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EVALUATION OF PRESENT PEST MANAGEMENT PRACTICES FOR THE POMEGRANATE WHITEFLY, *SIPHONINUS PHILLYREAE* IN UPPER EGYPT

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Abstract

Field trails were carried out to evaluate certain pest management practices for the pomegranate whitefly, *Siphoninus phillyreae* (Haliday) (Homoptera : Aleyrodidae) in Upper Egypt fields (Assiut Governorate) during 2000 season. Spray oil (Masrona) showed 91.0% average mortality for eggs, 51.9% against nymphs and 18.4% for adults. Masrona oil gave 28.1% and 61.8% reduction against mature and immature stages of the parasitoid, *Encarsia inaron* Walker (Hymenoptera : Aphelinidae), respectively.

Buprofezin and pyriproxyfen gave 8.2 and 17.8% mean mortality, respectively against adults of *S. phillyreae*, while they showed 94.1 and 88.6% against nymphs, respectively. The direct effect on eggs showed only 15.2 and 17.2% mean mortality, respectively. The two IGRs showed low toxicity against mature stages of the parasitoid (12.5 and 21.1%, respectively), while showed moderate toxicity against immature stages (42.5 and 57.4%, respectively).

Malathion was very effective against adults and nymphs of *S. phillyreae* and also killed the parasitoid. Malathion showed 95.4, 98.0 and 11.6% mean reduction against adults, nymphs and eggs of *S. phillyreae*, and over 98% average reduction on the parasitoid, respectively.

About 25,000 adults (5000 adults/month) of the *E. inaron* were released at five times between June to October 2000. The natural parasitism rate of *E. inaron* was 9.6 and 9.8% in tow plots. The rate of parasitism in realising plot increased to reach 72.5% by the end of the season, while reached 19.6% in no-releasing plot.

Using sticky material bands prevented ants from climbing into infested trees. Pruning pomegranate trees, collecting pruned parts and dropped leaves and burning them directly reduced infestation by more than 40%.

INTRODUCTION

The pomegranate whitefly, *Siphoninus phillyreae* (Haliday) (Homoptera : Aleyrodidae), is considered one of the most important pests attacking pomegranate trees, *Punica granatum* in Egypt (Priesner and Hosny 1932). About 95% of pomegranate trees are grown in Upper Egypt (Abd-Rabou 1998). Eggs are laid in clusters profusely dusted with white waxy powder on the underside of leaves. The first instar (crawler) searches the leaf to find a suitable vein and pierce its mouth parts. After settling, the insect remains in the same position until it becomes an adult. Heavy infestations lead to wilting, render curly, then attain a yellow and colour, dry up, smaller fruit and fall down. Damage can result in loss of leaves and weaken the trees, thus effecting on yield of fruits.

The immature whiteflies feed on the sucked sap and produce large quantities of sticky honeydew. Black sooty mould grow on this honeydew on the trees. The honeydew also attracts ants, which disrupt parasitoids. Control ants could be reached by using sticky material barriers or baits (Schalau 2000). Abd-Rabou (1994, 1998) recorded seven parasitoid species associated with *S. phillyreae.* He reported *Encarsia inaron* (Walker) (Hymenoptera : Aphelinidae) as the only parasitoid attacks this insect in Upper Egypt. Abd-Rabou and Abou-Setta (1998) found that the *E. inaron* was the dominant parasitoid of *S. phillyreae* in Giza (Central Egypt) and Assiut (Upper Egypt), with average parasitism rates of 38 and 46.5% over the year, respectively. In Giza, total parasitism reached a maximum of 80% during August 1994, with *E. inaron* being responsible for 66.1%. In Assiut, parasitism peaked at 93.1% in August with *E. inaron* accounting for 78% of the total. Females of *E. inaron* lay their eggs into third and fourth instars and hatches from the whitefly "pupae", parasitizing and eventually killing it (Gould *et al.,* 1992).

