# MANIPULATION OF *LEPTOMASTIX DACTYLOPII* AND *CRYPTOLAEMUS MONTROUZIERI* FOR AUGMENTATIVE RELEASE FOR CONTROLLING THE CITRUS MEALYBUG *PLANOCOCCUS CITRI* ON CITRUS UNDER GREEN HOUSE CONDITIONS

**MANGOUD, A. A. H.**

*Plant Protection Research Institute, ARC, Egypt*

(Manuscript received 3 August 2005)

***Abstract***

Under green house conditions in Germany, the role of *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) and *Cryptolaemus montrouzieri* (Mulsant) (Coleoptera : Coccinellidae) to reduce the population of the citrus mealybug, *Planococcus citri* (Risso) (Homoptera : Pseudococcidae) on citrus trees were studied during 2001 year. Four plots were used. In the first plot (10 adults and 15 larvae/ tree) of *C. montrouzieri* were released on 1st June 2001. The percent reduction increased gradually from 0.7 in May (before release) to 74.0 % in October. At the same time, fifteen individuals of *L. dactylopii* were released in the second plot. The results indicated that the percent of parasitism gradually increased from 0.64 % (before release) in May to 35.7 % in October. In the third plot 10 adults and 15 larvae/tree of *C. montrouzieri* were released on the first of June 2001 and then *L. dactylopii* was released (August 2001). The percent reduction.of infestation and percent of parasitism were calculated. After released *C. montrouzieri,* the percent reduction of *P. citri* in released plot reached 34.5 %, in August. Followed by release of *L. dactylopii* in August. Percent of parasitism increased gradually to reach 98.1%.

## INTRODUCTON

The citrus mealybug, *Planococcus citri* (Risso) (Homoptera : Pseudococcidae) is one of the most common citrus pests. It has a pan tropical and subtropical region distribution. The citrus mealybug attacks citrus, cotton, vines, mango, banana and ornamental plants (Hill, 1983 & Baker, 1998). Each female usually lays from 200 to 600 eggs. Eggs are laid in-groups covered by ovisac threads. Eggs are covered by a dense, fluffy, white mass of wax called the ovisac; therefore, the mealybugs are not easy to be control by pesticides. Mealybugs damage plants by inserting their threadlike mouth parts into any part of the citrus plants and suck out sap. Mealybugs excrete honeydew. Sooty moulds often grow on the honeydew causing infested plants to turn black. The citrus mealybug has a toxin in its saliva, which causes its host plants to drop leaves and buds. Infested plants usually die unless this pest is controlled (Baker 1998). Heavy infestation causes fruit drop and reduces yields, but their greatest damage is caused by honeydew on fruit and leaves. Build up of honeydew and

associated sooty mould fungus leads to reduced fruit quality and lower trees vitality (Cartwith and Browning 1999).

The encyrtid parasitoid, *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) is a tiny parasitic wasp among many parasitoid species that attack the citrus mealybug, *P. citri*. *L. dactylopii* is a solitary endoparasitoid. It prefers to lay eggs in third instar nymphs and young adult stages of citrus melaybug. It occasionally attacks second instar, but not mature adults. Female can lay 60 to 100 eggs during its life cycle (Su and Li 1993, Lentern 1998 and Cloyed 1998b)

The ladybird beetle, *Cryptolaemus montrouzieri* (Mulsant) (Coleoptera : Coccinellidae) is a predator species of several citrus mealybugs (Mani *et al.,* 1997). Adult female beetles lay their eggs among the cottony egg sac of mealybug adult female. Adult beetles and young larvae feed on mealybug eggs and nymphs, while large larvae feed on all stages (Anonymous 2001).

The present work is an attempt to evaluate the efficiency of the encyrtid parasitoid, *L. dactylopii* and the ladybird beetle, *C. montrouzieri* on the population of the citrus mealybug, *P. citri* under green house conditions in Germany.

## MATERIALS AND METHODS

**1-Experimental design:**

The study was conducted on citrus trees under green house conditions ($25\pm5^{\circ}$C and $65\pm5$ R. H.) in Kassel University, Germany during 2001.

The citrus trees selected for the present investigation had never received any pesticides applications. The citrus trees were similar in size, age, shape, height and vegetation. They were actually heavy infested by the citrus mealybug. The trees aged about 12 years old, with about 4-4.5 meters in height.

