, cessation of crawling, mucus secretion, lack of response to mechanical stimuli (mortality) and decomposition. Results showed no effects on the controls or snails

exposed to neem seed oil extract. Crude extracts of bark, root and leaf of neem at 500 and 700 mg kg⁻¹ produced mortality after exposure for 48 h for *L. aurora* and 72 h for *A. marginata*.

Soliman (2007) tested the essential oils of *Artemisia herba-alba* (Asso) and *Artemisia monosperma* (Delile) essential oils were tested against three sucking insect pests under laboratory and greenhouse conditions. These pests included *Bemisia tabaci* (Gennadius), *Aphis gossypii* (Glover) and *Thrips tabaci* (Lindman). Laboratory results showed that the LC₅₀ of *A. herba-alba* and *A. monosperma* were 0.042, 0.186% for eggs and 0.074, 0.075% for immature stages of *B. tabaci*. Also, both oils gave a high toxicity on *A. gossypii* with LC₅₀ 0.023 and 0.085%. *Artemisia herba-alba* and *A. monosperma* were more toxic on *T. tabaci* and *A. gossypii* than *B. tabaci* in the laboratory test. In contrast *T. tabaci* was sensitive for both oils (LC₅₀ 0.011 and 0.038%). These oils were efficient for controlling tested insects on cucumber plants at greenhouses. This treatment caused 85.41, 83.57% reduction in the population of *B. tabaci*, 90.44, 88.00% for *Aphis gossypii* and 87.45, 84.45% for *T. tabaci*. Chemical analysis of *A. herba-alba* and *A. monosperma* oils detected the presence of *hydrocarbon terpenes*, *oxygenated terpenes*, *hydrocarbon sesquiterpenes* and *oxygenated sesquiterpenes* represented about 16.38%, 58.91%, 21.61%, 2.74% and 21.53%, 57.17%, 19.32%, 1.70%, of the oil content, respectively