COMPARISON OF BIOLOGICAL AND CHEMICAL CONTROL METHODS AGAINST WHITEFLIES AND THRIPS IN GREEN HOUSE HERBS IN THE CENTRAL RIFT VALLEY OF ETHIOPIA

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ABSTRACT

Efficacy of the parasitoid *Eretmocerus ermicus* (Hymenoptera: Aphelinidae) and the predatory mite,*Amblyseius swirski* (Acarina: Phytoseiidae) were compared with conventional insecticides against whiteflies and thrips on herbs at Florensis farm in Koka, Ethiopia. Both biocontrol agents were released weekly in a green house measuring 500 m^2 and having nine herb species and 22 varieties. The parasitoid and the predator were released at a rate of 12 and 100 individual's m^{-2}, respectively. In an adjacent green house having the same size and host species diversity, a total of 14different insecticides were applied91 times on 75 different dates according to the practice followed by the farm. Adult insect pest population was monitored weekly using sticky yellow cards in each green house. Immatures of the insect pests and parasitized mummies including mobile swirski mites were estimated from leaf samples of forty randomly selected plants in each green house weekly. Thrips population in both green houses was low in the first three to four months (November to January/February). After January/February, thrips population in the biological control green house (BCGH) was lower than the conventional insecticide green house (CIGH). On the hand, white fly population was higher in BCGH than the CIGH throughout the experimental period. The predatory mite as measured by the proportion of plants having the predator was low initially (November through January) which later increased with time. On the other hand, the parasitoid was almost nil throughout the experimental period. Overall lower thrips number in BCGH than in CIGH and the presence of *A. swirski* in good number later in the season suggest the need and importance of considering *A. swirski* as an integral component of thrips management in herbs. Its use, however, entails use of effective biocontrol agents or Integrated Pest Management compatible products against the concurrently occurring white flies. *Eretmocerus ermicus* establishment was very poor and hence its influence on the pests.

Keywords: biocontrol, herbs, thrips, whiteflies, *eretmocerus ermicus*, *Amblyseius swirski*.

INTRODUCTION

Thrips (Thysanoptera: Thripidae) and whiteflies (Homoptera: Aleyrodidae) are common insect pests in flower farms of Ethiopia affecting production of various groups of plants including different cuttings, flowers, herbs, etc. [1]. Chemical control is widely adopted method for managing arthropod and disease pest complexes in various green houses producing flowers, cuttings and herbs in the Central Rift Valley (CRV) of Ethiopia. Various insecticides are used in rotation against these insect pests as a means of delaying the onset of pesticide resistance. However, the need to produce pest free product necessitate frequent application of pesticides which in turn aggravates development of pesticide resistance and hence decline in pesticides efficacy. Because of this and other related problems, there is a growing need to promote use of biocontrol agents (parasitoids and predators) in an Integrated Pest Management (IPM) program. The success obtained with the use of the predatory mite *Phytoseiulus persimilis* against red spider mites in cut roses has raised great interest in implementing biocontrol based IPM in the management of green house pests in Ethiopia [2].

Species from the genus *Eretmocerus* were introduced into many countries for biological control of pests [7]. *Eretmocerus ermicus* Rose and Zolnerowich (Hymenoptera: Aphelinidae) has been identified as an effective natural enemy of the *Bemisia argentifolii* [4]. The parasitoid has been recommended for effective control of *B. argentifolii* on poinsettia stock plants on summer in Europe [5]. The phytoseiid predatory mite, *Amblysius swirskii* Athias-henriot (Acari, Phytoseiidae) is effective in biological control of whiteflies in green houses [3]. Cage and field trials in commercial green house crops with the phytoseiid predatory mite *Amblysius swirski* have shown a high efficiency against thrips (*Frankliniella occidentalis*) and white flies (*Bemisia tabaci*) in sweet pepper [3]. *A. swirskii* predates on eggs and crawlers of *B. tabaci* and develops well on it [9]. *A. swirskii* is a very effective predator of western flower thrips [8] and *B. tabaci*[6]. These reportedly effective parasitoid and predator were introduced from Koppert Biological Systems in the Netherlands to assess their efficacy in comparison with conventional insecticides against thrips and whiteflies on herbs at Florensis farm located in the Koka area of the central Rift valley of Ethiopia.

MATERIALS AND METHODS

The study was conducted in two adjacent green houses each measuring 500 m^2 in Florensis flower farm located at Koka (08^o 23' N; 039^o 01' E). Bio-control agents were released in one of these green houses referred as biocontrol green house (BCGH) and the other green house was the Conventional insecticides applied green house (CIGH) where insecticides were applied according the rate and frequency determined by the farm. The biocontrol agents were the aphlenid parasitoid *Eretmocerus ermicus*

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(ercal) and the phytoseiid predatory mite *Amblyseius swirskii* (Swirski mite plus). A total of nine herb species and 22 varieties were considered. These include *Origanum* (Compactum, Gold); *Thymus* (Albiflorus, Red Carpet,Compactus); *Artemisia* (French Dragon); *Helichrysum* (Silberzwerg, Tall); *Mentha* (Spicata); *Rosmarinus* (Officionalis, Blue Rain); *Salvia* (Bicolor, Purple Beauty, Tricolor, Lcterina); *Satureja* (Indian Mint); *Thymus* (Silver Queen, Aureus, Doone Valley, Foxley, Lemon variegata).