Four citrus tree plots consist of 16 trees (4 replicates/each of four trees) were adopted. The first plot was used to study the effect of releasing the ladybird beetle, *C. montrouzieri* on the population of the pest. The second plot was used to study the effect of releasing *L. dactylopii*. The third plot was used to study the effect of releasing *C. montrouzieri* followed by *L. dactylopii*. The fourth plot was used as control (no-release).

In the first plot, the percent reduction of *P. citri* after releases was calculated according to equation of "Henderson and Tilton equation (1955)". Sample were taken monthly from June to October 2001.

In the second plot, number of the mealybug and rate of parasitism were estimated by simple counting live, dead and parasitized mealybugs per twig. Samples were taken monthly from June to October 2001.

In the third plot, the percent reduction of *P. citri* after release of *C. montrouzieri* was estimated. Samples were taken monthly from June to August 2001. As well, number of the mealybug and rate parasitism after release of *L. dactylopii* was also estimated. Samples were taken monthly from August to October 2001. Sample size was of 30 twigs was taken monthly.

**2-Rearing of *P. citri*:**

*P. citri* was reared under laboratory conditions (25 $\pm 2^{\circ}$C and 60 $\pm$ 5% R. H.) on potato sprouts. Potatoes were grown in pots (30 cm diameter X 25 cm height). Every potato plant was kept under a chimney glass fixed in the pot and covered with white muslin. The potted plants were irrigated and fertilized whenever necessary. The stock culture of *P. citri* was established by collected mealybug crawlers from the infested citrus trees using an aspirator and carefully transferred to the potatoes plants in the pots and kept in wooden cages (100x135x135 cm) with nylon gauze sides.

**3-Rearing of *C. montrouzieri*:**

*C. montrouzieri* stages were reared under the laboratory conditions (25$\pm$2$^{\circ}$C and 60$\pm$5% R. H.), on *P. citri* survivors, reared on potato sprouts. The source of *C. montrouzieri* was obtained from Katz Biotech Services Company, Germany. Adult and larval stages of *C. montrouzieri* were transferred to the infested potato sprouts grown in the pots and kept in the wooden cages. The adults and larvae of *C. montrouzieri* were collected by hand in plastic cage (10 cm length x 8 cm width x 2 cm height) with some pieces of papers and piece of rock wool containing sucrose for feeding and then transferred to the green house for releasing.

In the first plot, 10 adults and 15 larvae of *C. montrouzieri*/tree was released one time (June 2001) in the center of the tree.

**4-Rearing and release of *L. dactylopii*:**

*L. dactylopii* stages were reared under the same laboratory conditions mentioned before on *P. citri* survivors reared on potato sprouts. The source of *L. dactylopii* was obtained from the same Company. Adults of *L. dactylopii* were transferred to the infested potato sprouts grown in the pots and kept in the wooden cages. After establishing of the parasitoid culture, emerged adults of *L. dactylopii* were collected using an aspirator in a glass tube with a piece of rock wool containing sucrose for feeding and then transferred to the green house for releasing.

In the second plot, 15 individual (one-day-old parasitoids) of *L. dactylopii*/ citrus tree were released also one time by opening the tube in the center of the tree (June 2001).

**5-Releases of *C. montrouzieri* and *L. dactylopii*:**

In the third plot, 10 adults and 15 larvae of *C. montrouzieri* were released one time on 1st June 2001. After that, 15 individuals of *L. dactylopii* released also one time in 1st August 2001.

**6-Percent reduction in population by *C. montrouzieri*:**

The number of mealybug stages and number of predator individuals were estimated by simple counting of live, dead and percent reduction of mealybugs per twig.

**7-Rate of parasitism:**

The twig samples were dissected and stored in well-ventilated glass tubes for one week for emergence of the adult parasitoids. Rate of parasitism was estimated by simply counting live and dead mealybugs per twig and no. of emerged parasitoid adults.

$$\text{Percentage parasitism} = \frac{\text{No. parasitized}}{\text{Total (No. Parasitized + No. unparasitized)}} \times 100$$

**8-Elimination of ants:**

Sticky-bands (produced by Neudorff Company, Germany) were used to prevent ants from climbing into infested trees. The bands were replaced on tree trunk by new ones every month started from March to October.

