# INFLUENCE OF CERTAIN WILD PLANT EXTRACTS AGAINST *TETRANYCHUS URTICAE* AND PREDACIOUS MITE *AMBLYSEIUS ZAHERI* (ACARI: TETRANYCHIDAE: PHYTOSEIIDAE)

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## INTRODUCTION

Vegetable crops in Egypt are highly infested by sucking pests as aphid, whitefly and mites. Synthetic pesticides are still the major agent currently used for controlling these pests. The two-spotted spider mite, *Tetranychus urticae* Koch. has been recognized as a factor limiting the production of crops and is controlled by biological means. Its satisfactory control depends on selective pesticides. Although there were some privileges in their use, other problems such as resistance, environmental pollution, residual toxicity in food and hazards to natural enemies and human health hindered the successful application of such control (Pimental *et al.*, 1992). In recent years botanical pesticides have played an important role in the control of spider mite and proved to be effective on target mites (Mansour *et al.*, 1986; Reda and El-Banhawy 1986; Amer *et al.*, 1989).

The effectiveness of the essential oils on mite has been reported by Amer *et al.*, (1993); Ibrahium *et al.*, (1993) and El-Gengaihi *et al.*, (1996). The toxic and deterrent effects of the essential oils were studied on insects and mites by Orphanidis and Kalmoukas (1970); Rodriguez and Levin (1975); Purohit *et al.*, (1983) and Don-Perdo (1985).

The toxicity of the crude extracts for certain plants against adult females and eggs of *T. urticae* Koch, have been reported by several investigators, Barakat, *et al.*, (1985) for acetone and diethyl ether extracts of onion, garlic, caraway, devils apple, lupin, fenugreek, blackpepper, turnip, canna and glonybower on adult females and eggs of *T. urticae* Koch., Osman *et al.*, (1986) for *Nerium oleander* and *Caesalpinia sepiaria* against predatory mite, *Amblyseius gossipi*, El-Halawany *et al.*, (1989) for *Lantana*

*camara* against *Tetranychus arabicus* and Dimetry *et al.*, (2000) for *Curcuma longa* L., *Nicandera physaloids* L. and *Dodonaea viscose* L. against adult females of *T. urticae*.

The aim of the present study is to evaluate the toxic and repellent effects of the crude extracts of three wild plant, *Lygos raetam*, *Silybum marianum* and *Fagonia indica* on the eggs and adult stages of *T. urticae* and the adult stages of *Amblysius zaheri*.

## MATERIAL AND METHODS

Phytophagous mites were obtained from a laboratory colony of *T. urticae* Koch, reared on Lima bean (*Phaseolus vulgaris* L.) foliage at NRC Cairo under laboratory conditions (27 ± 2 °C and 70 – 75 % r.h.).

The predacious mite *A. zaheri* Yousef and El-Borolossy was found on leaves of egg plant and was fed on *T. urticae* in the laboratory.

Three wild plants, *Lygos raetam* (Fam: Leguminosae), *Silybum marianum* (Fam. Compositae) and *Fagonia indica* (Fam. Zygophyllaceae) were collected from different areas in South Sinai. Samples of the collected plants were left to dry in the laboratory for one week. Dried plants were ground using an electric mill, sieved and kept for extraction.

The crude extract was prepared according to the method adopted by Su and Horvat (1981) with some modifications. Samples (1 kg of plant) were blended and soaked in 3 liters of chloroform: methanol (1:1 v/v) for 24 hours and kept in brown colored bottles, 5 liters, provided with tight stoppers with continuous shaking overnight. The extracted solute was separated from the insoluble plant material collected and the latter reextracted with another 2 liters of the same solvent system for another 12 hours and the solvent was also separated. The collected two extracts (5 liters) were filtered over anhydrous sodium sulphate and then the solvent was evaporated under reduced pressure using a Rotary evaporator. The remaining residues were subjected to successive extractions with 4 different solvents (250 ml each), namely n-hexane, diethyl ether, ethyl acetate and ethanol. The crude extract of each solvent was filtered over anhydrous sodium sulphate and the solvent was evaporated using rotary evaporator at 40–50 °C to dryness. The resulting crude extract of each solvent used was weighted and kept in the deep freezer until evaluation.

**Direct effect on eggs of *T. urticae*:**

The direct effect on the egg stage was studied by confining two females on leaf discs for 24 hr., and then removed. These discs with deposited eggs (24 hr old)

were sprayed with different concentrations from each extract using a glass atomizer. Each test contained 5 concentrations and each concentration had 5 replicates (20 eggs/ replicate). Hatchability of eggs on each concentration was recorded 7 days after treatment.

