INSECTICIDAL EFFECT OF SOME CHEMICAL AND NATURAL PRODUCT AGAINST THE BLACK PARLATORIA SCALE, *PARLATORIA ZIZIPHI* (LUCAS) AND ASSOCIATED PARASITOIDS ON CITRUS TREES

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Abstract

The insecticidal efficacy of five chemical and natural controlling agents were evaluated against the black parlatoria, *Parlatoria ziziphi* (Lucas) (Homoptera : Diaspididae) on citrus trees during 2006 and 2007 seasons. In both seasons, Misrona oil and Buprofezin gave good reduction rates against nymphs, adults and adults with eggs after one, two and three months of spraying. Also, the two compounds caused medium toxicity to the associated parasitoids (*Encarsia citrine*, *Habrolepis aspidioti*, *Marietta leopardina* and *Aphytis chrysomphali*) after the same periods of treatment. Moreover, both compounds have major long-term effect. On the other hand, the natural control agents (M-pede, NeemAzal and Biofly) gave medium or low reduction against *P. ziziphi*, and gave lower toxicity against the parasitoids and have not long-term effect. The natural control agents can be used against the mobile crawlers and nymphal stages of this scale insect. The present treatments specially Misrona oil and Buprofezin proved effective controlling agents against this insect, but must be carefully time as crawlers and nymphs are active for a limited period. Such compounds could be used in IPM programs to reduce the scale insect population.

INTRODUCTION

The black parlatoria, *Parlatoria ziziphi* (Lucas) (Homoptera : Diaspididae) is an economic insect pest of citrus and other *Rutaceae,* dates, plum and guava (Williams and Williams, 1988). This scale established on other tropical and subtropical areas of the world (Quayle, 1938). It is a well-known insect pest of citrus fruits in the Mediterranean region and it has become the most important pest of citrus in Upper Egypt. Also, it affected all aerial parts of the plant, especially the upper surfaces of leaves. The armor of this species sticks so strongly to the plant substrate that it is practically impossible to remove (Fasulo and Brooks, 1986). It feeds slowly on plant sap and reduces plant vigour, heavily infested plants grow poorly and may suffer dieback of twigs and branches. An infested host is occasionally so weakened that it dies, leads to reduce host vigour, and the foliage and fruit may be discoloured with yellow streaking and spotting due to saliva toxicity and leaf drop, reducing productivity (Fasulo and Brooks, 1986). Armored scale secretes a protective cover over their

bodies. Eggs hatch into tiny mobile crawlers, which are the primary dispersal stage and move to new areas of the plant or dispersed by wind or animal contact. Dispersal of sessile adults and eggs occurs through human transport of infested plant material. The crawlers settle after few days, insert their mouthparts in the plant and begin to feed. Soon they secrete a protective cover and lose their legs. Large populations can build up before begin to show visible symptoms (Fasulo and Brooks, 1986). The highest population densities were usually in the lowest part of the canopy. Most scales settled on the upper leaf surface, the lower surface only became infested at very high population densities (El-Bolok *et al.,* 1984). Three parasitoid species of aphelinid and encyrtid parasitoids were recorded attacking *P. ziziphi* in Upper Egypt i.e. *Encarsia citrine* (Craw), *Habrolepis aspidioti* Compere & Annecke, and one hyperparasitoid, *Marietta leopardina* Motschulsky and *Aphytis chrysomphali* (Mercet) (Abd-Rabou, 1999)

The present work designed to study the long-term effect of some chemical and natural control agents on *P. ziziphi* and its associated parasitoids.

MATERIALS AND METHODS

1. Material used (natural control agents):

a. Biofly, an entomopathogenic fungi (3X 10^7 c.f.u./1ml), based on the fungus *Beauveria bassiana*. It was applied at a rate of 1.5 ml/ L.W.

b. Buprofezin (Applaud 25% SC) (insect growth regulator IGR's): A soluble concentration, containing 25% a.i., applied at a rate of 1.5 ml/liter of water.

c. Neemazal, a botanical extract containing 1% Azadirachtin A (10 g/liter) from the neem tree, *Azadirachta indica* (Meliaceae). It was applied at a rate of 1.5 ml/ L.W.

d. M-pede: 49% liquid (Potassium salts of unsaturated and saturated carboxilic acids). It was applied at a rate of 3 ml/ L.W.

e. Super Misrona 95% EC, a local mineral oil, containing 95% paraffinic oil w/w and 5% inert ingredients, unsulfonated residue content reached 92%. It was applied at a rate of 20 ml/ L.W.

