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The usage of mineral oils to control insects

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ABSTRACT

Oils had been used as pesticides for centuries and are some of the most effective safe alternatives to synthetic insecticides and fungicides**.** Mineral oils are consider a promising control agent against a wide varieties of pests all over the world. Here in this review article, a brief was given to show the importance of mineral oils, the usage and mode of action on target pests. Also, the effect of mineral oils on natural enemies, plant morphology and mammals. And the precautions should be followed in the usage of these compounds to get the aimed results.

Keywords: mineral oils, control insects

INTRODUCTION

Synthetic chemical compounds became unsafe method in controlling pests as they are one of the major reasons in the environmental pollution and cause a chronic diseases for humans and harmful for most of the living organisms. That's why the usage of these chemicals decreased all over the world and humans continued to find practical alternatives. Mineral oils are consider one of the safest methods in controlling pests especially the scale insects and mealybugs infesting different plants. Also, they play a fundamental role in the IPM programs on many pests.

The greatest activity in improving spray oil technology and application came in a 25-years period between 1945 and 1970, but long before this era there was a basic understanding that certain oil components were responsible for phytotoxicity and other factors were responsible for insecticidal efficiency. Oil company specialists seeking new uses for their product and applied entomologists seeking more effective means of pest control worked together during these years to develop many oil products for use on trees and shrubs, but particularly on fruit trees (Johnson, 1980**)**.

RESULTS

I. What is petroleum (mineral) oils:

Petroleum oils are highly refined, parrafinic oils that are used to manage pests and diseases of plants. Similar parrafinic oils are found in automotive and household lubricants and cleansers. Petroleum oils may be referred to many names, including horticultural oil, spray oil, dormant oil, summer oil, supreme oil, superior oil, Volck oil or white mineral oil. These names usually refer to particular types, uses or brands of petroleum oil. The terms "summer oil" or "all season oil" indicate that the product can be safely used on plant foliage during the growing season. Prior to the advent of modern, highly purified oils, the term "dormant oil" referred to heavier, less refined oils. They could only be used in the fall and winter after leaf drop or in the spring before plant buds open. Because these older, dormant oil sprays would damage growing foliage, they were used mainly to combat the over-wintering stages of the

pest or pathogen (Bográn *et al*., 2006). Besides oils are used in controlling weeds and as an adhesive in pesticides components.

I. Mineral oils can be divided into many groups:

1- Dormant oil: An oil used on woody plants during the dormant season. This term originally referred to heavier weight, less well-refined oils that were unsafe to use on plants after they broke dormancy. However, these older oils have been replaced with more refined, light-weight oils that have potential application to plant foliage. Dormant oil now refers to the time of application rather than to any characteristic type of oil.

2- Horticultural oils: An oil used to control a pest on plants.

3- Mineral oil: A petroleum-derived oil (as opposed to vegetable oils). Narrow-range oil: A highly refined oil that has a narrow range of distillation. Narrow-range oils fall in the superior oil classification. The terms may be used nearly interchangeably. Spray oil: An oil designed to be mixed with water and applied to plants as a spray for pest control.

4- Summer oil: An oil used on plants when foliage is present (also called foliar oils). As with dormant oil, the term now refers to the time an application is made rather than to the properties of the oil.

5-Supreme oil: A term used to categorize highly refined oils that distill at slightly higher temperatures and over a wider range than the narrow-range oils. Most supreme oils meet the characteristics of a superior oil.

6-Superior oil: A term originated by P.J. Chapman in 1947 to categorize summer-use oils that met certain specifications. This included a high proportion of paraffinic hydrocarbons and purification that allowed year-round use without phytotoxicity. Since then, further developments have resulted in oils that distill over a narrow temperature range. Most superior oils are now better referred to as narrow-range oils.

Oils pose few risks to people or to most desirable species, including beneficial natural enemies of insect pests. This allows oils to integrate well with biological controls. Toxicity is minimal, at least compared to alternative pesticides, and oils quickly dissipate through evaporation, leaving little residue. Oils also are easy to apply with existing spray equipment and can be mixed with many other pesticides to extend their performance Cranshaw and Baxendale, 2011).

I. The benefits of mineral oils:

1- Safe on the different environmental elements and the natural enemies.

2- Preserve the natural enemies.

3- Decrease the pollution percent.

4- Easy and safe to use.

5- Less in costs when compared with the traditional methods.

6- No pest resistance recorded.

II. Different between miscible and mayonnaise oils:

1- Miscibel oil:

Oil percent doesn't decrease from 85%, emulsions and surfactants materials help the spread of the oil into a very small drops when mixed with water which called the emulsifier. Tween and triton are used as emulsifiers.