**Direct effect on adult females of *T. urticae*:**

Adult females of *T. urticae* were confined on the lower surfaces of detached raspberry leaves (3 cm in dia.) while the upper surfaces were placed on cotton saturated with water. Mites were sprayed with different extracts using a glass atomizer. Each test contained 5 concentrations and each concentration had 5 replicates (20 females/replicate). Mortality was recorded 48 hr. after application. In every test, a control was included.

**Repellency and oviposition deterrence:**

Raspberry leaf discs (5 cm in dia.) were placed with the lower surface upwards in a Petri-dish lined with moist cotton wool. One half of each disc was treated separately with $LC_{50}$ concentration of each extract, while the other served as a control. Ten adult females of *T. urticae* were then introduced into the middle of each leaf disc. Ten replicates of leaf discs were used per extract. Orientation of the females *T. urticae* on treated and control discs were recorded 3, 5, 24 and 48 hr. after treatment. The number of eggs laid on both sides were recorded after 48 hr. The repellency was calculated according to Lwand *et al.*, (1985).

**Direct effect on predacious mite:**

Adult females of the predator *A. zaheri* were sprayed with different concentrations from different extracts using glass atomizer. Females were confined on the lower surfaces of detached raspberry clean leaves (5 cm in dia.) while the upper surfaces were placed on cotton saturated with water. Each test contained 5 concentrations and each concentration had 5 replicates (20 females/replicate). In every test, a control was included.

Corrected mortality counts according to Abbott's formula (1925) were statistically analyzed by Finney (1971). The toxic index of each extract was determined according to Sun (1950).

## RESULTS AND DISCUSSION

The data presented in Tables (1 and 2), show the relation between the percentage of mortality and concentrations of various extracts of *L. raetam*, *S.*

*marianum* and *F. indica* on eggs and adult females of *T. urticae*. The different plant extracts tested appeared to be more variable in their effects. The data obtained in tables 1 and 2 show that the toxicity effect of diethyl ether extract of *L. raetam* on both stages egg and adult were very close ($LC_{50}$= 0.0034 and 0.0036 gm/ml), respectively.

**TABLE (I)**

Toxicity of some plant extracts against egg stage of *T. urticae*.

| Extract | $LC_{50}$ (gm/ml) | $LC_{90}$ (gm/ml) | Slope | Toxicity index at: | |
|---|---|---|---|---|---|
| | | | | $LC_{50}$ | $LC_{90}$ |
| | *Lygos raetam* | | | | |
| Hexane | 0.3702 | 1.1350 | 2.63 | 0.93 | 0.67 |
| Diethyl ether | 0.0034 | 0.0111 | 2.51 | 100 | 68.83 |
| Ethyl acetate | 0.0050 | 0.0076 | 6.81 | 69.15 | 100 |
| Ethanol | 0.1160 | 0.2545 | 3.75 | 2.96 | 3.0 |
| | *Silybum marianum* | | | | |
| Hexane | 0.0113 | 0.0222 | 4.23 | 61.82 | 86.74 |
| Diethyl ether | 0.0070 | 0.0192 | 2.91 | 100 | 100 |
| Ethyl acetate | 0.0262 | 0.2572 | 1.29 | 26.67 | 7.48 |
| Ethanol | 0.0824 | 0.2041 | 3.25 | 8.48 | 9.42 |
| | *Fagonia indica* | | | | |
| Hexane | 0.0018 | 0.0042 | 3.52 | 100 | 100 |
| Diethyl ether | 0.0529 | 0.1035 | 4.39 | 3.42 | 4.05 |
| Ethyl acetate | 0.0152 | 0.0314 | 4.05 | 11.92 | 13.33 |
| Ethanol | 0.1976 | 0.7152 | 2.29 | 0.92 | 0.59 |

Based on the $LC_{50}$ value it can be arranged for egg stage in the following descending order of effectiveness: Diethyl ether, ethyl acetate, ethanol and hexane; while in case of adult females, toxicity can be arranged in a descending order as follows: Ethyl acetate, diethyl ether, ethanol and hexane. The data obtained in tables 1 and 2 show that the various extracts of *S. marianum* were the most toxic to adult females than the egg stage, while the toxicity effect of the extracts hexane, diethyl ether and ethyl acetate of *F. indica* on both stages egg and adult were very close ($LC_{50}$= 0.0018, 0.0529 and 0.0152 gm/ml and $LC_{50}$= 0.0023, 0.0559 and 0.0109 gm/ml, respectively).