2. Experimental design:

This study was conducted during two successive seasons 2006 and 2007 in a private farm of citrus (*Citrus paradise* Macfadyen) located in Qalubiya Governorate, Egypt. The citrus trees used in this study were 15-20 years old, 5-6 m height and heavily infested with *P. ziziphi*. The experiments were accomplished when pest population density was high during September (Moursi and Mesbah, 1985) and when parasitism rates were high during September (Abd-Rabou, 1999). In each treatment,

4 trees (replicates) were sprayed with one of the tested natural control agents or water (control). About 25 liters were sufficient to insure complete coverage of all parts of a tree till run-off. The sample consists of 30 leaves, which were randomly collected. *P. ziziphi* and associated parasitoids were counted just before spraying and 1, 2 and 3 months after spraying. In this trail, the whole tree was sprayed. The sampled leaves was kept in paper bags and transferred to the laboratory for careful examination. Nymphs, adults and adults with eggs were counted under a stereomicroscope. Each leaf was stored for seven days in glass for tube emergence and monitored daily for associated parasitoid emergence. Both surfaces of the leaf were inspected.

3. Statistical Analysis:

In two experiments, the percent reduction of infestation was calculated according to the equation of (Henderson and Tilton 1955). The data was subjected to analysis of variance (ANOVA) and the means were compared by LSD test at 0.05 level, using SAS program (SAS Institute, 1988).

RESULTS AND DISCUSSION

Use of non-selective pesticides, such as organophosphorus and pyrethroids compounds, interferes with the activity of natural enemies and may result in pest resurgence (Hardin *et al.,* 1995).

The first season (2006):

In the first season (2006), results in Table (1) showed that the pre-spraying counts ranged between 91-117, 53-68, 31-51 and 9-16 for nymphs, adults, adults+eggs and parasitoides, respectively.

In the first season (2006), results in Table (1) showed, significant difference between Misrona oil-treatment and Buprofezin and with natural control agents (Biofly, M-pede and NeemAzal) concerning on parasitoids.

Misrona oil gave 87.53, 88.54 and 89.28% reduction against nymphs, adults and adults with eggs, respectively after one month of treatment. While it gave medium toxicity of 54.29% on the parasitoids (*Encarsia citrine*, *Habrolepis aspidioti*, *Marietta leopardina* and *Aphytis chrysomphali*) after the same period.

Also, after two and three-month the results in Table (1) indicated that Misrona oil gave reduction rates of 90.33 & 89.33% against nymphs, 84.35 & 82.68% against adults and 88.12 & 83.59% against adults with eggs, respectively. On the other hand, the oil gave medium toxicity (55.00 & 60.98%) on the parasitoids after two and three-month, respectively.

These results are inagreement with those obtained by Coll and Abd-Rabou (1998). They found that Triona and Shecrona oils showed medium effect on parasitism

rates associated with *P. ziziphi*. Triona oil was more effective than Shecrona oil in reducing the density of nymphs and adults.

Proper mineral oils have proved to be effective, safe and economic for the control of scale insects. In contrary to synthetic organic pesticides, oils deposits have residual activity with no resistance problems developed by various pests (Helmy *et al.*, 1984).

Mineral oil was the most effective when applied on eggs. When crawlers were treated, they prevented from developing and the nymphs became not able to moult and grow normally. Mineral oil interferes with both respiration and membrane function and disrupts feeding activities. For oil to be effective, the material must coat the pest and its eggs, thus complete coverage is essential for optimum results (Sieburth *et al.*, 1998).

Buprofezin (IGR) gave 85.93, 80.38 and 81.03% reduction against nymphs, adults and adults with eggs, respectively after one month, while gave (68.25% toxicity) on the parasitoids.

After 2 and 3 months of treatment, the rate of reduction for nymphs, adults and adults with eggs recorded 90.29 & 88.86%, 84.54 & 80.23%, reduction against nymphs, while gave 84.54 & 80.23% and 87.16 & 82.13%, respectively. On the other hand, Buprofezin caused 66.67 & 70.73% after 2 and 3 months of application, respectively.

Buprofezin is a persistent insecticide with contact and stomach action. It kills larvae and nymphs during the period from the final instar stage to the time of moulting. Treated insects with this compound lay sterile eggs. It used as a persistent larvicide against Hemiptera, Alyrodidae, Coccidae, Diaspididae and Pseudococcidae.

Results in Table (1) indicated that Biofly (*B. bassinana*) gave a medium effect against nymphs, adults and adults with eggs of *P. ziziphi*, as it caused reduction rates of 82.52, 71.93 and 60.61%, respectively, after one month with a medium toxicity of 51.52% against the parasitoids.

