RESULTS AND DISCUSSION

1. Ecological studies:-

A. Survey of land snails in Egyptian clover and Cotton fields:

The survey of land snails conducted in the fields of Egyptian clover and Cotton in Gharbia and Fayoum Governorates proved the incidence of four common species belonging to one Family, three sub familes and four genera.

The classification and taxonomical position of these specie according to Godan, (1983) as follow:

Phylum:- **Mollusca**

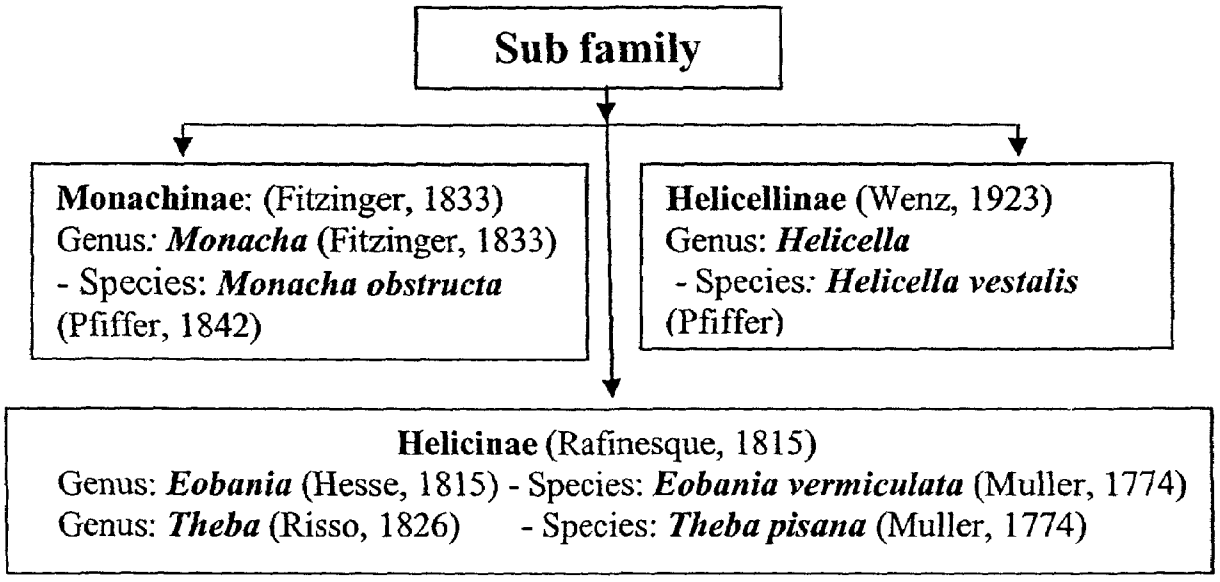
Class:- **Gastropoda** (Cuvier, 1798)

Sub class :- **Pulmonata** (Cuvier, 1817)

Order:- **Stylommatophora** (Schmidt, 1855)

Superfamily:- **Helicoidea** (Rafinesque, 1815)

Family:- **Helicidae** (Rafinesque, 1815)



Discription:

1-Monacha obstructa:- (Pfiffer)

Shell white, almost unicolor except towards the peristome which is of a transparent shade. Its umbilicus is close. (Kassab and Daoud, 1964)

2-Eobania vermiculata:- (Muller)

The shell is dextrally coiled (aperture right-handed). The aperture is more or less oval in outline a slightly thickened lip near the umbilicus. Color of the shell shows great variations, it may be chalky white, with or without a dark apex, or it may be ornamented with several spirally coiled brown bands. The mean diameter of the shell is 14.68 mm, ranging between 13 and 16 mm. the jaw is brown arcuate crossed by two or three darker ribs which protrude ventrally in the form of strong teeth. It measures about 1.7 mm across. Radula, it is about 4mm long. (Bishara, *et al.* (1968):

3-Helicella vestalis:- (Pfiffer)

Shell is depressed and robust with a black apex it has from 5 – 5.5 spires, having a bright white color pattern, its umbilicus is close and free. The shell may reach 12 mm in diameter and a height of 6 – 7.5 mm. (According to Kassab and Daoud, 1964).

4-Theba pisana:- (Muller)

The shell weight (0.38 – 0.45 gm), diameter (1.1 – 1.3 cm) the height were (1.1 cm). this snail varies greatly in shape. (El-Okda , 1979).

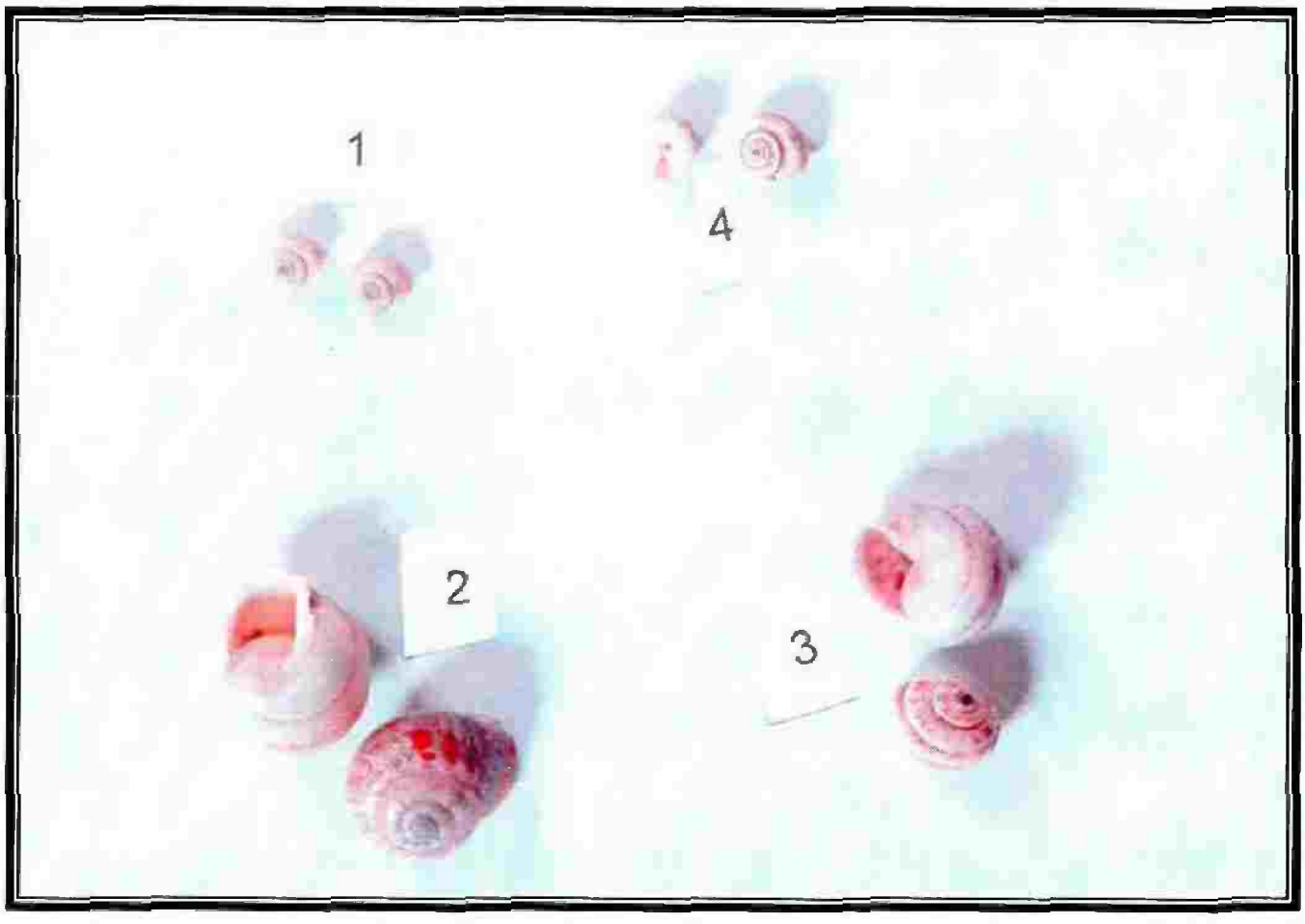


Fig (1). Land snails

1- ***Monacha obstructa***

2- ***Eobania vermiculata***

3- ***Theba pisana***

4- ***Helicella vestalis***

Data revealed that the four species were appeared in two Governorates and were infested the two field crops. It is of interesting to stated that *Monacha obstructa* snail appeared to be the most abundance in occurrence in two surveyed Governorates, than the other snails. Egyptian clover crop was found with heavy infestation than cotton crop

The four surveyed species were previously recorded on Egyptian clover; *M. obstructa* by Kady *et al.* (1983) and Nakhla *et al.* (2002); *E. vermiculata* by Mahrous *et al.* (2002) and Abd El-Wahab (2004); *Monacha cartusiana* by Abd El-Aal (2001), Mortada (2002), Metwally *et al.*(2002), Mahrous *et al.* (2002) and Mohamed (2006).

Some were recorded on cotton fields by Abd El-Wahab (2004) and Mohamed (2006).

The surveyed snail species were also recorded in another different host plants; *M. obstructa* in citrus (Ali and Suleman, 1992); *E. vermiculata* on ornamental plants (Ghamry *et al.*, 1993), in banana orchards (Nakhla *et al.*, 1993); on citrus trees (Hashem *et al.*, 1993), on washngtonia palm (Lokma, 1998); in Duranta plants and guava (Abd El-Karim, 2000); on Wheat, broad bean , maize, navel orange, mango and guava (Mahrous *et al.*, 2002); on broad bean, wheat and sugar cane (Abd El-Wahab, 2004); *H. vestalis* in banana orchards (Nakhla *et al.*,1993); on date palm shoots (Nakhla and Tadros, 1993);

on citrus trees (Hashem *et al.*,1993); *T. pisana* on date palm shoots (Nakhla and Tadros, 1993); on Guava and Orange trees (Idrees, 2003).

B. Population dynamic of land snails in Egyptian clover and Cotton Fields.

Survey studies showed that the four land snails; *Monacha Obstructa* (Pfiffer), *Eobania vermiculata* (Muller), *Helicella vestalis* (Pfiffer) and *Theba pisana* (Muller) were the most abundance and occurrence in Egyptian clover and Cotton fields at Gharbia and Fayoum Governorates. The population dynamics of these species were conducted during the two successive growing seasons 2004 / 2005 and 2005 / 2006.

1. In Gharbia Governorate:-

a. Population dynamics of land snails on Egyptian clover crop during 2004 / 2005 and 2005 / 2006.

Population dynamics of the four land snail species in Egyptian clover at Samanoud district (Gharbia Governorate), during the period from September to August at two successive growing seasons 2004 /2005 and 2005 / 2006 were tabulated in tables (2 & 3) and illustrated in figs (2 &3).

The obtained results showed that the relative abundance of snails in Egyptian clover crop distinctly throughout the months of the first season. *M. obstructa* snails were the most dominant

species followed by *T. pisana*, *E. vermiculata* and *H. vestalis*. Total means/$m^2$of these species during the whole months of 2004 / 2005 were 104.4, 39.2, 31.3 and 20.7 individuals respectively. The highest population density of *M. obstructa* (19.4 individuals/m^2) was recorded during April , while the lowest mean (3.3 individuals/m^2) was recorded during September. On the other hand, the highest mean of snail *T. pisana* was 7.9 individuals/m^2 in April and the lowest was 1.2 individuals/m^2 during September. The highest mean of *E. vermiculata* was 7.3 individuals/m^2 during April and the lowest was 1.1 individuals/m^2 during November but no snail individuals were recorded during September and October. The highest mean of *H. vestalis* was 5.2 individuals/m^2 during April and the lowest mean was 0.6 individual/m^2 during November. On the other hand no snail individuals were recorded and counted during September and October.

During the second season (2005/2006), Data in Table (3) and Fig (3) indicate the fluctuation pattern in population density of land snail species on the Egyptian clover crop. Where the population density of *M. obstructa* recorded the highest mean/m^2during April month (21.2 individuals), while the lowest was recorded during September (4.1 individuals/m^2). *T. pisana* occupied the second order and recorded with different abundance throughout year months whereas, its highest abundance recorded during April (9.1 individuals/m^2), while the lowest was in September (0.8 individual/m^2). *E. vermiculata* came in the third order after the

above mentioned snail species , its population density varied from 1.3 individuals/m^2during November to 7.5 individuals/m^2during April and no individuals of snail species were recorded during September and October. *H. vestalis* ranked in the last order and its population density recorded the highest during April (5.4 individuals/m^2), while the lowest was in November (1.7 individuals/m^2), and no means of snail species were recorded during September and October.

It is clear that snail population at second season were more abundance than those of the first one. This could be attributed to certain climatic factors, where the average values of temperature and R.H% at whole tested periods were (20.7 and 18.2 C^o) and (51.7 and 61.5%) during the two tested seasons respectively.

Table 2. Population dynamic of four land snails on Egyptian clover at Gharbia Governorate, during 2004 / 2005 season, in relation to temperature and relative humidity (R.H).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Sept.2004	0.0	1.2	0.0	3.3	4.5	1.1	26.84	50.9
Oct.	0.0	1.6	0.0	5.3	6.9	1.7	26.58	51.5
Nov.	0.6	2.4	1.1	6.4	10.5	2.6	23.4	52.3
Dec.	1.3	3.1	2.4	9.6	16.4	4.1	18.05	55.5
Jan.2005	2.8	4.5	3.3	11.3	21.9	5.5	15.2	53.7
Feb.	3.3	5.2	5.8	15.2	29.5	7.4	17.11	52.6
Mar.	4.6	7.1	6.2	17.6	35.5	8.9	16.15	51.6
Apr.	5.2	7.9	7.3	19.4	39.8	9.95	19.385	50.1
May.	2.9	6.2	5.2	16.3	30.6	7.7	23.175	47.3
Total	20.7	39.2	31.3	104.4	195.6	48.95		
Over all mean ± SD	2.3 ± 1.93	4.4 ± 2.43	3.5 ± 2.77	11.6 ± 5.82	21.7	5.6	20.7	51.7

L.S.D $_{0.05}$ = 1.84

Table 3. Population dynamic of four land snails on Egyptian clover at Gharbia Governorate , during 2005 / 2006 season, in relation to temperature and relative humidity (R.H).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Sept.2005	0.0	0.8	0.0	4.1	4.9	1.2	25.73	63.48
Oct.	0.0	1.5	0.0	6.2	7.7	1.9	22.54	63.735
Nov.	1.7	2.2	1.3	7.5	12.7	3.2	18.57	65.6
Dec.	1.9	4.1	1.9	8.1	16.0	4	15.77	69.76
Jan.2006	3.1	6.2	3.1	10.3	22.7	5.7	13.65	67.82
Feb.	3.6	8.1	5.6	14.6	31.9	7.98	14.17	57.39
Mar.	4.4	8.3	7.2	18.1	38.0	9.5	16.55	56.92
Apr.	5.4	9.1	7.5	21.2	43.2	10.8	16.55	55.12
May	3.1	5.8	5.5	20.1	34.5	8.6	19.92	53.66
Total	23.2	46.1	32.1	110.2	211.6	52.9		
Over all mean $\pm$ SD	2.6 $\pm$ 1.85	5.1 $\pm$ 3.12	3.6 $\pm$ 2.96	12.2 $\pm$ 6.40	23.5	5.9	18.2	61.5

L.S.D $_{0.05}$ = 2.11

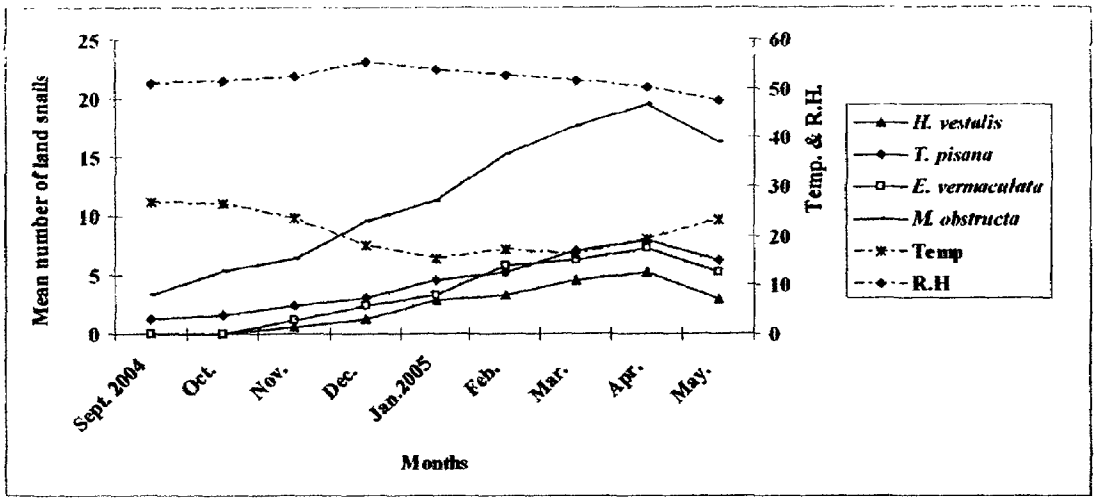


Fig 2. Population dynamic of four land snails on the Egyptian clover at Gharbia Governorate , during 2004/2005 season, in relation to temperature and relative humidity (R.H).

