Comparison between Directed and whole tree spraying by different natural control agents in reducing the populations of fig scale insect, *Russellaspis pustulans* on apple trees

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ABSTRACT

The efficacy of four natural control agents (Biovar, Bio-Ranza, NeemAzal and Super Misrona oil) as well as with Sumithion were tested against the fig scale insect, *Russellaspis pustulans* (Homoptera: Asteroleacaniidae) and its parasitoid, *Metaphycus* sp. on apple trees in Gharbia Governorate on 15th April during two successive seasons (2008 and 2009). In these trails, the whole tree spraying was compared with the oriented spraying (spraying of trunk and main branches). In the first season (2008), Biovar, Bio-Ranza, NeemAzal and Super Misrona oil agents gave moderate reduction on nymphs, non-gravid and gravid females also gave moderate toxicity on parasitoid. On the other hand, Sumithion gave highly average reduction to all stages of scale insect and its parasitoid. The whole tree spraying trail gave similar results to those obtained from the directed spray trail. About 7.5 litres of spraying volume per apple tree was sufficient to cover these parts, while about 20 litres of spraying volume per tree were sufficient to complete cover the whole tree. The results that obtained in second year (2009) were similar to those obtained from 2008 season.

INTRODUCTION

The fig scale insect, *Russellaspis (Asterolecanium) pustulans* (Cockerell) (Hemiptera : Asterolecaniidae) infesting 230 host plants including apple, fig and mulberry trees. It is distributed in different partas of the world (Hamon, 1977 and Cen, 1988). The injury is caused by different immature and mature stages of insect, which suck the plant sap and our beneath the outer bark near the base of twigs, branches and trunk of trees. When insects settles on a green shoot or rib of a leaf causing the epidermal layer to swell up forming a sort of cup, and causes shedding of the lower leaves and infestation starting on the trunk and main branches in early season (Borges *et al.*, 1988 and Gomma *et al.* ,1991). In Egypt, Hammad and Moussa (1973) recorded *A. pustulans* on *Acacia* sp., *Cassia* sp., *Bouhinia* sp., *Ceratonia* sp., *N. oleander, J. ovalifolia, Jasminium* sp. and *Erytherina numeana.* . *R. pustulans* attacks mango trees (Nada *et al.* 1990) and attacks apple trees (Mangoud, 1994). Moustafa (1995) studied the distribution and host plants of the species of family Asterolacanidae. Who recorded *B. bambusae* on *Thuja orientalis, Acalypha marginata, Dendrocalamus giganteus* in Daqahliya, Beheira, Giza and Fayium governorates and *A. phoneicis* recorded on *Phonix dactylifera* in Qalyubiya and Ismailia as well as *R. pustulans* which attacks ten host plant species in nine governorates. Two species from family Asterolicanidae recorded on ornamental host plants (Serage, 1998). Abd El-Razak (2000) recorded the fig scale, *R. pustulans* on *Bougainvillea* sp. Habib (1943) and El Minshawy *et al.* (1974) studied bionomics and biological studies of this pest. Seasonal history of this pest was conducted by Salam and Hamdy (1974). Later Ali (1993) studied the bionomics of *R. pustulans.* Who recorded 58 species belong to 27 families of host plants of *R. pustulans* in 13 governorates and recorded six parasitic and predator species associated with this pest. This pit scale insect had two main periods of seasonal abundance on fig trees under the local conditions at Qalyubiya. The first period was in summer and the second in autumn. El-Kifl et al. (1980) and Abd El-Salam and Mangoud (2001) studied the control measure of *R. pustulans* . Abd-Rabou (2007) recorded The parasitoid *Metaphycus lounsburyi* (Howard) *as a* prasitoids *R. pustulans.* Later Abd-Rabou and Evans (2010) recorded *Metaphycus asterolecanii (Mercet)* (Hymenoptera : Encyrtidae) associated with *R. pustulans.*

The main purpose of this study is to compare between different controlling methods (whole trees spraying and directed spraying) in reduction of the population of fig scale insect, *Russellaspis (Asterolecanium) pustulans* (Cockerell) on apple trees.