## RESULTS AND DISCUSSION

The mealybugs are not easy to be controlled by pesticides because the eggs are enmeshed in the waxy fluff, which being difficult for the pesticide to get through to kill them (Baker, 1998). Thus, *L. dactylopii* and *C. montrouzieri* were used to reduce the population of citrus mealybug (Ortu and Marras 1999).

**1-Release of *C. montrouzieri*:**

Results in Fig. (1) indicated that the pre-count numbers of *P. citri* in releasing plot was 65.4 individuals/twig and decreased gradually after releasing 50.2, 44.5, 33.8, 22.6 and 16.9 individuals/twig in June, July, August, September and October, respectively compared with the control plot. The pre-count numbers of mealybugs in control plot was 61.2 individuals/twig and reached to 58.3, 56.8, 44.9, 45.8 and 43.6 individuals/twig, respectively. Also, the results show that the percent reduction of *P. citri* in the releasing plot increased gradually from 0.7 in the beginning of the trail to 7.0, 13.7, 26.3, 45.1 and 74.0%, respectively in the following five months. On the other hand, the population of *P. citri* in the control plot increased gradually from 0.49 in the beginning the trail to reach 6.7% after five months.

The results agreed with those obtained by Ortu and Marras, (1999). They found that *C. montrouzieri* were particularly efficient in controlling the mealybugs where insecticides did not easily penetrate.

**2-Release of *L. dactylopii*:**

The natural number of *L. dactylopii* before releasing was 0.38 and 0.41/tree, respectively in the two selected plots (release and no-release plots).

Results in Fig. (2) indicated that the pre-count number of *P. citri* in releasing plot was 59.3 individuals/twig then decreased gradually after releasing to 44.5, 36.2, 32.5, 39.1 and 23.5 individuals/twig in June, July, August, September and October, respectively compared with the control plot. The number of mealybug in control plot was 55.8 individuals/twig and the number reached to 64.5, 54.2, 50.6, 49.8 and 40.1 individuals/twig, respectively. Also, the results show that the percent reduction of *P. citri* in the releasing plot increased gradually, from 0.64 before releasing to 5.2, 10.2, 18.8, 26.3 and 35.7% in the following five months. On the other hand, the population of *P. citri* in control plot increased gradually from 0.73 in the beginning of the trail to reach 5.7% after five months.

These results agreed with those obtained by Cadee and Van Alphen (1997). They found *L. dactylopii* preference for the second class, but also attacked third and fourth size class and adult of the citrus mealybug, *P. citri*. Also, Cloyed, 1998a&b found *L. dactylopii* has excellent searching abilities and can locate low densities of mealybugs. While, Celallo *et al.* (1998) found ten species of hymenopteran parasitoids were used in reduced the population of the citrus mealybug, *P. citri* and also found, *L. dactylopii* was the most common species parasitoids attacking mealybug.

**3-Releases of *C. montrouzieri* followed by *L. dactylopii*:**

**a. Releases of *C. montrouzieri*:**

Before releasing the predator, the natural average number of adults and larval stages of *C. montrouzieri* were 0.59 and 0.72/tree, respectively in the two selected plots (release and non-release plots). Ten adults and fifteen larval stages of *C. montrouzieri* were released one time, in early June 2001.

Results in Fig. (3) indicated that the pre-count number of *P. citri* in releasing plot was 72.5 individuals/twig then decreased gradually after releasing to 51.2, 31.5 and 25.8 individuals/twig in June, July and August, respectively.

The number of mealybugs in the control plot was 68.2 and the reached 60.1, 55.3 and 49.2 individuals/twig in June, July and August, respectively. Also, the results show that the percent reduction of *P. citri* in releasing plot increased gradually from 0.59 in May and after releasing 8.2, 20.3 and 34.5%, respectively in the following three months. On the other hand, the percent reduction numbers of *P. citri* in the

control plot increased gradually from 0.87 in the beginning the trail to reach 1.9% after three months.

**b. Release of *L. dactylopii:***

After reducing the population numbers of *P. citri* by 34.5% using *C. montrouzieri* then fifteen individuals/tree of *L. dactylopii* were released in August.

