IMPACTS OF PYRIPROXYFEN ON THE EFFICACY OF *ENCARSIA INARON* WALKER (HYM: APHELINIDAE) ON CONTROL OF *TRIALEURODES VAPORARIORUM* WESTWOOD (HOM.: ALEYRODIDAE)

Seyed Ali Hoseini* and Ali Asghar Pourmirza*

* Department of Plant Protection, Urmia University, Urmia, IRAN. E-mail: hoseini_s_a@yahoo.com

[Hoseini, S. A. & Pourmirza, A. A. 2010. Impacts of pyriproxyfen on the efficacy of *Encarsia inaron* Walker (Hym: Aphelinidae) on control of *Trialeurodes vaporariorum* Westwood (Hom: Aleyrodidae). Munis Entomology & Zoology, 5, suppl.: 1119-1124**]**

ABSTRACT: This study attempts to establish the combined effect of *Encarsia inaron* in junction with pyriproxyfen against *Trialeurodes vaporariorum* under greenhouse conditions. In the present study, we have found pyriproxyfen to be compatible with *E. inaron* in the control of the greenhouse whitefly. Whitefly mortality in the presence of the parasitoid was 93.9%, significantly higher than the mortality in the control group (37.2%). A non-significant difference between pyriproxyfen versus *E. inaron* performance was detected. Pyriproxyfen showed a negligible negative impact on the parasitism rates of *E. inaron*. It could be concluded that the biological control is being used as a complement to, rather than a substitute for, chemical control.

KEY WORDS: *Encarsia inaron, Trialeurodes vaporariorum,* pyriproxyfen, parasitism.

In spite of the conspicuous use of insecticides and natural enemies as whitefly control agents, there is a relative dearth of the impact of combined employment of either factor on suppression of whitefly densities. This study attempts to fill this arena by establishing the combined effect of the natural enemy in junction with an insecticide.

T. vaporariorum Westwood, is an economically important pest of various greenhouse vegetables, particularly tomatoes, and cucumbers, as well as ornamentals. This insect is now well established in the greenhouse ecosystems. Very often, control *T. vaporariorum* is mostly based on the application of insecticides, but whiteflies are resistant to many of the chemicals used. *E. inaron* Walker is one of the most important natural enemies of different whiteflies (Gould et al., 1995; Slobodyanyuk et al., 1993).

There is substantial evidence of whitefly parasitoids activity post application of some insecticides (Gerling, 1996; Gerling & Naranjo, 1998; Simmons & Jackson, 2000). One possible explanation for surviving of parasitoids could be the compatibility characteristics of compound used for suppression of the whiteflies with natural enemies. There is ample evidence that the integration of beneficial natural enemies with selective insecticides for IPM relies heavily upon the validity of the available information on the impacts of insecticides on the natural enemies (Hull & Beers, 1985; Hassan, 1992, 1994).

In order to establish such a notion, some scholars have employed the combination of more environmentally compatible insecticides and parasitoids to control whitefly populations under different conditions. For instance, Birnie and Denholm (1992) explored the capability of *E. mundus* to control *Bemisia tabaci* populations on cotton with the application of permethrin, showing the ability of the parasitoid population to recover after only one application of the compound. Devine et al. (2000) revealed the potential of piperonyl butoxide to improve the level of *E.*

mundus parasitism on *B. tabaci*, by slowing the development of the whitefly, increasing the parasitism in the treated whitefly population by 7–8%. Likewise, Van Driesche et al. (2001) demonstrated the possibility of using an insect growth regulator (buprofezin) in combination with *Eretmocerus eremicus* Rose and Zolnerowich to control *T. vaporariorum* and *B. tabaci* in poinsettias in commercial greenhouses.

Novel bio-rational insecticides owing to environmentally compatible features are rapidly replacing more toxic, broad-spectrum compounds to control pests of ornamental plants. These new formulations are widely regarded as safe, effective, and environmentally sound with minimal hazardous impact on non-target organisms. We used pyriproxyfen as a bio-rational insecticide, which is currently used in Iran to control different whiteflies populations under greenhouse conditions.