MATERIALS AND METHODS

1. Whole tree spraying:

In this experiment, the whole tree was sprayed. About 20 litres of spraying liquid per tree were sufficient to insure complete coverage of the whole apple tree.

2.Directed spraying (spraying trunks and main branches):

In this experiment, only trunks and main branches were sprayed. About 7.5 litres of spraying volume per tree were sufficient to cover the infested trunk and main branches.

Each spraying trial containing 16 trees (4 replicates) was applied. Other 16 trees were left as untreated check (control). A knapsack sprayer CP-20 of 20L was used.

4. Samples:

Twenty new branches (20-25 cm long) were selected random from all parts of the tree. Twenty trunks and also twenty main branches were selected; each sample was represented by one square inch were kept separately in plastic cups 5X9 cm, covered with muslin cloth and held in position by rubber bands to prevent the insect from escaping, then all samples transferred to the laboratory for counting by the aid of a stereomicroscope. The alive nymphs, adult females (gravid and non-gravid females) were counted under a stereomicroscope. Each sample was stored in well-ventilated emergence glass tube and was monitored daily for parasitoid, *Metaphycus* sp. emergence. Counts were made before spraying and 6, 12 and 21 days after spraying. The apple trees were 3-3.5m height and were heavily infested with the fig scale insect.

The following materials were tested:

a. **Bio-Ranza,** an entomopathogenic fungi (32 x 10^6 viable spore/ml), containing the fungus *Metarrihizium anisoplae* applied at a rate of 2 ml/liter of water.

b. **Biovar,** an entomopathogenic fungi (3200 viable spore/mg), containing the fungus *Beauveria bassiana* applied at a rate of 2 ml/liter of water.

c. **NeemAzal:** A botanical extract containing 1% Azadirachtin (2.5 g/liter) from the neem tree, *Azadirachta indica* (Meliaceae).

d. **Super Misrona 95% EC,** a local mineral oil, containing 95% paraffinic oil w/w and 5% inert ingredients, unsulfonated residue content reached 92% applied at a rate of 20 ml/ liter of water.

e. **Sumithion 57% EC** was applied at a rate of 2 ml/ liter of water.

5. Statistical analysis:

The percent reduction of infestation was statistically calculated according to the equation of **(Henderson and Tilton 1955).**

RESULTS AND DISCUSSION

1. Comparison between directed and whole tree spraying methods for controlling *Russellaspis pustulans* **on apple trees (2008 season):**

1.1.Directed spraying (spraying the trunk and main branches) during 2008:

Table (1) showed that the pre-treatment average numbers of nymphs reached (3.1-4.9 individuals/branch), non-gravid and gravid females (1.2-2.8 individuals/branch) and parasitoid, *Metaphycus* sp. (0.1-8.5 individuals/branch), respectively on new branches of apple trees. While, the average numbers of nymphs reached (79.4-96.8 individuals/inch), non-gravid and gravid females (39.7-55.8 individuals/inch) and *Metaphycus* sp. (1.1-1.8 individuals/inch), respectively on main branch of apple trees, whereas, the average numbers of nymphs reached (63.5-84.4 individuals/inch), non-gravid and gravid females (33.7-42.5 individuals/inch) and *Metaphycus* sp. (1.8-2.6 individuals/inch), respectively on main branch of apple trees.

Only trunks and main branches of apple trees were spraying, therefore the direct effect of different compounds were calculated. About 7.5 litres of spraying volume per tree were sufficient to cover the infested trunk and main branches.

On new branches: These branches did not sprayed directly but may be the drift of the sprayed compounds gave a little reduction; the drift of the compounds (Bio-Ranza, Biovar, NeemAzal, Super Misrona oil and Sumithion) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza were 19.22, 8.78 and 16.67, respectively. The percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza were 19.22, 8.78 and 16.67, respectively. The percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Biovar were 22.24, 9.37 and 16.67%, respectively. The percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of NeemAzal,were 6.64, 5.41 and 16.67%, respectively. and the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Super Misrona oil were 27.30, 23.42 and 44.44%, respectively (Table, 2).

