Safe Alternative Pesticides (Local Mineral Oils) For Controlling *Diaspidiotus perniciosus*, (SJS) and Greedy Scale Insect, *Hemiberlisia rapax* (HIMEPTERA: DIASPIDIDAE) Infesting Pear Trees under Irrigation in Burg El-Arab Area, Alexandria, Egypt

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ABSTRACT

Eight mineral oils (heavy and light) were chosen for evaluating their efficacy for controlling San Jose scale insect (SJS), *Diaspidiotus perniciosus* and greedy scale, *Hemiberlisia rapax* during winter months to prevent their spread establishment.

The data obtained revealed that the summer oil ,Caple-2® gave a highest reduction percentage on SJS followed by the heavy oils , Albolium®, Masrona® and Moxy oil® in two following seasons . Considering the effects of the tested mineral oils on SJS parasitoid, *Aphytis diaspidis*, Albolium oil® gave least reduction percentage of that parasitoid followed by Moxy oil®, Misrona® and Caple-2®. During summer season of 2005, there were no significant differences between all the tested mineral oils considering the reduction percentages of SJS. However, Caple 2® gave the highest reduction percentage of SJS followed by KZ®, Diver®, Super Masrona® and Chema oil® at the rate of 1.5% for each.

In winter, Masrona® (2.5%) gave a good result on reducing the number of the greedy scale insect. The tested mineral oils could be arranged in descending order according to the reduction percentage as follows: Masrona® > Caple-2® > Moxy oil® > Albolium® > Control in the first season. In the second season 2006, the same tested oils were arranged according to the deduced reduction percentages as follows: Caple-2® > Albolium® > Moxy oil® > Masrona® > control. The effect on parasitized individuals was less in case of using Moxy oil® or Masrona oil®.

Considering the effect of light mineral oils during the summer months, KZ oil® gave a good result followed by Caple-2®, Diver®, Super Masrona® and Chema oil®.

INTRODUCTION

The common pear species in Egypt is the European pear, *Pyrus communis* L, and it is cultivated at Burg el-Arab area (50 Km west Alexandria). Pear trees infested by two serious armoured scale insects (Himeptera: Diaspididae) namely the apple greedy scale, *Hemiberlisia*

rapax (Comstock) and San Jose Scale (SJS) *Diaspidiotus perniciosus* (Comstock) (Abdel-Razak,2007).

The greedy scale is an important quarantine pest's export of fruits like kiwifruits, pecan, tea and citrus (Bianchi *et al.*, 1994; Gill, 1997 and Claps *et al.*, 2001). It infests leaves of almond, apple, fig and pear causing leaf yellowing, development of necrotic patches and premature leaf drop, while the infestation of fruits causing fruit discolouration and premature drop (Abdel-Razak, 2007).

It is worth to mention that SJS,(*D.perniciosus*) was not recorded as an established pest in Egypt before according to the cited lists of Coccoidea by Hall (1922, 1923 and 1924) and Ezzat and Nada (1984). Also, the assigned distribution maps (CWIE,1951,and (EPPO &Zipcood Zoo, 2006) did not show any presence or record of SJS scale insect in Egypt till the observation of Moursi, (2001) who observed its occurrence on apple at two sites at Kafr El-Dawar, Behaira Governorate and Burg el-Arab, Alexandria Governorate.

San jose scale (SJS) infest leaves and causing necrotic patches at the feeding sites. Stems may become distorted and in cases of heavy infestation, early senescence occurs and branches or even whole plants may die. Red spotting on the fruits and/or necrotic spots on the leaves do not cause great damage; however, these symptoms can cause problems at plant quarantine inspection, because the species is on the quarantine schedules of many countries(Davidson &Miller, 1990 and Abdel-Razak, 2007). Gill (1997) mentioned that if the infested trees have not been treated to control the insect, SJS can kill mature trees in 2-3 years. The author also added that shortly after introduction to a new country, this pest can infest and kill whole orchards.

Extensive uses of chemical toxicants for pest control caused many problems, such as acute and chronic human and animal toxicity, development of insect resistance to chemicals and environmental pollution. So, alternative effective and environmental safe insecticides such as mineral oils are urgently needed (Abdel Salam, 1993 and Anonymous, 1997).