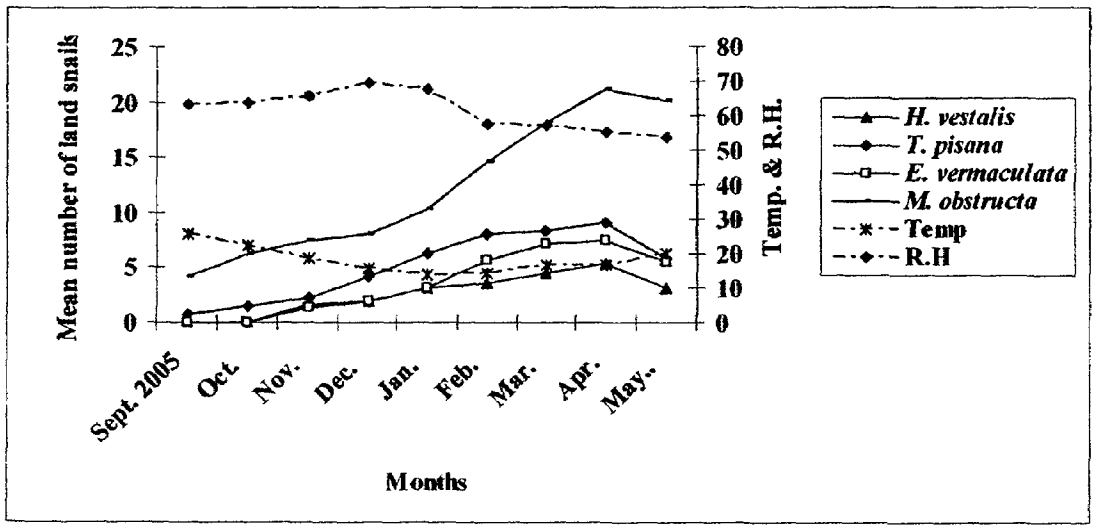


Fig 3. Population dynamic of four land snails on Egyptian clover at Gharbia Governorate , during 2005/2006 season, in relation to temperature and relative humidity (R.H).

b. Population dynamics of land snails on Cotton crop during 2004 / 2005 and 2005 / 2006.

Data in tables (4 & 5) and figs (4 & 5) demonstrate the occurrence of these snails on Cotton crop during the two growing seasons 2004 /2005 and 2005 / 2006. it is clear that the same land snails were recorded on Cotton crop with relative abundance throughout the whole months of growing season. At the first season, *M. obstructa* snails occurred with the highest total mean/m^2 (31.5 individuals) followed by *E. vermiculata* (8.2 individuals/m^2), *T. pisana* (6 individuals/m^2) and *H.vestalis* (3.6 individuals/m^2). Population density of *M. obstructa* ranged between 3.7 individuals /m^2during April to 6.4 individuals/m^2 during September and no snail individuals were counted during March. No individuals of *E.vermiculata* were recorded on Cotton crop during March and April whereas the mean/ m^2 number ranged between 1.1individuals/m^2 during July to 2.6 individuals/ m^2 during September. Population density of *T. pisana* was ranged between (0.7 individual/m^2) in July to (1.6 individuals/m^2) in September, and was nil during March month. *H. vestalis* disappeared on cotton crop during March, June and July months and recorded the highest density (1.3 individuals/m^2) during September while the lowest was recorded during April (0.4 individua/m^2) as represented in Table (4) and Fig (4).

Concerning the second season (2005 / 2006), Table (5) and fig (5) show that the *M. obstructa* was the predominant species and existed in high mean/m^2 during the different months of the season. Its population density recorded the highest mean during September month (8.1 individuals/m^2), while the lowest was during July (4.5 individuals/m^2). *E. vermiculata* occupied the second order and recorded different abundance throughout year months, whereas its highest abundance recorded during September (3.5 individuals/m^2), while the lowest was in April (0.2 individual/m^2), *T. pisana* came in the third order after the above mentioned snail species. Its population density varied from 1.0 individuals/m^2 during April to 1,7 individuals/m^2 during September and no snail individuals were counted during March. *H. vestalis* ranked the last order and its population density recorded the highest during September (1.5 individuals/m^2), while the lowest was in Jul (0.5 individuals/m^2), and no individuals were counted during March and jun. The total mean/m^2 of land snail population could be arranged according to their relative abundance on Cotton crop in the following descending order: *M. obstructa* > *E. vermiculata* > *T. pisana* > *H. vestalis*, whreas their total mean/m^2 during the whole months were 37, 13.5, 7.6 and 4.7 individuals, respectively. Population density recorded the highest mean m^2 during September in all cases, 8.1 , 3.5, 1.7 and 1.5 individuals /m^2 respectively. On the other hand, the lowest means were recorded in July for *M. obstructa* (4.5 individuals/m^2), *H.*

vestalis (0.5 individual), *T. pisana* (0.6 individual/m^2) while for *E. vermiculata* it recorded in April (0.2 individuals/m^2). No snail individuals were recorded and counted during March in all cases for *M. obstructa*, *E. vermiculata* and *T. pisana* but in case of *H. vestalis* no individuals were counted during March and June.

It is clear that snail population at second season were more abundance than those of the first season. This could be attributed to certain climatic factors, where the average values of temperature and R.H% at whole tested periods were (23.4 and 23.8 C^{o}) and (56.5 and 57.3%) during the two successive seasons respectively.

Table 4. Population dynamic of four land snails on Cotton at Gharbia Governorate , during 2004/ 2005 season, in relation to temperature and relative humidity (R.H.).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Mar.2005	0.0	0.0	0.0	0.0	0.0	0.0	16.15	51.58
Apr.	0.4	0.8	0.0	3.7	4.9	1.2	19.385	50.075
May.	0.8	1.2	1.3	5.9	9.2	2.5	23.175	47.32
Jun.	0.0	0.8	1.3	5.1	7.2	1.8	25.23	56.935
Jul.	0.0	0.7	1.1	4.3	6.1	1.5	26.92	59.58
Aug.	1.1	0.9	1.9	6.1	10	2.6	26.945	66.755
Sept.	1.3	1.6	2.6	6.4	11.9	3.1	25.73	63.48
Total	3.6	6	8.2	31.5	49.3	12.7		
Over all mean SD	0.5 ± 0.56	0.9 ± 0.49	1.2 ± 0.94	4.5 ± 2.21	7.1	1.8	23.4	56.5

L.S.D $_{0.05} = 0.8$

Table 5. Population dynamic of four land snails on Cotton at Gharbia Governorate , during 2005 / 2006 season, in relation to temperature and relative humidity (R.H.).

Months	Mean number of the land snails /m2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Mar.2006	0.0	0.0	0.0	0.0	0.0	0.0	16.55	56.92
Apr.	0.6	1.0	0.2	5.2	7.0	1.8	19.92	55.12
May.	0.9	1.6	1.6	6.1	10.2	2.6	23.2	53.66
Jun.	0.0	1.5	2.4	5.9	9.8	5.2	25.86	58.61
Jul.	0.5	0.6	2.7	4.5	8.3	2.1	26.48	61.74
Aug.	1.2	1.2	3.1	7.2	12.7	3.2	28	59.13
Sept.	1.5	1.7	3.5	8.1	14.8	3.7	26.27	55.95
Total	4.7	7.6	13.5	37	62.8	15.9		
Over all mean SD	0.7 ± 0.57	1.1 ± 0.61	1.9 ± 1.38	5.3 ± 2.62	9.0	2.3	23.8	57.3

L.S.D $_{0.05} = 0.9$

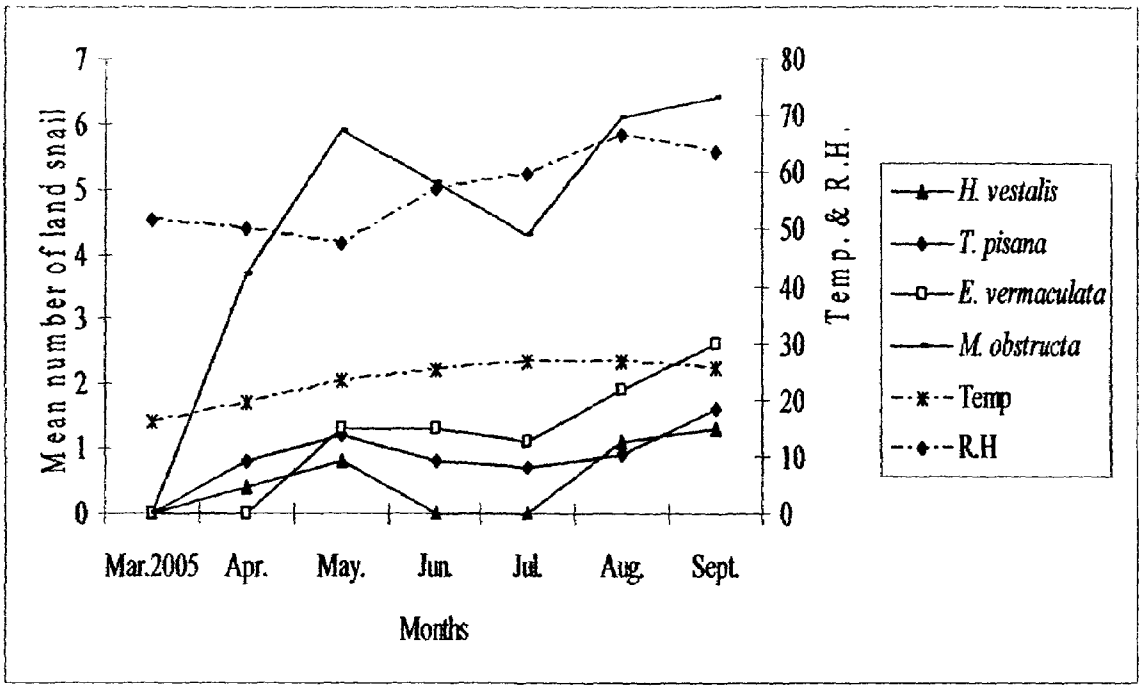


Fig 4. Population dynamic of four land snails on Cotton at Gharbia Governorate , during 2004/2005 season, in relation to temperature and relative humidity (R.H.).

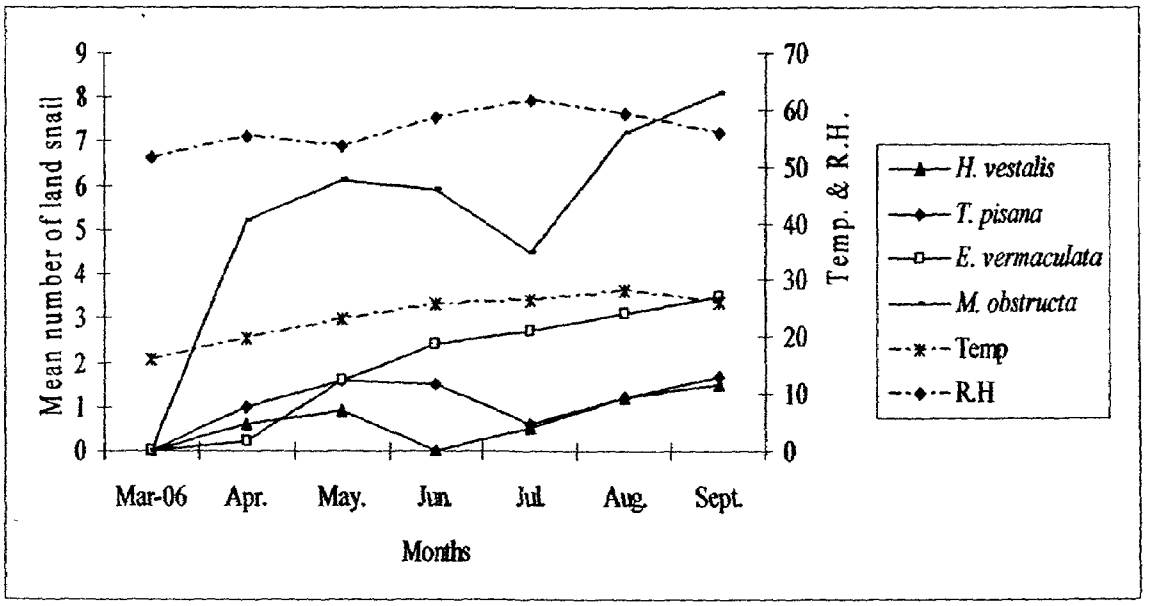


Fig 5. Population dynamic of four land snails on Cotton at Gharbia Governorate , during 2005/2006 season, in relation to temperature and relative humidity (R.H.).

2. In Fayoum Governorate:-

a. Population dynamics of land snails on Egyptian clover crop during 2004 / 2005 and 2005 / 2006.

Data in Tables (6 & 7) and Figs (6 &7) illustrate the population dynamics of the four land snails; *M.obstructa, H.vestalis, E.vermiculata* and *T. pisana.* at Sennores district (Fayoum Governorate), during the period from September to August at two successive growing seasons 2004 / 2005 and 2005 / 2006 on Egyption Clover crop.

The occurrence of the snails on Egyption Clover during 2004 / 2005(table 6 and fig 6) showed that the most common snail, was *M. obstructa*, its peak mean (28.1individuals/m^2) was recorded during April, While the lowest mean (3.8 individuals/m^2) was recorded during September. Total mean/m^2 of this snail species during 2004 was 152.4 individuals. On the other hand, the highest mean of *H. vestalis* was 7.5 individuals/m^2 in April and the lowest was 1.5 individuals/m^2 in November and no snails individuals were recorded during September and October. Total mean/m^2 of this snail species during 2004 was 32.7 individuals.

Regarding the relative occurrence of *E. vermiculata* snails on Egyption Clover during the different months of the study season, the highest mean/m^2 of snails occurred during April 9.1individuals/m^2), while the lowest was in October (0.2 individual/m^2). With total mean 45.4 individuals/m^2 during the months and no snail individuals were counted during December. Population density of *T. pisana* snail during

the different months of the study season show that, The highest mean/m^2 of snail was recorded during April were (10 individuals) , while the lowest was recorded in September (2 Individuals/m^2).

Concerning the second season 2005 / 2006, data in Table (7) and Fig (7) show the mean number/m^2 of the four land snails on Egyption clover at Fayoum Governorate .it is cleared that *M. obstructa* was the predominant species and existed the high mean during the different months of the season. Its population density recorded the highest mean during April (25.7 individuals/m^2), while the lowest was during September (5.0 individuals/m^2). *T. pisana* snail ranked the second order. It occurred with high mean during April (13.3 individuals/m^2) and with a few mean during September (1.8 individuals/m^2). *E.vermiculata* occupied the third order and recorded different abundance throughout season months whereas its highest abundance recorded during April (11.4 individuals/m^2), while the lowest was in October (1.9 individuals/m^2) and no snail individuals were recorded and counted during September. *H. vestalis* came in the last order after the above mentioned snail species. its population density/m^2 varied from 0.7 individual during October to 8.1 individuals during April and no snail individual, were counted during September.It is ofinteresting to state that the mean numbers of land snails were increased with the decrease in temperature in R.H% during the two successive seasons. Numbers of land snails increased during the period of September to April and decreased after that until May.

Table 6. Population dynamic of four land snails on Egyptian clover at Fayoum Governorate, during 2004 / 2005 season, in relation to temperature and relative humidity (R.H.).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Sept. 2004	0.0	2	0.0	3.8	5.8	1.5	26.34	52.62
Oct.	0.0	3.8	0.2	6.2	10.2	2.6	25.06	53.87
Nov.	1.5	4.3	2.2	10.8	18.8	4.7	20.89	54.73
Dec.	3.3	5.2	4.5	15.2	28.2	7.1	14.7	58.84
Jan.2005	4.3	7.3	6.3	17.7	35.6	8.9	14.33	55.35
Feb.	5	7.9	7.6	20.1	40.6	10.2	13.93	54.64
Mar.	6.2	9.2	8.2	25.3	48.9	12.2	17.28	57.81
Apr.	7.5	10	9.1	28.1	54.7	13.7	21.52	50.76
May.	4.9	8.2	7.3	25.2	45.7	11.4	25.47	47.39
Total	32.7	57.9	45.4	152.4	288.5	72.3		
Over all mean SD	3.63 ± 2.66	6.43 ±2.72	5.04 ± 3.48	16.93 ± 8.67	32.06	8.03	19.9	54.0

L.S.D $_{0.05}$ = 2.8.