On main branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. were (58.79, 50.72 and 44.08%), (60.55, 51.86 and 46.86%) and (56.37, 48.72 and 39.52%), respectively. Also, Super Misrona oil gave moderate effects, were (86.63, 76.22 and 58.94%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 95.00, 88.85 and 85.12%, respectively (Table, 2).In general Neem Azal was the least toxic to the parasitoid agent.

On trunks: also trunks sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza were 56.89, 50.74 and 41.96%, respectively. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Biovar were 58.11, 54.36 and 45.72%, respectively. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of NeemAzal were 58.28, 48.78 and 37.5%, respectively. Also, Super Misrona oil gave moderate effects, were (85.15, 75.91 and 57.38%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 95.12, 88.85 and 84.37%, respectively (Table, 2).

Biofly (*Beauveria bassinana*) is a fungus, which causes a disease known as the white muscdine disease in insects. When spores of this fungus come in contact with the cuticle of

Table (1): Average number of different stages of the the fig scale insect, *Russellaspis pustulans*/branch in square inch before and after directed spray of various compounds agents under field conditions (directed spraying method) during 2008 season.

Treatment	Rate of application ml/L. of water	Pre-treatment count									Post-treatment count after 21 days								
		New branch			Main branch			Trunk			New branch			Main branch			Trunk		
		N	A	p	N	A	P	N	A	p	N	A	p	N	A	p	N	A	p
Bio-Ranza	2 ml	3.4	1.6	0.2	95.4	42.6	1.5	77.2	35.6	2.1	3.4	1.8	0.2	49.6	33.1	1.3	55.3	38.2	1.3
Biovar	2 ml	4.6	1.9	0.1	88.6	41.9	1.7	63.5	34.8	1.9	5.1	2.1	0.1	44.1	31.8	1.4	44.2	34.6	1.1
NeemAzal	2.5 g	4.8	1.7	0.3	91.2	39.7	1.6	71.4	33.7	1.8	5.3	1.9	0.3	50.2	32.1	1.5	49.5	37.6	1.2
Super Misrona oil	20 ml	4.3	1.2	0.1	79.4	47.2	1.1	69.3	36.4	2.2	5.7	1.4	0.1	13.4	17.7	0.7	17.1	19.1	1.0
Sumithion	2 ml	3.1	1.8	0.3	85.6	51.8	1.3	79.2	41.6	2.4	3.2	1.7	0.2	5.4	9.1	0.3	6.4	10.1	2.4
Control	-	4.9	2.8	0.5	96.8	55.8	1.8	81.4	42.5	2.6	7.1	3.7	0.6	122.4	88.3	3.1	134.6	91.5	3.2

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

Table (2): Reduction percent induced by application of various compounds for controlling the fig scale insect, *Russellaspis pustulans* /branch in square inch under field conditions during 2008 season (directed spraying method).

Treatment	Rate of application ml/L. of water	Average reduction% after 21 days								
		New branch			Main branch			Trunk		
		N	A	P	N	A	P	N	A	P
Bio-Ranza	2 ml	19.22	8.78	16.67	58.79	50.72	44.08	56.89	50.74	41.96
Biovar	2 ml	21.92	10.38	16.67	60.55	51.86	46.86	58.11	54.36	45.72
NeemAzal	2.5 g	22.24	9.37	16.67	56.37	48.72	39.52	58.28	48.78	37.5
Super Misrona oil	20 ml	6.64	5.41	16.67	86.63	76.22	58.94	85.15	75.91	57.38
Sumithion	2 ml	27.30	23.42	44.44	95.00	88.85	85.12	95.13	88.85	84.37

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

insects, they germinate and grow directly through the cuticle to the inner body of their host. Producing toxins and draining the insect of nutrients eventually killing it **(Gorden, 1999).**