Results indicated also, that the various extracts of 3 plants were more toxic to adult stage than the egg stage. These results agree with that of Dimetry *et al.*, (2000) who reported that the petroleum ether extracts of *C. longa* L., *N. physaloides* L. and alcohol extract of *D. viscose* L. were the most potent tested against adult females of *T. urticae*. The egg stage was less susceptible to the different extracts tested. Amer *et al.*, (2005) reported that the adult females of *T. urticae* were

sensitive to crude ethyl acetate extract of *Francoeria crispa* (Forssk) than the egg stage, as well as the egg stage of *T. urticae* was less susceptible to the different extracts of *Capparis aegyptia* leaves and fruits (Hussein *et al.* 2005).

**TABLE (II)**

Toxicity of some plant extracts against adult females of *T. urticae*

| Extract | $LC_{50}$ (gm/ml) | $LC_{90}$ (gm/ml) | Slope | Toxicity index at: | |
|---|---|---|---|---|---|
| | | | | $LC_{50}$ | $LC_{90}$ |
| | *Lygos raetam* | | | | |
| Hexane | 0.0687 | 0.1751 | 3.15 | 1.09 | 0.81 |
| Diethyl ether | 0.0036 | 0.0073 | 4.24 | 20.60 | 19.32 |
| Ethyl acetate | 0.00075 | 0.00141 | 4.70 | 100 | 100 |
| Ethanol | 0.0295 | 0.0574 | 4.43 | 2.54 | 2.46 |
| | *Silybum marianum* | | | | |
| Hexane | 0.0022 | 0.0036 | 5.99 | 100 | 100 |
| Diethyl ether | 0.0037 | 0.0080 | 3.88 | 58.45 | 44.72 |
| Ethyl acetate | 0.0056 | 0.0100 | 5.02 | 39.28 | 35.67 |
| Ethanol | 0.0155 | 0.0330 | 3.92 | 14.03 | 10.80 |
| | *Fagonia indica* | | | | |
| Hexane | 0.0023 | 0.0040 | 5.51 | 100 | 100 |
| Diethyl ether | 0.0559 | 0.1633 | 2.75 | 4.19 | 2.44 |
| Ethyl acetate | 0.0109 | 0.0201 | 4.83 | 21.41 | 19.83 |
| Ethanol | 0.0145 | 0.1577 | 1.24 | 16.10 | 2.53 |

**Repellency and oviposition deterrence:**

Table (3) show that females of *T. urticae* preferred the untreated part of the leaves to feed and deposit eggs. After 48 hours of exposure the females deposited eggs on the treated part, the average number of eggs varied according to various extracts. A higher percentage of repellency was recorded in various extracts of *S. marianum* and *F. indica* (86.60 – 98.23 % and 85.53 – 97.0 %), respectively. While percent repellency decreased with extracts of *L. raetam* (55.81 – 80.84 %). Mansour and Ascher (1983) revealed that neem seed kernels prepared from various solvents strongly repelled the females of *Tetranychusa cinnabarines* (Boisd). Other plants such as *F. crispa* showed similar remarkable repellency against *T. urticae*. (Amer *et al.*, 2005)

**Toxicity effect on adult females of predacious mite *A. zaheri*.**

The data obtained in Table (4) show that adult females of *A. zaheri* were more sensitive to ethyl acetate extract of *L. raetam* ($LC_{50}$ = 0.00079 gm/ml) while less susceptible to ethanol extract of the same plant ($LC_{50}$ = 0.2944 gm/ml). From tables (2 and 4) the toxicity effect of ethyl acetate extract of *L. raetam* on both adult

females of *T. urticae* and predacious mite *A. zaheri* were very close ($LC_{50}$ = 0.00075 and 0.00079 gm/ml, respectively).