2- Mayonnaise oil: a creamy oil, oil percentage never less than 75% where the emulsion mixed with water and added to the oil with good stirring with a fine blender, as a result the water drops become surrounded with oil where the water percent not exceeds 20 %. Kasin is used as emulsifier.

III. The mode of action of mineral oils on insects:

1- The most important is that they block the air holes (spiracles) through which insects breathe, causing them to die from asphyxiation. Also, the spread of oil through the respiratory pores and block the insects trachea which lead to insect death.
2- Mineral oils create a thin layer on the insects' eggs surface where it stops the gas exchanges.
3- In some cases, oils also may act as poisons, interacting with the fatty acids of the insect and interfering with normal metabolism. Oils also may disrupt how an insect feeds, a feature that is particularly important in the transmission of some plant viruses by aphids (Cranshaw and Baxendale, 2011).
4- Cause hardness in eggs which make it difficult for the eggs to hatch.
5- Death of newly hatched individuals.
6- Mineral oils form a layer on the plant parts prevent the settlement of the newly hatched individuals of the insects.
7- Dissolve the external waxy layer on the insect body causing dehydration.

Early in 1956, spray oils in combination with organophosphorus insecticides were introduced in Egypt for control of mealybugs. Petroleum oils have several advantages over the majority of the synthetic pesticides employed today to control orchard and other plant pests. They have been judged to possess no health hazards when compared with most synthetic pesticides. Moreover, it apparent those pests are unable to develop populations resistant of them (Aly *et al*., 1984).

VI. The usage of mineral oils in controlling insects:

Mineral oils still have the advantage of being effective against resistance of strains. Also, they mentioned that development of resistance was not recorded for mineral oils (Micks and Berlin, 1970).

El-Sebae *et al*., (1976) studied the possibility of relying on locally produced base oil by El-Nasr Co. at Alexandria to formulate acceptable miscible spray oils using locally produced surfactants. They found that such local formulations are of economic advantages to save hard currency spent in importing ready made spray oils and also will help development local formulation industry which gave excellent results against scale insects, mealybugs, mites and aphids. Helmy *et al*. (1982) stated that mineral oils of various qualities have traditionally been used as curatives to down insects and mites.

Consequently, field studies were conducted with the objective of developing information on the use of locally spray oils separately for control of the soft scales. The mineral oil star oil showed a considerable reduction (99.2% reduction after 60 days from treatment) when used on the soft scale insect *Pulvinaria psidii* Maskell (Hemiptera: Coccidae) infesting guava trees (Aly *et al*., 1984). Helmy *et al*., (1984b) reported that formulations of proper mineral oil were effective, safe and economic without resistance problems developed by pests.

In a survey on the usage of horticultural oils in USA and Canada, they stated that oil was found to be effective for controlling scale insects and mites and most respondents reported little toxicity (Johnson and Caldwell, 1987). The oils are cheaper and less phytotoxic than their predecessors Beattie *et al*. (1989) with no empirically demonstrated resistance by pests.

Miscible oils tested against two scale insects; *Lepidosaphes beckii* Newman and *Parlatoria ziziphus* (Lucas) (Hemiptera: Diaspididae) infesting citrus trees in Sheben El- Kanater at Qaluobiya Governorate were successful as scalicides and ovicides for summer and winter spraying (Helmy *et al.,* 1992).

El-Sisi *et al*., (1995) studied the base and formulated spray oils of American (Sun oil 99%) and Egyptian (local American from 99% at a rate of 1.0% & super misrona oil (95%) at 1.5 %) as summer spray oils against the wax scale insect *Ceroplastes floridensis* Comstock (Hemiptera : Coccidae) infesting orange trees at El-Behaira Governorate. Results obtained indicated that the base oil of American spray is lightly heavier than Egyptian as recorded by specific gravity viscosity and distillation properties, also, both oils have already the same value of purity (% unsulfonated residue).

On the other hand, formulated American spray oil was poor in emulsion stability test than Egyptian spray oils. Regarding to the efficiency of tested oils on *C. floridensis*, data clearly showed the superior efficacy of the recommended Egyptian oil, super misrona (95%) at 1.5 %, followed by the American and Egyptian sun oil (99%) at 1.0%. Their reduction were 94.9, 91.4 and 92.8% on mean *C. floridensis* population, respectively. 6 weeks after summer application. Also, light defoliation and no fruit droping were recorded in all cases two weeks after summer application. Liu and Stansly (1995) indicated that adult mortality of *Bemisia argentifolii* Bellows and Perring (Homoptera : Aleyrodidae) infesting tomatoes under greenhouses was the highest when compared with other chemical compound used (insecticidal soap, plant derived surfactant and broad spectrum pyrethroid) also, it repelled the whiteflies for up to 5 days and the numbers of their eggs were significantly reduced on treated leaves.