The goals of this study were to test the possible compatibility of pyriproxyfen with *E. inaron* in suppression of *T. vaporariorum* populations and to elucidate the level of control.

MATERIAL AND METHODS

In this experiment pyriproxyfen, was tested to determine its effect on the parasitism capability of *E. inaron* in the control of *T. vaporariorum*, using a greenhouse cage evaluation. A colony of *T. vaporariorum* was initiated from adults collected in the West Azerbaijan province (northwest of Iran), from tomato and ornamental plants, and kept in rearing room, on tobacco plants. Adults of *E. inaron* were collected in this region too, on weeds, and reared on tobacco plants, which were infested with *T. vaporariorum* nymphs. The rearing room was kept at 26 ± 2˚C with a photoperiod of 16:8 (Light: Dark) over the experiments.

The experimental design included two levels (presence and absence) of two factors (parasitoid and insecticide). There were, therefore, four treatments: (1) application of pyriproxyfen, (2) application of pyriproxyfen and introduction of *E. inaron*, (3) introduction of *E. inaron*, and (4) no application of pyriproxyfen and no introduction of *E. inaron* (control). Each treatment was replicated five times, using one bean plant per treatment and replicate, making a total of 20 plants. The plants were infested with *T. vaporariorum* adults in the rearing room, allowed to lay eggs for 3 days on leaves and then removed. The plants were kept in the rearing room and, after 10 days, first and second instars whitefly nymphs were present on the leaves. The number of nymphs per leaf ranged from 180 to 240. Plants were then maintained in a greenhouse inside a transparent construct covered with organdy for the rest of the experiment. Pyriproxyfen was sprayed at a rate of 0.05 g a.i. /liter in treatments (1) and (2). It was applied two times; 1day after the plants had been put in the greenhouse and 10 days later.

E. inaron was introduced before application of the insecticide, in treatments (2) and (3) at a total rate of 12 to 18 females per replicate, following the recommended ratio proposed by Jones et al. (1999). Adult parasitoids were placed in the cages in two separate introductions, beginning on the first day that the plants were put in the greenhouse and 8 days later.

Plants were evaluated every 3-4 day during the first week and then weekly until all the adults of *T. vaporariorum* and *E. inaron* emerged. The number of living whitefly nymphs and pupae, the number of parasitized whitefly nymphs and parasitoid pupae, and the number of pupal cases from where an adult (whitefly or parasitoid) had emerged was a counted. This experiment included only one generation of the whitefly *T. vaporariorum* and the parasitoid *E. inaron*.

Analysis of variance was performed on mortality and parasitism (Statistical Graphics Corporation 1999), with the transformation of Z = arcsine$\sqrt{X}$; where X is mortality or parasitism. Analysis of variance (ANOVA) was used to analyze mortality data of last day in the experiment. Mortality data means was separated with Turkey's HSD test at 95% confidence level. The T-test was performed to compare mean of parasitism percentages.

RESULTS

The percentage mortality of *T. vaporariorum* nymphs treated with pyriproxyfen was significantly higher than untreated control cohorts (F = 18, 6; df = 3; P = 0.002). As expected, the introduction of the parasitoid after application of pyriproxyfen, produced a major influence on whitefly reduction. For instance, the addition of *E. inaron* significantly increased the mortality rate of *T. vaporariorum* nymphs. There was a non-significant difference between the mortality of the whitefly immature life stages, which were subjected by either insecticide or parasitoid treatment. The highest mortality (93.9%) of whitefly was observed with the introduction of *E. inaron* in conjunction with pyriproxyfen (Fig. 1). The application of pyriproxyfen or *E. inaron* solely against whitefly caused 78.9 and 71.3% mortality, respectively. The natural mortality of the whiteflies was 37.2% under test conditions.