Table 7. Population dynamic of four land snails on Egyptian clover at Fayoum Governorate , during 2005 / 2006 season, in relation to temperature and relative humidity (R.H.).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Sept. 2005	0.0	1.8	0.0	5.0	6.8	1.7	28.03	52.23
Oct.	0.7	2.9	1.9	7.8	13.3	3.3	23.305	55.47
Nov.	2.1	4.1	3.0	9.9	19.1	4.8	17.68	48.84
Dec.	2.9	6.2	7.2	13.4	29.7	7.4	15.43	59.34
Jan.2006	3.4	8.7	7.9	15.5	35.5	8.9	13	58.44
Feb.	4.7	10.8	9.2	18.9	43.6	10.9	15.31	54.18
Mar.	7.2	11.7	9.9	22.6	51.4	12.9	18	51.94
Apr.	8.1	13.3	11.4	25.7	58.5	14.6	21.84	50.13
May	5.3	10.8	9.8	23.8	49.7	12.4	25.17	49.6
Total	34.4	70.3	60.3	142.6	307.6	76.9		
Over all mean SD	3.82 ± 2.76	7.8 ± 4.19	6.7 ± 4.05	15.8 ± 7.41	34.2	8.5	19.8	53.4

L.S.D $_{0.05}$ = 2.9

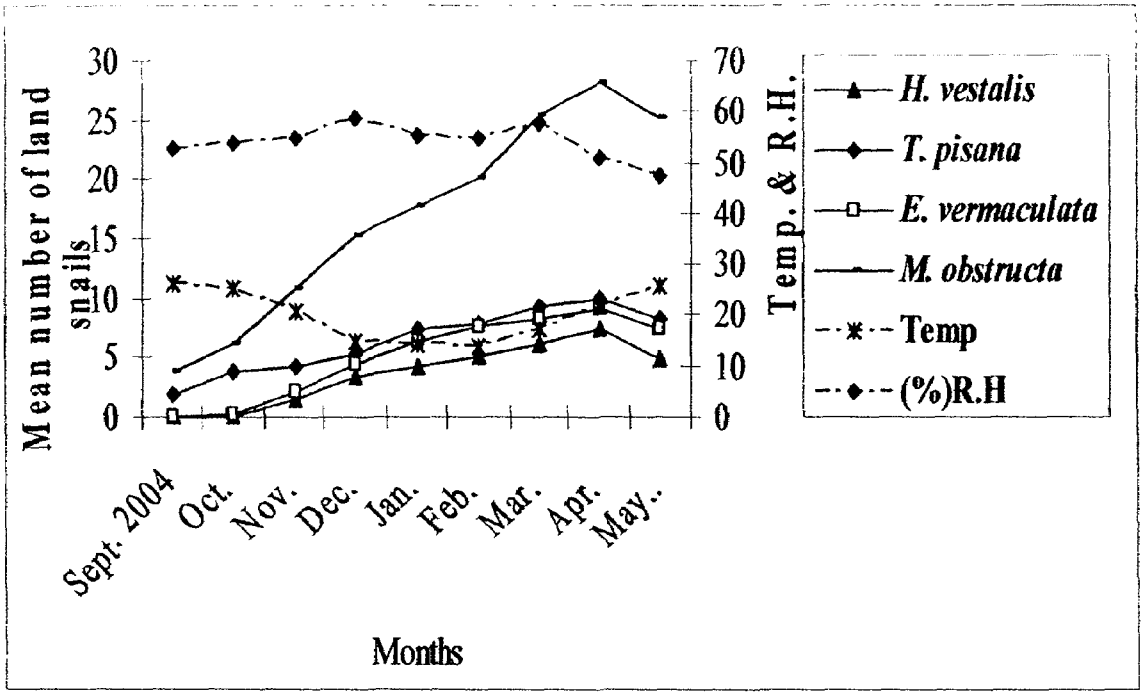


Fig 6. Population dynamic of four land snails on the Egyptian clover at Fayoum Governorate , during 2004/2005 season, in relation to temperature and relative humidity (R.H.).

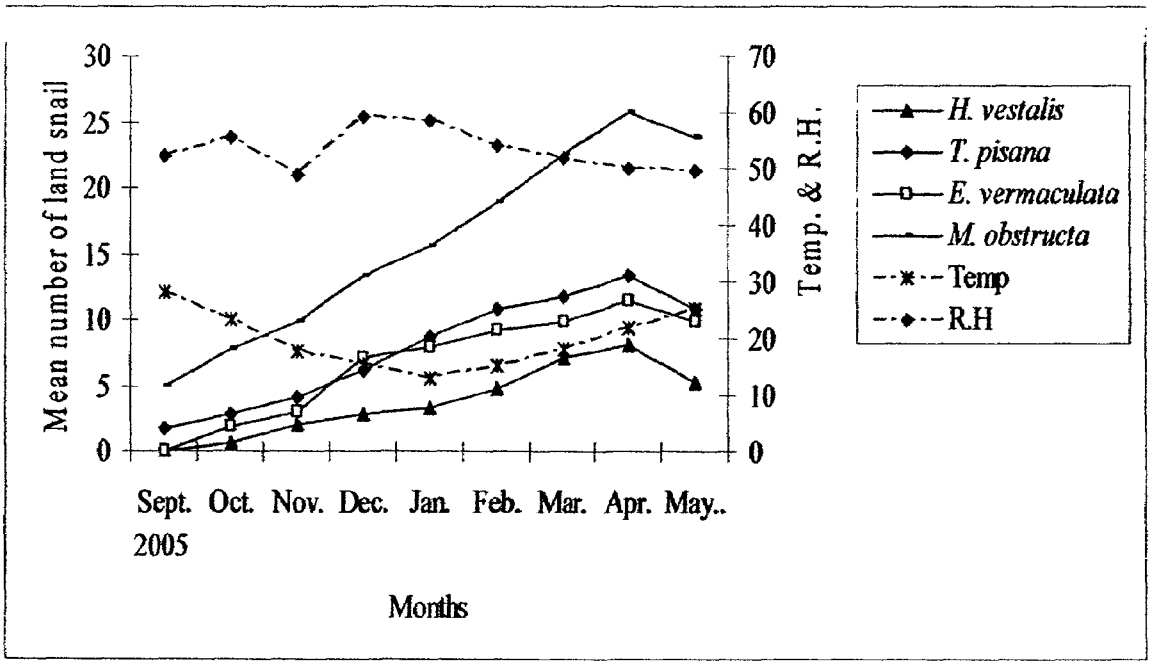


Fig 7. Population dynamic of four land snails on the Egyptian clover at Fayoum Governorate , during 2005/2006 season , in relation to temperature and relative humidity (R.H.).

b. Population dynamics of land snails on Cotton crop during 2004 / 2005 and 2005 / 2006.

Data in tables (8 &9) and figs (8 &9) revealed the occurrence and relative abundance of these land snails species on Cotton crop throughout the two seasons , the most common snail infesting cotton was *M.obstructa,* its peak mean (10.1 individuals/m^2) was recorded during September while the lowest (4.1 individuals/m^2) was recorded during April and no snails were counted during March. Total mean of snail species during 2004 / 2005 was 44 individuals/m^2. *T.pisana* occurred on cotton with highest mean (2.5individuals) during September, while the lowest was recorded in April (1.5 individual/m^2) and no individuals were counted during March. Total mean of snails recorded throughout the whole months of study season was 11.7 individuals/m^2, during September mean of *E.vermiculata* was (4.1 individuals/m^2), while the lowest mean was recorded during April (0.8 individual/m^2) and no mean of snails individuals was counted during March. Total mean of this species was (10.8) individuals/m^2. *H.vestalis* showed the highest mean during September (1.5 individuals/m^2) and decreased to (0.5 individual/m^2) in April and July. Total mean/m^2 of this species was 5.7 individuals. *M.bstructa* was dominating over all other population snail species (with total mean of 44 individuals) on cotton crop followed by *T.pisana* (11.7 individuals), *E.vermiculata* (10.8 individuals) and *H.vestalis* (5.7 individuals).

Data of the second season illustrated in Table (9) and Fig (9). It is revealed that *M. obstructa* occurred in highest mean, followed by *E. vermiculata* , *T.pisana* and *H. vestalis*. Their total mean/m^2 during the whole months were 47.6, 15.2, 14.4 and 7.7 individuals respectively. The highest means/m^2 for these species were recorded during September and averaged 12.7, 5.7, 3.1 and 2.5 individuals respectively, while the lowest were recorded in April and averaged 5.2 , 1, 1.3 and 0.7 individuals, and no snail individuals were recorded and counted during March for the three first species but the last species disappeared during March and June

Generally, snail means at the second season 2005 / 2006 were most vulnerable followed by the first season 2004 / 2005, This could be attributed to certain climatic factors, where the average values of temperature and R.H% at whole tested periods were (25.9 and 25.7C°) and (51.8 and 51.3%) during the two successive seasons respectively.

From the foregoing results, it could be concluded that. *M. obstructa* is considered the main and more abundant snail pest in Egyptian clover and Cotton fields in both Gharbia and Fayoum Governorates, followed by *E. vermiculata*, *T . pisana* and *H. vestalis.*

On the other hand El-okda (1979) found that the snail *E. vermiculata* was more abundant than that of *T. pisana* and *H. vestalis* on ornamental plants in Alexandria Governorate; El-Deeb *et al.* (1999) found that the snail *T. pisana* > *E. vermiculata* > *H.*

vestalis > *M. obstructa* > *Oxychills Sp* on field crops, vegetable crops and fruit trees Orchards.

In both field crops, the population of all these snail pests started in lower density, then gradually increased, reaches its peak during April month in Egyptian clover and during September month in Cotton crop, this is in agreement with Kady *et al.* (1983) they reported that the population of *M. obstructa* in the Egyptian clover field in Mansoura began to increase gradually from the end March to the middle of April

Ali and Suleman (1992) reported that maximum population densities of *M. obstructa* immatures were observed during April and early May, and it was followed by peak density of adults in October to November. Abd El-Karim (2000) recorded the population dynamics of *E. vermiculata* snails at Kafr El-Sheikh Governorate on Duranta, Guava and Banana fruits, he found that two peaks population were recorded during April and December. Nakhla *et al.* (2002) studied the population activity of the clover land snail *M. obstructa* at El-Saff, Giza Governorate during two successive years from October (1997) to September (1999), the two highest seasonal activities were achieved during Winter and Spring seasons. Idrees (2003) found that *T. pisana* snails on Guava and Orange trees, recorded the highest population during March. There are negative correlation between the population density of land snails and air temperature as population increased with the decrease in air temperature, reaching high population during Winter months, and lowest population during Summer months.

These results are in agreement with El-Okda (1979) who reported that activity of *E. vermiculata*, *T. pisana* and *H. vestalis* was enhanced during periods of decreased temperature and increased humidity. Ismail (1997), Baker andVogelzang (1988) studied the population dynamics of *T. pisana* snails in different sites > the snails were abundant in Spring especially near its edge. and rare in Summer. Hassanein and Hamed (1989) reported that the number of *Helicella sp* increased during late Summer and Autumn consequently. Ali and Suleman (1992) noticed that the snail *M. obstructa* remained active most months of the year except Summer months.

The four land snail species were recorded all over the whole year months, infesting other vegetable, fruit trees and field crops as well as ornamental plants and grassy lawns as mentioned by Hashem *et al.* (1992); Ali and Suleman (1992); Ghamry *et al.*(1993); Hashem *et al.* (1993); Nakhla *et al.* (1993 a); Nakhla and Tadros (1993); Mohamed (1994); El-Deeb *et al.* (1996 b); Lokma (1998); Hegab *et al.* (1999); El-Deeb *et al.* (1999); Abd El-Karim (2000); Abd El-Aal (2001); Metwally *et al.* (2002); Mahrous *et al.* (2002); Nakhla *et al.* (2002); Idrees (2003); Abd El-Wahab (2004) and Mohamed (2006).

These terrestrial land snails transferred from these habitats to the newly cultivated fields by Egyptian clover and cotton. It is recommended to control these injerous pests not only on the main crop fields but also in other cultivated surrounded fields.

Table 8. Population dynamic of four snails on Cotton at Fayoum Governorate , during 2004/2005 season, in relation to temperature and relative humidity(R.H.).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp. (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Mar.2005	0.0	0.0	0.0	0.0	0.0	0.0	17.28	57.81
Apral	0.5	1.5	0.8	4.1	6.9	1.7	21.525	50.765
May.	1.1	2.3	1.5	7.9	12.8	3.2	25.475	47.39
Jun.	0.8	2.0	1.2	7.5	11.5	3.3	28.545	50.115
Jul.	0.5	1.6	1.0	6.2	9.3	2.3	30.125	51.53
Aug.	1.3	1.8	2.2	8.2	13.5	3.4	30.3	52.42
Sept.	1.5	2.5	4.1	10.1	18.2	4.6	28.03	52.23
Total	5.7	11.7	10.8	44	72.2	18.1		
Over all mean SD	0.8 ± 0.52	1.7 ± 0.82	1.5 ± 1.31	6.3 ± 3.33	10.3	2.6	25.9	51.8

L.S.D $_{0.05} = 1.01$

Table 9. Population dynamic of four land snails on Cotton at Fayoum Governorate , during 2005 /2006 season, in relation to temperature and relative humidity (R.H.).

Months	Mean number of the land snails /m^2				Total	Over all mean	Temp (C)	R.H. (%)
	H. vestalis	*T. pisana*	*E. vermaculata*	*M. obstructa*				
Mar.2006	0.0	0.0	0.0	0.0	0.0	0.0	18	51.94
Apr.	0.7	1.3	1.0	5.2	8.2	2.1	21.84	50.13
May.	1.5	2.6	2.1	7.1	13.3	3.3	25.17	49.6
Jun.	0.0	2.5	1.8	6.9	11.2	2.8	28.25	50.55
Jul.	0.9	2.2	1.5	6.6	11.2	2.8	29.33	51.68
Aug.	2.1	2.7	3.1	9.1	17.0	4.3	30.22	53.19
Sept.	2.5	3.1	5.7	12.7	24.0	6.0	27.51	51.98
Total	7.7	14.4	15.2	47.6	84.9	21.3		
Over all mean SD	1.1 ± 0.98	2.1 ± 1.07	2.2 ± 1.83	6.8 ± 3.85	12.1	3.04	25.7	51.3

L.S.D $_{0.05} = 1.2$

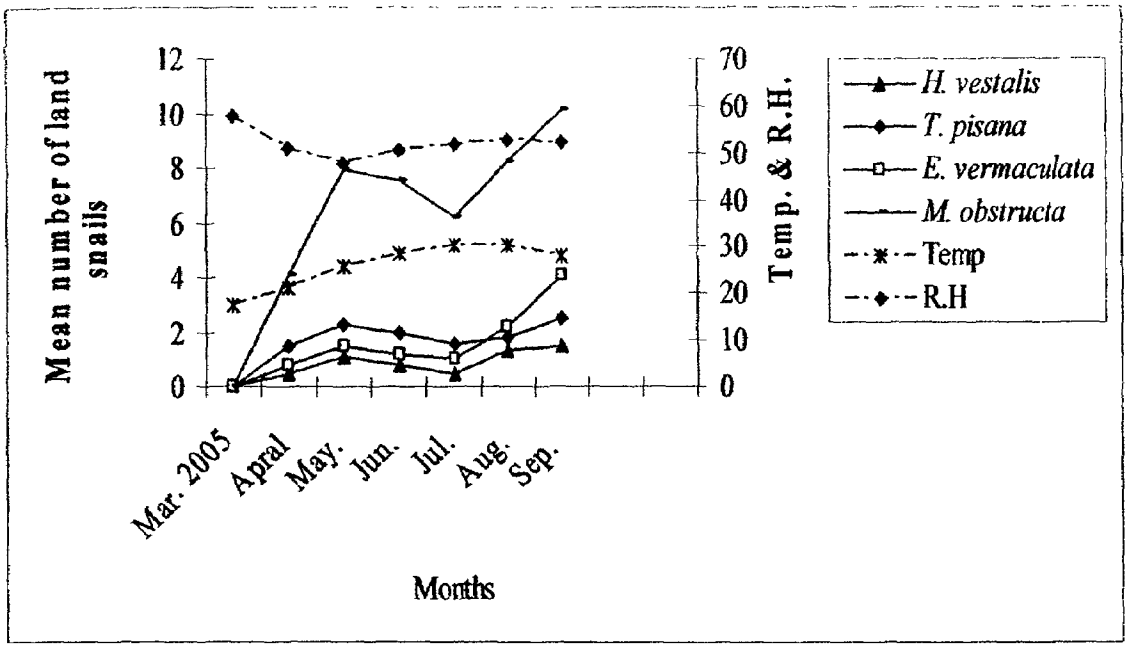


Fig 8. Population dynamic of four land snails on cotton at Fayoum Governorate , during 2004 / 2005 season, in relation to temperature and relative humidity (R.H.).