Local sprays of mineral oils are used for years against the scale insects, mealy bugs, thrips, aphids and mites on different crops and fruit trees, (El-Deeb *et al.*, 2002 and Moursi, 1996). Oil sprays are used most commonly in horticulture to control scale insects and mites (Chapman *et al.*, 1952). Micks and Berlin (1970) and El Sebae (1977) stated that resistance was not recorded for mineral oils which still have the advantage of being effective against the insect resistant strains.

The present work aimed to study the efficacy of different types of mineral oils (three heavy/winter mineral oils :Albolium oil® 80%; Masrona oil ®85% and Moxy oil® 82% and five light/summer mineral oils :CAPL2 oil ®96.62%; Chema oil® 96.6% Diver oil® 97% KZ oil® 95% and Super Masrona oil® 95%) used as emulsifiable concentrated formulationd against two armoured scale insects (Himeptera: Diaspididae) (which have different physiology, histology, behavior and ecology but they have the same feeding and injury effect to pear trees, leaves and fruits)and they are San Jose Scale, [*Diaspidiotus perniciosus* (Comstock)] and the greedy scale, (*Hemiberlesia rapax* (Comstock)). Also, the present investigation was trying to find out the most effective compound, which could control the two insects successfully and synchronize by the same application.

MATERIALS AND METHODS

All experiments were carried out at Burg el-Arab area to evaluate the efficacy of tested mineral oils against San Jose Scale, (SJS) and the greedy scale infested pear trees and their side effect on their parasitoid. The experiments were carried out during summer season of 2005 and winter seasons of 2005 - 2006 on pear trees by using different types of winter and summer mineral oils as follows :

Compounds	Rate of application (%)	Source (Company)
Winter mineral oils		
Albolium oil® 80%	2.5	Kafr El-Zayat pesticides and chemicals Co.
Masrona oil® 85%		Misr Petroleum Co.
Moxy oil® 82%		Alexandria Pesticides and chemicals industries Co.
Summer mineral oilS		
CAPL2 oil® 96.62% E.C	1.5	Central Agricultural Pesticides Laboratory (CAPL)
Chema oil® 96.6% E.C		Chema Industries
Diver oil® 97% E.C		El-Helb pesticides and Chemical Co.
Kz oil® 95% E.C		Kafr El-Ziat Pesticides and Chemicals Co.
Super Masrona oil® 95% E.C		Misr Petrolium Co.

Three field experiments were carried out at three neighboring irrigated pear orchards. Pear trees were similar uniformity in shape and size in each farm. Two experiments were done at winter seasons (2nd week of January,2005 and 2006) using three winter mineral oils and the third one at summer season (1st week of July, 2005) using five summer mineral

oils according to the recommendations of the Egyptian Agricultural Ministry scale insect pest control guide.

The experiment was made at the dormant period of deciduous pear trees and after pruning of the dried and/or infested branches to reduce the population and improve spray penetration.

Treatments as well as control (untreated) were replicated five times (five trees /replicate) and randomly distributed over 150 trees (same age, height and size). Spraying was accomplished by means of a conventional knapsack sprayer with a 20 liters tank; at rate of 10-12 liters /tree to ensure complete coverage of all parts of the tree. Twenty five branches (10-15 cm long) from each treatment in winter experiments and 25 branches and 50 leaves from each treatment in summer experiments, were selected to be examined, pre-treatment and at four periods post-treatment (two, four, six and eight weeks). Collected samples were transferred to the laboratory and examined using stereoscopic binocular microscope to determine the number of living insects (the economic pests and beneficial insects). Numbers of living individuals were counted immediately to evaluate the efficiency of the tested mineral oils. The percentage of reduction was calculated according to Staford and Summer (1963) for armoured scale insect and Henderson and Tilton (1955) for the parasitoid. Statistical analysis of variance and L.S.D value for comparing the mean effects of each treatment were adopted according to Snedecor (1970).

RESULTS AND DISCUSSIONS

Effect of the tested materials on tested insects (winter 2005 and 2006) :

The first experiment was carried out during the dormant period of deciduous pear trees (started at 2nd week of January, 2005) to evaluate the effect of three winter (heavy) mineral oils, (Masrona®, Moxy® and Albolium®) at the rate of 2.5% and a summer (light) oil (CAPL-2®) at the rate of 1.5% against *Diaspidiotus perniciosus* (Comstock); *Hemiberlesia rapax* (Comstock) and their side effect on the parasitoid *Aphytis diaspidis* (Fig.1).

