

EVALUATION OF JOJOBA OIL FOR CONTROL OF SPIDER MITE (ACARI : TETRANYCHIDAE) IN EGYPT

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Abstract

The efficacy of jojoba oil against different stages of the phytophagous mite, *Tetranychus arabis* Attiah, and the adult female of the predaceous mite *Euseius scutalis* (Athias-Henriot) was studied. Predaceous mite females were more tolerant to the oil than any of the phytophagous mite stages, where the LC₅₀ and LC₉₀ for *E. scutalis* adult females were 5.08 and 14.36 %, while those for *T. arabis* larvae, deutonymphs, adult females and eggs were 0.53 and 4.28, 1.21 and 5.17, 1.60 and 6.35, and 2.53 and 10.86 %, respectively. The biological aspects of *T. arabis* were highly affected by treating eggs and adult females with different concentrations of jojoba oil. In egg treatment, hatchability increased while incubation period of eggs as well as life cycle were prolonged as concentration increased, and the percentage of individuals which succeeded to reach adulthood was affected. After adult treatment, life cycle was prolonged and the female fecundity decreased as concentration increased. The female longevity was prolonged in case of the low concentration (1.5 %) and was shortened in case of the high concentration (2 %). A greenhouse experiment was conducted to evaluate jojoba oil for control of the two-spotted spider mite, *T. arabis*, population with three concentrations. The percentages of reduction one, 3, 7 and 15 days after treatment were 38.13, 51.12, 56.87 and 63.19 % with the oil concentration of 1 %; 60.50, 70.50, 79.30 and 80.20 % with 2 % and 76.26, 78.81, 92.66 and 92.44 % with the concentration of 3 %, respectively.

Introduction

Jojoba oil is obtained from the seeds of the slow growing jojoba plant (*Simmondsia chinensis*), which is now widely grown in several countries (Ronhotra and Gelroth, 1989). The range value of jojoba oil in jojoba seeds is 45-60 % (Haumann, 1983); based on several collections of jojoba seeds, a mean value is reported at 53.2 % (Clark and Yermanos, 1980). Currently, jojoba oil is widely used in cosmetics and pharmaceuticals, and as an industrial lubricant. Very little is known of the toxicological and health consequences of jojoba oil to food (Ronhotra and Gelroth, 1989).

On the other hand, many natural products, especially oils, were tested for their pesticidal effect on various economic

pests, especially mites (Jacobson et al., 1978; Schauer and Schmutterer, 1981; Mansour and Ascher, 1983; Barakat et al., 1984; Abo-El-Ghar et al., 1986; El-Halawany et al., 1988; Abo-El-Ghar et al., 1990; Sawires et al., 1995; Nassar et al., 1995; and Iskander et al., 1995).

The aim of the present work is to study the effect of jojoba oil on the two-spotted spider mite *Tetranychus arabis* Attiah, which is the most economically important mite species of a wide spread nature in Egypt, and its most efficient predaceous mite, *Euseius scutalis* Athias-Henriot.

Materials and Methods

The two-spotted spider mite (green form), *Tetranychus arabis* Attiah, was chosen as a phytophagous mite to study the toxicity and the effect of jojoba oil on its biological aspects, while *Euseius scutalis* (Athias-Henriot) was selected as a predaceous mite to evaluate its adult female sensitivity to the same oil. Jojoba oil was prepared as emulsifiable concentrate 96 % in the Central Agricultural Pesticides Laboratory (CAPL) by Dr. A.G. El-Sisi.

Rearing Technique of Mites :

A pure culture of each species was maintained on detached mulberry leaves placed with the lower surface upwards on moist cotton wool pads in Petri dishes (20 cm. in diameter). *E. scutalis* individuals were fed on *T. arabis* immatures.

Toxicity Tests :

* Ovicidal action :

Twenty adult females of *T. arabis* were allowed to lay eggs on the lower surface of a mulberry leaf disc (2.5 cm. in diameter). Four discs were placed in a Petri dish on moist cotton wool pads (each disc was considered as a replicate). The females were removed after 24 hours and the eggs were counted. The disc surfaces carrying the eggs were sprayed with the aqueous solution of jojoba oil using a manual glass atomizer. Five concentrations of the oil were used to determine slope, LC₅₀'s and LC₉₀'s according to Finney, 1952. The numbers of non-hatched eggs were counted and the percentage of mortality was corrected by using Abbott's formula, 1925.