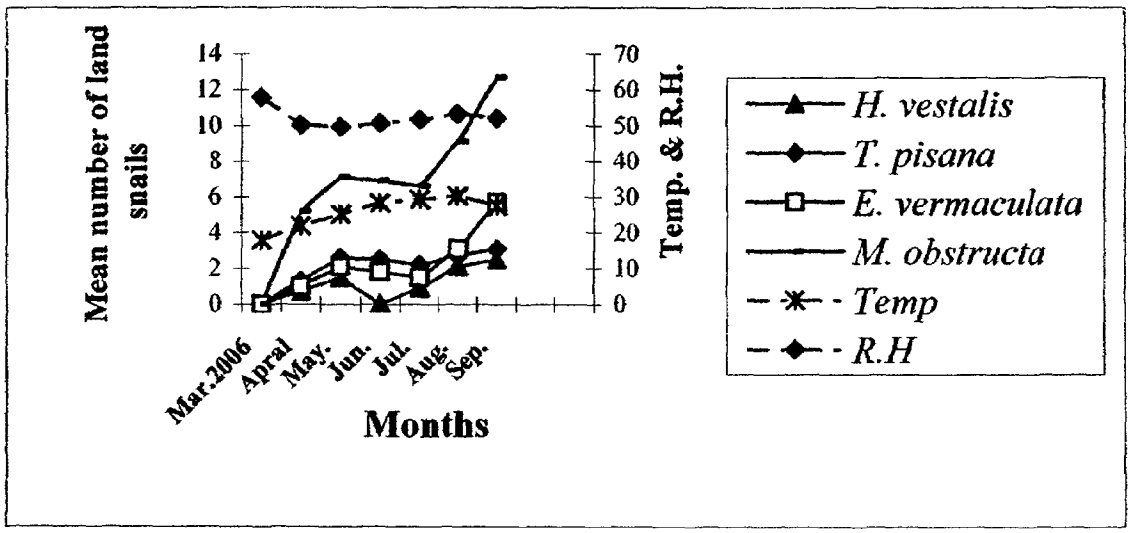


Fig 9. Population dynamic of some land snails on cotton at Fayoum Governorate , during 2005/2006 season, in relation to temperature and relative humidity (R.H.).

2. Toxicological studies:

A. Toxicity of some chemicals and mineral oils againist *Monacha obstructa* under laboratory conditions:-

Methomyl (Lannate) as an insecticide, Copper sulfate, Sodium borate as mineral salts and three mineral oils (CAPL- 1, CAPL- 2, Sol.EC) were toxicologically studied on glassy clover snail; *Monacha obstructa* using four different techniques:

a. Bait technique:

Mortality percentages of *M.obstructa* snails treated with bran baits containing different concentrations of Methomyl, Copper sulfate, Sodium borate, CAPL- 1, CAPL- 2 and Sol.EC are tabulated in Table (10). Data revealed that mortality percentages increased with increasing the concentrations of the tested compounds, i.e at the First day 13.3, 20.0 and 33.3% mortalities were obtained with the concentrations 0.05, 0.1 and 0.2% of Methomyl respectively, while 0.5, 1.0 and 3.0% of Copper sulfate carried on bran bait achieved 6.7, 13.3 and 26.7% mortality respectively. At the same time Sodium borate gave 0.0, 6.7 and 26.7% mortality with concentrations 1.0, 2.5 and 7.0% respectively. The same chemicals, after 4 days revealed 20, 40.0 and 60.0% mortality with Methomyl; 13.3, 33.3 and 46.7% mortality with Copper sulfate and 13.3, 26.7 and 53.5% with sodium borate, respectively. Also, it is clear that mortality percentages increased with the prolonging the treatment period, where 33.3, 63.3

and 100% mortality were occurred after 7 days of treatment with Methomyl, 26.7, 53.3 and 86.7% mortality with Copper sulfate and 20.0, 46.7 and 80.0 % with Sodium borate respectively.

In case of the tested oils, after one day exhibited no mortality percentage, while after four days, there are mortality percentages ranged from 6.7 to 40% for CAPL-1, 0.0 to 6.7% for CAPL-2 and 6.7 to 20.0% for Sol.EC. On other hand after seven days of treatment, the mortality percentages increased to 26.7, 46.7 and 60.0% for the concentrations 2.5, 5 and 9% of CAPL-1 respectively. Whereas mortality percentages for CAPL-2 were 6.7% with concentration 1.5%. While, the other two concentrations 5 and 7% gave no mortality. Sol.EC caused 20.0, 26.7 and 33.3% mortality when used by concentrations 2.5, 3.5 and 5%, Respectively.

From the obtained results it could be concluded that using mineral oils in bait technique to control land snails is not recommended even with using more than the double recommended rate per feddan.

LC_{50} & LC_{90} values and slope, as a percents of the three tested compounds carried by bran baits against *M. obstructa* are calculated and shown in Table (11) and fig (10). The tested compounds, used as baits, could be arranged according to their relative toxicity for *M. obstructa* in descending order as follows: Methomyl (LC_{50} = 0.07%), Copper sulfate (1%) and Sodium borate (2.6%). While LC_{90} for Methomyl (0.13), Copper sulfate (4.3) and Sodium borate (10.6).The

Slope values were (4.6, 2.0 and 2.1) for the tested chemicals, respectively.

b. Residual film technique:

Data in Table (10) show the efficacy of Methomyl, Copper sulfate, Sodium borate, CAPL-1, CAPL-2 and Sol.EC, when used as residual film technique against adult of *M. obstructa*. Results showed that mortality percentage increased proportionally with increasing the compound concentration .After 24 hours the concentrations 0.02, 0.03 and 0.05 % Methomyl gave 33.3, 66.7 and 93.3% mortality respectively. The concentrations 0.1, 0.3 and 0.5% of Copper sulfate gave 20.0, 53.3 and 86.7% mortality respectively, while the concentrations 0.7, 1.0 and 1.5% of Sodium borate gave 26.7, 40.0 and 80.0% mortality respectively. In case of the oils, Sol.EC was the most toxic followed by CAPL-1 and CAPL-2. Mortality percentages were 20.0, 33.3 and 66.7% for CAPL-1 concentrations 1, 3 and 5% respectively. While CAPL-2 gave 20.0, 40.0 and 73.3% mortality with concentrations 5, 7 and 10% respectively. On the other hand, Sol.EC induced 26.7, 66.7 and 86.7% with the concentrations of 3, 5 and 7% respectively.

Data in Table (11) and fig (11), (12) showed the comparative response of *M.obstructa* to Methomyl, Copper sulfate, Sodium borate, CAPL- 1, CAPL- 2 and Sol.EC when used as residual film technique. LC_{50}, LC_{90} values of these compounds against *M. obstructa* adult were (0.02 and 0.05%) for Methomyl, (0.23 and 0.7%) for Copper

sulfate and (1.03 and 1.5%) for Sodium borate, (3.76, 23.7 and 1.6%) for CAPL- 1, (7.7, 15.04 and 4.4%) for CAPL- 2 and (4.16, 7.9 and 4.57) for Sol.EC respectively. while slope values were (4.75, 2.58 and 7.3, 1.6, 4.4 and 4.57), respectively.

c. Leaf Dipping technique:

Data in Table (10) show the mortality percentages of *M. obstructa* adults when fed on lettuce leaf discs which were dipped on different concentration of Methomyl, Copper sulfate, Sodium borate, CAPL-1, CAPL-2 and Sol.EC compounds. Tested concentrations of these compounds showed a considerable variations in snails mortality on the first day after treatment. Obtained mortalities were 6.7, 13.3 and 26.7% with Methomyl concentrations 0.03, 0.05 and 0.1%, respectively. On the other hand, 0.0, 6.7 and 20.0% mortalities with Copper sulfate concentrations 0.25, 0.5 and 1.0%, respectively were obtained. In the case of Sodium borate the concentrations 1.0, 3.0 and 5.0% gave 0.0, 6.7 and 13.3% mortality. Tested concentrations of these mineral oils exhibited no mortality after 24 hours from treatment.

After 4 days of treatment, mortality percentages of Methomyl against adults of *M.obstructa* increased to 13.3, 33.3 and 53.3% respectively, 13.3, 26.7 and 33.3% for Copper sulfate respectively, 6.7, 20.0 and 46.7% for Sodium borate, 20.0, 13.3 and 6.7% mortality for CAPL-1 concentrations 1, 2 and 4%, CAPL-2 gave 13.3, 26.7 and 33.3% mortality for the concentrations 1, 3 and 5%, respectively.

Mortality percentage of this snail on the 7th day were 26.7, 53.3 and 86.7% for Methomyl, 20.0, 60.0 and 93.3% for Copper sulfate and 13.3, 40.0 and 73.3% for Sodium borate, respectively. In case of mineral oils, the cumulative mortality were (33.3, 46.7 and 60.0%) for CAPL-1, (20.0, 53.3 and 73.3%) for CAPL-2 and (26.7, 33.3 and 53.3%) for Sol.EC, respectively. It is cleared that the molluscicidal effect considerably varied according to the type of chemicals. Also mortality percentage of this snail increased with increasing in the concentrations of these compounds and prolonging the period after treatments.

Data in Table (11) and fig (13), (14) represented LC_{50} & LC_{90} and Slope values of the tested compounds against *M. obstructa* adult. The obtained results revealed that LC_{50} values of Methomyl, Copper sulfate, Sodium borate, CAPL-1, CAPL-2 and Sol.EC were 0.5, 0.4, 3.35, 2.4, 2.6 and 3.03 respectively. On the other hand LC_{90} values of the same compounds were 1.54, 0.9, 11.56, 31.3, 11.43 and 19.55 % respectively. While Slope values were (2.46, 3.9, 2.38, 1.2, 2.0 and 1.6) respectively.

d. Repellency test :

The Data in Table (12), (13) and Fig (15, 16) represent average repellency and attractancy action (average from 1 to 6 hours) of Methomyl, Copper sulfate, Sodium borate, CAPL-1, CAPL-2 and Sol.EC against *M. obstructa* adult. Methomyl concentrations; 0.01, 0.03 and 0.05% showed strong repellent action after 6 hours. The

average repellency percentages (RP%) were 46.7, 66.7 and 93.3% repellency, class (III, IV and V) respectively. In the case of Copper sulfate, (RP%) averaged 33.3, 46.7 and 73.3% after 6 hours, class (II, III and IV) for concentrations 0.05, 0.1 and 0.2%, respectively. Sodium borate revealed weakly repellent action after 6 hours. Its (RP%) averaged -6.7, 26.7 and 60.0%, class (I, II and III) for concentrations 1.0, 2.0 and 3.0%,respectively.

Mineral oils, were used at concentrations of 1, 5 and 10%. CAPL-1at the first concentration (1%) gave weakly repellent effect after 1 hours (6.7% RP, class I), while 5, 10% gave 60.0 and 86.7% RP, class (III and V). CAPL-2 had a moderate attractant action (-33.3%) at concentration 1%, while the others concentrations (5, 10%) gave 66.7 and 33.3% (RP) respectively which represent in class IVand II. On the other hand 1% of Sol.EC oil showed strong attractant percentages (-60%, class III), where the other concentrations (5 and 10%) gave average repellency percentages 33.3 and 53.3% (class II and III) respectively. After 6 hours the average attractancy and repellency percentages for CAPL-1, CAPL-2 and Sol.EC were (-66.7, 26.7 and 66.7%; class IV, II and IV), (-33.3, 53.3 and 86.7%; class II, III and V) and (6.7, 40.0 and 93.3%; class; I, II and V) respectively.

Generally, tested compounds (Methomyl, Copper sulfate and Sodium borate) gave a fair good results when used in baits against snails than when used in dipping method.

Harpaz and Oseri (1961) found that spraying 0.5% of Isolan insecticide gave 93.0% mortality against *Theba pisana* while 1% bait revealed only 28.2% mortality.

Ghamry *et al.* (1993) found that Metaldehyde compound was the most effective one against *M. obstructa* and *Eobania vermiculata* followed by Methiocarb, Thiocarb, Syanophose and Monocrotofos. All these tested pesticides failed to gain a good results agaist *Cochlicella acuta.*

The foregoing results revealed that, when used bait technique, Lannate exhibit 100% mortality after one week, at concentration of 0.2%, followed by the mineral salt Copper sulfate (86.7%) mortality at concentration of 3%. Concerning mineral oils, CAPL-1 gave 60% mortality at concentration of 90%, while CAPL-2 gave the least toxic effect.

When used CAPL-2 as toxic bait technique, it exihibite 6.7% mortality at concentration of 1.5%, while no mortality occurred when used at concentrations 5 and 7%, this could be attributed to the repellency and attractancy effect on land snails as it appear an attractancy action at low concentration (6.7%), while it proved

repellency action at high concentrations (5 and 10%), and no feeding was happened in the high concentration.

Methomyl (Lannate) was used as moluscicide by El-Okda (1976); El-Okda (1979); El-Okda(1983); El-Okda (1984); El-Okda *et al.* (1989); Radwan *et al.* (1992); Mourad and Zedan (1996); Okka *et al.* (1996); Ismail (1997); Zeddan (1999); Abd El-Aal (2005).

Also, mineral salts were used moluscicide to control land snails by El-Bahi *et al.* (1992); Nakhla *et al.* (1993 b); El-Wakil and Mesbah (1995) Nakhla and El-Sisi (1995); and Ismail *et al.* (2001).

Mineral oils were tested against land snails by Anonymous (1971); El-Okda (1983) and Awad (1994).

Table 10. Toxic action of some chemicals and mineral oils against *M. obstructa* by using different techniques .

Chemical and mineral oils used	Bait technique				Resdual film technique		Dipping technique			
	Conc. %	Mortality (%) after			Conc. %	Mortality (%) after	Conc. %	Mortality (%) after		
		1day	4days	7days		24 h		1day	4days	7days
Methomyl	0.05	13.3	20.0	33.3	0.02	33.3	0.03	6.7	13.3	26.7
	0.1	20.0	40.0	63.3	0.03	66.7	0.05	13.3	33.3	53.3
	0.2	33.3	60.0	100.0	0.05	93.3	0.1	26.7	53.3	86.7
Copper sulfate	0.5	6.7	13.3	26.7	0.1	20.0	0.25	0.0	13.3	20.0
	1.0	13.3	33.3	53.3	0.3	53.3	0.5	6.7	26.7	60.0
	3.0	26.7	46.7	86.7	0.5	86.7	1.0	20.0	33.3	93.3
Sodium borate	1.0	0.0	13.3	20.0	0.7	26.7	1.0	0.0	6.7	13.3
	2.5	6.7	26.7	46.7	1.0	40.0	3.0	6.7	20.0	40.0
	7.0	26.7	53.5	80.0	1.5	80.0	5.0	13.3	46.7	73.3
CAPL-1	2.5	0.0	6.7	26.7	1	20.0	1	0.0	20.0	33.3
	5	0.0	26.7	46.7	3	33.3	2	0.0	13.3	46.7
	9	0.0	40.0	60.0	5	66.7	4	0.0	6.7	60.0
CAPL-2	1.5	0.0	6.7	6.7	5	20.0	1	0.0	13.3	20.0
	5	0.0	0.0	0.0	7	40.0	3	0.0	26.7	53.3
	7	0.0	0.0	0.0	10	73.3	5	0.0	33.3	73.3
Sol.EC.	2.5	0.0	13.3	20.0	3	26.7	1	0.0	6.7	26.7
	3.5	0.0	6.7	26.7	5	66.7	2	0.0	20.0	33.3
	5	0.0	20.0	33.3	7	86.7	3	6.7	33.3	53.3

Table 11. LC_{50}, LC_{90} and Slope values of some chemicals and mineral oils used by different techniques against *Monacha obstructa*.