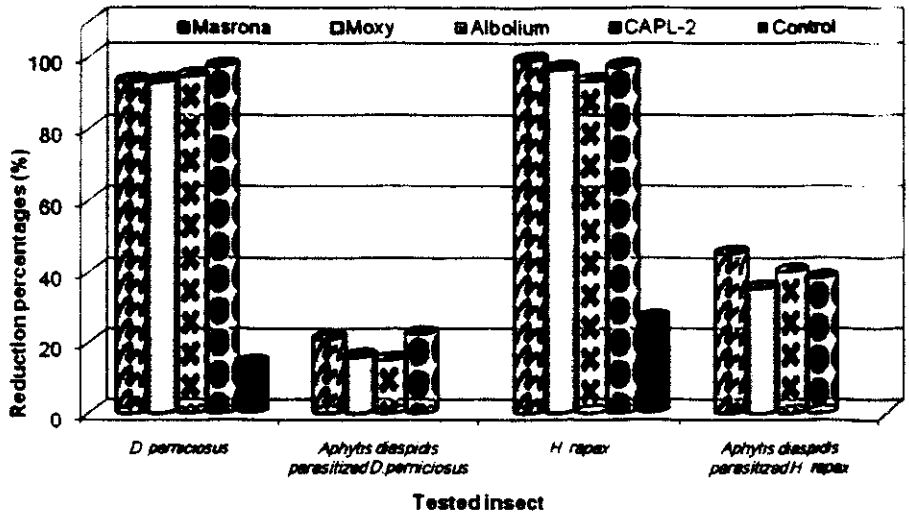

Fig (1). Effect of the tested mineral oils on *D. perniciosus* and *H. rapax* infested pear trees and affecting its parasitoid *Aphytis diaspidis* under irrigation at Burg el-Arab area (Winter 2005).

Data presented in Fig. (1) show that the summer oil CAPL-2® was the most effective one throughout the experiment period, against *D. perniciosus* (SJS) where it caused average reduction percentage of 97.38% followed by Albolium oil® (94.7%)(with no significant differences) then Masrona oil ®(93.18%) and Moxy oil® (93.1%)(with significant differences in between). The data also illustrated that there were no significant differences between the tested mayonnaise heavy oils (Masrona®, Moxy oil ®and Albolium®).

On the other hand, Masrona oil® was the most effective insecticide against *H. rapax* followed by CAPL-2®, then Moxy oil® without significant differences in between where they caused average reduction percentages of 99.1%, 97.4% and 96.5%, respectively, but Albolium oil® was the least effective insecticide with an average reduction percentage of 93.2% which differ significantly with the other tested materials.

Considering the probable occurring side effects of the tested mineral oils on the non-targeted *Aphytis diaspidis*, (a main parasitoid of *D. perniciosus*) in pear trees orchard, during winter seasons of 2005, data illustrate that Albolium mineral oil® caused least reduction effect (15.0%) followed ascendingly by Moxy oil® (15.9%) without significant differences in between, then Masrona oil ®(21.0%) and CAPL-2® oil which caused highest parasite reduction effect (22.4%) without significant differences in

between. Based on the deduced percentage reduction of the parasitoid (parasitized individuals) during 2005, (winter season), the tested mineral oils had more than double reduction effect against *Aphytis diaspidis* when it parasitized *H. rapax* and could be arranged in the following ascending order : (35.3, 38.3, 40.2 and 45.2%) for Moxy oil®, CAPL-2®, Albolium oil® and Masrona oil®, respectively.

El-Halawany *et al.* (1987) reported that Albolium oil ®had lower toxicity to the predatory mite, *Amblyseius gossypii*. Accordingly, Albolium® could be used successfully on citrus trees against both insects and mites when developing valid pests management control programs.

The experiment was repeated again in winter months of 2006 for confirming the efficiency of the same formerly, tested materials against the same insects and the data are illustrated in Fig. (2).