Results in Fig. (3) indicated that the pre-count number of *P. citri* in release plot was 25.8 and decreased gradually after releasing 21.3, 16.2 and 5.2 individuals/twig in August, September and October, respectively. The pre-count number of mealybug in the control plot was 49.2 and the reach 51.3, 55.2 and 57.2 individuals/twig, respectively. Also, the results show that the percent reduction of *P. citri* in the release plot increased gradually, from 47.9 before releasing the parasitoid and after releasing the predator to 60.5 and 98.1% after three months. On the other hand, the percent reduction of *P. citri* in the control plot increased gradually from 2.3 in the beginning of the trial to reach 5.4% after three months.

Used in conjunction the Encyrtid parasitoid, *L. dactylopii* and the predator, ladybird beetle, *C. montrouzieri,* proved to be effective in reducing citrus mealybug, *P. citri* population. The beetle is most useful where mealybugs occur in large colonies and the wasp is more effective when mealybugs are scattered among the plants. This combination improved the efficacy of biological control agents of citrus mealybug, these results agreed with the findings of Cloyed (1998a).

In Israel, Mendel *et al.* (1998) found the possibility of managing *P. citri* populations in citrus plantations by inundative releases of predators and parasitoids such as *C. montrouzieri, Sympherobius sanctus, L. dactylopii* and *Anagyrus pseudococci.*

Although, *C. montrouzieri* is efficient against the mealybug pests, but these beetles can interfere with the parasitoid effectiveness because they feed also on parasitized mealybugs.

**4-Elimination of ants:**

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

Control ants is important because they can move mealybugs from one plant to another. Ants also protect mealybugs from predators and parasitoids (Cloyed, 1998b).

Ant individuals are important predators of a wide-range of parasitoids. They are commonly attracted to honeydew produced by *P. citri.* Damage is generally increased in severity when the citrus mealybug is associated with ants (DeLotto, 1964)

The results indicated that the conjunction between the predator, ladybird beetle, *C. montrouzieri* and Encyrtid parasitoid, *L. dactylopii* is good to reduce the population of the citrus mealybug, *P. citri.*