Chemicals and mineral oils	Bait technique after 7 days			Resdual film technique after 24 hours			Dipping technique after 7 days		
	LC_{50} %	LC_{90} %	Slope	LC_{50} %	LC_{90} %	Slope	LC_{50} %	LC_{90} %	Slope
Methomyl	0.07	0.13	4.6	0.02	0.05	4.75	0.5	1.54	2.46
Copper sulfate	1	4.3	2.0	0.23	0.7	2.58	0.4	0.9	3.9
Sodium borate	2.6	10.6	2.1	1.03	1.5	7.3	3.35	11.56	2.38
CAPL-1	-	-	-	3.76	23.7	1.6	2.4	31.3	1.2
CAPL-2	-	-	-	7.7	15.04	4.4	2.6	11.43	2.0
Sol.EC.	-	-	-	4.16	7.9	4.57	3.0	19.55	1.6

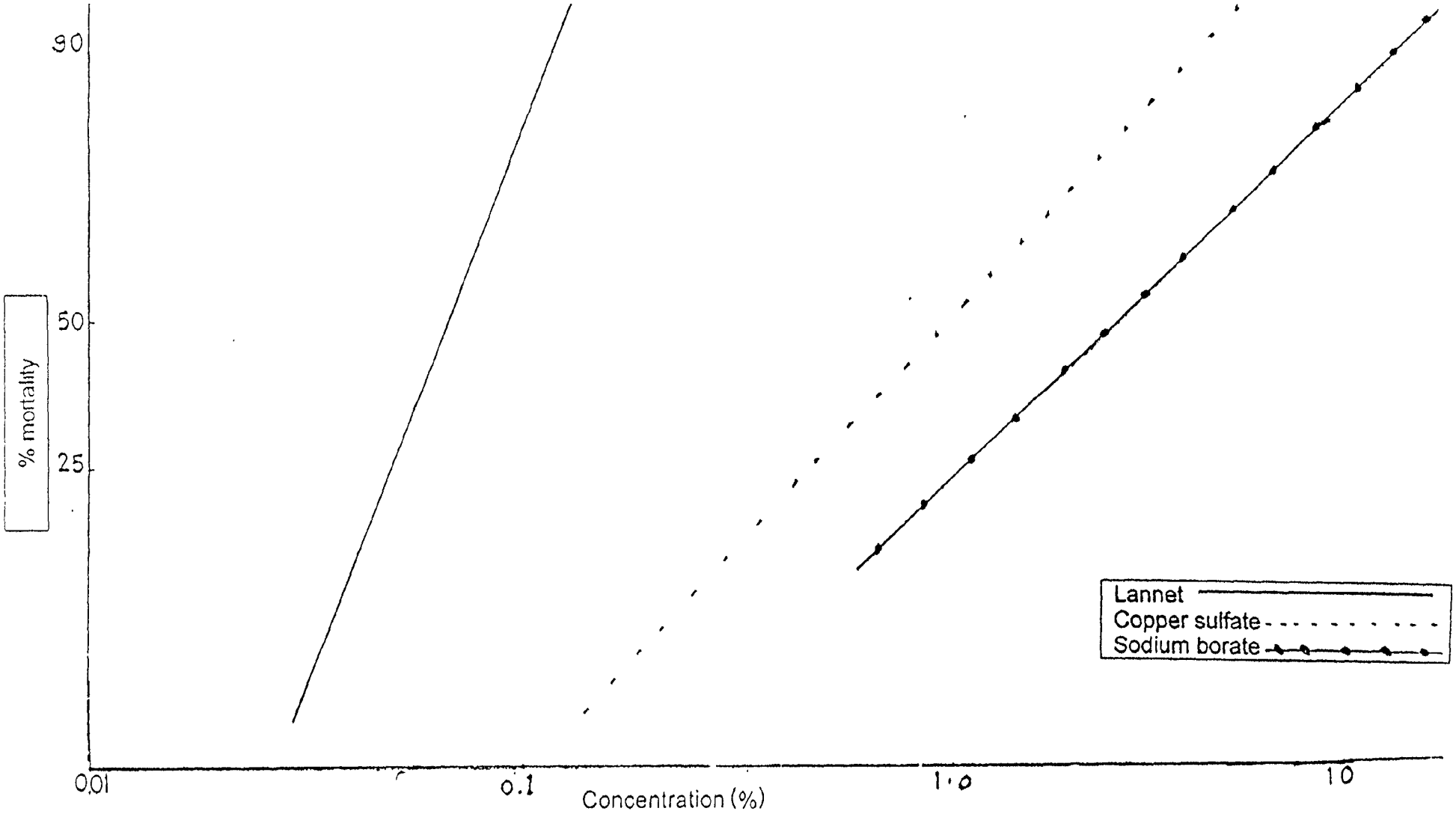


Fig 10. Toxicity lines of Methomyl, Copper sulfate and Sodium borate as baits technique against *Mònacha obstructa*

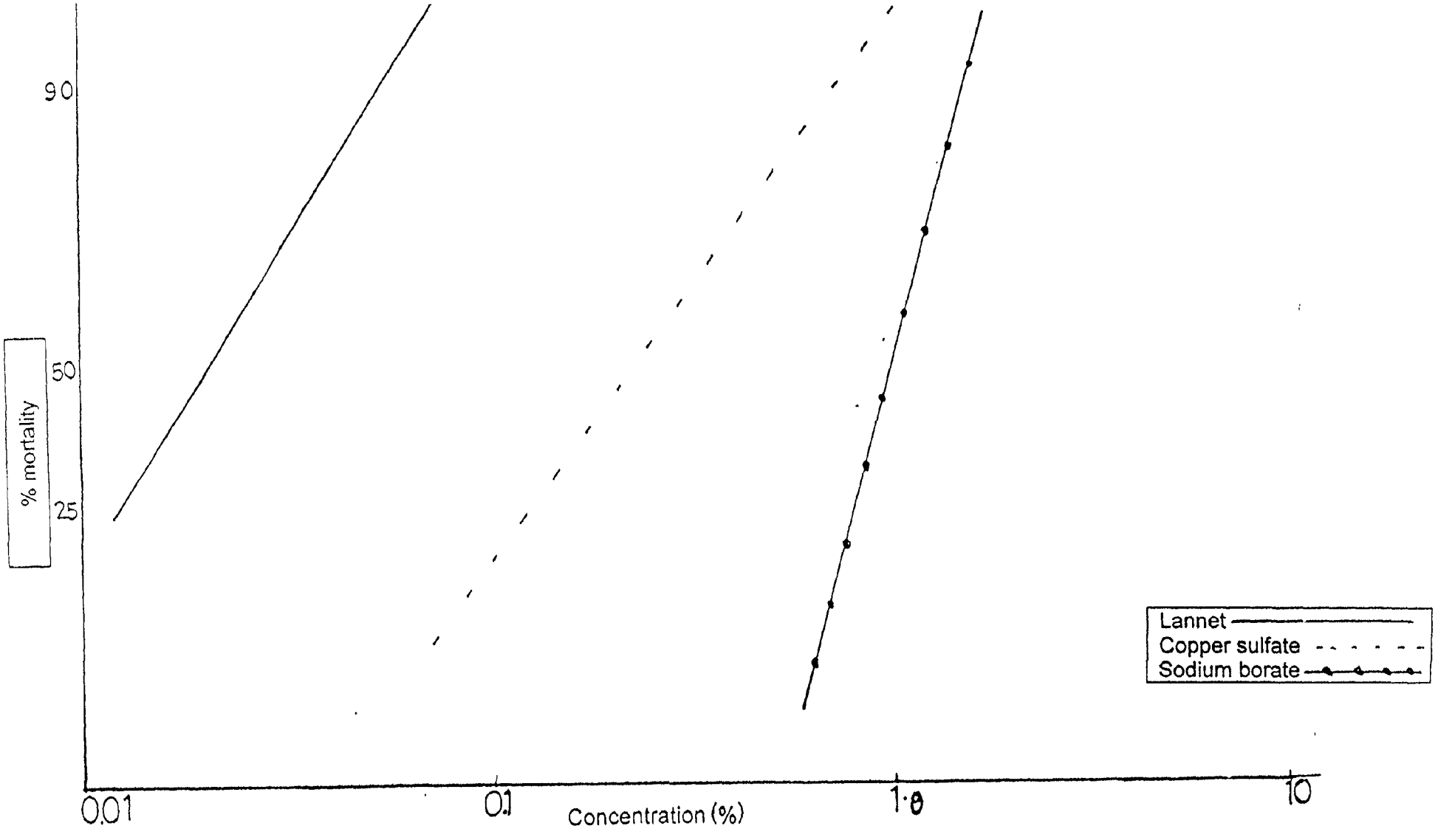


Fig 11. Toxicity lines of Methomyl, Copper sulfate and Sodium borate as residual film technique against *Monacha obstructa*

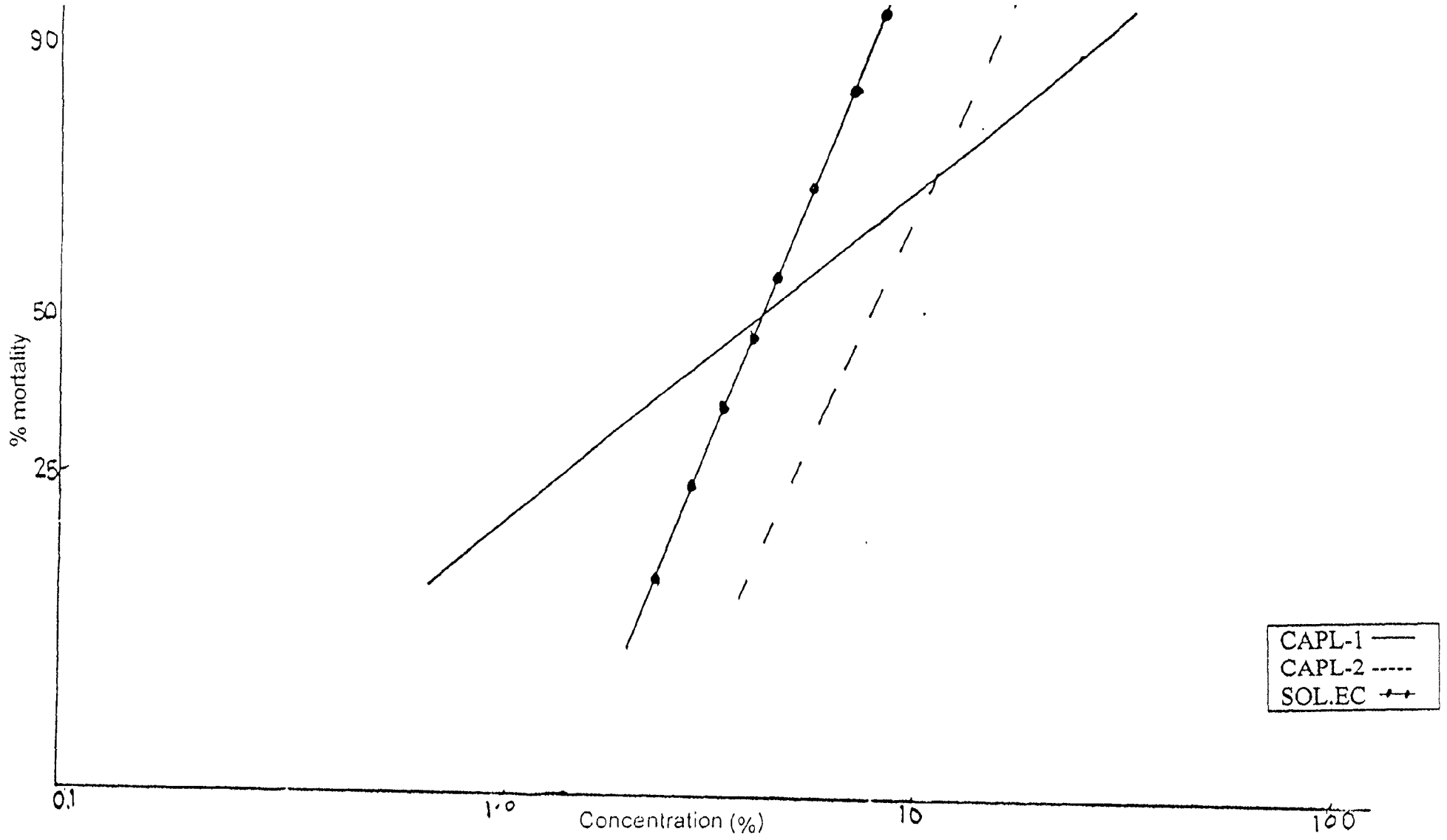


Fig 12. . Toxicity lines of CAPL-1, CAPL-2 and Sol as residual film technique against *M.obstructa*

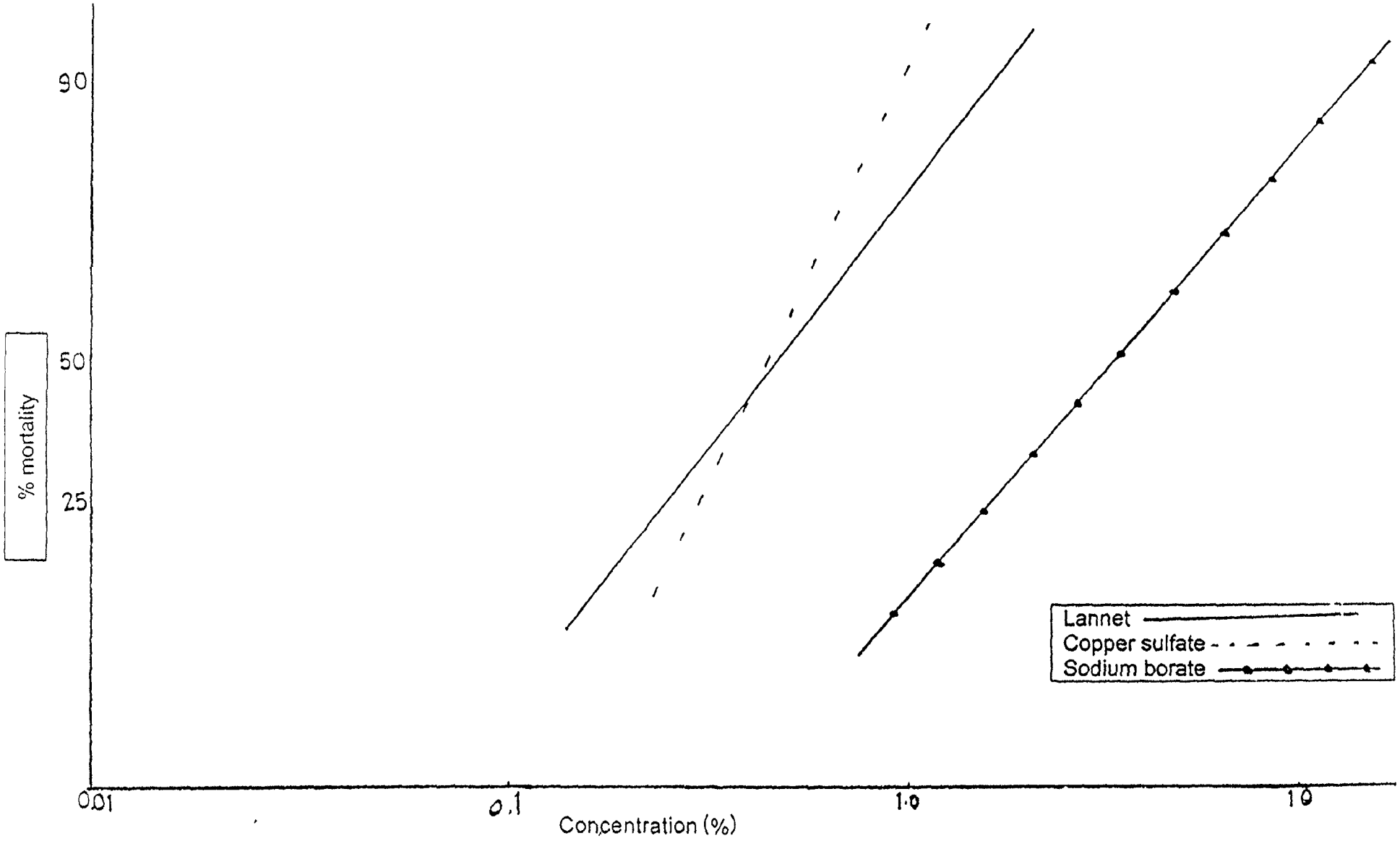


Fig 13. Toxicity lines of Methomyl, Copper sulfate and Sodium borate as dipping technique against *Monacha obstructa*

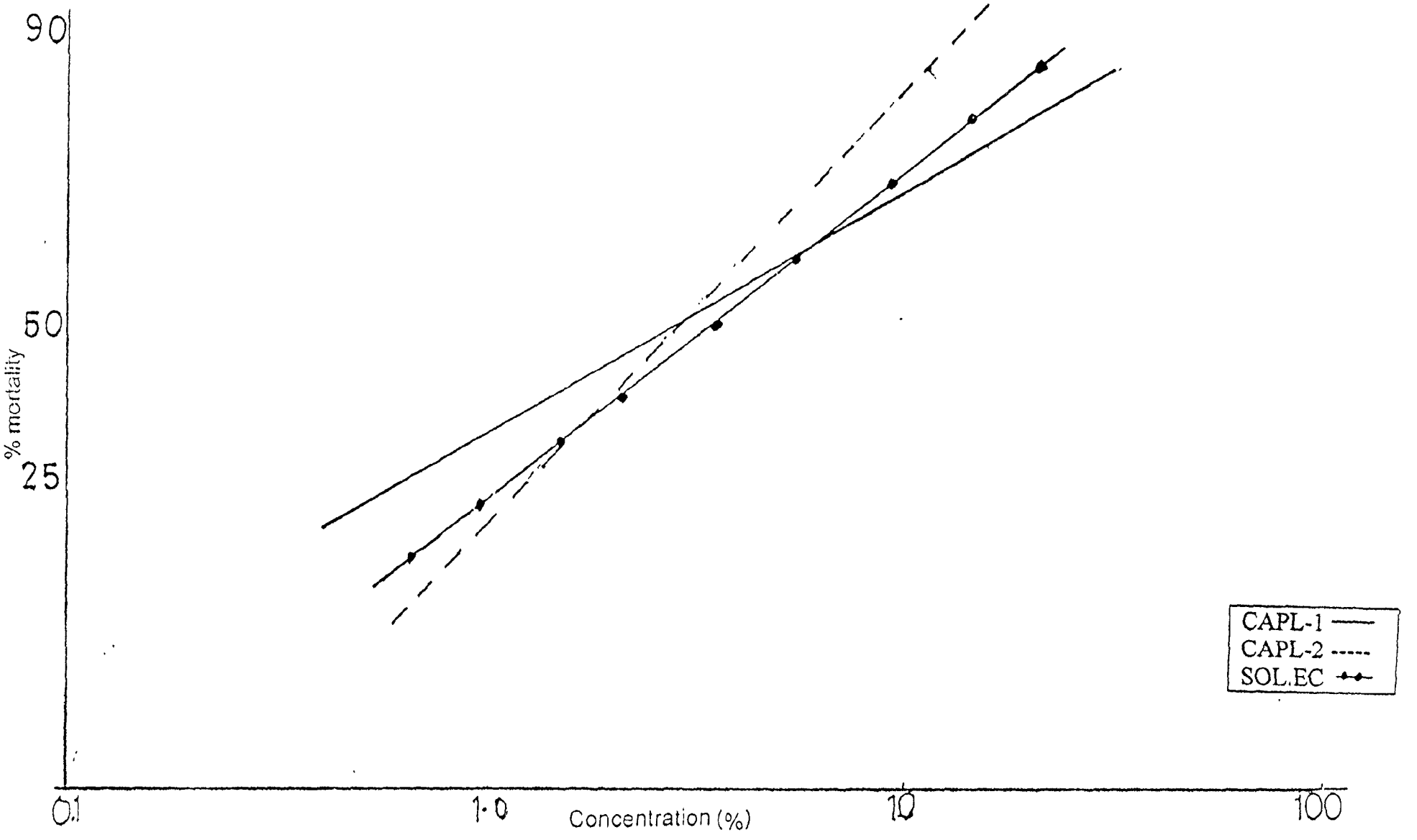


Fig 14.: Toxicity lines of CAPL-1, CAPL-2 and Sol as dipping technique against *M.obstructa*

Table 12. Average repellency and attractancy percentage (RP%) of some chemicals against *Monacha obstructa*.