After two and three months, Biofly gave reduction rate of 77.95 & 66.14% against nymphs, 68.76 & 64.64% against adults and 56.07 & 48.77% against adults with eggs, respectively. Whereas it caused 59.09 & 68.07% reduction against the parasitoids after the same periods, respectively.

Table 1. Effect of certain controlling agents on the black parlatoria, *Parlatoria ziziphi* and its parasitoids/leaf during 2006 season in Qalubiya governorate.

Treatment	Rate of application	Pre-spraying counts				Intervals of post-spraying counts											
						One month				Two months				Three months			
		N	A	A+E	P	N	A	A+E	P	N	A	A+E	P	N	A	A+E	P
Biofly	1.5 ml/l.	101	53	37	11	28	21	24	7	43	28	29	9	74	35	42	9
NeemAzal	1.5 ml/l.	117	61	31	13	67	33	28	8	91	48	36	12	111	58	50	12
M-pede	3 ml/l.	95	59	41	9	44	27	39	7	77	34	49	8	79	55	61	11
Super Misrona	200 ml/l.	91	68	33	10	18	11	8	6	17	18	7	9	21	22	12	10
Buprofezin	1.5 ml/l.	112	65	48	12	25	18	15	5	21	17	11	8	27	24	19	9
Control	-	116	68	51	16	184	96	84	21	224	115	91	32	251	127	113	41

Treatment	Rate of application	% reduction of insect and parasitoids at different intervals after treatment											
		One month				Two months				Three months			
		N	A	A+E	P	N	A	A+E	P	N	A	A+E	P
Biofly	1.5 ml/l.	82.52	71.93	60.61	51.52	77.95	68.76	56.07	59.09	66.14	64.64	48.77	68.07
NeemAzal	1.5 ml/l.	63.89	61.68	45.16	33.11	59.72	53.47	34.92	53.85	56.15	49.09	27.21	63.92
M-pede	3 ml/l.	70.80	67.58	42.25	40.74	64.14	65.92	33.02	55.56	61.57	50.49	32.85	52.30
Super Misrona	200 ml/l.	87.53	88.54	89.28	54.29	90.33	84.35	88.12	55.00	89.33	82.68	83.59	60.98
Buprofezin	1.5 ml/l.	85.93	80.38	81.03	68.25	90.29	84.54	87.16	66.67	88.86	80.23	82.13	70.73
F value										94.03 ***	64.03 ***	24.01 ***	45.13 ***
LSD										5.08	6.25	4.68	3.36

N= Nymphs A = Adults A+ E = Adults with eggs P= Parasitoids

The entompathogenic fungus *B. bassinana* infect the insects with contact and do not need to be consumed by their host to cause infection. Once the fungus has killed its host, it grows back out through the softer portions of the cuticle, covering the insect with a layer of white mold. This downy mould produces millions of new infective spores that released to the environment (Groden, 1999). For M-pede (potassium salts), it caused differential reduction rates against nymphs, adults and adults with eggs of *P. ziziphi* ranging from 70.80% against nymphs after one month of treatment to 32.85% against adults with eggs after three months. Moreover, the compound gave toxicity rate of 40.74, 55.56 and 52.30% against parasitoids after 1, 2 an 3 months, respectively.

Insecticidal soaps provide a new alternative insecticide affecting both active and settled stages. Soap is safe to use especially for sensitive areas, because of their short residual effect, and thus helping to conserve beneficial species (Townsend, 1999).

Similarly, results in Table (1) indicated that Neemazal gave a medium effect against nymphs, adults and adults with eggs of *P. ziziphi*. The higher effect (63.89% reduction) was observed against nymphs after one month, whereas the lower effect (27.21%) was recorded after 3 months against adults with eggs.

The insecticidal effect of Neemazal against parasitoides was 33.11, 53.85 and 63.92% after 1, 2 and 3 months of treatment, , respectively.

Neem is a botanical extract containing 1% Azadirachtin. The present Neem product contains around 2% of the most potent insect growth regulators as an active ingredient, with 90% organic oil base. Neem is growth regulator, antifeedant and effective on insects, which have become resistant to conventional insecticides. Neem controls the early stages disrupting their ability to develop to adults (Ascher, 1993 and Sclar, 1994).

Statistical analysis in Table (1) revealed differences in responses to the five treatments (Biofly, M-pede, NeemAzal, Misrona oil and Buprofezin) in 2006 season that proved highly significant among nymphs, adults and adults with eggs ($F= 94.03$, 64.03 and 24.01, $P<0.05$) and LSD were 5.08, 6.25 and 4.86, respectively, also for parasitoids (*E. citrine*, *H. aspidioti*, *M. leopardina* and *A. chrysomphali*) ($F= 45.13$, $P<0.05$ and LSD = 3.36).