In this respect, **Sieburth *et al.*, (1998);** reported that mineral oil must coat the pest and its eggs, since complete coverage was essential for optimum results. Mineral oil was the most effective when applied against eggs, and treated first instars stopped development. Nymphs were not able to moult and to grow normally. Mineral oil interferes with both respiration and membrane function and disrupts feeding activities. Oil must coat the pest and its eggs, since complete coverage is essential for optimum results. These results were in agreements of the data recoded in

1.2.Whole trees spraying during 2008:

Table (3) showed that the pre-treatment average numbers of nymphs reached (3.9-5.2 individuals/branch), non-gravid and gravid females (1.9-2.9 individuals/branch) and parasitoid, *Metaphycus* sp. (0.3-0.6 individuals/branch), respectively on new branch of apple trees. While, the average numbers of nymphs reached (74.6-89.2 individuals/inch), non-gravid and gravid females (37.3-44.6 individuals/inch) and *Metaphycus* sp. (1.0-1.5 individuals/inch), respectively on main branch of apple trees, whereas, the average numbers of nymphs reached (57.8-69.1 individuals/inch), non-gravid and gravid females (30.1-43.4 individuals/inch) and *Metaphycus* sp. (2.2-3.4 individuals/inch), respectively on main branch of apple trees.

In this experiment, the whole tree was sprayed. About 20 litres of spraying liquid per tree were sufficient to insure complete coverage of the whole apple tree.

On new branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application 56.09, 50.39 and 41.67%, (59.29, 52.89 and 55.56% and 53.54, 51.38 and 39.52% for Bio-Ranza, Biovar and NeemAzal were, respectively. Also, Super Misrona oil gave moderate effects, were (84.43, 78.07 and 73.33%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 94.93, 91.31 and 83.33%, respectively (Table, 4).

On main branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application 53.83, 51.16 and 47.36%, 54.64, 52.56 and 52.15% and 54.83, 50.23 and 49.11%, for Bio-Ranza, Biovar and NeemAzal were, respectively. Also, Super Misrona oil gave moderate effects, were (82.51, 77.65 and 69.92%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 93.44, 91.69 and 82.46%, respectively (Table, 4).

On trunks: also trunks sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza, Biovar and NeemAzal were 59.75, 50.55 and 41.81%, 57.12, 53.56 and 48.27% and 54.95, 52.40 and 48.27%, respectively. Also, Super Misrona oil gave moderate effects, were (84.49, 78.60 and 66.63%) on nymphs, non-gravid & gravid females and on

Table (3): Average number of different stages of the fig scale insect, *Russellaspis pustulans*/branch of in square inch before and after whole trees spray of various compounds agents under field conditions during 2008 season.

Treatment	Rate of application ml/L. of water	Pre-treatment count									Post-treatment count after 21 days								
		New branch			Main branch			Trunk			New branch			Main branch			Trunk		
		N	A	p	N	A	P	N	A	p	N	A	p	N	A	p	N	A	p
Bio-Ranza	2 ml	4.7	2.1	0.4	81.1	38.1	1.0	68.1	30.1	3.2	2.6	2.5	0.7	41.9	23.2	0.5	40.2	21.7	1.8
Biovar	2 ml	3.9	2.3	0.3	79.2	32.3	1.1	59.2	32.2	2.6	2.0	2.6	0.4	40.2	19.1	0.5	41.7	21.8	1.3
NeemAzal	2.5 g	4.1	2.4	0.4	82.3	41.1	1.2	62.5	40.2	2.2	2.4	2.8	0.6	41.6	25.5	0.5	41.3	27.9	1.1
Super Mis-rona oil	20 ml	5.1	1.9	0.5	74.6	42.9	1.4	66.4	39.1	3.1	1.0	1.0	0.4	14.6	11.7	0.4	15.1	12.2	1.0
Sumithion	2 ml	4.7	2.4	0.4	80.4	39.6	1.2	57.8	36.6	2.9	0.3	0.5	0.2	5.9	4.1	0.2	4.4	5.2	0.4
Control	-	5.2	2.9	0.6	89.2	44.6	1.5	69.1	43.4	3.4	6.3	7.2	1.8	99.6	56.1	1.9	101.2	62.7	2.9

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

Table (4): Reduction percent induced by whole tree spraying of various compounds for controlling the fig scale insect, *Russellaspis pustulans*/branch of in square inch under field conditions during 2008 season.