Leaves began to appear on pomegranate trees on late-March or early of April and remained free of *S. phillyreae* infestation until the end of May. By early June, the different stages of the insect start to occur on the leaves until defoliation took place by late-November and December, therefore spraying trial conducted in June.

The exoskeleton (cuticle) of whiteflies is consists of protein and chitin. During the processes of ecdysis, the old cuticle is sheded and a new one is commonly grown. IGRs (antimoulting or juvenile hormone) interfer with the development of insects. Buprofezin interferes with the development of the insects exoskeleton. It is toxic to eggs and disrupts moulting of the immature stages of whiteflies and reducing the development of females and decrease their egg production (fecundity).

Pyriproxyfen is juvenile hormone mimic (JHM), thus causing wet and turn dark body for whiteflies. JHM determines the type of moult, if JHM is present then a moult will lead to a larval form. If it is absent, the larvae will pupate emerging to the adult form. In JHM inhibits fact metamorphosis into an adult from. JHM is also concerned with the regulation of reproduction in adults, especially females, raising the possibility of control insects by halting egg production in pests. When whiteflies are treated with JHM, immature stages (egg, nymphs, pupae) they fail to develop into mature adults (Hammock 1990).

The main objectives of this study were 1-Evaluating more than one group of pesticides to controlling this insect. 2- Augmentative release of *E. inaron* for controlling this pest. 3- Eliminating ants by using sticky material bands. 4- Pruning and sanitation to reduce infestation.

MATERIALS AND METHODS

1. Chemical control

- **Malathion 57% EC** (conventional toxicants).
- **Buprofezin (Applaud 25% SC)** (Antimoulting compound).
- **Pyriproxyfen (Admiral 10% EC)** (Juvenile hormone compound).
- **Mineral oil (Masrona 95% EC).**

In this experiment, whole trees were treated by different compounds compared with recommended material, Table 1. About 20 litre solution per tree were quite enough to insure complete coverage.

Table 1. Materials tested for *S. phillyreae* control.

No.	Treatment
A	Untreated
B	Spraying with mineral oil (Masrona) 2%.
C	Spraying with buprofezin 0.15 %.
D	Spraying with pyriproxyfen 0.15 %.
E	Spraying with malathion 0.2%.

2. Experimental design: Each spraying plot contained 16 trees (4 replicates/ each of four trees) and 16 trees were used as untreated check (control). The field trails were carried out in a private farm located in Assiut Governorate during 2000 growing season. The abundance of *S. phillyreae* was recorded from selected 30 leaves samples (within arms reach the lower canopy of each tree) (Pickett and Wall 2000). Sampled leaves were kept in paper bags and transferred to the laboratory for careful examination. Eggs, immature stages and pupae were counted under a stereomicroscope. Each leaf was stored in glass emergence tube and monitored daily for parasitoid emergence. Counting the adults of *S. phillyreae* and the parasitoids were done in the field. To avoid escape adults of *S. phillyreae* and the parasitoids, the leaves were counted very early in the morning. Pre-spraying counts were made just before spraying and the post-spraying counts were made weekly for three months.

3. Biological control

Mass rearing of *S. phillyreae* : Small pomegranate plants, about one year old, were grown in pots (30 cm diameter X 25 cm height). Every plant was kept under a chimney glass fixed in the pot with its upper opening covered with black muslin to reduce illumination inside. Emerged adults of *S. phillyreae* were collected from the infested pomegranate trees using an aspirator. The adults of *S. phillyreae* were then carefully introduced into the chimney glasses.

Mass rearing of *E. inaron* : *E. inaron* stages were reared under laboratory conditions (25 ± 2ºC and 60 ± 5% RH, on *S. phillyreae* survivors using the method described by Abd-Rabou (1994). Adults of *E. inaron* were collected by aspirator and transported from the field to pomegranate trees.