**TABLE (III)**

Relative percentage distribution and oviposition of *T. urticae* on treated leaf discs with different extract of *L. raetam, S. marianum* and *F. indica* at $LC_{50}$ conc.

| Extract | % Distribution of mites on treated leaf part after: | | | | No. of eggs/female after 48 hr. | | % Repellency |
|---|---|---|---|---|---|---|---|
| | 3 h | 5 h | 24 h. | 48 h. | T | C | |
| | *Lygos raetam* | | | | | | |
| Hexane | 2 | 4 | 12 | 30 | 1.14 | 5.95 | 80.84 |
| Diethyl ether | 5.56 | 5.56 | 25.93 | 44.44 | 1.9 | 4.31 | 55.81 |
| Ethyl acetate | 1.82 | 1.82 | 22.22 | 29.10 | 1.5 | 5.4 | 72.04 |
| Ethanol | 3.77 | 3.77 | 7.55 | 43.40 | 1.04 | 4.09 | 74.57 |
| | *Silybum marianum* | | | | | | |
| Hexane | 3.23 | 4.84 | 5 | 5 | 0.12 | 6.78 | 98.23 |
| Diethyl ether | 0 | 2.08 | 2.13 | 10.64 | 0.91 | 6.79 | 86.60 |
| Ethyl acetate | 4.76 | 4.92 | 3.39 | 6.78 | 0.14 | 3.69 | 96.21 |
| Ethanol | 0 | 0 | 5.56 | 17.65 | 0.33 | 5.15 | 93.59 |
| | *Fagonia indica* | | | | | | |
| Hexane | 2 | 4 | 6 | 10 | 0.6 | 5.1 | 88.24 |
| Diethyl ether | 1.54 | 0 | 13.85 | 37.25 | 0.17 | 5.66 | 97.0 |
| Ethyl acetate | 2.82 | 1.41 | 18.31 | 34.29 | 3.11 | 3.11 | 85.53 |
| Ethanol | 3.08 | 3.08 | 18.46 | 32.81 | 3.98 | 3.98 | 92.71 |

T = treated C = control

**TABLE (IV)**

Toxicity of some plant extracts against adult stage of the predacious mite *A. zaheri*

| Extract | $LC_{50}$ (gm/ml) | $LC_{90}$ (gm/ml) | Slope | Toxicity index at: | |
|---|---|---|---|---|---|
| | | | | $LC_{50}$ | $LC_{90}$ |
| | *Lygos raetam* | | | | |
| Hexane | 0.0824 | 0.1711 | 4.04 | 0.96 | 0.81 |
| Diethyl ether | 0.0076 | 0.0121 | 6.34 | 10.37 | 11.38 |
| Ethyl acetate | 0.00079 | 0.00138 | 5.27 | 100 | 100 |
| Ethanol | 0.2944 | 0.9890 | 2.43 | 0.27 | 0.14 |
| | *Silybum marianum* | | | | |
| Hexane | 0.0036 | 0.0053 | 7.69 | 100 | 100 |
| Diethyl ether | 0.0062 | 0.0105 | 5.50 | 58.70 | 50.38 |
| Ethyl acetate | 0.0091 | 0.0179 | 4.36 | 39.54 | 29.50 |
| Ethanol | 0.0356 | 0.1065 | 2.69 | 10.13 | 4.97 |
| | *Fagonia indica* | | | | |
| Hexane | 0.0035 | 0.0123 | 2.34 | 100 | 100 |
| Diethyl ether | 0.0840 | 0.1703 | 4.17 | 4.17 | 7.22 |
| Ethyl acetate | 0.0204 | 0.0265 | 11.21 | 17.19 | 46.45 |
| Ethanol | 0.0420 | 1.4705 | 0.83 | 8.33 | 0.84 |

Generally the data from tables (2 and 4) indicated that the all extracts of the 3 plants were more toxic to adult female of *T. urticae* than the female of *A. zaheri*. Momen and Amer (1994) reported that the Lupin extract was slightly toxic to eggs and females of the predator *A. barkeri*. Essential oil of mint, *Mentha virdis* was more toxic to female of *T. urticae* than to female of Phytoseiid predators, *Amblyseius yosefi*, *A. zaheri*, *P. finitimes*, *A. barkeri*, *A. deleomi* and *T. athiasae* (Momen *et al.*, 2001).

Take into consideration the combined effects of these extracts on the phytophagous mite *T. urticae* and the predator *A. zaheri* (Table 5), the ethanol extracts of *L. raetam*, *S. marianum* and *F. indica* were 9.98, 2.30 and 2.90 times more toxic to the female of *T. urticae* than to the female of the predator *A. zaheri*. Thus in a habitat where the predator is associated with phytophagous mites it is necessary to apply the least toxic material to the predator and the most efficient to the prey.