Treatment	Rate of application ml/L. of water	Average reduction% after 21 days								
		New branch			Main branch			Trunk		
		N	A	p	N	A	P	N	A	P
Bio-Ranza	2 ml	56.09	50.39	41.67	53.83	51.16	47.36	59.75	50.55	41.81
Biovar	2 ml	59.29	52.89	55.56	54.64	52.56	52.15	57.12	53.56	48.27
NeemAzal	2.5 g	53.54	52.38	50.00	54.83	50.23	49.11	54.95	52.40	48.27
Super Mis-rona oil	20 ml	84.43	78.07	73.33	82.51	77.65	69.92	84.49	78.60	66.63
Sumithion	2 ml	94.93	91.31	83.33	93.44	91.69	82.46	94.81	90.25	85.73

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

Metaphycus sp., respectively.. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 94.81, 90.25 and 85.73%, respectively (Table, 4).

2. Comparison between oriented and whole tree spraying methods for controlling *R. pustulans* on apple trees 2009 season:

2.1.Oriented spraying (spraying the trunk and main branches) during 2009:

Table (5) showed that the pre-treatment average numbers of nymphs reached (4.9-6.8 individuals/branch), non-gravid and gravid females (1.2-1.9 individuals/branch) and parasitoid, *Metaphycus* sp. (0.1-0.4 individuals/branch), respectively on new branch of apple trees. While, the average numbers of nymphs reached (51.1-62.3 individuals/inch),Table (3) and table (4). Non-gravid and gravid females (21.8-31.0 individuals/inch) and *Metaphycus* sp. (1.1-1.4 individuals/inch), respectively on main branch of apple trees, whereas, the average numbers of nymphs reached (36.2-44.1 individuals/inch), non-gravid and gravid females (20.0-30.1 individuals/inch) and *Metaphycus* sp. (1.8-2.4 individuals/inch), respectively on main branch of apple trees.

On new branches: these branches did not sprayed directly but may be the drift of the sprayed compounds gave a little reduction; the drift of the compounds (Bio-Ranza, Biovar, NeemAzal, Super Misrona oil and Sumithion) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza, Biovar and NeemAzal Super Misrona oil and Sumithion were 18.11, 15.11 and 20.00%, 24.48, 19.54 and 20.00%, 22.25, 21.18 and 20.00%, 25.70, 20.42 and 20.00%, and 22.89, 18.10 and 20.00%, respectively (Table, 6).

On main branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza, Biovar and NeemAzal were 50.37, 50.11 and 49.09%, 61.75, 56.45 and 50.00% and 54.45,54.14 and 46.67%, respectively. Also, Super Misrona oil gave moderate effects, were 85.71, 81.30 and 60.00% on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females since it gave 94.72, 93.42 and 83.33%, respectively (Table, 6).

On trunks: also trunks sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza, Biovar and NeemAzal were 58.98, 52.32 and 45.42%, 59.01, 58.73 and 49.49% and 54.67, 51.52 and 48.47%, respectively Table (5) and Table (6). Also, Super Misrona oil gave moderate effects, were 86.57, 77.18 and 62.96% on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 94.10, 89.01 and 82.36%, respectively (Table, 6).

