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EFFICIENCY OF THREE TYPES OF OILS AGAINST *APHIS FABAE* AND *TETRANYCHUS URTICAE*

MOUSTAFA OMAYMA K., HALA M. ABOU-YOUSEF AND Z.M. EL ATTAL

Central Agricultural Pesticides Laboratory, Agricultural Research Centre, Dokki, Egypt

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Abstract

Refined paraffinic oil, vegetable oil and esterified seed oil emulsified with ethoxylated fatty alcohol were evaluated in laboratory studies against the faba bean aphid *Aphis fabae* Koch and the red mite *Tetranychus urticae* Scop. The results showed that half-dose 80% EC was the most toxic against the adults of both faba bean aphid and red mite at LC25 , LC50 and LC90 levels. Alpha-z 96.4% EC came next in toxicity and the vegetable oil was the least effective . It is of interest to denote that all candidate oils exhibited 100 % mortality against aphid adults after 24 hours from treatment at the concentrations 200, 100 and 50 ppm. Complete inhibition of egg hatchability of the red mite *T. urticae* was obtained at 200 and 100 ppm for all oils.

Proper mineral oils, esterified seed oils and vegetable oils of consistent quality can contribute in the development of sound integrated pest management programs, since they are environmentally compatible, possess unique modes of action, novel tools for resistance management and reduce impact on beneficial insects.

INTRODUCTION

Environmental contamination of air, water, soil and food as affected by agricultural, industrial and social activities has become a threat to the continued existence of many plant and animal communities of the ecosystem and consequently dramatically threatens the human race. Therefore, increasing concern among environmental groups, the farmers and the general public about the adverse effects of the agricultural production has been cited, particularly the extensive use of agricultural chemicals.

In recent years, pest control has definitely shifted from dense pesticide use to integrated pest management where the focus on biological control and other natural resources with reduced reliance on chemicals became the main objective. Control of insects through oils are consistent with the requirements of integrated pest management programs necessary for sustainable agriculture.

Historical overview of oils as toxicants and/or activator adjuvants indicated that mineral oils among the oldest organic pesticides were first used. Stable soap-oil emulsions were recommended as early as 1882. By mid 1980,s , the emulsified vegetable based products were introduced as the second generation. Esterified seed oils in 1996 gained a wide acceptance as activator adjuvants (Killick and Schulties, 1998).

Jojoba oil from *Simmondsia chensis* (Link) is used in cosmetics and proved promising for use in more than a dozen industries. Jojoba oil seems to have outstanding commercial promise in agriculture industry (Manthey *et al*, 1985).

The present studies were conducted to assess the efficiency of three types of oils against the faba bean aphid *Aphis faba* and the red mite *Tetranychus urticae*.

MATERIALS AND METHODS

Experimental oils

1. Alpha-z oil 96.4% EC : It is a highly purified paraffinic oil supplied by Cooperative Organization of Petroleum. Its physical properties and structural composition were determined according to ASTM methods (Anonymous , 1980). Percentage carbon atoms in paraffinic structure (% Cp) was calculated by determining the refractivity intercept (RI) and kinematic viscosity gravity constant (KVGC) adopting the method of Smith (1953). The base oil was prepared to promote a quick-breaking emulsion using ethoxylated fatty alcohol.

2. Vegetable oil 95% EC; Corn oil, commercial grade, emulsified with nonionic emulsifier possessing low hydrophile-lipophile balance (HLB).

3. Half-dose 80% EC: It consists of 80% jojoba oil – provided by Egyptian Natural Oil Co.- which is a liquid wax with two double bonds and one ester group in each constituent molecule. The wax consists mainly of fatty esters (eicosenoic and docosenoic acids) of decyl alcohol (Wisniak, 1987).

Testing and evaluation

1. Aphicidal efficiency: Colonies of *Aphis fabae* were reared on faba bean seedlings in the laboratory at 25 °C and 90% RH. The adults were exposed to 6 concentrations

of candidate spray oils by the dipping technique according to Sawicki *et al* (1980). Each concentration was replicated three times and each replicate contained ten aphids. The average percentage mortality was calculated after 3 and 24 hours. The mortality percentages were corrected according to Abbott's formula (1925).