Chemical used	Concentration %	RP % after	
		1 hours	Class
Methomyl	0.01 0.03 0.05	46.7 66.7 93.3	III IV V
Copper sulfate	0.05 0.1 0.2	33.3 46.7 73.3	II III IV
Sodium borate	1.0 2.0 3.0	-6.7 26.7 60.0	I II III

Table 13. Average repellency and attractancy percentage (RP %) of some mineral oils against *Monacha obstructa*:

Mineral oils	Concentr. ation %	RP % after 1 and 6 hours			
		1 hour	class	6 hours	class
CAPL-1	1 5 10	6.7 60.0 86.7	I III V	-66.7 26.7 66.7	IV II IV
CAPL-2	1 5 10	-33.3 66.7 33.3	II IV II	-33.3 53.3 86.7	II III V
Sol.EC.	1 5 10	-60.0 33.3 53.3	III II III	6.7 40.0 93.3	I II V

RP % = Repellency and attractancy percentage.Positive values (+) expressed repellency and negative values (-) attractancy.

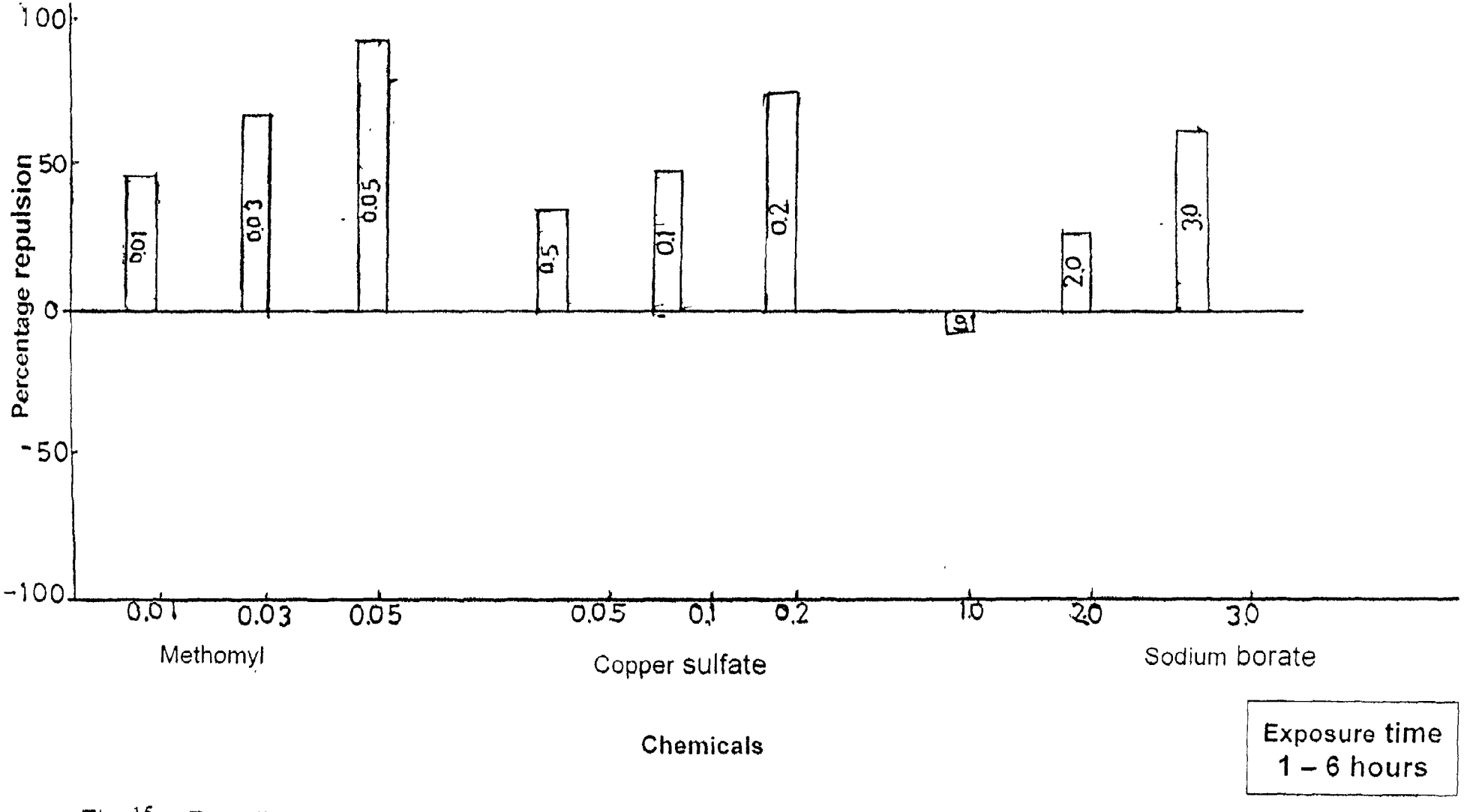


Fig 15. Repellency and attractancy of Methomyl, Copper sulfate and Sodium borate against *M. obstructa*

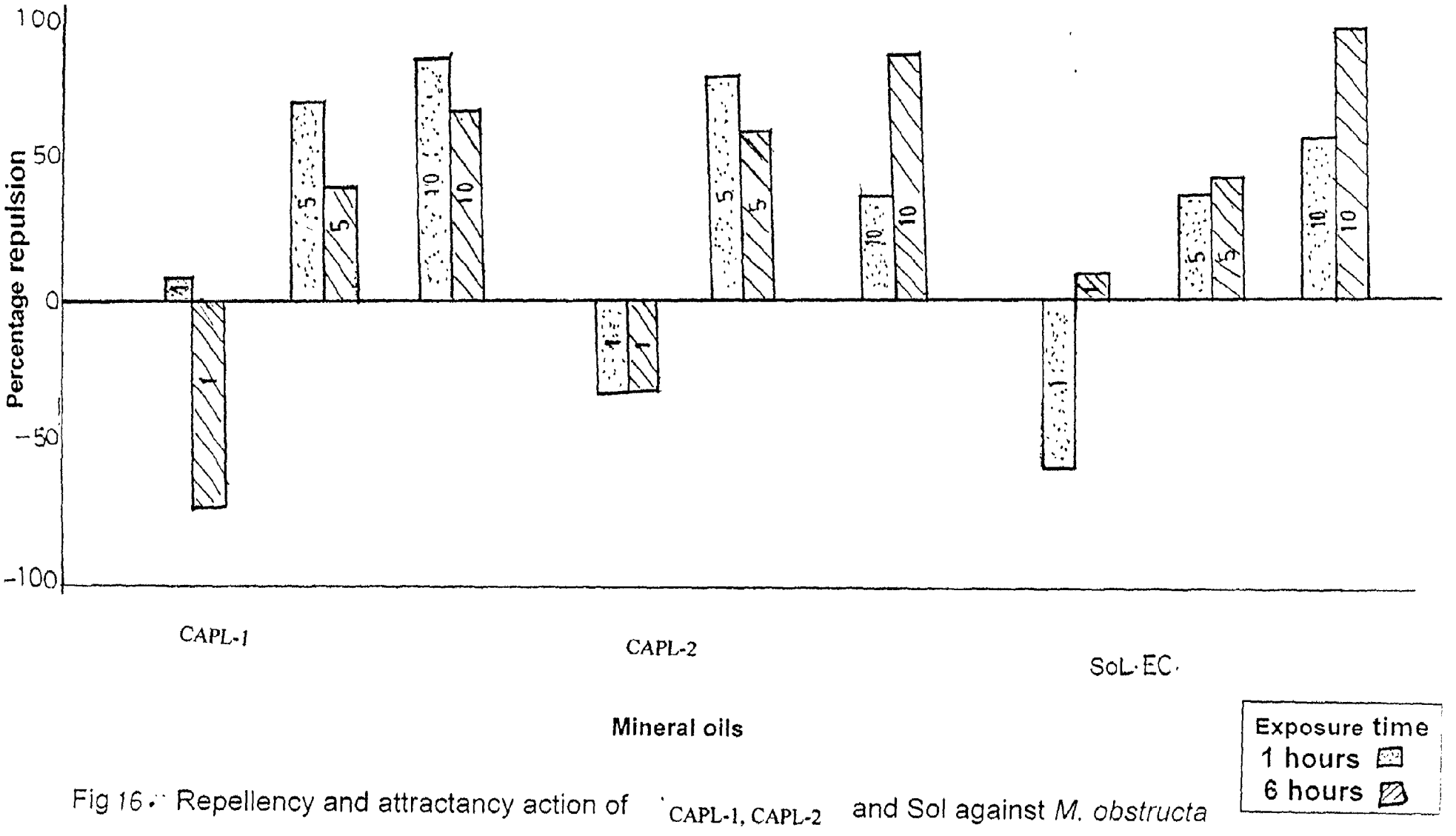


Fig 16 : Repellency and attractancy action of CAPL-1, CAPL-2 and Sol against *M. obstructa*

B. Toxicity of some plant extracts againist *Monacha obstructa* under laboratory conditions:-

Fennel, Black pepper, Santonica, Red pepper, Pomegranate and Neem plant extracts were tested against glassy clover snail *M. obstructa* by four different bioassay techniques.

1. Water extracts.

Boiled water extracts of the three plants; Santonica, Red Pepper and Pomegranate were tested against adults of glassy clover snail *M. obstructa.* Four bioassay techniques were conducted; bait technique, residual film technique, leaf dipping technique and repellency tests. Results revealed that all crude boiled water extracts had no effect on snails and no mortality individuals was recorded during the tested period. These results were in agreement with Ghamry (1994) and Ghamry (1997).

2. Acetone extracts.

Crude Acetone extracts of the above mentioned plants in addition to Fennel, Black pepper and Neem plants were tested against *M. obstructa*. Using four bioassay techniques. A control test (check) was paralled conducted using the same techniques, without any treatments. Results revealed that, No mortality in snail individuals was recorded in control tests during the tested period. For bait, residual film and dipping techniques.

a. Bait technique:

The results tabulated in table (14) show the effect of Fennel, Black pepper, Santonica, Red pepper, Pomegranate and Neem against *M. obstructa* by bait technique. The results indicated that Fennel and Pomegranate , exhibited the highest toxic action followed by Black pepper, Santonica and Red pepper . The toxicity of Neem extract which used as a standard to compare other extracts with it, revealed a very weak toxicity. The results after one day were 6.7, 13.3 and 26.7% mortality with concentrations 0.05, 0.1 and 0.3g / ml respectively for Fennal, 13.3, 20.0 and 33.3% mortality with concentrations 0.33, 0.65 and 1.0 respectively for Pomegranate. The results after four days for the same plant extracts and same concentrations were (26.7, 53.3 and 73.3%) and (26.7, 40.0 and 60.0% mortality) respectively. Mortality after seven days averaged (33.3, 66.7 and 93.3%) and (33.3, 73.3 and 93.3%) respectively. On the other hand, the mortality percentages of Black pepper, Santonica, Red pepper and Neem after 24 h of application were (0.0, 6.7 and 20.0%) for concentrations (0.1, 0.3 and 0.6 g/ml) respectively for Black pepper and (0.0, 0.0 and 13.3%) for Santonica at concentrations (0.5, 1.0 and 1.5 g/ml) respectively, Red pepper gave (0.0, 13.3 and 20.0%) mortality for concentrations (0.3, 0.6 and 1.3 g/ml) and the Neem doesn't give mortality with concentrations (5, 10 and 15%). The results for these plant extracts after four days from treatment were (13.3, 40.0 and 53.3%), (6.7, 13.3 and 33.3%),

(13.3, 33.3 and 46.7%) and (0.0, 0.0 and 0.0) respectively.At the same time, the mortality percentage of snails increased after seven days from treatment to (26.7, 60.0 and 86.7%), (13.3, 26.7 and 53.3%), (20.0, 46.7 and 73.3%) and (0.0, 13.3 and 53.3%) respectively.

LC_{50}, LC_{90} and Slope Values of the tested extracts (Fennel, Pomegranate, Black pepper, Santonica and Red pepper) against adults of *M. obstructa*. are shown in table (15)and Fig (17).The obtained results revealed that LC_{50} values of these plant extracts were (0.08, 0.42, 0.2, 1.55 and 0.7 mg/ml) respectively. On the other hand LC_{90} values of the same plant extracts were (0.3, 0.92, 0.8, 5.24 and 2.5 mg/ml) respectively.

b. Residual film technique:

Table (14) showed the comparative response of *M. obstructa* adult to some plant extracts when used as residual film treatment. The efficiency of Fennel and Pomegranate was high followed by Black pepper, Santonica, Red pepper and Neem. After 24 hours, Fennel exihibit (26.7, 53.3 and 100%) mortality for concentrations (0.01, 0.05 and 0.1g/ml) respectively, while Pomegranate gave (33.3, 60.0 and 93.3%) mortality with concentrations (0.15, 0.3 and 0.5 g/ml) respectively. On the other hand Black pepper, Santonica, Red pepper and Neem mortality percentage averaged (20.0, 46.7 and 80.0%), (0.0, 6.7 and 13.3%), (13.3, 40.0 and 86.7%) and (13.3, 33.3 and 66.7%) respectively after 24h post-treatment for the

concentrations (0.3, 0.6 and 0.75g/ml), (1, 2 and 4g\ml), (0.5, 0.7 and 1.5g/ml) and (5, 10 and 15%) respectively.

Data tabulated in table (15) and illustrated in Fig (18) showed the LC_{50}, LC_{90} and Slope values of the tested extracts against *M. obstructa*. LC_{50} values were 0.02, 0.2, 0.5, 0.9 and 12.3 gm/ml for Fennel, Pomegranate, Black pepper, Red pepper and Neem respectively. While LC_{90} values were (0.07, 0.5, 1.1, 1,6 gm/ml and 32.1%) respectively. Slope values were (2.71, 3.43, 4.13, 4.58 and 3.08) in the same respective order.

c. Leaf Dipping technique:

The results tabulated in table (14) show the mortality percentages of *M.obstructa* adults exposed to lettuce leaves dipped in Fennel, pomegranate, Black pepper, Santonica, Red pepper and Neem extracts. Tested concentration of these plant extracts showed a considerable variation in the snail mortality on the first day after treatment where 0.0, 6.7 and 20% mortality were obtained with concentrations 0.025, 0.05 and 0.1g/ml of Fennel, 6.7, 13.3 and 20.0% mortality with 0.5, 0.7 and 1.2 g/ml of Pomegranate. Black pepper exhibited 6.7, 13.3 and 26.7% mortality with concentrations 0.3, 0.6 and 0.75g/ml. Santonica gave 0.0, 13.3 and 20.0% mortality with concentrations 1, 2 and 4 g/ml. On the other hand 0.5, 0.7 and 1.0g/ml Red pepper achieved 0.0, 6.7 and 13.3% mortality respectively. In the case of Neem tested concentrations (5, 10 and 15%). After four days, Fennel

revealed mortality(20.0, 33.3 and 53.3%) respectively with sub mentioned concentrations. While pomegranate gave (13.3, 26.7 and 46.7% mortality), Black pepper gave (13.3, 26.7 and 46.7% mortality) and Santonica cause (13.3, 20.0 and 40.0% mortality) respectively. On the other hand Red pepper gave (6.7, 26.7 and 33.3% mortality) respectively, while Neem don't give mortality after four days from treatment. The percentage mortality increased after seven days from treatment for the same plant extracts to (26.7, 60.0 and 86.7%), (20.0, 40.0 and 80.0%), (20.0, 53.3 and 80.0%), (13.3, 33.3 and 60.0%) and (20.0, 40.0 and 73.3%), respectively. The same trend was observed in the case of both Neem with the same concentarions which caused (6.7, 20.0 and 33.3%) mortality for the tested plant extract after seven days respectively.

