SUMMARY AND CONCLUSIONS

These studies on the integrated control of the citrus leaf miner *Phyllocnistis citrella* Stainton were carried out in Citrus Orchards in Qalubia Governorate, during two successive seasons. It is aimed by the present study to explore all practices which may be minimize the population of the citrus leaf miner (CLM). Each factor was tested alone and finally the suitable of it were chosen in integrated programme depending on the activity of factors to control *P. citrella*. Citrus fruits considered the most important fruits in Egypt either for export or local consumption. The area of cultivated fruits in Egypt ranged between 950,000 to 1000,000 feddan, 40% percentage of this area citrus orchards. The citrus leaf miner is the most important pest which attack the citrus orchards. In this experiment, samples of 20 leaves/ each were weekly collected from each experimental unit .Larvae and pupae and also the infestation rate with CLM was calculated to evaluate the effect of different factors and the ability to introduce it in integrated control program to citrus leaf miner. The evaluated control methods were tested in relation to citrus leaf miner (CLM, *P. citrella*) infestation to mature navel orange (*Citrus sinensis*) and sour orange trees and seedlings (*C. aurantium*). The majority of new leaves in spring were never infested but that in summer and autumn were highly infested with this respect pest. The obtained results are, briefly summarized in the following:

1. Chemical control:

Three chemical treatments (Vertimec + KZ oil, Confidor and Admiral) were tested against *P. citrella* with two concentration (recommended and half-recommended). The results of the efficacy of tested compound revealed that Vertimec + KZ oil with recommended and half-recommended concentrations gave the best results to control the citrus leaf miner. The mean reduction rate was 75.26% and

67.99% and the residual effect was the longest (21 days) within all other treatments. Confidor with recommended and half-recommended concentration was less effective than Vertimec + KZ oil with the mean reduction rate was 63.82% and 50.82%. While, Admiral with two concentrations have lower effectiveness than Vertimec and Confidor. Admiral with two concentrations caused 32.52% and 29.61%. reduction in larvae and pupae population . So Vertimec + KZ oil gave the best results to control citrus leaf miner with residual effect was the longest within all insecticides (21 days). Then Vertimec + KZ oil was the most effective against citrus leaf miner resulting in 100% reduction to larval and pupal population in comparison with the control after 30 days form application, so it can be recommended to spray Vertimec + KZ oil with recommended or half-recommended.

2. Biological control:

This course of investigation was carried out during the period from 11 September 2003 to December 4th 2003, in citrus orchard (sour orange) in Qalubia Governorate, by release the parasitoid *Cirrospilus quadristriatus* with two rate 8 and 12 parasitoid individuals per replicate. Twenty newly emerged leaves were randomly picked up weekly from each replicate. Larvae, pupae and calculate the infestation rate. Percentage of parasitism was recorded by exam 50 stage of *P. citrella* (larvae and pupae).

2.1. Study the infestation rate:

The above mentioned results on the efficacy of release parasitoid *C. quadristriatus* with two rate 8, 12 parasitoid individuals and control (without release) revealed that, the differences between treatments were low significant. The annual average of infestation rate with *P. citrella* in both release 8 and 12 parasitoids recorded 68.68% and 68.80%, respectively, but in control it was 74.2%. So, the differences in infestation rate between treatments was simple because the shoots of sour orange in treatments were preferable and susceptible to attack

with more insect adults females of *P. citrella* which may deposit their eggs on the leaves of treatments by flying moths.

2.2. Larvae and pupae population:

Weekly samples were picked up form each treatments to record the number of larvae and pupae, there was low difference in numbers of CLM of larvae and pupae between 8 & 12 released parasitoid and control. The annual average of number of *P. citrella* in 8 and 12 parasitoids and control (without release) was 28.29, 26.75 and 30.53 stage of *P. citrella*, respectively.

2.3. The percentage of parasitism:

The obtained results showed highly significant and positively differences in the percentage of parasitism of *P. citrella* between treatments. In the case of release 8 parasitoids the % of parasitism increased to (20.6%) parasitism after one week of release and the highest percentage of parasitism was 35.3% recorded at October 23rd. But in the rate of 12 parasitoids was percentage of parasitism 24.6% after one week of release. After six weeks at October 23rd, the percentage of parasitism was 57.3%, however, after seven weeks of release it become 61.3% at the end of October. The highest percentage of parasitism reached 70% at November 13th. But in control the role of natural enemies was lower during the same period, the highest percentage of parasitism 30% at the same date(13th November). The annual average for 8 and 12 parasitoids and control (without release) was 23.57%, 41.40% and 14.05% percentage of parasitism, respectively. So, the above mentioned results revealed that the release of 12 parasitoid individuals gave the best results of percentage of parasitism.