2. Acaricidal efficiency: It was assessed against adults and eggs of the red mite *Tetranychus urticae* Koch. Discs of castor-oil leaves were placed on wet cotton in petridishes . Ten adults females were permitted to oviposit for 24 hours on the discs of castor-oil leaves. Seven concentrations of each oil, replicated three times were used. Eggs laid on the discs and the discs with ten females were dipped in each emulsion for 20 seconds and excess emulsion was blotted off with a filter paper. The number of hatched and unhatched eggs were recorded up to the ninth day after application. The corrected percent mortalities were statistically computed according to Finney (1971).

3. Phytotoxicity: Phytotoxic action of the experimental oils was investigated by visual comparisons. Cotton seedlings of 45-day old cultivated in pots No. 50 kept under field conditions were sprayed with each spray emulsion at the concentration of 1.5% using a Knapsack sprayer during May 2001.

RESULTS AND DISCUSSION

The characteristics of the base oil used for the formulation of Alpha-z are listed in Table 1. To achieve a spray oil promoting its maximum insecticidal and acaricidal activity with a minimum plant injury, several factors were considered in the formulation of the base oil. The efficiency of spray oil depends on the physicochemical properties (Omayma and El Attal, 1985).

As shown in Table 1, the base oil was highly paraffinic (%Cp = 75) and possessing a narrow boiling range (70 °C). It has been firmly established that paraffinic oils possessing a narrow boiling range have been superior to either naphthenic oils or those of a wide boiling range. To minimize phytotoxicity, percentage UR should be minimum 92% by volume. The experimental base oil was 94%. Moreover, this base oil was prepared to have a relatively quick-breaking emulsion resulting in a high foliar retention with a consequent optimum pesticidal activity.

Table 1. *physical properties and structural composition of Alpha-z base oil*

Property	Test method	Value
Kinematic viscosity, centistocks	ASTM 445	10.34
Percentage unsulphonated residue (UR)	ASTM 483	94
Distillation at 760 mm Hg, °C	ASTM 447	
50%		340
10 – 90%		70
Neutralization number , acidity	ASTM 974	0.05
Percentage carbon atoms in paraffinic structure, %Cp	RI-KVGC	75

The effect of the three oils on adults of *Aphis fabae* are summarized in Tables 2 and 3. Half-dose was the most toxic as indicated by LC25, LC50 and LC90 after 3 hours followed by Alpha-z. Vegetable oil was however the least effective, Table 2. Ford and Loveridge (1995) have demonstrated that the addition of ethylated esterified oils to alpha-cypermethrin resulted in reduced response times of adult mustard beetles due to increased transfer of the insecticide to the insect accompanied by increased internal levels of toxicant.

Table 2. *Effect of candidate spray oils on the adults of Aphis fabae* after 3 hours from treatment

Spray oil	LC50 (ppm)	LC25 (ppm)	LC90 (ppm)	Slope
Alpha-z	3.32	6.79	26.58	2.16
Half-dose	2.47	4.32	19.87	3.57
Vegetable oil	4.46	7.67	37.80	1.95

An interesting result is that all experimental oils exhibited 100% mortality against the aphid adults after 24 hours at 200 , 100 and 50 ppm concentrations, Table 3. The same table indicates that half-dose caused 100% mortality at all concentrations including 12.5 ppm.

Toxicity of oils tested on the adults of the red mite is presented in Table 4 in which half-dose was the most effective at the LC25, LC50 and LC90 levels followed by Alpha-z , then the vegetable oil. The same trend was observed against the eggs of *T. urticae* in which the half-dose demonstrated superiority at the LC25 and LC50 levels,

Table 5. Complete inhibition of hatchability was observed at 200 and 100 ppm of all oils tested, Table 6.

Table 3. Toxicity of the experimental spray oils on the adults of *Aphis fabae* after 24 hours

Spray oil	% Mortality				
	Concentration In ppm				
	200	100	50	25	12.5
Alpha-z	100	100	100	100	90
Half-dose	100	100	100	100	100
Vegetable oil	100	100	100	100	70

Table 4.Toxicity of experimental oils on the adults of *T. uricae* after 24 hours

Spray oil	LC25 (ppm)	LC50 (ppm)	LC90 (ppm)	Slope
Alpha-z	2.41	6.78	48.75	1.49
Half-dose	1.08	11.70	27.00	3.36
Vegetable oil	6.20	10.28	57.07	2.05