Release of *E. inaron* : The releasing plot size (one feddan) in a farm located in Assiut during 2000 season and also another plot size (one feddan) was selected for no-release (control). The pomegranate trees (El-Manfaloty), nearly of the same age (ca. 10 years) and size (height 6-7 m), were used for realising and non-realising treatments.

About 5000 adults of *E. inaron* were released monthly beginning from June to October 2000 i.e. total of 25,000 individuals. One day old parasitoids were released in the pomegranate field. The tube in which the wasps were delivered was opened in the centre of the tree and then taped or wedged in the infested tree with *S. phillyreae*. The tube was removed when all of the parasitoids found their way out (usually within few hours). The levels of parasites were determined each month. The trees have been free of insecticides for at least 8 weeks prior to releasing the parasitoids and no pesticides were applied during the study period.

Parasitism: The whitefly infestations and level of parasitism were estimated by simply counting live, dead and parasitized whiteflies per leaf. Each sample consists of 30 infested leaves. *S. phillyreae* eggs and crawlers were eliminated. Each leaf was stored in well glass emergence tube and monitored daily for parasitoid emergence.

4. Elimination of ants: Sticky-bands (produced by Neudorff Company, Germany) were used to prevent ants from climbing into infested trees, these bands were replaced by new one every month started from March to October.

5. Sanitation: Pruning was carried out in Mid-December 1999 to remove most of the infested shoots and branches. All pruned parts of the pomegranate trees were collected and burned directly after pruning. Also, the dropped leaves in winter were buried in deep holes then covered with sand or clay to enrich the soil with organic matter and to eliminate a source of infestation.

RESULTS AND DISCUSSION

1. Chemical control: The average pre-spraying numbers of adults, nymphs and eggs of *S. phillyreae* were 9.8-11.4, 31.2-38.1 and 38.3-44.2/leaf, respectively and the average numbers of mature and immature of *E. inaron* were 5.4-6.2 and 9.4-10.1/leaf, respectively, Table 3.

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

The data in Table 2 show that mineral oil (Masrona) gave 91.0% average reduction against eggs and killed the crawlers, while, gave 51.9% against nymphs and low effect against adults (18.4%). Masrona oil was moderately toxicity against mature stages of the parasitoid (28.1%), while was relatively toxic against its immature stages (61.8%).

Oils demonstrate both toxic and repellent effect on adult of whiteflies, thus preventing the emergence of adults from treated pupae. Lack of egg mortality from oil treatment was consistent with that observed by Sieburth *et al.,* (1998) with Sun spray-treated whiteflies eggs. They observed that larvae died in the process of emergence. They noted that death occurred in the emergence process inability to attach to treat surfaces. Sieburth *et al.,* (1998) were evaluated Ultra-Fine oil on nymphs of *Bemisia argentifolii.* Over 90% of those remained alive developed abnormally, remaining small and failing to moult into the next stage. Adults failed to emerge from approximately 94 to 99% of treated pupae.

The results in Table 2 indicated that the buprofezin and pyriproxyfen gave low toxicity against adults of *S. phillyreae*, they gave only 8.2 and 17.8%, respectively, while, they gave 94.1 and 88.6% average reduction against nymphs, respectively. IGRs also did not kill eggs immediately but very affected the crawlers. The direct effect on eggs gave only 15.2 and 17.2%, respectively. The two IGRs gave low toxicity against mature stages of *E. inaron* (12.5 and 21.1%, respectively), while gave moderate toxicity against its immature stages (42.5 and 57.4%, respectively).

Table 2. Effect of tested insecticides on the *S. phillyreae* and its parasitoid (*E. inaron*) / leaf during 2000 season.