The second season (2007):

The results obtained during season (2007) followed the same trend of those obtained through season (2006) (Table, 2).

These results showed that the pre-spraying counts ranged between 89-112 for nymphs, 43-55 for adults and 28-38 for adults+eggs, and 8-12 for parasitoides.

Also, the results indicated that there were significant difference between the insecticidal efficacy of both Misrona oil and Buprofezin treatments and that of the other controlling agents (Biofly, M-pede and Neemazal).

Misrona oil gave 91.01, 88.44 and 81.89% reduction against nymphs, adults and adults with eggs of *P. ziziphi,* respectively after one month of treatment, whereas it gave medium toxicity of 56.36% on the parasitoids at the same time of inspection (Table, 2).

Also, after two and three months the results indicated that Misrona oil gave reduction rates of 95.56&93.42% against nymphs, 91.77&89.49% against adults, 82.96& 80.19% against adults with eggs and 57.58&48.33% against parasitoids, respectively.

Helmy *et al.,* (1992) observed that the Egyptian miscible oils were successful as scalicides and scale ovicides for summer and autumn spraying on citrus trees infested by *P. ziziphi.*

For Buprofezin, it gave 86.54, 81.51 and 81.98% reduction against nymphs, adults and adults with eggs, respectively after one month, while its toxicity rate against the parasitoides after the same period recorded 60.0% (Table, 2).

Also, after two and three months the results indicated that Buprofezin gave 93.51&91.33% reduction against nymphs, 89.94&88.21% reduction against adults, 83.04&80.99% reduction against adults with eggs and 50.00&52.63% reduction against parasitoides, respectively.

The IGR`s (antimoulting or Juvenile hormone) are chemicals, which interfere with the development of insects. Buprofezin is belongs to the chemical group thiadiazines, which interfere with the development of the insects exoskeleton (CSI-chitin synthesis inhibitor). It is toxic to eggs and disrupts moulting of the young stages. It does not control adults but reduced the development of females and lowers their egg production (fecundity). It is selective being non-toxic or of low toxicity to parasitoids (Hammock, 1990).

Results in Table (2) generally indicated that Biofly have a medium effect against different stages of *P. ziziphi.* Such effect ranged between 81.44% reduction against nymphs after 1 month and 53.68% reduction against adult with eggs after 3 months. Moreover, the compound gave 40.09, 51.52 and 42.58% toxicity against parasitoides after 1, 2 and 3 months of treatment, respectively.

months against adult with eggs. Also, the insecticidal effects of the compound against parasitoides recorded after 1,2 and 3 months were 40.00, 41.67 and 44.74% toxicity, respectively.

Table 2. Effect of certain controlling agents on the black parlatoria, *Parlatoria ziziphi* and its parasitoids/leaf during 2007 season in Qalubiya governorate.

Treatment	Rate of application	Pre-spraying counts				Intervals of post-spraying counts											
						One month				Two months				Three months			
		N	A	A+E	P	N	A	A+E	P	N	A	A+E	P	N	A	A+E	P
Biofly	20 ml/l.	89	43	31	11	20	14	13	7	31	21	15	8	41	25	31	10
NeemAzal	1.5 ml/l.	97	45	28	8	45	19	14	6	55	25	16	7	69	31	21	7
M-pede	3 ml/l.	112	52	38	10	51	23	21	7	61	35	24	9	76	42	32	8
Super Misrona	200 ml/l.	101	48	29	11	11	6	6	6	6	5	6	7	10	7	8	9
Buprofezin	1.5 ml/l.	92	55	34	8	15	11	7	4	8	7	7	6	12	9	9	6
Control	-	109	49	28	12	132	53	32	15	146	62	34	18	164	68	39	19

Treatment	Rate of application	% reduction of insect and parasitoids at different intervals											
		One month				Two months				Three months			
		N	A	A+E	P	N	A	A+E	P	N	A	A+E	P
Biofly	1.5 ml/l.	81.44	69.89	63.31	49.09	73.99	61.40	60.15	51.52	69.38	58.11	53.68	42.58
NeemAzal	1.5 ml/l.	61.69	60.69	65.25	40.00	57.67	56.09	52.94	41.67	52.72	50.36	46.15	44.74
M-pede	3 ml/l.	62.39	59.11	51.64	44.00	59.34	46.81	47.99	40.00	54.89	41.79	39.54	49.47
Super Misrona	200 ml/l.	91.01	88.44	81.89	56.36	95.56	91.77	82.96	57.58	93.42	89.49	80.19	48.33
Buprofezin	1.5 ml/l.	86.54	81.51	81.98	60.00	93.51	89.94	83.04	50.00	91.33	88.21	80.99	52.63
F value										51.45 ***	23.91 ***	24.03 ***	25.41 ***
LSD										2.69	1.44	2.44	2.47