* Larva, deutonymph and adult tests

Twenty *T. arabis* larvae, deutonymphs or adult females of the same age were transferred to a mulberry leaf disc (5 cm. in diameter) for studying the toxicity of jojoba oil on the two-spotted spider mite different stages. The same was made with *E. scutalis*, but just for adult females only. Each treatment was replicated four times. The disc surfaces carrying the individuals of the same age were sprayed with five concentrations of jojoba oil for each stage as indicated in the egg treatment.

Effect of Jojoba Oil on the Biology of *T. arabis*

Changes in the biology of *T. arabis* were determined after treating eggs with four concentrations (1.5, 3.5, 4.0 and 5.5

%), and adult females with two concentrations (1.5 and 2.0 %). In egg treatment, hatchability and incubation period of treated eggs were determined, and the newly hatched larvae were transferred individually to clean leaf discs and left to develop until reaching the adult stage to determine the life cycle duration and the percentage of individuals which succeeded to reach adulthood (% survival). In adult treatment, the treated females deposited their eggs, then the same technique was followed as in the egg treatment until reaching the adult stage, adults were sexed and left to copulate. Ten mated females were left singly to complete their life and the total number of eggs per female was estimated. Leaf discs were changed when needed. Examination was undertaken twice daily. An analysis of variance (ANOVA) was done for incubation period and life cycle after egg treatments and for life cycle, female longevity and fecundity after adult treatments.

Greenhouse Experiment

To evaluate the efficacy of jojoba oil against the phytophagous mite, *T. arabicus*, population bean seeds of *Phaseolus vulgaris* L. were sown in pots (7 inches in diameter). The bean seedlings were infested with the spider mite three weeks after sowing. Three concentrations (1, 2 and 3 %) of jojoba oil were sprayed only once by the means of a manual atomizer, one month after sowing. Five pots (each represented a replicate) were sprayed with each concentration, while five pots were left untreated as control. One seedling (the same one) from each replicate was examined microscopically 1, 3, 7 and 15 days after treatments to count the moving stages of the two-spotted spider mite. A pre-count was made before spraying to estimate the percentage of reduction in mite population according to Henderson and Tilton equation, 1955. All experiments were carried out at a room temperature of $25\pm 2^{\circ}\text{C}$ and relative humidity of $65\pm 5\%$.

Results and Discussion

Toxicity of Jojoba Oil Against *T. arabicus* and *E. scutalis*

The toxic action of jojoba oil revealed that all the stages of *T. arabicus* were more susceptible than *E. scutalis* adult female (Table 1 & Fig. 1). The LC_{50} and LC_{90} were 0.5342 and 4.2781, 1.2137 and 5.1722, 1.5996 and 6.3471, and 2.5292 and 10.8619 % for larva, deutonymph, adult female and egg of *T. arabicus*, respectively, compared with 5.0807 and 14.3594 % for *E. scutalis* adult female. It could also be concluded that eggs of *T. arabicus* were more tolerant than other stages of the two-spotted spider mite. This finding is in agreement with Sawires et al. (1995) and Iskander et al. (1995) who stated that the adult females were more susceptible to all the tested plant extracts than the eggs of the two-spotted spider mite.

Effect of Jojoba Oil in the Biological Aspects of *T. arabicus*

After treating *T. arabicus* eggs with four concentrations and adult females with two concentrations of jojoba oil, changes in the biology were determined.

*** After egg treatment**

The results compiled in Table (2) show that hatchability percent of the treated eggs with jojoba oil concentrations of 1.5, 3.5, 4.0 and 5.5 % decreased as concentration increased which averaged 66.7, 34.4, 33.3 and 23.3 %, respectively, compared with 96.7 % for control check. Incubation period of eggs was significantly increased after treating eggs with the previously mentioned concentrations which averaged between 7.81 and 8.,20 days compared with 5.21 days for untreated eggs. Treating eggs resulted in considerable prolongation of the life cycle period of *T. arabicus* averaging between 13.42 and 14.21 days compared with 10.86 days for control. The percentage of individuals which succeeded to reach the adult stage ranged between 83.3 and 100 % in the different treatments, where all the hatched larvae managed to reach adulthood after treating eggs with the oil concentration of 1.5 %, while the percentage survival reached 87.1, 83.3 and 90.5 % after treating eggs with the oil concentrations of 3.5, 4.0 and 5.5 %, respectively.

*** After adult treatment**

As shown in Table (3), the life cycle of *T. arabicus* females was prolonged as concentration increased, which averaged 13.07 and 15.10 days for individuals produced from females treated with oil concentrations of 1.5 and 2 %, respectively, compared with 10.86 days for those produced from untreated females. While concentration of 1.5 % caused prolongation of the female longevity (26.90 days) compared with control check (20.86 days), the concentration of 2.0 % significantly shortened the female longevity (9.30 days). The oil concentration highly affected the spider mite female fecundity, where 1.5 and 2.0 % decreased the total number of eggs per female to 76.80 and 43.40 eggs, respectively, compared with 98.70 eggs per female in the control check.