Table 5. Efficiency of the spray emulsions against the eggs of *T. urticae*

Spray oil	LC25 (ppm)	LC50 (ppm)	LC90 (ppm)	Slope
Alpha-z	2.41	6.78	48.75	1.49
Half-dose	2.09	6.70	40.80	2.36
Vegetable oil	6.61	11.39	52.15	2.84

Table 6. Effect of candidate oils on the hatchability of *T. urticae*

Spray oil	% Hatched eggs					
	Concentration In ppm					
	200	100	50	25	12.5	6.25
Alpha-z	0	0	6.25	11.33	50.20	70.30
Half-dose	0	0	5.00	6.62	37.48	62.98
Vegetable	0	0	51.86	65.39	67.45	83.73

No visual phytotoxicity up to one month from the application of oils at the concentration of 1.5% was shown on cotton plants of 45 days old. Half-dose (jojoba oil) and the vegetable oil (corn oil) are of botanical source and are not expected to cause injury to plants. In case of Alpha-z comprising mineral oil base, the safety to plants can be assumed to depend on : (1) percentage of aromatics and olefins, (2) distillation data , (3) acidity, (4) type, concentration and chemical identity of the emulsifier used, and (5) ambient conditions. The high efficiency od Alpha-z can be attributed to; (1) high paraffinicity (%cp = 75), (2) narrow boiling range (70 °C) and (3) the relatively quick-breaking emulsion resulted in high foliar retention with a consequent optimum pesticidal activity (El Attal *et al*, 1983). To minimize phytotoxicity of Alpha-z, percentage of unsulfonated residues (UR) was 94%. It is recommended that this value should be at least 92%. Usage of highly paraffinic oils possessing the above mentioned physical and chemical properties over a period of time has shown no problems of accumulation in the environment or hazards to orchards.

In conclusion, proper mineral and vegetable oils and esterified seed oils of high quality formulation for consistent emulsion formation can be considered as significant elements for crop production management. They have distinct advantages over broad spectrum pesticides; (1) they may be handled with a minimum of protective clothing, (2) cause little or no damage to beneficial insects and mites, (3) pests are unlikely to develop resistance against them, (4) exempted from the requirements of tolerance by EPA, and (5) the active ingredients being principally hydrocarbon chains or fatty acids or esters are intrinsically biodegradable.

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فعالية ثلاثة أنواع مختلفة من الزيوت ضد حشرة من الفول والعنكبوت الأحمر

أميمة كمال مصطفي – هالة محمد أبو يوسف – زكريا مصطفي العتال

المعمل المركزي للمبيدات ، مركز البحوث الزراعية – الدقى – الجيزة

تم تقييم زيت بارا فيني (الجيل الأول) وزيت نباتي (الجيل الثاني) واستر نبات الجوجوبا (الجيل الثالث) وذلك ضد من الفول والعنكبوت الأحمر معمليا بعد تجهيزها علي صورة مركزات قابلة للإستحلاب باستخدام ايثوكسي الكحول الدهني، ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١- أعطى مستحضر هاف-دوز ٨٠٪ كفاءة عالية ضد الحشرات اليافعة لكل من من الفول والعنكبوت الأحمر وتبع هذا المستحضر مباشرة مركز ألفا-زد ٩٦.٤ ٪ وكان أقلهم فعالية الزيت النباتي ٩٥٪ .

٢- أعطت الزيوت الثلاثة المختبرة نسبة ١٠٠٪ موت ضد الحشرات اليافعة لمن الفول بعد ٢٤ ساعة من التعريض للتركيزات ٢٠٠ ، ١٠٠ و ٥٠ جزء في المليون.

٣- تم الحصول علي ١٠٠ ٪ في منع فقس بيض العنكبوت الأحمر عند معاملتها بتركيزي ٢٠٠ و ١٠٠ جزء في المليون.

إن الزيوت البارافينية المعدنية واسترات الزيوت النباتية والزيوت النباتية ممثلة للأجيال الثلاثة ذات المواصفات المناسبة والمجهزة بتقنية عالية يمكن اعتبارها كأحد العناصر الأساسية في المكافحة الرشيدة للآفات وتعتبر من الأركان الهامة للزراعة العضوية للحد من المخاطر والسلبيات المرتبطة بالمبيدات الكيماوية .