The percentage parasitism of *E. inaron* in junction with pyriperoxyfen was marginally higher than application of pyriproxyfen followed by the introduction of *E. inaron* (Fig. 2). This was also illustrated in (Fig.1), which was discussed previously. These parasitism rates, however, did not differ significantly at the end of the assay. (T = 1.86; df = 4; P = 0.135).

DISCUSSION

The results obtained from the experiment revealed that the application of pyriproxyfen and introduction of the parasitoid wasp caused a significant effect on the control of *T. vaporariorum*. Furthermore, the salient result of this trial was that the simultaneous application of pyriproxyfen and *E. inaron* led to the highest mortality rate of the whitefly. Gonzalez-Zamora et al. (2004) employed *Eretmocerus mundus* and oxamyl concurrently and separately to control *Bemisia tabaci* as the procedure we employed in this study. According to their findings, no interaction was detected between the two factors in question. Furthermore, they found that *E. mundus* caused the highest mortality. The combined impact of insecticides and whitefly parasitoids was also studied by Helyer et al. (1984) using *E. formosa* to control *T. vaporiarorum* on tomato. The significant high whitefly mortality in the application of insecticide together with parasitoid might be due to low toxicity, if any, of pyriproxyfen on *E. inaron*. A similar pattern has been found with this insecticide, tested on different populations of whitefly parasitoids. For instance, Heidari et al. (2006) found that pyriproxyfen reduced adult emergence of *E. formosa* only by 27.5%, and it had no mortality effects on the adult stage of the parasitoid. Similar results have been also observed in some other cases; Medina et al. (2003) argued that pyriproxyfen is non-toxic or harmless to the penultimate and ultimate larval stages and adults of the green lacewing, *Chrysoperla carnea*. Likewise, in the case of the predatory bugs, *Orius* spp., pyriproxyfen had a negligible impact on adult female oviposition capability and on egg's vigour and viability has been reported (Nagai, 1990).

In the current study, a non-significant difference between parasitism percentage in presence and absence of pyriproxyfen implies that this insecticide poses some characteristics, which are not harmful on foraging and parasitism behaviour of adult wasps.

Very often, priori experience implies that mortality data of the whitefly by itself cannot show the fate of the population dynamism, because the experiment only included one generation of the whitefly and parasitoid. To obtain a comprehensive profile, several authors (Birnie and Denholm, 1992; Simmons and Minkenberg, 1994; Goolsby et al., 1998; Heinz and Parrella, 1998) have been attempted to show the ability of some parasitoid species, to control whitefly populations in extended laboratory and semi-field assays. These authors maintained whiteflies in cages and released adult parasitoids, albeit in different proportions than in the present work, and generally for more than one generation with promising results. They argued that the beneficial impact of parasitoid in suppression of whitefly density can be fairly uncontroversial. With retrospect, the chief point that can be gleaned from foregoing discussion is that the results of current research were in line with findings of recently mentioned scholars. By and large, however, the level of control of whitefly populations obtained in proceeding assays solely with natural enemy treatment could not be acceptable by growers. Nevertheless, the enhanced control level can always be considered a valuable tool in the framework of integrated pest management programs preventing the pest outbreak, enhancing the effectiveness of other management strategies, reducing doses and cost for their application.

LITERATURE CITED

Birnie, L. C. & Denholm, I. 1992. A novel approach to evaluating the impact of pesticides on beneficial arthropods in the laboratory. Aspect. Appl. Bio., 31: 105–112.

Devine, G. J., Wright, D. J. & Denholm I. 2000. A parasitic wasp (*Eretmocerus mundus* Mercet) can exploit chemically induced delays in the development rates of its whitefly host (*Bemisia tabaci* Genn.). Biological control, 19: 64–75.

Gerling, D. 1996. Status of *Bemisia tabaci* in the Mediterranean countries: opportunities for biological control. Biological control, 6: 11–22.

Gerling, D. & Naranjo, S. E. 1998. The effects of insecticide treatments in cotton fields on the levels of parasitism of *Bemisia tabaci* (Gennadius) s.l. Biological control, 12: 33–41.