3. Agricultural control:

This course of investigation was carried out during two successive years 2002-2003 and 2003-2004 by using two kinds of fertilization, nitrogen (N) and potassium (K). Weekly sample (20 leaves) were picked up from each replicate of Navel orange orchard in Qalubia Governorate, to explore the effect of different levels of fertilization, in reducing the infestation and larvae & pupae population of CLM.

3.1. The first season:

This experiment was carried out during 2002-2003 to evaluate the effect of nitrogen and potassium fertilization.

3.1.1. The infestation rate:

The results showed that nitrogen fertilization led to produce more shoots and terminal leaves which concerned with highly attraction for citrus leaf miner. But the using of potassium fertilization led to tissue toughness and may be, sometimes, limits citrus leaf miner mobility and feeding.

3.1.2. The total number larvae and pupae:

Also, the using of nitrogen led to more number of larvae and pupae which was infested leaves of citrus Navel orange, but using potassium fertilization led to the decrease the number of larvae and pupae. So it can be recommended not used high level of nitrogen fertilization during summer and autumn season, because it using led to high number of larvae and pupae, also increase the infestation rate. Also, it can be recommended to use the second level of potassium fertilization (100 kg/fed.) depending on lowest of number larvae with pupae and infestation rate.

3.2. The second season:

3.2.1. The infestation rate:

Statistical analysis showed highly significantly difference between the treatment with recommended dose of nitrogen with double recommended dose of potassium fertilization (500 kg nitrogen + 400 kg potassium per feddan) which showed highly level of infestation and double of recommended dose of nitrogen with recommended of potassium fertilization (1000 kg nitrogen + 200 kg potassium/fed.) which caused lower level of infestation with *P. citrella*.

3.2.2. The total number of larvae and pupae:

The obtained results indicated that the population of citrus leaf miner larvae and pupae occurred in non significant difference under the treatment of fertilization.

4. Natural control:

This course of investigation was carried out during two successive years 2002-2003 and 2003-2004 in two citrus orchards one treated with insecticides and another was untreated to explore the role of natural enemies in reducing the population of the citrus leaf miner.

4.1. The first year:

4.1.1. Study of percentage of parasitism:

The obtained results during the first year in the treated orchards indicated that the high % of parasitism either in treated orchard or untreated was recorded during the period form the mid. Of July to the mid. of October where it was 28% and 36% in treated and untreated respectively with insecticides and another the untreated one indicated that the high percentage was recorded during the period form mid-July and the mid-October. So it can be seen there was obvious effect in the

reducing percentage of parasitism to *P. citrella* due to the use of insecticides in the treated orchard.

4.1.2. The predation rate:

The highest two peaks of predation rate was recorded during the mid-July and the end of October in the treated orchard with insecticides recording 34% and 38% predation rate, respectively. But in the untreated orchard the highest predation rate was occurred at the end of June and the end of September showing 52% and 64%, respectively. It can conclude that the role of predators untreated orchard with insecticides was the higher than in the treated one . Also, the percentage of predation was high than the percentage of parasitism.

4.2. The second year:

4.2.1. The percentage of parasitism:

The percentage of parasitism showed in a treated orchard was recorded two peaks occurred during the mid-July and the end of September with 34% and 24% percentage of parasitism, respectively. While an untreated orchard it was occurred during the mid-July and the mid-October recording 36% and 52%, respectively. So, it can be said that the role of parasitoids was higher in an untreated orchard than in that treated orchard because the use of insecticides decreases the number of parasitoids.

4.2.2. The predation rate:

The role of predators in a treated orchard appeared in two peaks of predation in the mid. of July and at the end of October which was 46% and 32% predation rate, respectively. But it was in untreated orchard in the mid. of July and in the mid. of September recording 50% predation in two peaks. So it can be said that there was visible role predators in untreated orchard with insecticides higher than the treated orchard.