**TABLE (V)**

Evaluation of the acaricidal properties of some plant extracts against adult stages of *T. urticae* and the predacious mite *A. zaheri*

| Extract | *T. urticae* $LC_{50}$ (gm/ml) | *A. zaheri* $LC_{50}$ (gm/ml) | No. of folds compared with the predator *A. zaheri* |
|---|---|---|---|
| | *Lygos raetam* | | |
| Hexane | 0.0687 | 0.0824 | 1.20 |
| Diethyl ether | 0.0036 | 0.0076 | 2.11 |
| Ethyl acetate | 0.00075 | 0.00079 | 1.05 |
| Ethanol | 0.0295 | 0.2944 | 9.98 |
| | *Silybum marianum* | | |
| Hexane | 0.0022 | 0.0036 | 1.64 |
| Diethyl ether | 0.0037 | 0.0062 | 1.68 |
| Ethyl acetate | 0.0056 | 0.0091 | 1.63 |
| Ethanol | 0.0155 | 0.0356 | 2.30 |
| | *Fagonia indica* | | |
| Hexane | 0.0023 | 0.0035 | 1.52 |
| Diethyl ether | 0.0559 | 0.0840 | 1.50 |
| Ethyl acetate | 0.0109 | 0.0204 | 1.87 |
| Ethanol | 0.0145 | 0.0420 | 2.90 |

## SUMMARY

Three wild plants, *Lygos raetam*, *Silybum marianum* and *Fagonia indica* were successively extracted with four different solvents. These extracts were tested for their toxicity and repellency against the two-spotted spider mite, *Tetranychus*

*urticae* Koch and their direct toxicity to adult female of the predacious mite *Amblyseius zaheri* Yousef and El-Borolossy. The adult females of *T. urticae* were sensitive to various extracts of three plants than the egg stage. A higher repellency was recorded in various extracts of *S. marianum* and *F. indica* and decreased with extracts of *L. raetam.*

Laboratory studies indicated that the adult female of the predacious mite *A. zaheri* was more sensitive to ethyl acetate extract of *L. raetam* while less susceptible to ethanol extract of the same plant. All various extracts of the three plants were more toxic to adult female, *T. urticae* than the female of *A. zaheri.*

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## REFERENCES

**ABBOTT, W.S. (1925):** A method of computing the effectiveness of an insecticide. *(J. Econ. Entomol, 18, 265-267).*

**AMER, S.A.A., A.S. REDA and N. Z. DIMETRY (1989):** Activity of *Abrus precatorius* L. extracts against the two spotted spider mite *Tetranychus urticae* Koch. (Acari: Tetranychidae) *(Acarologia 30, 209 – 219).*

**AMER, S.A.A., B.A. ABOU-AWAD and E.M. EL-BANHAWY (1993):**Toxicity of orange peel and lemon grass oils to the spider mite, *Tetranychus urticae* and *Eutetranychus orientalis* with effects on the development and reproduction (Acari:Tetranychidae). *(African J. Agric. Sci. 20, 95 - 102).*

**AMER, S.A.A., S.A. SABER and M.M.M. SOLIMAN, (2005):** Acaricidal activity of *Francoeria crispa* (Forssk.) extract on the two-spotted spider mite, *Tetranychus urticae* (Koch.) (Acari: Tetranychidae). *(J. Egypt. Ger. Soc. Zool. 46 E: 33 – 41).*

**BARAKAT, A.A., G.M. SHEREEF, S.A. ABDALLAH and S.A.A. AMER (1985):** Toxic action of some plant extracts against *Tetranychus urticae* Koch. *(Bull. ent. Soc. Egypt Econ. Ser. 14, 233 - 242).*

**DIMETRY, N.Z., S.E. EL-GENGAIHI, S.A.A. AMER and S.M. MOHAMED (2000):** Acaricidal potentials of some medicinal plants against the two-spotted spider mite, *Tetranychus urticae* Koch. *(In 8th Workshop Practice Oriented Results on Use and Production of Neem Ingredients and Phermones, 16-18 February (1998): Edited by Kleeberg, H and Zebitz, C.P.W.) Durck and Graphi Giesse, 117 – 125)*

**DON-PEDRO, K.N. (1985):** Toxicity and some citrus peels on *Dermestes maculatus* Deg, and *Callosobruchus maculatus* (F.). *(J. Stored Prod. Res. 81, 31 – 32).*

**EL-HALAWANY, M.E., G.A. IBRAHIM, G. ABO-EL-GHAR and M.E. NASSAR (1989):** Repellency and toxic effects of certain plant extracts on *Tetranychus urabicus* Attiah (Acarina :Tetranychidae). *(Agric. Res. Rev. 67, 69 -74).*