Gonzalez-Zamora, J. E., Leira, D., Bellido, M. J. & Avilla, C. 2004. Evaluation of the effect of different insecticides on the survival and capacity of *Eretmocerus mundus* Mercet to control *Bemisia tabaci* (Gennadius) populations . Crop protection, 23: 611–618.

Goolsby, J., Ciomperlink, M. A., Legaspi, B. C., Legaspi, J. C. & Wendel, L. E. 1998. Laboratory and field evaluation of exotic parasitoids of *Bemisia tabaci* (Gennadius) (Biotype "B") (Homoptera: Aleyrodidae) in the Lower Rio Grande Valley of Texas. Biological control, 12: 127–135.

Gould, J. R., Bellows, T. S & Paine, T. R. 1995. Preimaginal development, adult longevity and fecundity of *Encarsia inaron* (HYM: Aphelinidae) parasitizing *Siphoninus phillyreae* (HOM: Aleyrodidae) in California. Entomophaga, 40 (1): 55-68.

Hassan, S. A. 1992. Guidelines for testing the effects of pesticides on beneficial organisms . Descriptions of test methods. Bull. IOBC/WPRS, 15: 18–39.

Hassan, S. A. 1994. Activities of the IOBC/WPRS working group , Pesticides and Beneficial Organisms . Bull. IOBC/WPRS, 17: 1–5.

Heidari, A., Moharramipour, S., Pourmirza, A. A. & Talebi, A. A. 2006. Effects of buprofezin , pyriproxyfen and fenpropathrin on the reproductive parameters of *Encarsia formosa* (Hymenoptera: Aphelinidae). Journal of Entomological Society of Iran, 25: 17-34.

Heinz, K. M. & Parrella, M. P. 1998. Host location and utilization by selected parasitoids of *Bemisia argentifolii* (Homoptera: Aleyrodidae): implications for augmentative biological control. Environmental Entomology, 27: 773–784.

Helyer, N. L., Ledieu, M. S., Hussey, N. W. & Scopes, N. E. A. 1984. Early season integrated control of whitefly on tomatoes using oxamyl in British Crop Protection Conference Monograph, pp. 293–297.

Hull, L. A. & Beers, E. H. 1985. Ecological selectivity: Modifying chemical control practices to preserve natural enemies In Biological Control in Agricultural IPM Systems (M. A. Hoy and D. C. Herzog eds.), Academic Press, New York, pp. 103–122.

Jones, W. A., Greenberg, S. M. & Legaspi, B. 1999. The effect of varying *Bemisia argentifolii* and *Eretmocerus mundus* ratios on parasitism. Biocontrol, 44: 13–28.

Medina, P., Smagghe, G., Budia, F., Tirry, L. & Vinuela, E. 2003. Toxicity and absorption of azadirachtin, diflubenzuron, pyriproxyfen, and tebufenozide after topical application in predatory larvae of *Chrysoperla carnea* (Neuroptera: Chrysopidae). Environmental Entomology, 32: 196-203.

Nagai, K. 1990. Effects of a juvenile hormone mimic material, 4-phenoxylphenyl (RS)-2-(2-pyridyloxy) propyl ether, on *Thrips palmi* Karny (Thysanoptera: Thripidae) and its predator *Orius* sp. (Hemiptera: Anthocoridae). Applied Entomology and Zoology, 25: 199-204.

Simmons, A. M. & Jackson, D. M. 2000. Evaluation of foliar-applied insecticides on abundance of parasitoids of *Bemisia argentifolii* (Homoptera: Aleyrodidae) in vegetables. Journal of Entomological Science, 35: 1–8.

Simmons, G. S. & Minkenberg, O. P. 1994. Field-cage evaluation of augmentative biological control of *Bemisia argentifolii* (Homoptera: Aleyrodidae) in southern California cotton with the parasitoid *Eretmocerus nr. californicus* (Hymenoptera: Aphelinidae). Environmental Entomology, 23: 1552–1557.