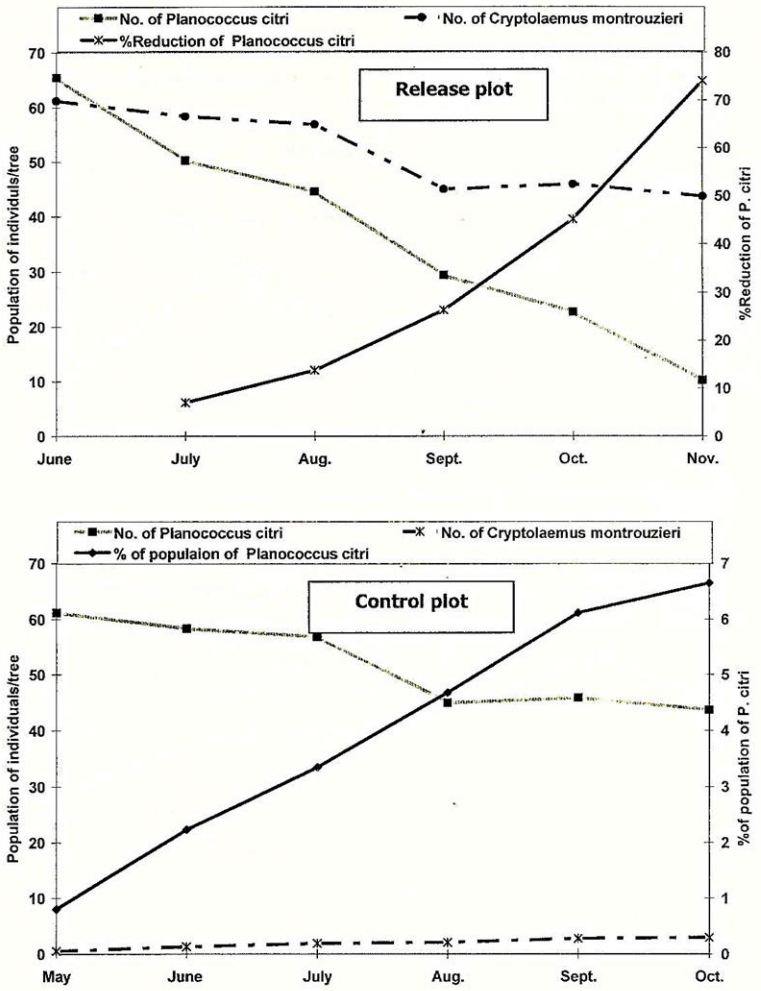


Fig. 1. Fluctuation in the population numbers of *P. citri* and *C. montrouzieri* in the release plot and %reduction of the mealybug on citrus trees under green house conditions in Germany during 2001 year.

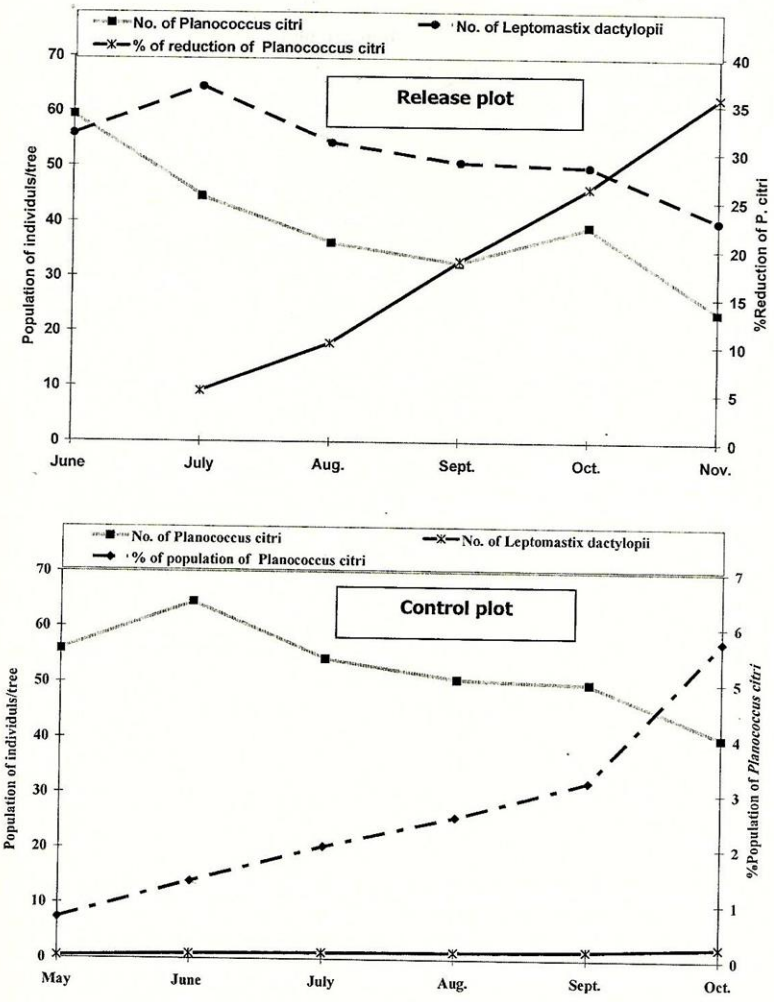


Fig. 2. Fluctuation in the population numbers of *P. citri* and *L. dactylopii* in the release and in control plot and %reduction of the mealybug on citrus trees under green house conditions in Germany during 2001 year.