**EL-GENGAIHI, S., S.A.A. AMER and S.M. MOHAMED (1996):** Biological activity of Thyme oil and Thymol against *Tetranychus urticae* Koch. *(Anz. Schad. Pflan. Univ. 69: 157-159).*

**FINNEY, D.J. (1971):** Probit analysis. Cambridge Univ. Press. London, 318 pp.

**HUSSEIN, H.E., M. ABOU-ELELLA, S.A.A. AMER and F.M. MOMEN (2005):** Repellency and toxicity of extracts from *Capparis aegyptia* to *Tetranycus urticae* Koch. (Acari: Tetranychidae). *(J. Egypt. Ger. Soc. Zool. 46 E: 115 -130).*

**IBRAHIM, M.E., A.H. ABOU-ZEID, N.E. AWAD and S.A.A. AMER (1993):** The essential oil and some extracts of *Cotula cinerea* L. and their biological activity of *Tetranychus urticae. (Egypt. J. App. Sci. 8 (6) 1-14).*

**LWANDE, W., P.W. HASSANALI, P.W. NJOROGE, M.D. BENTELY, F. DELLE MONACHE and J.I. JONDIKO (1985):** A new 6, a-hydroxy pterocarbon with insect antifeedant and antifungal properties from the roots of *Tephrosia hildebrntii* Vatke. *(Insect Sci. Applic. 6: 537 – 547).*

**MANSOUR, F.A. AND K.R.S. ASHER (1983):** Effect of neem *Azadirachta indica* seed kernel extracts from different solvents on the carmine spider mite *Tetranychus cinnabarinus. (Phytoparasitica 11 (3/4): 177-185).*

**MANSOUR, F., U. RAVID AND E. PUTIENSKY (1986):** Studies of the effects of essential oils isolated from 14 species of Labiatae on the spider mite *Tetranychus cinnabarinus.* (Phytoparasitica 14: 137 – 142).

**MOMEN, F.M. AND S.A.A. AMER (1994):** Effect of some foliar extracts on the predatory mite *Amblyseius barkeri* (Acarina: Phytoseiidae). *(Acarologia 35, 3: 223 – 228).*

**MOMEN, F.M., S.A.A. AMER AND A.M. REFAAT (2001):** Influence of mint and pepper mint on *Tetranychus urticae* and some predacious mites of the family Phytoseiidae (Acari: Tetranychidae: Phytoseiidae). *(Acta Phyto. Entom. Hungarica, 36 (1-2): 143 -153).*

**ORPHANIDIS, P.S. AND KALMOUKOS (1970):** Negative chemotropism of *Dacus oleae* (G. Mel) adults against essential oils. *(Ann. Inst. Phytopath. Benaki N. S. 9: 288 – 289)*

**OSMAN, A.A., S.M. ABO-TAKA AND G.E. ABO-EL-GHAR (1986):** Effectiveness of two ornamental plant extracts on the predacious mite, *Amblyseius gossipi* El-Badry (Acari: Phytoseiidae). *(Minufiya J. Agric. Res. 11 (2): 1059 -1067).*

**PIMENTEL, D., H.ACQUAY, M. BILTONEN, J. NELSON, V. LIPNER, S.GIORDANO, A. HOROWTTZ and M. D'AMORE (1992):** Environmental and economic coasts of pesticide use. *(Bioscience 42: 750 -760).*

**PUROHIT, P., M. MUSTAFA and Z. OSMANI (1983):** Insecticidal properties of plant extract of *Cumminum cyminum*. Linn. *(Science and Culture 4: 101- 107).*

**REDA, A.S. and E.M. EL-BANHAWY (1986):** Effect of cumarin and gallic acid allelochemics on survival development and reproduction of the two-spotted spider mite *Tetranychus urticae* (Acari: Tetranychidae). *(International J. Acarol. 12: 159 – 162).*

**RODRIGUEZ, E. and D.H. LEVIN (1975):** Biochemical parallelisms of repellents and attractants in higher plants and arthropods, In Recent advances in Phytochemistry: Biochemical Interaction Between plants and Insects. *(Edited by Wallace, J. and Mansell, R.L. Plenum press, New York, 215 - 270.)*

**SU, H. AND R. HORVAT (1981):** Isolation, identification and insecticidal properties of *Pipper nigrum* amides. *(J. Agric Food Chem., 29: 115 – 118).*

**SUN, Y.P. (1950):** Toxicity index and improved method of comparing the relative toxicity of insecticides. *(J. Econ. Entomol. 43: 45 – 53).*