2.2.Whole trees spraying during 2009:

Table (7) showed that the pre-treatment average numbers of nymphs reached (3.0-4.2 individuals/branch), non-gravid and gravid females (1.1-1.6 individuals/branch) and parasi-

toid, *Metaphycus* sp. (0.2-0.7 individuals/branch), respectively on new branch of apple trees. While, the average numbers of nymphs reached (62.2-71.2 individuals/inch), non-gravid and

Table (5): Average number of different stages of the fig scale insect, *Russellaspis pustulans*/branch of in square inch before and after directed spray of various compounds agents under field conditions (directed spraying method) during 2009 season.

Treatment	Rate of application ml/L. of water	Pre-treatment count									Post-treatment count after 21 days								
		New branch			Main branch			Trunk			New branch			Main branch			Trunk		
		N	A	p	N	A	P	N	A	p	N	A	p	N	A	p	N	A	p
Bio-Ranza	2 ml	4.9	1.3	0.1	51.1	22.1	1.1	44.1	20.0	1.9	4.7	1.6	0.1	38.9	18.4	1.4	44.9	19.9	1.4
Biovar	2 ml	5.2	1.2	0.3	61.2	30.0	1.2	40.1	21.6	2.2	4.6	1.4	0.3	35.9	21.8	1.5	40.8	18.6	1.5
NeemAzal	2.5 g	5.6	1.4	0.2	55.4	28.1	1.2	39.2	26.2	2.3	5.1	1.6	0.2	38.7	21.5	1.6	44.1	26.5	1.6
Super Misrona oil	20 ml	5.4	1.3	0.3	61.6	21.8	1.4	41.7	29.2	1.8	4.7	1.5	0.3	13.5	6.8	1.4	13.9	13.9	0.9
Sumithion	2 ml	6.2	1.6	0.4	51.9	31.0	1.2	36.2	30.1	2.1	5.6	1.9	0.4	4.2	3.4	0.5	5.3	6.9	0.5
Control	-	6.8	1.9	0.4	62.3	32.2	1.4	44.6	29.9	2.4	8.2	2.9	0.5	95.1	53.4	2.5	111.7	62.6	2.7

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

Table (6): Reduction percent induced by application of various compounds for controlling the fig scale insect, *Russellaspis pustulans*/branch of in square inch under field conditions during 2009 season (directed spraying method).

Treatment	Rate of application ml/L. of water	Average reduction% after 21 days								
		New branch			Main branch			Trunk		
		N	A	P	N	A	P	N	A	P
Bio-Ranza	2 ml	18.11	15.11	20.00	50.37	50.11	40.09	58.98	52.32	45.42
Biovar	2 ml	24.48	19.54	20.00	61.75	56.45	50.00	59.01	58.73	49.49
NeemAzal	2.5 g	22.25	21.18	20.00	54.45	54.14	46.67	54.67	51.52	48.47
Super Mis-rona oil	20 ml	25.70	20.42	20.00	85.71	81.30	60.00	86.57	77.18	62.96
Sumithion	2 ml	22.89	18.10	20.00	94.72	93.42	83.33	94.10	89.01	82.36

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

Table (7): Average number of different stages of the fig scale insect, *Russellaspis pustulans*/ branch in square inch before and after whole trees spray of various compounds agents under field conditions during 2009 season.

Treatment	Rate of application ml/L. of water	Pre-treatment count									Post-treatment count after 21 days								
		New branch			Main branch			Trunk			New branch			Main branch			Trunk		
		N	A	p	N	A	P	N	A	p	N	A	p	N	A	p	N	A	p
Bio-Ranza	2 ml	3.8	1.2	0.7	71.2	33.2	1.2	62.4	21.3	1.2	2.3	1.2	0.2	49.6	28.9	0.8	38.9	21.6	0.5
Biovar	2 ml	3.1	1.1	0.2	66.1	30.6	1.4	59.8	18.6	1.3	1.7	1.0	0.1	37.4	25.1	0.9	36.5	19.5	0.4
NeemAzal	2.5 g	3.2	1.3	0.2	70.5	36.1	1.5	60.7	19.2	1.6	2.0	1.4	0.1	51.1	33.4	1.0	37.2	20.8	0.6
Super Mis-rona oil	20 ml	3.0	1.6	0.4	62.2	29.8	1.4	59.3	20.1	1.4	0.8	0.5	0.2	13.5	9.4	0.6	11.8	6.8	0.3
Sumithion	2 ml	4.0	1.1	0.2	65.3	29.6	1.2	61.5	20.8	1.6	0.3	0.1	0.05	6.2	3.2	0.2	4.9	3.1	0.1
Control	-	4.2	1.4	0.3	71.2	37.1	1.6	63.1	21.9	1.7	5.2	2.1	0.4	116.1	66.9	2.8	89.6	49.2	1.4