Data in Table (15) and Fig (19) represented LC_{50}, LC_{90} and Slope values of the six tested plant extracts against *Monacha obstructa* . LC_{50} values of Fennel, Pomegranate, Black pepper, Santonica, Red pepper and Neem were 0.04, 0.79, 0.51, 3.1, 0.75 and 22.91 respectively, where LC_{90} values were 0.11, 1.62 , 1.0, 11.2, 1.4 and 84.9 respectively. On the other hand Slope values of these plant extracts were 2.58, 4.13, 4.25, 2.3, 4.6 and 2.25 respectively.

d. Repellency test of plant extracts :

Data in Table (14) and Fig (20) show the results of average

repellency and attractancy action (average from 1 to 6 hours) in the case of plant extracts against *M. obstructa* adult. Fennal showed repellent effects after 6h. Its average attractancy was -73.3% , while repellency percentages (RP%) were 13 and 80% repellency class IV, I and IV with concentrations 0.02, 0.05 and 0.1g/ml respectively. On the other hand 0.075g/ml Pomegranate had attractancy after 6h and their (RP%) were -60 but the two higher concentrations 0.33 and 0.65g/ml had repellent action (class III, II and IV%, respectively). Black pepper gave (RP%) averaged -66.7% with concentration 0.03 but repellency percentages (RP%) were 6.7 and 66.7% class IV, I and IV with concentrations 0.3 and 0.55g/ml. Santonica showed very strong repellent effects after 6h. its average repellency percentages (RP%) were 15, 40 and 90% class I, II and V with concentrations 0.13, 0.25 and0.5g/ml respectively. Red pepper gave attractancy percentages -80 with concentration 0.05 while it doesnt give any effect with concentration 0.1g/ml. Although Neem revealed strong repellency percentages (RP%) (18, 22 and 27% class I, II, II) with concentrations 5, 10 and 15% respectively.

Table 14. Toxic action and averg e repellency and attractancy of some plant extracts against *M. obstructa* by using four techniques .

Plant extracts	Bait technique				Resdual film technique		Dipping technique				Repellency test		
											RP% after		
	Conc g/ml	%Mortality after			Conc g/ml	Mortality% after	Conc g/ml	% Mortality after			Conc g/ml	1 hours	class
		1day	4days	7days		24 h		1day	4days	7days			
Fennel	0.05	6.7	26.7	33.3	0.01	26.7	0.025	0.0	20.0	26.7	0.02	-73	IV
	0.1	13.3	53.3	66.7	0.05	53.3	0.05	6.7	33.3	60.0	0.05	13	I
	0.3	26.7	73.3	93.3	0.1	100.0	0.1	20.0	53.3	86.7	0.1	80.0	IV
Pomegranate	0.33	13.3	26.7	33.3	0.15	33.3	0.5	6.7	13.3	20.0	0.075	-60.0	III
	0 65	20.0	40.0	73 3	0 3	60 0	0 7	13.3	26.7	40.0	0.33	33.3	II
	1.0	33.3	60.0	93.3	0.5	93.3	1.2	20.0	46.7	80.0	0.65	80.0	IV
Black pepper	0.1	0.0	13.3	26.7	0.3	20.0	0.3	6.7	13.3	20.0	0.03	-66.7	IV
	0.3	6.7	40.0	60.0	0.6	46.7	0.6	13.3	26.7	53.3	0.3	6.7	I
	0.6	20.0	53.3	86.7	0.75	80.0	0.75	26.7	46.7	80.0	0.55	66.7	IV
Santonica	0.5	0.0	6.7	13.3	1	0.0	1	0.0	13.3	13.3	0.13	15	I
	1.0	0.0	13.3	26.7	2	6.7	2	13.3	20.0	33.3	0.25	40.0	II
	1.5	13.3	33.3	53.3	4	13.3	4	20.0	40.0	60.0	0.5	90.0	V
Red pepper	0.3	0.0	13.3	20.0	0.5	13.3	0.5	0.0	6.7	20.0	0.05	-80.0	IV
	0.6	13.3	33.3	46.7	0.7	40.0	0.7	6.7	26.7	46.7	0.1	0.0	I
	1.3	20.0	46.7	73.3	1.5	86.7	1.0	13.3	33.3	73.3	0.3	60.0	III
Neem	5*	0.0	0.0	0.0	5	13.3	5	0.0	0.0	6.7	5	18	I
	10	0.0	0.0	13.3	10	33.3	10	0.0	0.0	20.0	10	22	II
	15	0.0	0.0	53.3	15	66.7	15	0.0	0.0	33.3	15	27	II

Table 15. LC_{50}, LC_{90} and Slope values of some plant extracts used by different techniques against *Monacha obstructa*.

Plant extracts	Bait technique after 7 days			Resdual film technique after 24 hours			Dipping technique after 7 days		
	LC_{50} g/ml	LC_{90} g/ml	Slope	LC_{50} g/ml	LC_{90} g/ml	Slope	LC_{50} g/ml	LC_{90} g/ml	Slope
Fennel	0.08	0.3	2.26	0.02	0.07	2.71	0.04	0.11	2.85
Pomegranate	0.42	0.92	3.72	0.2	0.5	3.43	0.79	1.62	4.13
Black pepper	0.2	0.8	2.19	0.5	1.1	4.13	0.51	1.0	4.25
Santonica	1.55	5.24	2.42	-	-	-	3.1	11.2	2.3
Red pepper	0.7	2.5	2.3	0.9	1.6	4.58	0.75	1.4	4.6
Neem	-	-	-	12.3	32.1	3.08	22.91	84.9	2.25

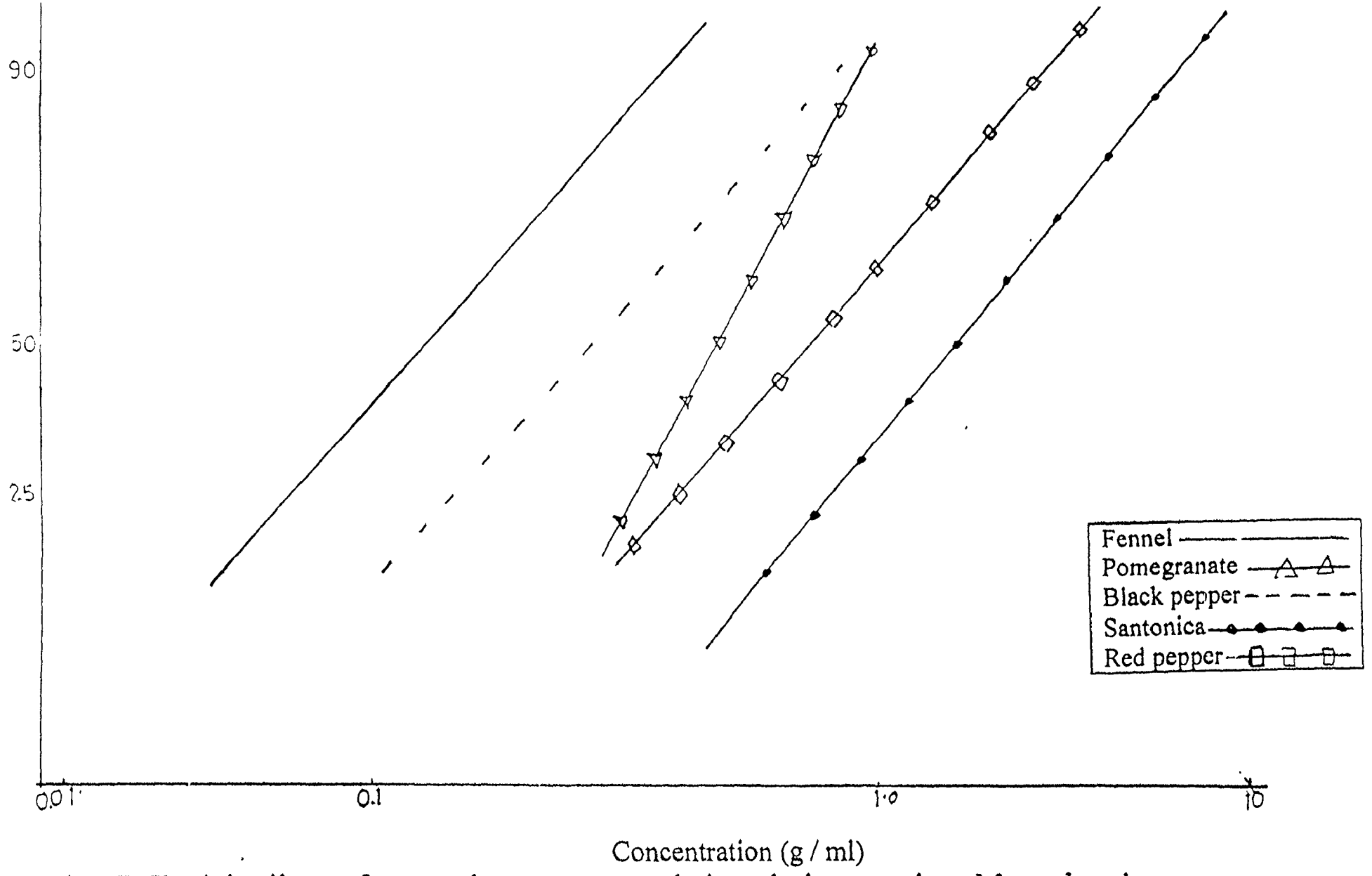


Fig 17. Toxicity lines of some plant extracts as bait technique against *Monacha obstructa*

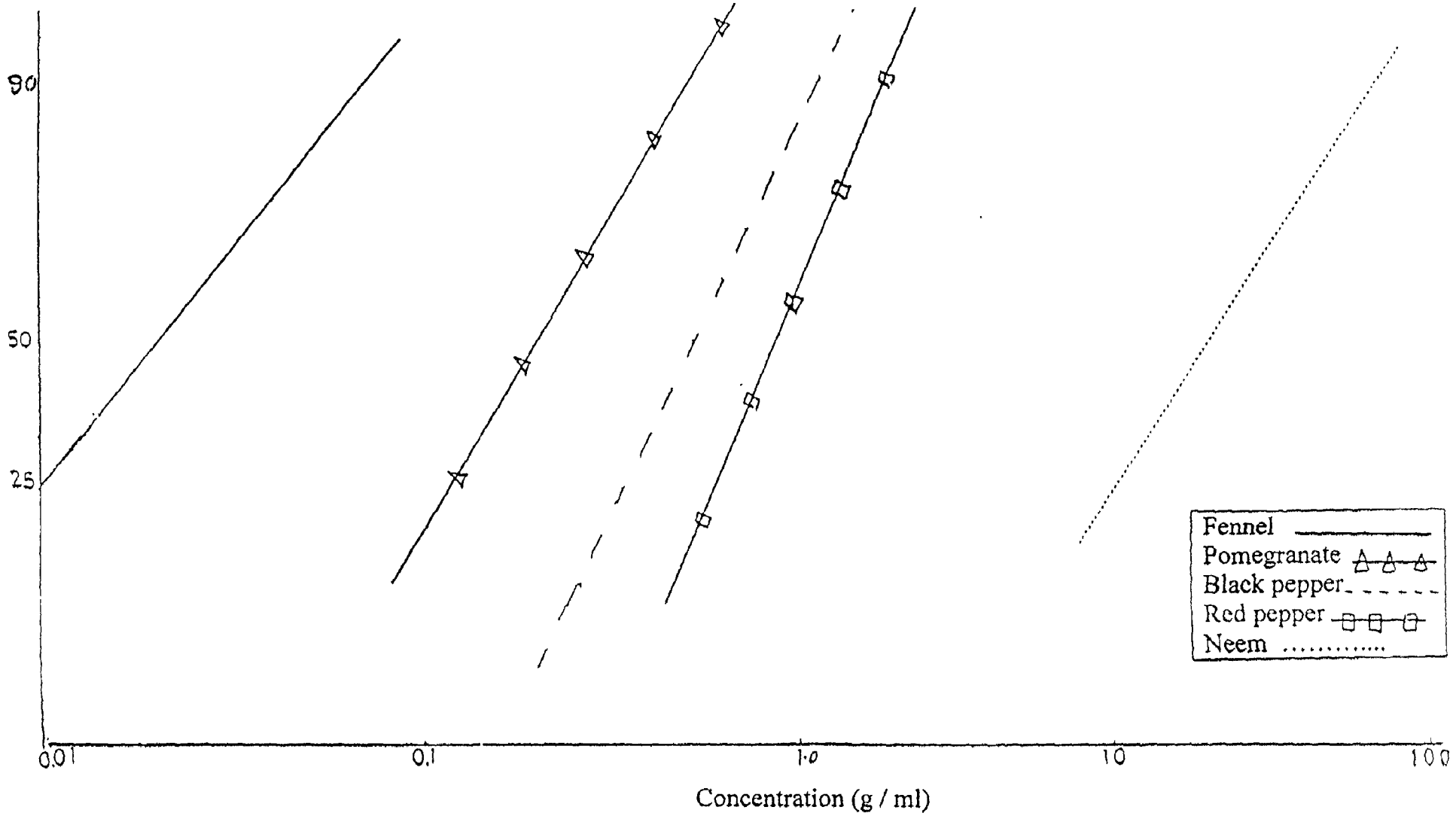


Fig 18. Toxicity lines of some plant extracts as residual film technique against *Monacha obstructa*

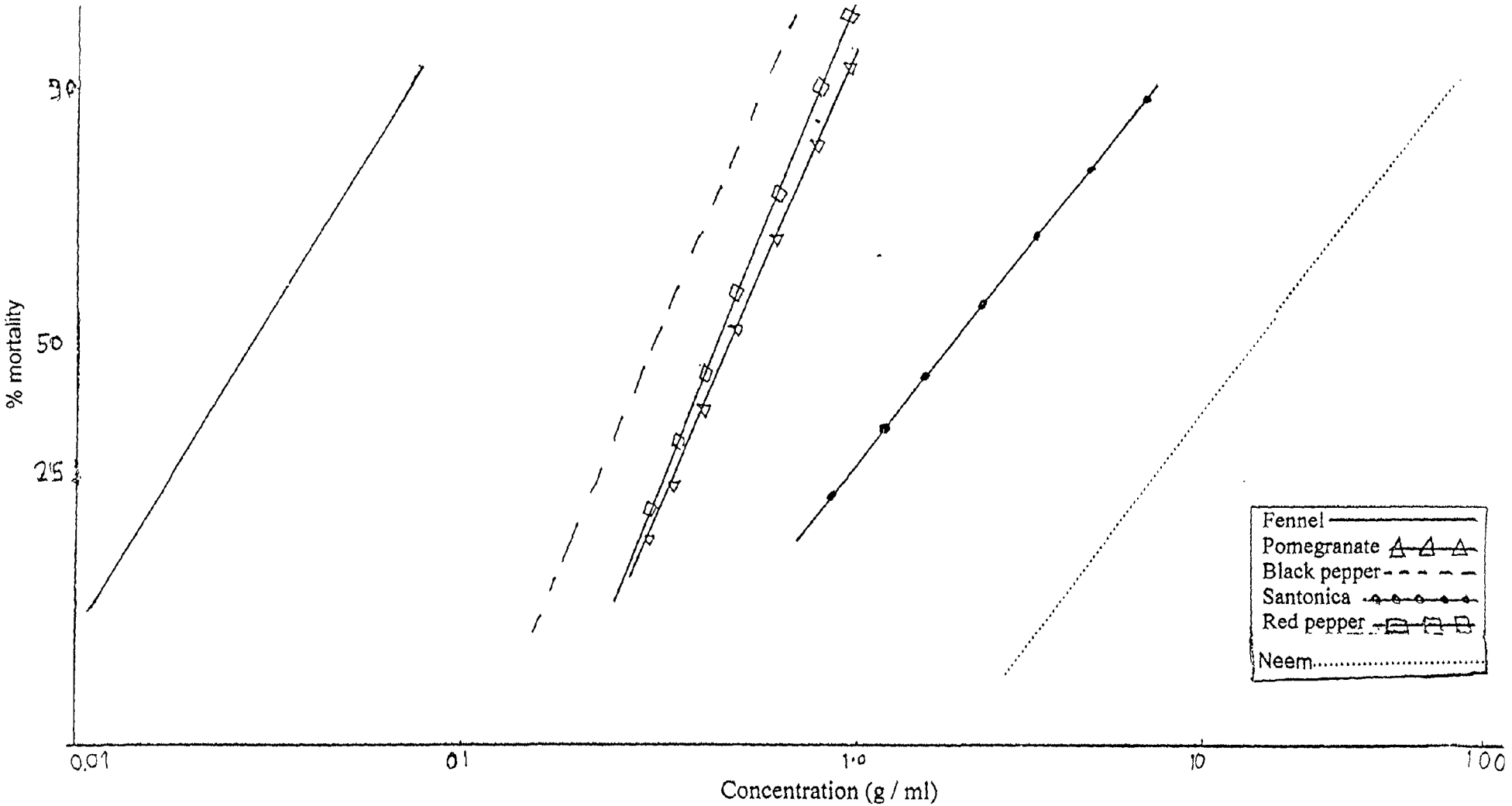


Fig 19. Toxicity lines of some plant extracts as dipping technique against *Monacha obstructa*