5. Mechanical control:

5.1. Study the effect of pruning:

The first season was occurred from January 2002 to January 2003. Five peaks of infestation rate were recorded in both oppress pruning and moderately pruning.The highest peak in oppress pruning was recorded during the period from the 21st to 13th September, showing 100% infestation. While the highest peak of infestation in moderately pruning was occurred from the end of June to the end of the second week of September which it was about 100% infestation. generally the infestation rate was high in the case of oppress pruning than it in moderately pruning because the oppress pruning in citrus trees led to produce high number of shoots and terminal leaves which was highly susceptible (the most preferred) to citrus leaf miner *P. citrella* in summer and autumn seasons. As for the mean number of larvae and pupae of citrus leaf miner during the same year it recorded six peaks in the oppress pruning the highest one was recorded in the beginning of the third week of September recording 36.3 individual /20 leaves (sample). While, in the moderately pruning only five peaks recorded during the same period, and the highest one was 34 individual/20 leaves at the end of the second week of September.

5.1.2. The second season:

This experiment of investigation was carried out during 2003-2004 in navel orange orchard in Qalubia Governorate. Also six peaks appeared in oppress pruning, but the highest one was occurred at the end of the second week of June (about 96.6%/20 leaves). While in the trees appeased to moderately pruning six peaks, of infestation rate were recorded with highest one at the second week of July (about 56.6% infestation/20 leaves). Also, the total number of larvae and pupae go in the same trend from the side of peaks number and the time of appearance (five peaks and the highest was the end of the second week of June) (about 30.2 stage/20 leaves). While, it was recorded in moderately pruning the number of larvae and pupae peaks

were about five peak, with the highest number of larvae and pupae appeased at the second week of July (14.3 stage/20 leaves). So, it may conclude that the oppress pruning led to produce more newly emerged shoots and terminal leaves which it was highly susceptible to infested by citrus leaf miner, and subsequently increase in high level of infestation and numbers of larvae and pupae.

5.2. Effect of light:

This experiment was carried out during one year from April 2003 to April 2004 on the newly, grown sour orange seedlings. The obtained data showed four peaks of infestation rate in the under light seedlings, and the highest peak appeared at the end of the third week of September (48.3% /20 leaves). Also, in the treatment without light seedlings five peaks were recorded, with the highest peaks at the end of the third week of September. As for the total numbers of larvae and pupae four peaks were registrated in under light seedlings, and the highest numbers appeared at the end of the third week of September (9.6 stage/20 leaves). While, in without light, seedlings treatments six peaks were recorded, with the highest peak (7.6 stage/20 leaves), during the end of the third week of September. So it can be said the infestation rate and total number of larvae and pupae were high in the without light seedlings than the under light seedlings, also the infestation rate started early in without light treatment than in the under light seedlings.

6.Trial of using IPM program:

Evaluation of each control agents separately, it was aerial to use group of these agents in integrated program, depending on the efficacy of factors on the citrus leaf miner. So, the IPM program comprised chemical control by using Vertimec 25 cm^3 + 250 cm^3 KZ oil per 100 Liters water and biological control by release parasitoids of *C. quadristriatus* after the end of the residual effect of using chemical

control. This experiment was carried out during the period from the 23rd June to the 15th September. Results obtained showed highly significantly difference in infestation rate and number of larvae and pupae between IMP program treatment and control. Also, this program may be used twice during the season depending on the population of *P. citronella*.

CONCLUSIONS

This investigation was conducted in Qalubia Governorate, during two successive seasons 2002-2003 and 2003-2004. Results obtained may be concluded in the followings :

1- The infestation rate of *P. citrella* appeared during the period from the mid-May to the first of December in old trees, also the high level of population of *P. citrella* was in summer and autumn seasons but in spring the citrus orchard never infested with citrus leaf miner(75% of total shoots in all the year). Only the newly shoots and terminal leaves in summer and autumn (25% of total shoots in all the year) harbored the highest level of infestation rate of *P. citrella*.

2- The application of Vertimec 1.8% (Abamectin) + KZ oil with two concentrations recommended 25 cm^3 Vertimec + 250 cm^3 KZ oil/100 L. water and half concentration achieved good results.

3- The release of the parasitoid *C. quadristriatus* gave good results, but the release must be repeated every six weeks to keep the balance between the pest and the parasitoid.

4- Potassium fertilization led to tissue toughness and limit mobility and feeding the citrus leaf miner, but the nitrogen fertilization led to increase numbers of newly shoots and leaves which was highly susceptible in summer and autumn seasons.

5- The oppress pruning led to the tree produce more shoots in summer and autumn. So this shoots was highly infested with CLM. Hence it can be recommended that must be avoid the oppress pruning in old trees.

6-A trial of preparing IPM program gave promising trend to reduce the infestation rate with citrus leaf miner and at the same time led to decrease in the chemical control and subsequently minimize the environmental pollution.