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

gravid females (29.6-37.1 individuals/inch) and *Metaphycus* sp. (1.2-1.6 individuals/inch), respectively on main branch of apple trees, whereas, the average numbers of nymphs reached (59.3-63.1 individuals/inch), non-gravid and gravid females (18.6-21.9 individuals/inch) and *Metaphycus* sp. (1.2-1.7 individuals/inch), respectively on main branch of apple trees.

On new branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. Since the percentages of reduction of the numbers of nymphs, adults and parasitoid due to the application of Bio-Ranza, Biovar and NeemAzal were 53.44, 52.38 and 50.00%, 57.82, 56.31 and 62.50% and 51.22, 48.72 and 62.50%, respectively. Also, Super Misrona oil gave moderate effects, were (82.91, 85.12 and 62.50%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 94.23, 95.67 and 84.25%, respectively (Table, 8).

On main branches: these branches sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. were (54.39, 51.86 and 52.38%), (62.86, 54.63 and 54.38%) and (52.62, 48.83 and 52.38%), respectively. Also, Super Misrona oil gave moderate effects, were (85.79, 82.55 and 62.38%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 93.78, 94.02 and 88.09%, respectively (Table, 8).

On trunks: also trunks sprayed directly with spraying solution; the three control agents (Bio-Ranza, Biovar and NeemAzal) gave low reduction of nymphs and non-gravid & gravid females and gave also low toxic effects on the parasitoid, *Metaphycus* sp. were (56.17, 54.65 and 40.47%), (57.08, 53.2 and 56.04%) and (56.91, 51.56 and 46.42%), respectively. Also, Super Misrona oil gave moderate effects, were (85.74, 84.87 and 69.39%) on nymphs, non-gravid & gravid females and on *Metaphycus* sp., respectively. While Sumithion gave highly percent reduction on nymphs and non-gravid and gravid females were 94.39, 93.33 and 91.07%, respectively (Table, 8).

As mentioned before, about 20 litres of spraying liquid was sufficient to insure complete coverage of all parts of the apple tree (whole tree spraying) while, 7.5 litres (oriented spraying) per tree were sufficient. In other words, the treatment of infested branches is more economic (about 2.6 times less), and safer to environment than the spraying of the whole tree.

Ali (1993) tested the effect of organophosphorous compounds (Basudin, Malathion, Sumithion and Tokuthion), IGR (Pyriproxyfen) and Indian lilac (*Melia azedarah*), observed organophosphorous insecticides were the best effective against all stages of *R. pustulans* and IGR and Indian lilac were less toxicant the aforementioned compounds. Mangoud (2001) stuided the distribution of the fig scale insect, *Russellaspis pustulans* on various parts of apple trees. He found that 51.6 and 46.6% of adults and nymphs stages, respectively were concentrated on trunks, while 48.4 and 53.4%, respectively were distributed between main branches, (new branches and new leaf opetiols). Also found the fig scale insect was concentrated in the direction of water pipe in new reclaimed lands. Mangoud (1994) studied the effiaicy of different control agents against the fig scale insect, *Russellaspis pustulans* on apple trees. He found that prothiophos, malathion, diazinon and Shecrona oil gave 92-96% reduction in numbers of nymphs. Also found, that fenitothion and buprofezin reduced the infestation by 72 and 71%. The tested insecticides gave less effect against gravid femlaes. The percent reduction in infestation did not exceed 81% in case of non-gravid females. The effect on eggs under gravid

Table (8): Reduction percent induced by whole tree spraying of various compounds for controlling the fig scale insect, *Russellaspis pustulans*/branch in square inch under field conditions during 2009 season.