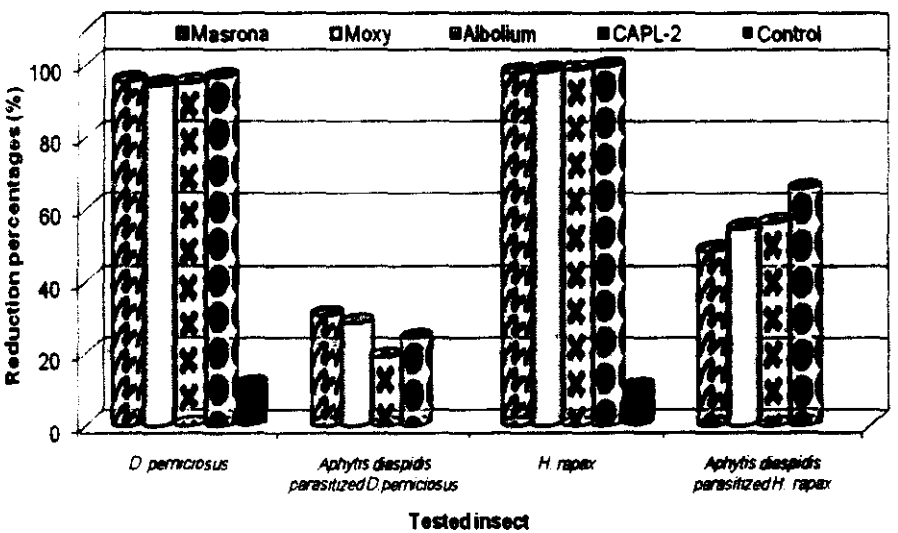

Fig (2). Effect of the tested mineral oils on *D. perniciosus* and *H. rapax* infested pear trees and their side effect on parasitoid *Aphytis diaspidis* under irrigation at Burg el-Arab area (Winter 2006).

Data shown in Fig. (2) elucidate that all the tested mineral oils against SJS were almost, efficient without significant differences in between, but they differ significantly with untreated control. CAPL-2® gave the highest average of reduction percentages of SJS population (99.6%) > Masrona® (95.4%) > Albolium ®(94.9%) > Moxy oil® (94.3%), compared to the completely coincided mortality of the individuals of untreated control.

So, there were no significant differences between all mineral oils tested against the greedy scale, which were significantly different from the untreated check. In this concern, the light summer mineral oil CAPL-2® showed the highest average reduction percentage. Though, the tested mineral oils could be arranged in a descending order as follows : CAPL-2 ®(99.6%) > Albolium® (98.7%) > Moxy oil® (98.2%) > Masrona® (97.9%) compared to the untreated control .

Also, the drastic side effect of tested mineral oils were determined on *Aphytis diaspidis*, parasitoid of inspected SJS and the greedy scale on the infested branches of pear trees during the winter seasons of 2006. Present data show that the tested materials affected the non-target *A. diaspidis* parasitized *D. perniciosus*, where they could be arranged descendingly according to their reduction effect as follows : Masrona ®(30.8%) > Moxy ®(28.6%) > CAPL-2® (24,45%) > Albolium® (19.1%).

Therefore, when they were tested against *A. diaspidis* parasitized greedy scale the mineral oils could be arranged descendingly according to the obtained results as: CAPL-2® (65.7%) > Albolium ®(56.3%) > Moxy® (54.7%) > Masrona ®(48.7%).

Effect of the tested materials on tested insects (summer 2005) :

During July, 2005, SJS infested pear trees in large numbers caused great damage to the trees and fruits. Therefore, this experiment was carried out to evaluate the effect of five summer mineral oils, namely, KZ®, CAPL-2®, Diver®, Super Masrona® and Chema oil® at the rate of 1.5% for each, beside an untreated control treatment.