Helmy (2002) stated that, five treatments were sprayed weekly for seven times to study their efficacy on *Bemisia tabaci* (Gennadius) (Homoptera : Aleyrodidae) attacking tomato at Fayoum Governorate and the deleterious effect on the associated parasitoid; *Encarcia* sp. The percentage of tomato leaf curl virus (TLCV) symptoms and the average fruit / plant in each treatment. Result indicated that (super misrona oil + actellic) gave the highest effect on different stages. Super royal oil, misrona oil, capl 2 oil at 1.5% and actellic 0.15% alone came next. Actellic alone recorded highly significant deleterious effect on *Encarcia* sp. (Hymenoptera : Aphelinidae) pre mature stages followed by (super misrona oil + actellic , then the three tested miscible oils at 1.5% gave low effect. All candidate spray oils at 1.5% gave very good results on (TLCV) %. The joint action between super misrona oil and actellic recorded the highest average of tomato fruits / plant (45-48) followed by the three tested oils. Actellic alone gave (35-38) during the two studied seasons 1999-2000.

Leucaspis riccae Targioni Tozzetti (Hemiptera: Diaspididae) and *Euphyllura straminea* Loginova (Hemiptera: Psyllidae) are great economic importance pests infesting olive trees at Fayoum Governorate. They used kz, super royal and super misrona at 1.5% at February in compared with the recommended spray. Alboleum 2% + malathion 0.15%. Result indicated that's super misrona 1.5% gave superior effect (93.44 & 88.465%), followed by kz oil and super royal oil. However, the recommended spray gave satisfactory control on *L. riccae* moderate effect on *E. straminea* (Helmy *et al*., 2002). Kwaiz *et al*., (2004) tested three winter oils; tiger (2.5%), folk (2%) and alboleum (2.5%) and one summer oil; kimesol (1.5%) to control *P. psidii* on guava trees in autumn at Qaluibiya Governorate. Data showed that, kimesol was the highly effect followed by Alboleum, tiger and folk oil with significant difference between the first one and the three other treatments. Also, no phytotoxicity effects were observed on the treated trees one month after treatment *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) is protected inside mines so, it was suggested that mineral oils could act as a surfactant, reduce the surface tension and increase the penetration of *Bacillus thuringiensis* Berliner (Bacillaceae)

suspension through the epidermis of the citrus leaf (Dias *et al*, 2005). El-Sahn (2007) mentioned that, the mayonnaise oil (Alboleum) recorded the highest reduction percent on the population of *Saissetia coffeae* (Walker) (Hemiptera:Coccidae) infesting *Cycas revoluta* Thunb (Cycadaceae) palm like plant with 94% after 94.63% after 25 days from spraying. She also, found that Alfa z oil recorded 94.01% reduction on *Parlatoria pergandii* Comstock (Hemiptera: Diaspididae) infesting *Schefflera arboricola* (Hayata) (Araliaceae) shrubs. In general the nymphal stage was the most affected stage followed by adult then gravid females.

Soliman *et al*., (2007) mentioned that the miscible oils bio-dux, cabl-2 and citrole recorded general mean reduction percent on *Kilifia acuminata* (Signoret) (Hemipera: Coccidae) infesting mango trees 78.87, 86.67 and 82.62 %, respectively. Mckenna *et al.,* (2007) stated that, oil was used safely during the pre-blossom period, between 1 and 21 days after fruit set, and between 70 and 94 days after fruit set. A spray programme based on applications of oil during these safe periods provided adequate control of armored scale insects.*B. thuringiensis* and *B. thuringiensis* plus mineral oil are active against the leafminer, demonstrating that these bio pesticides penetrate into leaf mines, thereby killing the larvae. (Amiri Besheli, 2007)

VII. Effect of mineral oils on natural enemies:

There was no phytotoxicity on the treated plants which extend the safe use of mineral oils in controlling soft scale insects (Aly *et al*., 1984). Helmy *et al*., (1984) stated that the separate miscible oils were preferred for controlling scale insects due to the on harmful effects on the beneficial parasite *Aphytis lepidosaphes* Comp (Hymenoptera : Aphelinidae). Liu and Stansly (1995) stated that mineral oils have low toxicity to many organism, including parasitoids and predators of whiteflies and therefore could be considered “biorational”.

VIII. Effect of mineral oils on plant Morphology:

Mayonnaise (2.5-3%) and miscible (1.5-1.75%) oils type controlled citrus scale insects without any harmful effect for citrus trees (Hindi *et al.,* 1964). Ibrahim(1990) studied some effects of mineral oils application on the morphological aspects of citrus trees, she found that tested oils, developed the color of the fruit, and it enhanced the average weight of the fruits Also, oils didn’t affect the percentage of total soluble solids of the fruits. The treatment with 1.5% of KZ oil caused reduction in the thickness of leaf lamina, but increased the thickness of midrib region. Also, the previous treatment increased the shoot diameter and the vascular cylinder thickness.