Treatment	Rate of application ml/L. of water	Average reduction% after 21 days								
		New branch			Main branch			Trunk		
		N	A	P	N	A	P	N	A	P
Bio-Ranza	2 ml	53.44	52.38	50.00	54.39	57.86	52.38	56.17	54.65	40.47
Biovar	2 ml	57.82	56.71	62.50	62.86	54.63	54.08	57.08	53.12	56.04
NeemAzal	2.5 g	51.22	48.72	62.50	52.62	48.83	52.38	56.91	51.56	46.42
Super Mis-rona oil	20 ml	82.91	85.12	62.50	85.79	82.55	62.38	85.74	84.87	69.39
Sumithion	2 ml	94.23	95.67	84.25	93.78	94.02	88.09	94.39	93.33	91.07

N= Nymphs, A = Adult females (gravid and non-gravid females), P = Parasitoid (*Metaphycus* sp.)

females ranged between 19-48% reduction. Mangoud (2000) studied the effect of different compounds against the fig scale insect, *R. pustulans* by two srpaying trails (oriented and whole tree spraying) under field conditions. He found that light oil + sulfur, light oil alone and light oil + malathion gave 97.4, 96.6 and 95.1% average reduction in the oriented spraying method (spraying of infested branches) before pruning and the average cost was 40.75 LE/feddan. Oil + sulfur and oil alone gave 96.1 and 94.2% average reduction. Oil + malathion gave 88.6% (after pruning) and the average cost was 34.3 LE/feddan. On the other hand in whole tree spraying gave the same results which were obtained from oriented spraying except the cost before pruning was 135 LE/feddan and 120 LE/feddan (after pruning).

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الملخص العربى

المقارنة بين الرش الموجه والكلي للأشجار باستخدم بعض المركبات الطبيعية ضد حشرة التين الفنجانية القشرية علي أشجار التفاح

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تمت مقارنة فعالية المركبات الأربع (بيوفار – بيورانزا – النيم - زيت مصرونا المعدني) مقارنة بمبيد السومثيون ضد حشرة التين الفنجانية القشرية والطفيليات المصاحبة لها علي أشجار التفاح في محافظة الغربية خلال موسمين متتاليين (2008، 2009). في هذه التجارب تمت المقارنة بين الرش الكلي للأشجار مقارنة بالرش الموجة الجزئي (رش الجذع والأفرع الرئيسية). في الموسم الأول (2008)، وجد أن المركبات الأربع (بيوفار – بيورانزا – النيم - زيت مصرونا المعدني) أعطت نتائج متوسطة ضد الأعمار غير الكاملة لحشرة التين الفنجانية، وضد الإناث غير الحاملة والحاملة للبيض كذلك كانت للمركبات الأربع سمية متوسطة ضد ضد الطفيل *Metaphycus* sp. بينما أعطي مبيد السومثيون نسبة خفض عالية ضد جميع الأعمار وكذلك سمية عالية ضد الطفيليات في طريقتي الرش (الرش الموجة الجزئي والرش الكلي). كما وجد أن المركبات الأربع أعطت نتائج قريبة عند الرش الكلي للأشجار مقارنة بالمتحصل عليها من الرش الجزئي. من جهة أخري عند المعايرة لكمية محلول الرش المستخدم وجد أنه في الرش الكلي احتاجت الشجرة لـ 20 لتر لتغطية الشجرة تغطية كاملة، بينما احتاجت الشجرة لـ 7,5 لتر لتغطية الجذع والأفرع الرئيسية في حالة الرش المجه الجزئي. كذلك وجد أن النتائج المتحصل عليها في السنة الثانية (2009) مقاربة لنتائج الموسم الأول (2008).