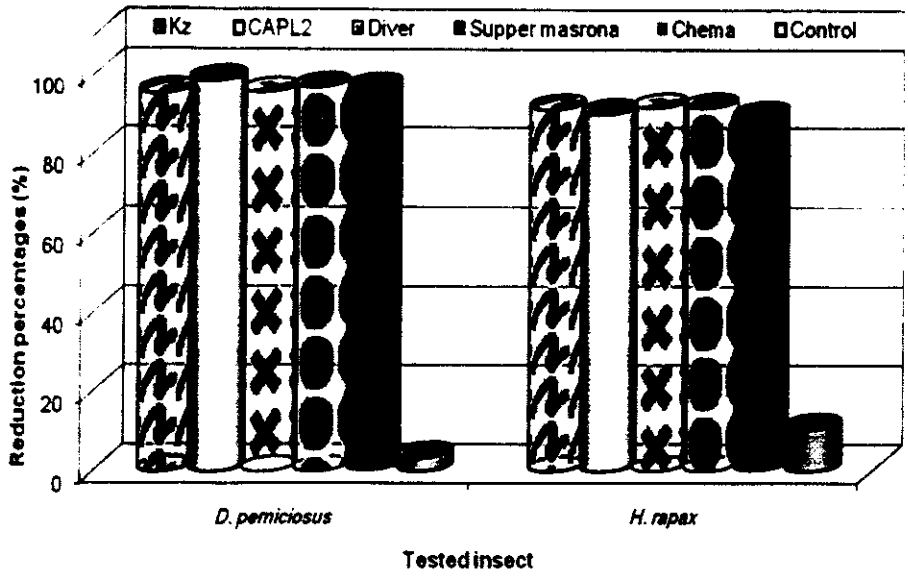

Fig. (3) : Mean effects of the tested mineral oils against *D.perniciosus* and *H.rapax* infested pear trees under irrigation system at Burg el-Arab area, Alexandria (Summer season of 2005).

Data presented in Fig. (3) proved that CAPL-2® was the most efficient one where it caused a high reduction percentage of 98.7% and that might be due to its relative rapid mode of action after spray application in the summer season. Herein, according to the calculated averages of reduction percentages of *D. perniciosus*, the tested summer mineral oils could be arranged in the following descending order : CAPL-2® (98.7%) > Chema oil® (97.2%) > Super Masrona® (97.0%) > Diver® (95.7%) > KZ oil® (95.4%), compared to the untreated control (3.5%). There were not only insignificant differences between the effect of CAPL-2 oil®, Chema oil® and Super Masrona oil®, but also between Diver oil® and KZ oil®.

Ghihamoulat (2005) observed that control opportunities for SJS dictated by life cycle events and annual dormant season applications of superior oil are the foundational of the scale insect control in peach.

Data also indicated the non-significant differences between all experimented mineral oils, versus the detected significant difference between each of these tested mineral oils and control one; which represents the natural reduction of the greedy scale population. The calculated averages of reduction percentages of *H. rapax* individuals can

be arranged in the following descending order: Super Masrona® (91.9%) > Diver® (91.8%) > KZ ®(91.4%) > CAPL-2 ®(90.2%) > Chema® (90.1%), compared to the untreated control .

These results are in agreement with those obtained by Blank *et al.* (1995), who controlled the greedy scale on kiwifruits with organophosphates, pyrethriods and mineral oils, and found that organophosphates and pyrethroid residues remaining on the fruits but there were no mineral oil residues. They also decided that the use of mineral oil treatment at 1% was the preferred choice in an integrated pest management programme.

It is worth to mention here that during summer months of 2005, the inspected rate of parasitized individuals of the SJS and the greedy scale by the parasitoid *Aphytis diaspidis* was low to the limit that the effect of the tested mineral oils on the activity of that parasitoid couldn't be calculated.

The above results are agreed with those obtained by Redding and Alston (2003) who stated that the use of delayed dormant spray targeting over wintering scale is the best approach, once a scale infestation has been identified. They recommended horticultural oil alone or plus insecticide if the rate of infestation be high. They added also that if scales infestations are sever enough to warrant further clean up, insecticide sprays may also be timed with crawler activity during spring and summer.

Finally, from the above mentioned results, it can be concluded that the application of the mineral oils gave a good control of the two armored scales, *D. perniciosus* and *H. rapax* infesting pear trees under irrigation at Burg el-Arab area during the subsequent winter and summer annual seasons of 2005 and 2006.

Recently, an interesting extension of the use of mineral oils against homopterous insects is encouraged. Mineral oils are valuable insecticide materials in fruit trees because they have little residual toxicity for beneficial insects as mentioned by Rawhy (1966), Helmy *et al.* (1984) and Gomaa *et al.* (1995).

The presented data are also agreed with those obtained by El-Halawany *et al.* (1987), Moursi *et al.* (1991), Blank *et al.* (1995), Gomaa *et al.* (1997) and Helmy *et al.* (2006) who stated that the use of local mineral oils for controlling scale insects are better than the organophosphates and pyrethroid compounds for more effect and protection of the environment. Besides, mineral oils are preferable without hazardous effects, and meanwhile the oils showed the same significant superiority. Also, they recorded that Albolium® and KZ oils® gave a good results and can be used as safely scalicides for both winter and early summer sprays against the armored scale insects.

Mineral oils have several advantages over the majority of synthetic pesticides, so that they are employed today to control orchards and other plant pests, where they have been judged to posses no health hazards when compared with most synthetic pesticides. Moreover, the pests are often unable to develop resistance to the mineral oils (El-Sebae, 1977 and Aly *et al.* 1984).