Treatment	Rate of application /L.W.	Pre spraying count					Average number (six samples)					Average reduction% after three months (six samples)				
		Whitefly			Parasitoid		Whitefly			Parasitoid		Whitefly			Parasitoid	
		A	N	E	Ad	I	A	N	E	Ad	I	A	N	E	Ad	I
Masrona oil	20 ml	11.4	34.2	44.2	6.1	10.1	8.2	16.2	3.6	5.2	3.4	18.4	51.9	91.0	28.1	61.8
Buprofezin	1.5 ml	10.5	38.1	39.1	5.4	9.8	8.5	2.2	30.1	5.6	4.9	8.2	94.1	15.2	12.5	42.5
Pyriproxyfen	1.5 ml	10.9	36.1	38.3	6.2	9.6	7.9	4.1	28.8	5.8	3.6	17.8	88.6	17.2	21.1	57.4
Malathion	2 ml	9.8	31.2	40.1	5.9	9.4	0.4	0.6	32.2	0.1	0.1	95.4	98.0	11.6	98.6	98.8
Control	-	12.7	37.8	45.6	5.4	9.2	11.2	37.2	41.4	8.1	8.1	-	-	-	-	-

A = Adults N = Nymphs E= Eggs

Ad = Adults I= Immatures

According to John (1993) time of application is more important for IGRs. He suggested that early applications in population development was critical for optimal control. Accordingly, initial timing of application should be considered when the first instars (crawlers) appear on the crown leaves. Buprofezin gave good reduction against immature whiteflies, thus providing a long residual period against nymphs. In addition, provided the best fruits quality. Vapour activity however, provides a long residual period of control (John 1993).

In general, the present results were in harmony with that of Harshman (1996), who found that buprofezin and pyriproxyfen sterilized eggs of treated adults. Buprofezin prevents successful moulting at all nymphal stages, while only prevents adult emergence following the least nymphal stages. Adults of parasitoids and whiteflies were observed in more response to contact with residues of pyriproxyfen. IGRs provided the best control and activity against the early instars of *S. phillyreae*. In addition, buprofezin was to impact the egg laying of adult exposed to fresh residues. Results indicated that buprofezin acts by contact, inhalation or both.

The data in Table 2 indicate that malathion was very effective against adults and nymphs of *S. phillyreae* and also kill the parasite (*E. inaron*). Malathion is contact insecticide effects the nervous system, thus gave low effect (11.6%) against eggs. Malathion gave 95.4 and 98.0% reduction against the adults and nymphs of *S. phillyreae*, respectively. Malathion showed toxic effect against the parasitoid (over 98% average reduction), Table 2.

It could be concluded that good coverage of the foliage and underside of leaves with contact insecticide (malathion) is essential for best results against nymphs and adults of *S. phillyreae*. Immature whiteflies do not move, so the insecticide must reach them at their feeding sites.

IGR`s (buprofezin and pyriproxyfen) often control immature stages by affecting nymphal development, but do not provide good adult control. On the other hand, short residual contact insecticides may control adults, but not effect on egg hatch. Mineral oil controls the eggs and crawlers of this insect.

2. Biological control: The natural parasitism rate of *E. inaron* was 9.6 and 9.8% in the two selected plots (releasing and no-releasing ones). The rate of parasitism in realising plot increased gradually to reach 72.5% by the end of the season. The rate of parasitism in no-releasing plot increased slowly form 9.8% to reach 19.6% in the end of the season, Fig. 1.

E. inaron is an active parasitoid against *S. phillyreae* and requires repeated releases, therefore *E. inaron* was released every month. The black pupal case of the parasitoid causes *S. phillyreae* nymph to appear black after 10 days. *E. inaron* began to appear within 2 to 3 weeks after first release against *S. phillyreae.* The parasitoid pupa chews a round hole upon to escape from the body of the whitefly. In contrast, healthy whitefly adults push their way out of their pupal case, leaving a "T" shaped split in the whitefly remains. Parasitoids take approximately three weeks to develop from eggs to adults. The adults live two to three weeks, laying about 160 eggs each (Driestadt and Flint 1995).