There was no phytotoxicity symptoms occurred on the tested orange and grapefruit trees in summer spraying. The oils can be used safely on orange trees at middle Egypt in autumn when temperature does exceed 34°C (Helmy *et al.,* 1992)

IX. Effect of mineral oils on mammals:

Soliman *et al*., (2007) studied the effect of mineral oils on rats (as an example of mammals), they found that oils caused increase in White blood cells counts, aspartate transminase and alanine transaminase activities of treated rats after 15 and 30 days from treatment comparison with control. Changes occurring in the creatinine concentration showed a significant increase in rats treated with the tested chemicals 30 days from treatment, except in the case of bio-dux oil, while there were no significant changes after 15 days in rats treated with tested oils. On the contrary, tested chemical (Chlorpyrifos-methyl) caused a significant decrease in red blood cells count and hemoglobin values after 15 and 30 days form treatment, except in rats treated with bio-dux oil. Hemoglobin content showed no significant changes over the same periods.

X. The usage of airoplanes in the application of mineral oils treatments:

However, Helmy *et al.* (1984a) showed that aerial application by a fixed wing airoplane, phytotoxicity appeared severely on orange fruits sprayed by supracide (40%) at a concentration of 1.0%. Regarding to kz oil efficacy on reduction % on *Cornuaspis beckii* (Newm.) (Hemiptera: Diaspididae). Aerial application with 8.0 L. and ground spraying by 54 L. / F. recorded 87.08% and 86% reduction, respectively. While application by 6 L. / F. gave 64.41% three months after summer treatment. The reduction % was 80.26%, 77.90 and 79.53% at the lower, medium and high level, respectively. Aerial application by 6 L. oil / F. was the least harmful to hymenopterous parasitoid *A. lepidosaphes* Comp. followed by 8 L., then ground application with 54 L. oil / F.

Comparison between aerial and ground application on citrus trees using kz oil against the purple scale insect *C. beckii* and its influences on the parasitoid *A. lepidosaphes* were studied by Helmy *et al*., (1988) using six and eight liters / feddans by a helicopter equipped with a 200 liters tank and a ground application at 54 liters / feddan using a motor sprayer with 600 L. tank. Field observation showed that aerial application by 6 liters kz oil / fddan had no effect on defoliation . Light defoliation occurred with 8 L. / feddan and 54 liters kz oil / feddan by ground application. No fruit dropping were recorded between all treated and untreated trees.

XI. There is some precautions must be followed to use mineral oil in controlling different pests infesting plant safely and with great effectiveness:

1- Always read and follow label instructions.

2- Cover all plant surfaces, especially the undersides of leaves and crevices of branches and stems where pests can hide. Avoid large spray droplet sizes by using proper equipment and spray pressure.

3- To minimize the risk of plant injury, avoid treating when temperatures are below 40°F or above 85°F degrees or when the relative humidity is above 90 percent.

4- Not all pests/diseases are susceptible to oils. When using any pesticide, proper pest identification is critical. Avoid treating drought-stressed plants.

5- Do not apply oils in combination with sulfur or sulfur-containing pesticides such as Captan or Karathane. They can react with oils to form phytotoxic compounds. Because elemental sulfur can persist for long periods, label directions on most oils prohibit their use within 30 days of a sulfur application.

6- Apply dormant oil sprays only after winter hardening.

7- Do not spray when shoots are growing.

Finally mineral oils are very promising control agent in Egypt and it needs more attention and supervision from the government authority to extend the usage of mineral oils on various agricultural pests and to observe the manufacturing of these compounds to ensure its validity and efficiency. Also, a lot of researches are still needed to improve the application of mineral oils as a safe control agent.

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ARABIC SUMMARY

إستخدام الزيوت المعدنية لمكافحة الآفات الحشرية

إكرام إسماعيل حلمي و فايزة أحمد محمد كويز و أمنية محمد نبيل الصحن.
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أستخدمت الزيوت المعدنية كمبيدات حشرية لعقود والتي تعتبر من البدائل الآمنه للمبيدات المخلقة ضد الحشرات والفطريات. الزيوت المعدنية تعتبر من الوسائل الواعدة لمكافحة العديد من الافات في كل انحاء العالم. وفي هذا المقال تم عمل عرض لأهمية الزيوت المعدنية وإستخداماتها وتأثيرها على الآفات المستهدفة. وأيضا تأثير الزيوت المعدنية على الأعداء الحيوية والنبات والثدييات وما هي الإحتياطات الواجب توافرها في استخدام هذه المركبات للحصول على النتائج المطلوبة بامان.