These previous results of the effect of jojoba oil on the biology of *T. arabicus* are in agreement with those of several investigators who tested the miticidal effects of some plant extracts on mites. Iskander et al. (1995) found that treating eggs and adult females of *T. arabicus* with Shihh, Sorrel and Kalakh extracts prolonged the incubation period of eggs and life cycle, shortened the female longevity and decreased the female fecundity. Nassar et al. (1995) when testing the effect of Duranta and Lantana plant extracts on the biology of the two-spotted spider mite, found that both extracts affected life cycle, longevity and the total number of deposited eggs per female. Barakat et al. (1984) observed that treatment with devil's apple, lupin, black pepper, caraway, fenugreek, onion, turnip and glowry bower plant extracts significantly shortened female longevity and decreased the fecundity. Jacobson et al. (1978) found that the rate of egg deposition for the red citrus mite,

Panonychus citri has been reduced as a result of treatment with hexane extracts of neem kernels. Schauer and Schmutterer (1981) reported that aqueous extracts of high concentrations (2.5, 5, 10 %) of methanolic extracts of neem seeds reduced the fecundity of *T. urticae*. Similar results were obtained by Mansour and Ascher (1983) who found that extracts of neem seed kernels affected the behavior and fecundity of the carmine spider mite, *Tetranychus cinnabarinus*.

Effect of Jojoba Oil on *T. arabicus* Population

Table 4 includes the percentages of reduction in the two-spotted spider mite population on bean seedlings after different intervals following treatment with three concentrations of jojoba oil. It is clearly shown that the percentage of reduction increased as oil concentration increased at each investigation date, and successively increased along the experiment period for each concentration. the percentage of reduction after 1, 3, 7 and 15 days from treatment with 1, 2 and 3 % of jojoba oil were 38.13, 51.12, 56.87 and 63.19 %; 60.50, 70.50, 79.30 and 80.20 %; and 76.26, 78.81, 92.66 and 92.44 %, respectively.

From the achieved results, this material could be used in integrated pest management programs after successful work under field conditions is reached.

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References

Abbott, W.S. 1925. A method of computing effectiveness of an insecticide. J. Econ. Entomol., 18: 265-267.

Abo-El-Ghar, G.E.S.; A.E. El-Sheikh and A.A. Osman. 1986. Toxicity of some ornamental plant extracts to the two-spotted spider mite *Tetranychus urticae* Koch (Acarina : Tetranychidae) in Egypt. Minufiya J. Agric. Res., 11: 1003-1010.

Abo-El-Ghar, G.E.S.; G.I. Zohdi; A.I. Farrag and A.E. Sanad. 1990. Effect of some plant extracts on the development and reproduction of the spider mite *Tetranychus urticae* Koch and the stigmatid predator *Agistemus exsertus* Gonzalez. Bull. ent. Soc. Egypt, Econ. ser., 18: 105-116.

Barakat, A.A.; G.M. Shereef; S.A. Abdallah and S.A. Amer. 1984. Effect of some pesticides and plant extracts on some biological aspects of *Tetranychus urticae* Koch. Bull. ent. Soc. Egypt, Econ. Ser., 14: 225-232.

Clark, J.A. and D.M. Yermanes. 1980. Jojoba- variability in oil content and composition in collection of 1156 native plants. J. Am. Oil. Chem. Soc., 57: 170.

El-Halawany, M.E.; Z.R. Sawires and M.E. Nassar. 1988. Biological and toxicological studies of certain plant extracts on *Tetranychus urticae* Koch. Bull. Zool. Soc. Egypt, 36: 37-41.

Finney, D.J. 1952. Probit analysis (Second Edition), Cambridge Univ. Press, London.

Haumann, B.F. 19883. Jojoba. J. Am. Oil. Chem. Soc., 60 : 44.

Henderson, C.F. and E.W. Tilton. 1955. Test with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.

Iskander, N.G.; A.K.F. Iskander; A.G. El-Sisi and S.M. Ibrahim. 1995. Pesticidal efficiency of some botanicals formulated as emulsifiable concentrates against the spider mite, *Tetranychus arabicus* Attiah. Egypt. J. Agric. res. (in press).

Jacobson, M.; D.K. Reed; M.M. Crystal; D.S. Moreno and E.L. Sonderstorm. 1978. Chemistry and biological activity of insect feeding deterrents from certain weed and crop plants. Ent. Exp. & Appl., 24: 448-457.