Jetter *et al.,* (1997) found that *E. inaron* reduced ash whitefly population to undetectable levels. The best way to conserve the parasitoid is to avoid pesticide usage in or near trees where *E. inaron* is present. Thousand whitefly parasites were enough for a 1000 square feet in a greenhouse with a low level of infestation (few whiteflies per plant). In the rare case in which whitefly may reach high numbers, spraying the foliage repeatedly with water or a soap spray was recommended (Pickett *et al.,* 1996). Flint and Parrella (1992) found that releases of the parasitic wasp *Encarsia formosa* have been successful in controlling greenhouse whitefly.

For biological control to be successful, more selective or less persistent insecticides such as oils, soaps or abemctin must be used for control of other insects (Sieburth *et al.,* 1998).

Pickett and Pitcairn (1999) examined the dispersal ability of *E. inaron* by releasing two hundred and fifty adults into a single tree in a one ha pomegranate orchard. Based on yellow sticky card traps, they found that the adult population spreaded at least 45 m from the release tree within 9 weeks of release date. Over the same period, the parasitoid population increased 64 folds.

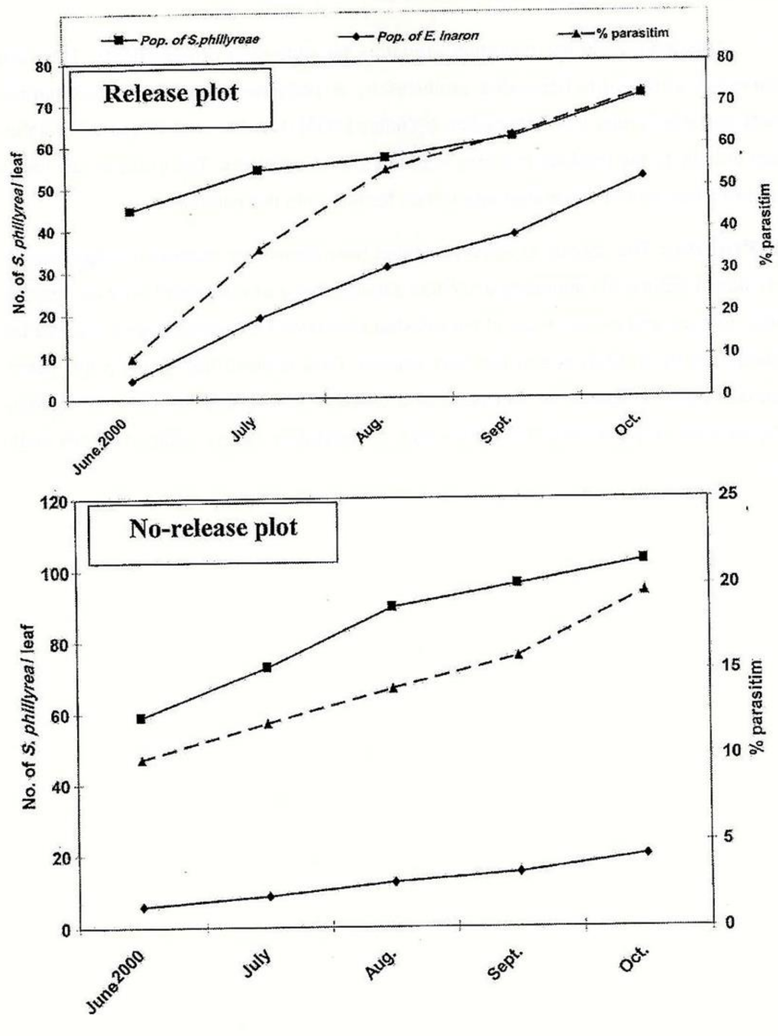

Fig. 1. No. of *S. phillyreae, E. inaron* and % parasitism on pomegranate trees during 2000 year.

3. Elimination of ants: The results showed that the sticky material bands prevented ants from climbing into infested trees.