Slobodyanyuk, G. A., Ignat'eva, T. N. & Andreenko, O. N. 1993. A system of protection of cucumbers against greenhouse whitefly. Zashchita Rastenii (Moscow), 4: 45.

Van Driesche, R., Hoddle, M. S., Lyon, S. & Sanderson, J. 2001. Compatibility of insect growth regulators with *Eretmocerus eremicus* (Hymenoptera: Aphelinidae) for whitefly (Homoptera: Aleyrodidae) control on poinsettias: II trials in commercial poinsettia crops. Biological control, 20: 132–146.

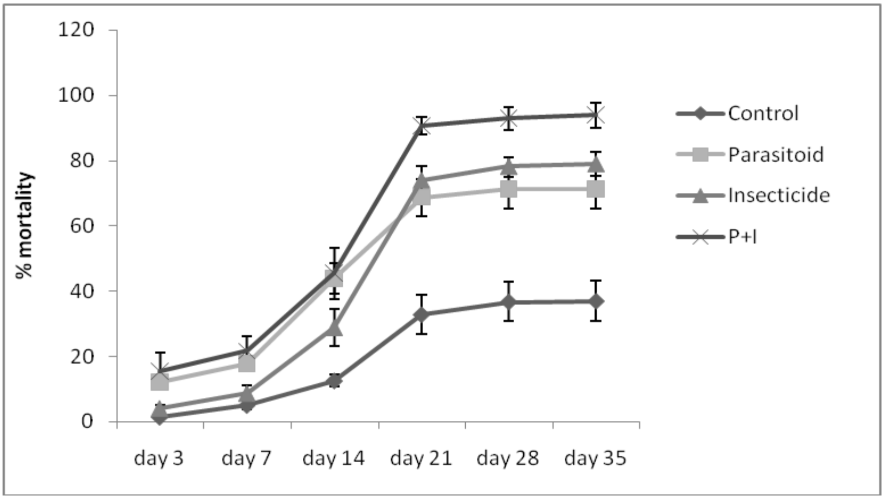

Figure 1. Cumulative percentage mortality of *Trialeurodes vaporariorum* larvae in the experiment, considering the four treatments: pyriproxyfen (▲), pyriproxyfen plus *Encarsia inaron* (X), *E. inaron* (■), and control (♦). Vertical bars indicate the standard error of the mean.

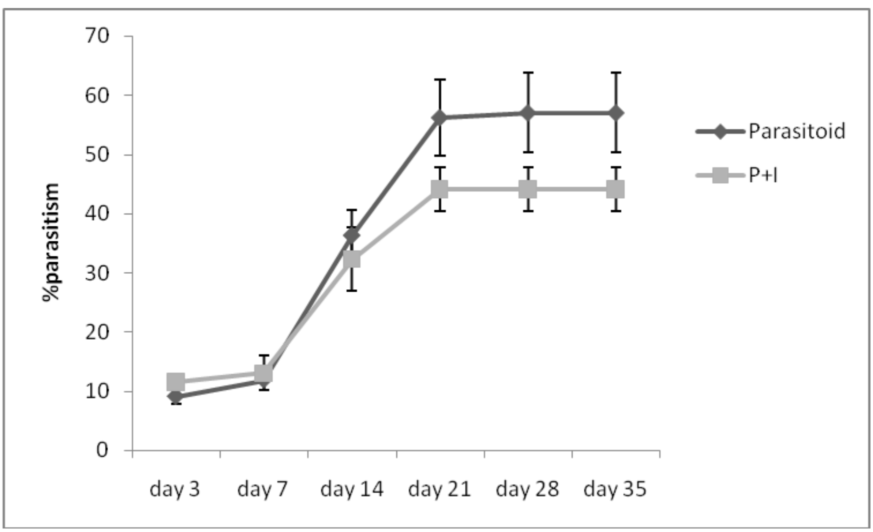

Figure 2. Cumulative percentage parasitism of *Encarsia inaron*, considering the tow treatments: pyriproxyfen plus *E. inaron* (■), *E. inaron* (♦). Vertical bars indicate the standard error of the means.