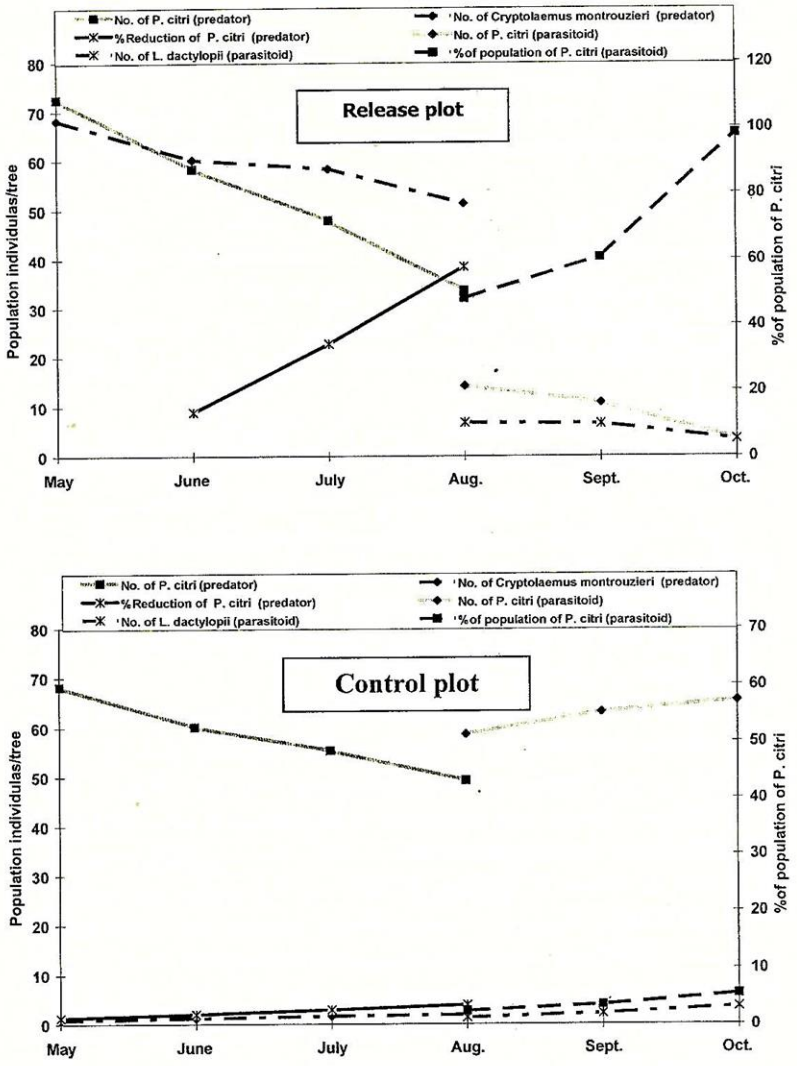


Fig. 3. Fluctuation in the population numbers of *P. citri*, *L. dactylopii* & *C. montrouzieri* in the release and in control plots and %reduction of the mealybug on citrus trees under green house conditions in Germany during 2001 year.

## REFERENCES


1. Anonymous, 2001. Mealybugs and their bio-control. http://www.flora.0unconn.edu/imp/scout comb.html.
2. Baker, J. R. 1998. Ornamental and turf insect note 19 (ENT/ort-019). http://www.ces.ncsu.edu/depts/ent/motes/Turf/flower_contents/orn_t19/not19.html.
3. Cadee, N. and J. J. M. Van Alphen. 1997. Host selection and sex allocation in *Leptomastidea abnormis* a parasitoid of the citrus mealybug, *Planococcus citri.* Entomologia Experimentlis et Applicata, 83 (3): 277-284.
4. Celallo, F. A., D. Papacek and G. H. Walter. 1998. Survey of mealybugs and their parasitoids in south-east Queensland citrus. Australian J. Entomol., 37 (3): 275-280.
5. Cloyed, R. 1998a. *Leptomastix dactylopii.* http:\\www.entomology. wisc. edu/mbcn/ky411.htm.
6. Cloyed, R. 1998b. Citrus mealybug management in greenhouses and interiorscapes.http:\\www.fao.org/bulletins/1998%bulletins/sept%2098 /09.htm.
7. DeLotto, G. 1964. Observations on African mealybugs (Hemiptera : Coccoidea). Bull. Br. Mus. Nat. Hist. Ent., 14 (8): 341-397.
8. Hendrson, C. F. and E. W. Tilton. 1955. Test with acaricides against the brown wheat mite. J. Econ Entomol., 48: 157-161.
9. Hill, D. S. 1983. *Planococcus citri* (Risso). pp. 217. In Agricultural Insect Pests of the Tropics and Their Control, 2nd Edition. Cambridge University Press, 746 pages.
10. Mani, M., V. J. Lakshmi and A. Krishnamoorthy. 1997. Side effects of some pesticides on the adult prey consumption of *Cryptolaemus montrouzieri* Mulsant (Coccinellidae : Coleoptera).Indian Journal of Plant Protection, 25 (1): 48-51.
11. Mendel, Z., S. Gross, S. Steinberg, M. Cohen and D. Blumberg. 1998. Trails to control the citrus mealybug in citrus orchards by inundative releases on natural enemies. VIIIth International Symposium on Scale Insect Studies, 41 pp.
12. Ortu, S. and P. Marras. 1999. Biological control of *Planococcus citri* (Risso) with *Leptomastix dactylopii* Howard for reducing insecticides use in citrus in Sardinian. http://www.ejb.org/ feedback/proceedings/05/ortuingl.html.
13. Su, T. H. and C. T. Li. 1993. Factors affecting the sex ratio of *Leptomastix dactylopii* Howard, a parasitoid of *Planococcus citri* (Risso). Chinese J. Entomol., 13: 319-330.