N= Nymphs A = Adults A+ E = Adults with eggs P= Parasitoids

Statistical analysis in Table (2) indicated differences in responses to the five treatments (Biofly, M-pede, NeemAzal, Misrona oil and Buprofezin) in 2007 season that proved highly significant among nymphs, adults and adults with eggs (F= 51.45, 23.91 and 24.03, P<0.05) and LSD values were 2.69, 1.44 and 2.44, respectively, also for parasitoids (*E. citrine*, *H. aspidioti*, *M. leopardina* and *A. chrysomphali*) (F= 25.41, P<0.05 and LSD = 2.47).

The effects of Azadirachtin, prevent both ecdysis and apolysis, and can cause death before or during molting (Mordue and Blackwell, 1993).

These results are in harmony with those obtained by Mangoud and Abd El-Gawad (2005), who found that mineral oil gave good reduction against nymphs, adults and adults with eggs of *Parlatoria ziziphi* while it showed medium and high toxicity on its parasitoids during two seasons (2001&2002) on grapefruit trees.

It could be concluded that the natural control agents (M-pede, NeemAzal and Biofly) gave medium or low reduction against the black parlatoria, *P. ziziphi*, and they gave less toxicity against the parasitoids, (*E. citrine*, *H. aspidioti*, *M. leopardina* and *A. chrysomphali*). These natural control agents can be used against the mobile crawlers and nymphal stages of this scale insect. The present treatments proved effective, but must be carefully timed as crawlers and nymphs are active for a limited period. Such compounds could be used in IPM programs to reduce the scale insect population.

Misrona oil and Buprofezin proved effective role against all stages of *P. ziziphi* and gave medium toxicity against parasitoids, and could be recommended for use in IPM programs. Oil and Buprofezin have a major long-term effect on *P. ziziphi*, meanwhile the oil did not have long-term effect on the parasitoids.

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التأثير الإبادي لبعض عناصر المكافحة الكيميائية والطبيعية ضد حشرة النبق القشرية والطفيليات المرتبطة بها علي أشجار الموالح

أشرف عبد السلام هندي منجود

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – جيزة

حشرة النبق القشرية تعتبر من أهم الآفات الحشرية التي تصيب أشجار الموالح في مصر. ولقد أجريت دراسة تقييم فاعلية بعض المبيدات الكيماوية والطبيعية ضد الحشرة والطفيليات المصاحبة لها وذلك علي أشجار الموالح خلال موسمي ٢٠٠٦، ٢٠٠٧. أوضحت النتائج أن زيت مصرونا المعدني ومنظم النمو الحشري ببروفيزين أعطيا نسبة خفض في تعداد هذه الحشرة بنسبة مرتفعة ضد الأعمار غير الكاملة والإناث الكاملة والإناث الكاملة الواضعة للبيض بعد شهر وشهرين وثلاثة أشهر من المعاملة خلال موسمي الدراسة بينما أعطيا سمية متوسطة ضد الطفيليات المصاحبة للحشرة خلال الموسمين وكا ن لكل من الزيت المعدني والببروفيزين تأثير متبقي فعال طويل. في حين أعطت المركبات الطبيعية (إم بيد – نيمازال –البيوفلاي) نسبة خفض في تعداد الآفة تراوحت بين نسبة خفض متوسطة وضعيفة خلال الموسمين في حين أعطت سمية ضعيفة ضد الطفيليات المرتبطة بها كما لم يكن لها تأثير متبقياً فعالاً. وأمكن التوصل الي أنه يمكن إستخدام المركبات التي من أصل طبيعي في خفض تعداد كل من الحوريات المتحركة والأعمار الحورية الآخري علي أن يوضع في الإعتبار الوقت المناسب لعملية المكافحة ويكون في توقيت خروج الأعمار الحورية المتحركة أو تواجد الكم الأكبر من الحوريات وبذلك يمكن إدراجها في برامج المكافحة المتكاملة. كما يمكن استخدام مركبي الزيت المعدني الخفيف وكذلك منظم النمو الحشري في برامج المكافحة المتكاملة نظراً لتأثيرها الجيد علي جميع أطوار الحشرة وسميتها المتوسطة للطفيليات المصاحبة لها.