Mansour, F.A. and K.R.S. Ascher. 1983. Effect of neem (*Azadirachta indica*) seed kernel extracts from different solvents on the carmine spider mite, *Tetranychus cinnabarinus* Phytoparasitica, 11: 177-185.

Nassar, O.A.; S.M. Ibrahim; N.G. Iskander and A.K.F. Iskander. 1995. Biological and toxicological studies of certain plant extracts on *Eutetranychus anneckeii* Meyer and *Tetranychus urticae* Koch. Egypt. J. Agric. res., 73: 703-713.

Ronhotra, G.S. and J.A. Gelroth. 1989. Nutritional considerations of jojoba oil. Cereal Foods World, 34 : 876-877.

Sawires, Z.R.; N.G. Iskander and M.A. Ahmed. 1995. Toxic action of some plant extracts against *Tetranychus urticae* Koch. Proc. 8th Nat. Conf. of Pest. & Dis. of Vegetables & Fruits in Egypt, p. 165-177.

Schauer, M. and H. Schmutterer. 1981. Effects of neem kernel extracts on the two-spotted spider mite *Tetranychus urticae*. Proc. 1st Int. Neem Conf., p. 259- 266.

Table 1. Toxicity of jojoba oil on the developmental stages of *T. arabicus* and the adult female of *E. scutalis*.

Stage	LC50 %V./V.	LC90 %V./V.	Slope
<i>Tetranychus arabicus</i>			
Egg	2.5292	10.8619	2.0224
Larva	0.5342	4.2781	1.4167
Deutonymph	1.2137	5.1722	2.0331
Adult female	1.5996	6.3471	2.1385
<i>Euseius scutalis</i>			
Adult female	5.0807	14.3594	2.8368

Table 2. Effect of jojoba oil on some biological aspects of *T. arabicus* after egg treatment.

Concentration V./V.	% Hatch-ability	% Incubation period of eggs	% Life cycle	% Survival*
1.5%	66.7	7.93±0.9286b	13.30±1.0593b	100
3.5%	34.4	7.81±0.8583b	14.00±1.2472b	87.1
4.0%	33.3	8.17±0.8596b	14.10±1.1005b	83.3
5.5%	23.3	8.20±0.7888b	14.40±1.3499b	90.5
Check	96.7		10.86±0.3499a	100
		5.21±0.4103a		

* Survival = Percentage of hatched larvae which succeeded to reach adulthood.

- Means followed by a similar letter in a column are not significantly different at P = 0.01 by Duncan's multiple range test.

Table 3. Effect of jojoba oil on some biological aspects of *T. arabicus* after adult female treatment.

Concentration V./V.	Life cycle	Longevity	No. of eggs/female
1.5%	13.07±0.2575b	26.90±2.7264a	76.80±6.8118b
2.0%	15.10±0.5385c	9.30±2.1108c	43.40±8.0994c
Check	10.86±0.3499a	20.86±1.6846b	98.70±8.0836a

- Means followed by a similar letter in a column are not significantly different at P = 0.01 by Duncan's multiple range test.

Table 4. Effect of jojoba oil against *T. arabicus* population on bean seedlings, under greenhouse conditions.

Conc V./V.	Pre-treatment	No. of moving stages/5 seedlings and percentags of reduction after indicated intervals from treatment									
		1 day		3 days		7 days		15 days			
		No.	%	No.	%	No.	%	No.	%	No.	%
1 %	283	185	38.13	166	51.12	303	56.87	308	63.19		
2 %	237	99	60.50	84	70.50	122	79.30	140	80.20		
3 %	291	73	76.26	74	78.81	53	92.66	65	92.44		
Check	230	243	-	276	-	571	-	680	-		

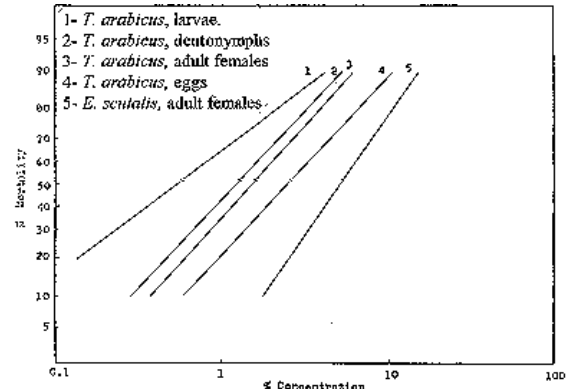


Figure 1- Toxicity lines for Jojoba oil against different stages of *T. arabicus* and adult females of *E. scutalis*