# دور طفيل اللبتومستيكس وكذلك مفترس الكربتوليمس في مكافحة بق الموالح الدقيقي علي أشجار الموالح تحت ظروف الصوب الزراعية

**أشرف عبد السلام هندي منجود**

*معهد بحوث وقاية النباتات- مركز البحوث الزراعية- الدقي-الجيزة .*

تم أجراء ثلاث تجارب لخفض تعداد بق الموالح الدقيقي *Planococcus citri* بإستخدام الطفيل *Leptomastix dactylopii* وباستخدام المفترس *Cryptolaemus montrouzieri* علي أشجار الموالح تحت ظروف الصوبة الزجاجية في مدينة فتزنهاوزن بجمهورية المانيا. تم تصميم التجارب الثلاث : ففي التجربة الأولي تم اطلاق مفترس *C. montrouzieri* بمعدل ١٠ فرد كامل و ١٥ يرقة/شجرة في بداية شهر يونية ٢٠٠١ بمفرده لدراسة تأثيره علي خفض تعداد بق الموالح الدقيق. وقد أتضح من النتائج أن إطلاق المفترس أعطي نتائج جيدة حيث أدي الي خفض تعداد بق الموالح الدقيقي بنسبة ٧,٠، ١٣,٧، ٢٦,٣، ٤٥,١ ، ٧٤,٠% في أشهر يونية ، يوليو ، أغسطس ، سبتمبر و أكتوبر علي الترتيب. أما في التجربة الثانية فقد تم اطلاق ١٥ فرد/شجرة من طفيل *L. dactylopii* في بداية شهر يونيو٢٠٠١ بمفرده لدراسة تأثيره علي خفض تعداد بق الموالح الدقيق. وقد أتضح من النتائج أن اطلاق الطفيل أعطي نتائج غير جيدة حيث أن الطفيل لا يعمل جيدا في التعداد العالي. فقد أدي الي خفض تعداد بق الموالح الدقيقي بنسبة ٥,٢، ١٠,٢، ١٨,٨، ٢٦,٣ ، ٣٥,٧% في أشهر يونية، يوليو ، أغسطس ، سبتمبر و أكتوبر علي الترتيب. بينما في التجربة الثالثة فقد تم اطلاق مفترس *C. montrouzieri* في بداية التجربة (بداية شهر يونية ٢٠٠١) ثم بعد ذلك تم اطلاق طفيل *L. dactylopii* في شهر أغسطس. فقد أوضحت النتائج أن مفترس الكربتوليمس أعطي خفض في التعداد بنسبة ٨,٢ ، ٢٠,٣ ، ٣٤,٥% في أشهر يونية ، يولية وأغسطس علي التوالي وتلاه اطلاق الطفيل حيث أعطي نسبة تطفل وصلت الي ٩٨,١% في نهاية التجربة. أوضحت النتائج أن عملية الأطلاق المزدوجة لمفترس *C. montrouzieri* لخفض تعداد البق الدقيق في البداية ثم طفيل *L. dactylopii* أعطي نتائج ممتازة لمكافحة بق الموالح الدقيقي علي الموالح تحت ظروف الصوب الزراعية. كما أتضح من النتائج أن مكافحة النمل من الوسائل الهامة التي تساعد الطفيليات والمفترسات علي اداء عملها حيث يتغذي النمل علي الندوة العسلية التي يفرزها البق الدقيقي مما يؤثر علي دور الأعداء الحيوية.