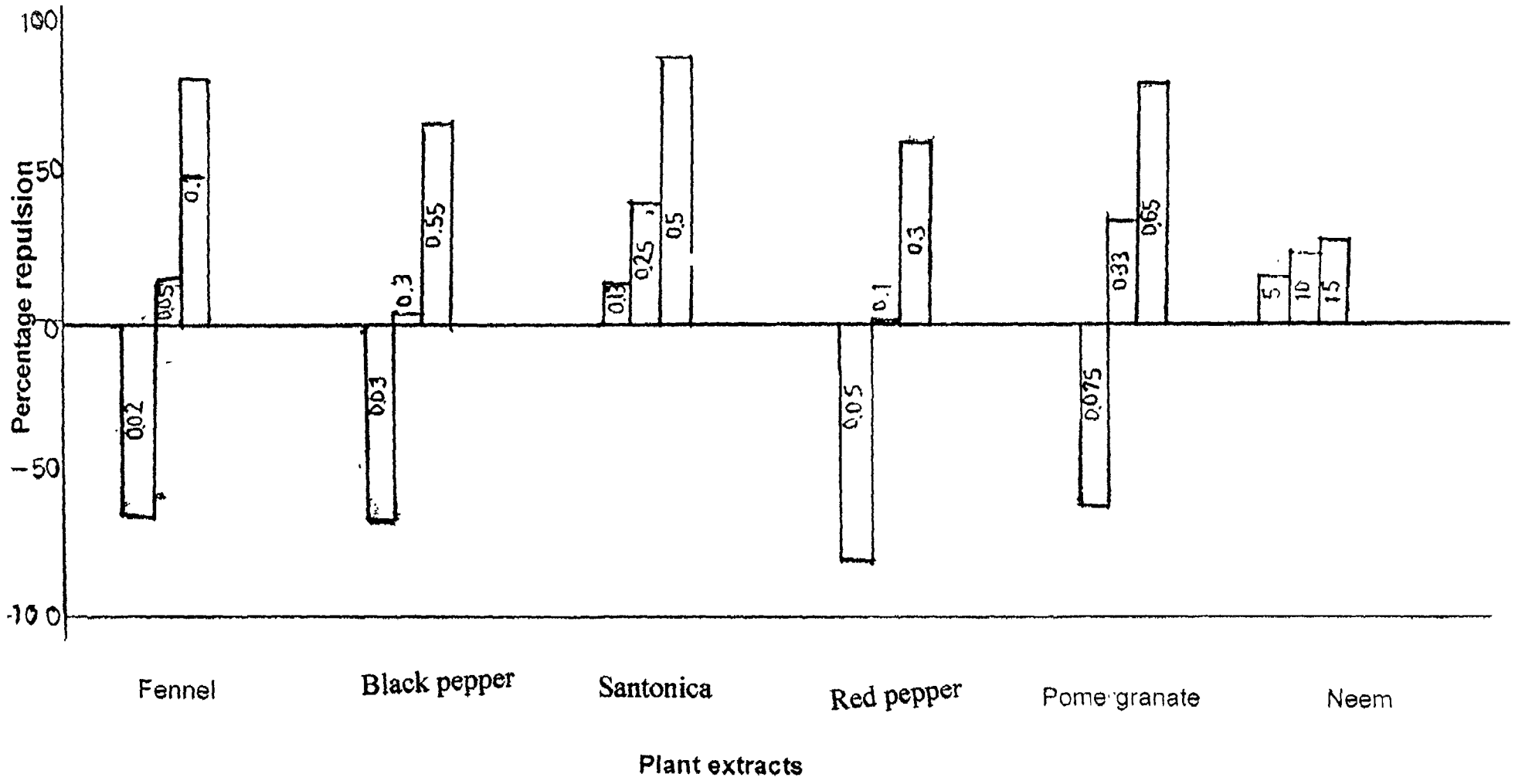


Fig 20. Repellency and attractancy of some plant extracts against *M. obstructa* (Exposure time 1 hour)

e. General identification of the toxic components in plant extracts using Thin layer chromatography:-

In order to identify the plant extract components, the extracts were subjected to Thin layer chromatography (TLC) technique. TLC indicates the different fractions obtained from acetone plant extract. The extracts of Black pepper, Pomegranate, Fennel, Santonica, Red pepper and Neem contained 5, 2, 3, 2, 6 and 3 spots, respectively. The acetone extract of Black pepper yielded 5 fractions having (RF) values of 0.4, 0.5, 0.6, 0.8 and 0.9 cm. Other plant extracts showing the different developed fractions are presented in (Fig 21).

Hussen *et al.* (1994) reported that, the active ingredient in Calotropis procera responsible for the molluscicidal activity was isolated from its latex by solvent extraction.

Several authers used plant extracts to control land snail pests. Hamdy and El-Wakil (1993); Ghamry (1994, 1997); Zidan *et al.* (2001) used several plant extracts against *M. obstructa*, *Eobania vermiculata* and *Theba pisana*. Ebenso (2004) used Neem extract and reported that, there is no effects on the snails exposed to Neem seeds oil extract. Gaber *et al.* (2006) used Neem extract against land snails: *M. obstructa* and *E. vermiculata*.

From the foregoing results, it could be concluded that, plant extracts can be used in controlling the injurious land snails, using the bait technique, especially extracts of Fennel, and Pomegranate as they exhibit more than 90% mortality after 7 days of treatment.

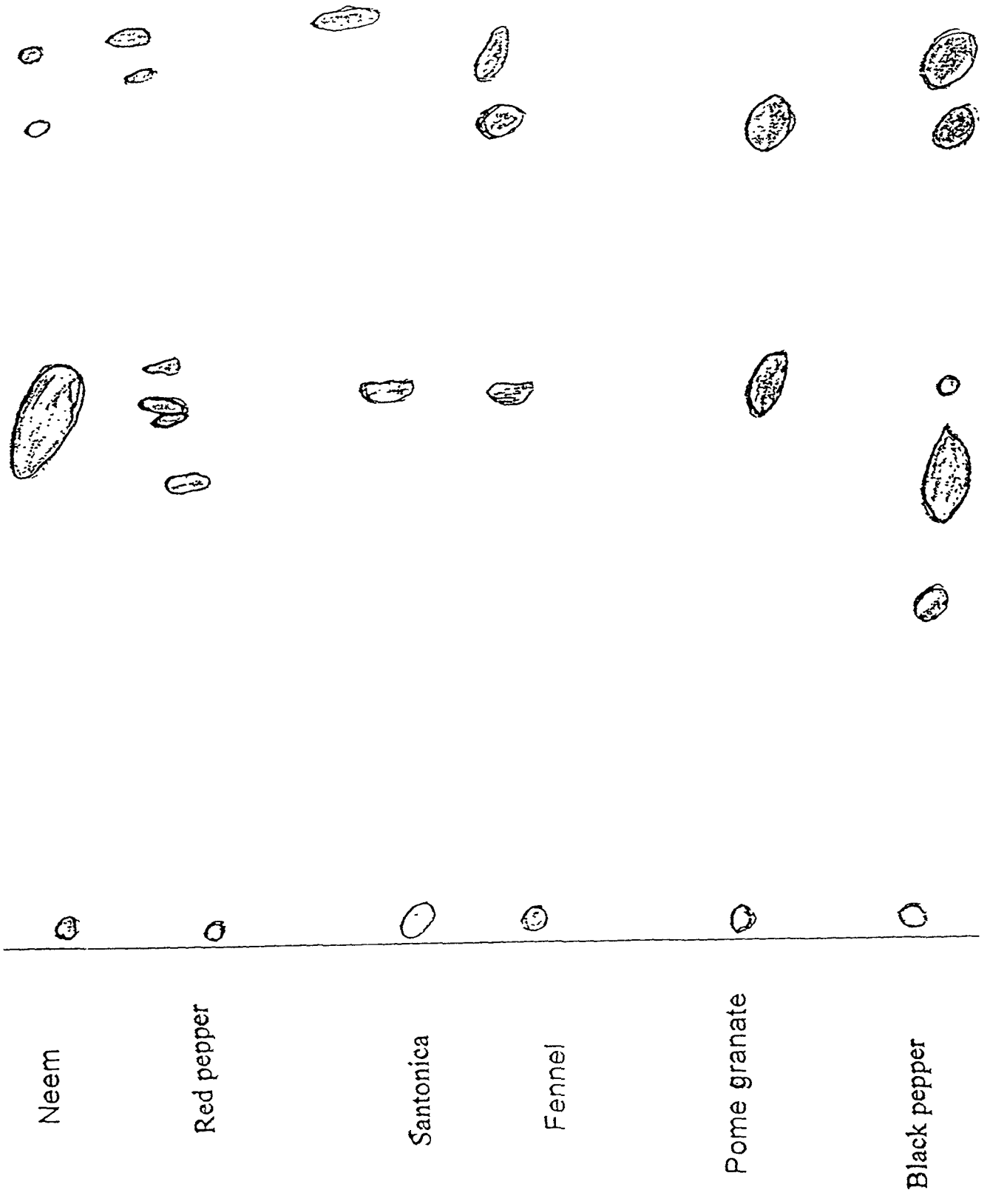


Fig 21. Thin layer chromatograms of plant extracts.

SUMMARY

1. Ecological studies.

The ecological studies were conducted in Samanoud district, Gharbia Governorate to represent the Lawer Egypt and Sennores district, Fayoum Governorate to represent the Upper Egypt. In both districts, two field crops were chosen; Egyptian clover (*Trifolium alexandrinum L.*) as a Winter field crop and Cotton (*Gossypium hirsutum L.*) as a Summer field crop.

A. Survey of land snails:-

Survey of land snails which infesting Egyptian clover and Cotton was conducted in both Samanoud and Sennores districts. The results revealed the following:-

1- Survey of terrestrial snails infesting Egyptian clover and Cotton in Gharbia and Fayoum Governorates through the period from Sebtember to Augast during the two successive seasons 2004/2005 and 2005/2006, revealed the occurrence of four land snail species belonging to Super-family Helicoidea , Family Helicidae and three sub families; Monachinae, Helicinae and Helicellinae. These species are ; glassy clover snail *Monacha obstructa* (Pfiffer), brown garden snail *Eobania vermiculata* (Muller), small sand snail *Theba pisana* (Muller) and small dsert snail *Helicella vestalis* (Pfiffer).

2- *M. obstructa* snail was the predominantes species in both

Governorates followed by *E. vermiculata, T. pisana and H. vestalis.* Egyptian clover crop was found with heavy infestation than Cotton crop.

B. Population dynamics of land snails infesting Egyptian clover and Cotton crops in Gharbia and Fayoum Governorates:-

Seasonal population dynamics of land snails were conducted in Sammanoud and Sennoures districts. One feddan was selected for Egyptian clover and Cotton crops in the two districts, five replicates of quadrate plots ($1m^2$) were randomly examined at biweekly intervals. The results revealed the following.

1- Egyptian clover crop was infested severelly with land snails during the two successive seasons 2004/2005 and 2005/2006 followed by Cotton crop. In Gharbia Governorate, the population density of land snails on Egyptian clover reached 195.6 and 211.6 individuals /m^2 in both seasons respectively, while on cotton crop it reached 49.3 and 62.8 individuals respectively.In Fayoum Governorate these densities reached 288.5 and 307.6 individuals /m^2 on Egyptian clover and 72.2 and 84.9 individuals on Cotton crop in both seasons, respectively.

2- In both governorates; *M. obstructa* snail was the predominant species on Egyptian clover and Cotton crops, while *H. vestalis* snail was occurred with lower number in two field crops.

3- According to the population density of these land snails in both governorates, they can be arranged on Egyptian clover as follow:- *M. obstructa* > *T. pisana* > *E. vermiculata* > *H. vestalis*, while on Cotton, they arranged as follow:- *M. obstructa* > *E. vermiculata* > *T. pisana* > *H. vestalis*.

4- population density peaks of *M. obstructa*, *E. vermiculata*, *T. pisana* and *H. vestalis* on Egyptian clover were recorded during April while the lowest population density were recorded during September for *M. obstructa* and *T. pisana*, and during November for *H.vestalis* and *E. vermiculata* in both Gharbia and Fayoum Governorates.

5- In Cotton crop, peak population density of land snails was recorded during September in Gharbia and Fayoum Governorates , while the lowest density was recorded during July for *E. vermiculata* and *T. pisana* , during April for *M. obstructa* but the lowest density for *H. vestalis* was recorded during April in the first season and during July in the second season in Gharbia Governorates while in Fayoum the lowest density was recorded during April for all snail species. On the other hand these land snails did not recorded during March in Gharbia and Fayoum Governorates.

2. Toxicological studies:

In these studies, One insecticide , tow Inorganic salts and three mineral oils as well as sex plant extracts, were tested against glassy

clover snail *M. obstructa* as bait, residual film, Leaf Dipping and repellency techniques.

A. Molluscicidal effect of some chemicals and mineral oils:

Methomyl (insecticide), Copper sulfate, Sodium borate (inorganic salts); CAPL-1, CAPL-2 and SOL.EC (mineral oils) were tested. Results revealed the following:-

1- Molluscicidal effect of these compounds was tested as a bait technique, Methomyl compound exhibited the highest molluscicidal effect followed by Copper sulfate and Sodium borate, Values of LC_{50},s for Methomyl, Copper sulfate and Sodium borate were 0.07, 1 and 2.6 respectively. In case of mineral oils CAPL-1 was more effective followed by CAPL-2 and Sol.EC.

2- When used these chemicals and mineral oils as a residual film technique, Methomyl was more toxic than Copper sulfate and Sodium borate. Values of LC_{50},s for these chemicals were 0.02, 0.23 and 1.03 respectively. In case of mineral oils; CAPL-1 was more toxic followed by other oils. Values of LC_{50},s for CAPL-1, CAPL-2 and Sol.EC were 3.76, 7.7 and 4.16 respectively.

3- Leaf Dipping technique test revealed that Methomyl was the highest toxic. Values of LC_{50},s for Methomyl, Copper sulfate and Sodium borate were 0.5, 0.4 and 3.35 respectively. On the other hand mineral oil CAPL-1 was more effective. . Values of LC_{50},s for CAPL-1, CAPL-2

and Sol. EC were 2.4, 2.6 and 3.0 respectively.

4- The same compounds were tested as a repellency agents. Methomyl and Sol.EC gave strong repellency than the other compounds.

B. Molluscicidal effect of some plant extracts:

Boiled water extracts of Santonica (*Artemisia herba . alba-Asso)*, Red Pepper (*Capsicum annum L.*) and Pomegranate (*Punica granatum L.)* as well as the acetone extracts of these plants in addition to Fennel (*Foeniculum vulgare l.*), Black pepper (*Piper nigrum l.*) and Neem (*Azadirachta indica*) were tested against *M. obstructa*, using the four mentioned techniques.The results revealed the following:-

1- When using the four bioassay techniques; all crude boiled water extracts of Santonica, Red Pepper and Pomegranate had no effect on snails and no mortality individuals was recorded during the tests period

2- Acetone extracts of Fennel, Black pepper, Santonica, Red Pepper, Pomegranate and Neem were used as baits, against adults of *M. obstructa* under laboratory conditions. the Fennel plant extract exibited the highest effect followed by other plant extracts while Neem was proved the least toxic one. Values of LC_{50},s for Fennel, Black pepper, Santonica, Red Pepper, Pomegranate were 0.08, 0.42, 0.2, 1.55 and 0.7 respectively.

3- the same plant extracts were tested as a residual film

technique against *M. obstructa*. Finnel plant extracts was more toxic, while the Santonica was the least toxic one. Values of LC_{50},s for Fennel, Pomegranate, Black pepper, Red pepper and Neem were 0.02, 0.2, 0.5, 0.9 and 12.3. respectively.

4- These plant extracts were tested as a Dipping technique against *M. obstructa* adult. Data showed that the Fennel plant extract was more effective, while the Neem was the least toxic one. Values of LC_{50},s for Fennel, Pomegranate, Black pepper, Santonica, Red pepper and Neem were 0.04, 0.79, 0.51, 3.1, 0.75, 22.91 respectively.

5- The same plant extracts were tested as a repellency tests against *M. obstructa* adult. Data showed that the Santonica and Neem plant extracts were revealed strong repellency than other plant extracts.

6- In order to identify the plant extract components, the extracts were subjected to Thin layer chromatography technique which indicated the different fractions obtained from acetone plant extract. The extracts of Black pepper, Pomegranate, Fennel, Santonica, Red pepper and Neem contained 5, 2, 3, 2, 6 and 3 spots, respectively. The acetone extract of Black pepper yielded 5 fractions having (RF) values of 0.4, 0.5, 0.6, 0.8 and 0.9 cm. Other plant extracts were showing the different developed fractions.