Ants individuals are important predators for wide-rang of parasitoids. They are commonly attracted to honeydew produced by *S. phillyreae*. Ants may disturb parasitoids and discourage their oviposition (Schalau 2000). It is best not to apply the adhesive directly to the trunk as this may lead to bark rot problems. Tall grass or low hanging branches do not effort alternate routes for ants into the canopy.

4. Pruning: The canopy of heavily infested host plants can increase sunlight and air circulation around the immature whiteflies causing many of the pests to dry up and die. Also, remove and pruned most of the infested shoots and branches due to reduced the infestation by *S. phillyreae* in the next season. Data showed that pruning the pomegranate trees, collected pruned parts and dropped leaves and burned directly techniques were very practiced. More than 40% of infestation can be reduced by this method.

REFERENCES

1. Abd-Rabou, S. 1994. Taxonomic and biological studies on the parasites of whiteflies (Hemiptera : Aleyrodidae) in Egypt. Ph.D. Thesis, Fac. of Science, Cairo Univ.
2. Abd-Rabou, S. 1998. The efficacy of indigenous parasitoids in the biological control of *Siphoninus phillyreae* (Homoptera : Aleyrodidae) on pomegranate in Egypt. Pan-Pacific Entomologist, 74 (3): 169-173.
3. Abd-Rabou, S. and M. M. Abou-Setta. 1998. Parasitism of *Siphoninus phillyreae* (Homoptera : Aleyrodidae) by the Aphelinidae parasitoids at different locations in Egypt. J. HYM. Res., 7 (1): 57-61.
4. Driestadt, S. H. and F. L. Flint. 1995. Ash whitefly (Homoptera : Aleyrodidae) over-wintering and biological control by *Encarsia inaron* (Hymenoptera : Aphelinidae) in North California. Environ. Entomol., 24: 259-464.
5. Flint, M. L. and M. P. Parrella. 1992. Whiteflies in the greenhouse. http://www.ipm.ucdavis. edu/PMG/PESTNOTES/pn002.html.
6. Gould, J. R., T. S. Bellows and T. D. Paine. 1992. Evaluation of biological control of *Siphoninus phillyreae* (Haliday) by the parasitoid *Encarsia partenopea* (Walker) using life-table analysis. Biological Control, 2: 257-265.
7. Harshman, L. 1996. Impact of IGR`s on whiteflies and their natural enemies.http://www.ipm.ucdavis.edu/IPMPROJECT/1996/96biorational.html.
8. Hammock, B. D. 1990. Expression and effect of the juvenile hormone esterase in a baculovirus vector. Nature, 344: 458-461.
9. Jetter, K., Klonsky and C. H. Pickett. 1997. A cost/benefit analysis of the ash whitefly biological control program. J. Arboriculture, 23: 561-569.
10. John, C. P. 1993. Evaluation of insect growth regulators for management of whiteflies in melons. http://ag.arizona.edu/pubs /crops/az1101_5.html.

11. Pickett, C. H. and R. Wall. 2000. Long term evaluation of the ash whitefly parasitoid, *Encarsia inaron*. http://plant.cdfa.ca.gov. /biocontrol/reports/ 99annual/ 99A15.html.

12. Pickett, C. H. and M. J. Pitcairn. 1999. Classical biological control of ash whitefly: factors contributing to its success in California. Bio Control, 44: 143-158.

13. Pickett, C. H., J. C. Ball, K. C. Casanave, K. M. Klonsky, K. M. Jetter, L. G. Bezark and S. E. Schoenig. 1996. Establishment of the ash whitefly parasitoid, *Encarsia inaron* (Walker) ornamental street and its economic benefit to trees in California. Bio Control, 6: 260-272.

14. Priesner, H. and M. Hosny. 1932. Contributions to knowledge of whiteflies of Egypt. Bulletin Ministry of Agriculture, Egypt, 121, 8 pp.