As mentioned by Hussien (2000), the summer emulsifiable mineral oils are recommended for their advantages in possibility for buildup of resistance, because oil killed by physical and physiological effects; save the hard currency paid for the imported insecticides; much safer to consumer and the farm workers, without any harmful residues in the crop and proved to be more friendly to the environment including the natural enemies; and this will support the use of the mineral oils in the suggested IPM programs

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الملخص العربي

تأثير المكافحه ببعض الزيوت المعدنية الشتوية والصيفية على نوعين من الحشرات القشرية الحقيقية التي تصيب أشجار الكمثرى في منطقة برج العرب

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اجريت عدة تجارب لتقييم بعض الزيوت المعدنية الشتوية (مايونيز) والصيفية علي نوعين من الحشرات القشرية الحقيقية علي اشجار الكمثري في المزارع المروية بمنطقة برج العرب 50 كم غرب الإسكندرية) وذلك في عامين متتاليين وخلال الموسم الشتوي بعد التقليم والموسم الصيفي قبل إنتقال الحشرات لإصابة الثمار.

1) حشرة البرنشيوزا القشرية *Diaspidiotus perniciosus*

أ – المعاملات الشتوية

تم إجراء التجربة خلال فصل الشتاء في موسمين متتاليين بعد سقوط الأوراق وبعد عملية التقليم الشتوي لاشجار الكمثرى وذلك بهدف الحد من انتقال الحشرة إلى الثمار المتكونة وتمت هذة التجربه في نهاية موسم الشتاء وأوائل الربيع ، وقد تم تقييم ثلاثة انواع من الزيوت الشتوية وهي زيت المصرونا

والموكسي أويل والألبوليوم بمعدل 2.5% وكذلك الزيت الصيفي كابل2 بمعدل 1 5% وأثبتت التجارب أن الزيت الخفيف (الصيفي) كابل2 كان أكثر فاعلية على خفض تعداد الحشرة يليه الألبوليوم ثم المصرونا ثم الموكسي أويل . وبخصوص التأثير على الطفيل *Aphytis diaspidis* وجد أن زيت الألبوليوم كان أقلها تأثيرا في خفض تعداد الطفيل يليه الموكسي أويل ثم المصرونا ثم الكابل2 .

ب- المعاملات الصيفيه

تم تقييم 5 أنواع من الزيوت الصيفية وهي كزد ، كابل2 ، دايفر . سوبر مصرونا والكيما أويل بمعدل 1.5% لكل منهم وقد اظهرت النتائج المتحصل عليها أن الكابل2 هو الأكثر تأثير في خفض تعداد الحشرة يليه الكيماأويل ثم السوبر مصرونا والدايفر والكزد اويل .

2) حشرة التفاح القشريه *H. rapax*

أ – الموسم الشتوي

أجريت نفس التجربة السابقة لتقييم الزيوت الشتوية وهي الألبوليوم وسوبر مصرونا وموكسي أويل والزيت الصيفي كابل2 على خفض تعداد الحشرة خلال موسمين متتاليين وقد وكان زيت مصرونا الأكثر تأثيرا يليه الكابل2 بدون فرق معنوي ثم الموكسي أويل ثم الألبوليوم . وعند تكرار التجربة في الموسم التالي اظهر الزيت المعدني كابل2 أعلى تأثير في خفض تعداد الحشرة يليه الألبوليوم ثم الموكسي أويل ثم المصرونا بدون فرق معنوي بينها .

من ناحية أخرى كان التأثير على الاقراد المتطفل عليها بالطفيل *A. diaspidis* واضحا وانخفض هذا التاثير بنسبة أكبر عند استعمال زيت المصرونا وكانت أقل تأثرا عند استعمال الموكسي أويل وذلك في موسم شتاء 2005 بينما في يناير 2006 كان الاثر الضار الجانبى اكثر وضوحا باستعمال كابل 2 و العكس صحيح مع استعمال سوبرمصرونا .

ب – الموسم الصيفي :

كابل2 كان هوالاكثر تأثيرا على خفض تعداد حشرة البرنشيوزا يليه الكيما اويل ثم السوبر مصرونا ثم الدايفر ثم كزد اويل . أما في حالة حشرة التفاح القشرية فأن كزد اويل كان أكثرها تأثيرا علي خفض تعداد الحشرة بدون فروق معنوية بينه وبين باقي الزيوت .