15. Schalau, J. 2000. Managing whiteflies. http://ag.arizona.edu/yavapai /anr/hort/ byg/archive/ whiteflies. html.

16. Sieburth, P. L., W. J. Schoeder and R. T. Mayer. 1998. Effect of oil and oil-surfactant combinations on silver leaf whitefly nymphs (Homoptera : Aleyrodidae) on collard. Flora. Entomol., 81: 446-452.

تقييم بعض عناصر المكافحة المتكاملة لذبابة الرمان البيضاء في صعيد مصر

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لتقييم بعض عناصر المكافحة المتكاملة لذبابة الرمان البيضاء (سيفونينس فيليري) تم أجراء تجارب في محافظة أسيوط في سنة ٢٠٠٠ . فقد أعطي الزيت المعدني (مصرونا) ٩١٪ نسبة أباده ضد بيض حشرة ذبابة الرمان البيضاء حيث تسبب قتل الأعمار اليرقية الأولي (الحوريات المتحركة) بعد فقس البيض مباشرة بينما أعطي ٥١,٩٪ نسبة أباده ضد الأعمار غير الكاملة وأعطي ١٨,٤٪ ضد الأعمار الكاملة. كما أعطي نسبة أباده ضعيفة (٢٨,١٪) للأعمار غير الكاملة لطفيل (انكارسيا انارون) علي الجانب الآخر أعطي نسبة ابادة متوسطة (٦١,٨٪) ضد الأعمار الكاملة لهذا الطفيل.

منظما النمو الحشريان (بابروفيزين ، بيروبروكسيفين) لم يقتلا الأعمار الكاملة لذبابة الرمان البيضاء. فقط أعطيا نسبة ابادة (٨,٢ ، ١٧,٨٪) علي الترتيب. في حين أعطيا (٩٤,١ ، ٨٨,٦٪) ضد الأعمار غير الكاملة علي الترتيب. وهما لا يقتلان البيض مباشرة ولكن لهما فاعلية كبيرة بعد فقس البيض الي حوريات متحركة ، ولكن التأثير المباشر لهذان المبيدان كان (١٥,٢ ، ١٧,٢٪) علي الترتيب. كما أعطيا نسبة ابادة قليلة ضد الأعمار الكاملة لذبابة الرمان البيضاء (١٢,٥ ، ٢١,١٪) علي الترتيب بينما اعطيا نسبة ابادة متوسطة ضد الأعمار غير الكاملة (٤٢,٥، ٥٧,٤٪) علي الترتيب.

الملاثيون فعال ضد الأعمار غير الكاملة والأعمار الكاملة لذبابة الرمان البيضاء وكذلك ضد الطفيل. مبيد الملاثيون مبيد تأثيره بالملامسة ويؤثر علي الجهاز العصبي وكان تأثيرة علي بيض الذبابة قليل (١١,٦٪) علي الجانب الآخر فقد كان تأثيرة (٩٥,٤ ، ٩٨٪) علي الأعمار الكاملة وغير الكاملة لذبابة الرمان البيضاء . في حين كان تأثيره عالي ضد الطفيل (اكثر من ٩٨٪).

تم اطلاق حوالي ٢٥٠٠٠(خمسة وعشرون الف طفيل) بمعدل ٥٠٠٠ طفيل / شهريا بين شهري يونيو وأكتوبر. وقد كانت نسبة الطفيل الطبيعية قبل عملية الأطلاق (٩,٦٪) وقد ذادت نسبة التطفل تدريجيا حتي وصلت الي (٧٢,٥٪) في نهاية الموسم.

تم استخدام أشرطة لاصقة لمنع تسلق حشرات النمل الي الطفيليات لأن النمل يفترس هذه الطفيليات وقد منعت النمل فعلا من التسلق علي أشجار الرمان.

تم اجراء تقليم الأشجار وتم جمع نواتجه وكذلك الأوراق المتساقطة شتاء بما عليها من ذبابة بيضاء وتم دفنها في حفر عميقة أدي الي خفض تعداد الذباب بنسبة حوالي ٤٠٪ بالموسم التالي.