Releases of predators and parasitoids (in BCGH)

Rate and frequency of releases of the bio-control agents (ercal and swirski mite plus) were according to the suppliers (Koppert Biological systems, the Netherlands) recommendations. Releases were made weekly (every Thursday). Ercal was released at the rate of 12 individuals per square meter (6000 in 500 m^2) and swirski mite plus at 100 individuals per sq meter (50, 000 in 500 m^2). Ercal was released by randomly placing sachet (card) containing the parasitoid uniformly. The predator was supplied in a half liter can (50, 000 individuals) and applied using automated blowers.

Insecticides applied (in CIGH)

Fourteen different insecticides were used and a total of 91 applications were made on 75 different dates between 11 November 2009 and 28 June 2010. This corresponds to application of insecticides once in three days. Table-1 shows the pesticide groups and their frequency of usage as well as their target pests. Most frequently applied pesticides include: Azadirachtin (Nimbecidine), Pyrethirinen (Spruzit), Thialcoprid (Calipso), and Spinosad (Tracer).

Table-1. Major pesticide types and their frequency of application against whiteflies and thrips in the chemical control green house at Florensis, 2009/10.

Target pest	Active ingredient	Product	Frequency
Whiteflies (WF)	Buprofezin	Applaud	6
	Thiocylam hydroxy	Evisect	4
Thrips (TH)	Azadirachtin	Nimbicide	19
	Spinosad	Tracer	8
	Lufenuron	Match	4
Both WF and TH	Pyrethirinen	Spruzit	13
	Thiacloprid	Calipso	11
Mite	Abamectin	Acrimectin	2
	Azadirachtine	Nimbiciden	2

Data collection and analysis

Adult population of thrips and white flies landed on the yellow sticky card were counted weekly from each green house. A binomial data (presence and absence) was collected weekly on the occurrence of the different life stages of both insect pests as well as the released bio-control agents from leaf samples of forty randomly selected plants from each green house; incidences were calculated as a proportion of total plants sampled. Mean values obtained from weekly samplings were used to visualize the pest population trend in BCGH and CIGH. Population fluctuation of the released natural enemies in BCGH was visualized in the same fashion, i.e. from weekly mean values. Mean thrips and white fly population in BCGH and CIGH were compared using t-test; Regression analysis was also made to determine variables (biotic and environmental) with significant effect on thrips and white flies population in the BCGH. In this case weekly mean values of weather data were used. Weather data including day and night temperature and relative humidity were collected daily.

RESULTS AND DISCUSSIONS

Monitoring of adult population

Number of both whiteflies and thrips was low during the first three to four months. During this period population of both insect pests was generally slightly higher in BCGH than in the CIGH. Between end of March and June, thrips population in BCGH was by far lower than CIGH (Figure-1). On the other hand whitefly population in BCGH was higher than CIGH throughout the season which was more pronounced after mid February (Figure-2).

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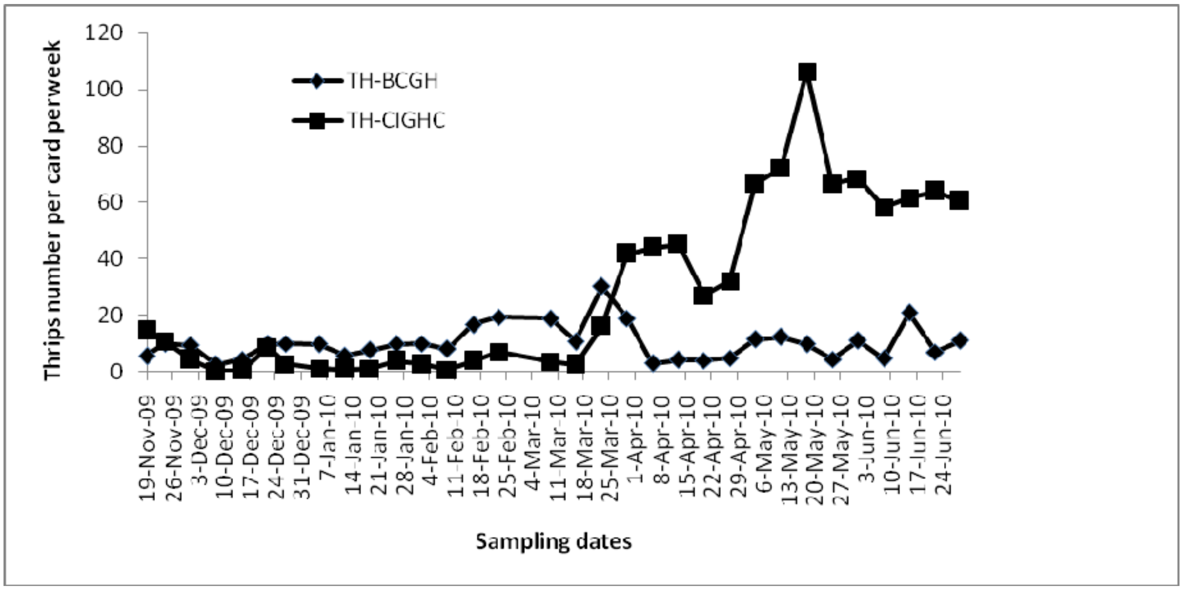

Figure-1. .Mean thrips number landed on yellow sticky card on herbs from BCGH (ercal and swirski mite plus released) and CIGH (conventional insecticides applied green house).

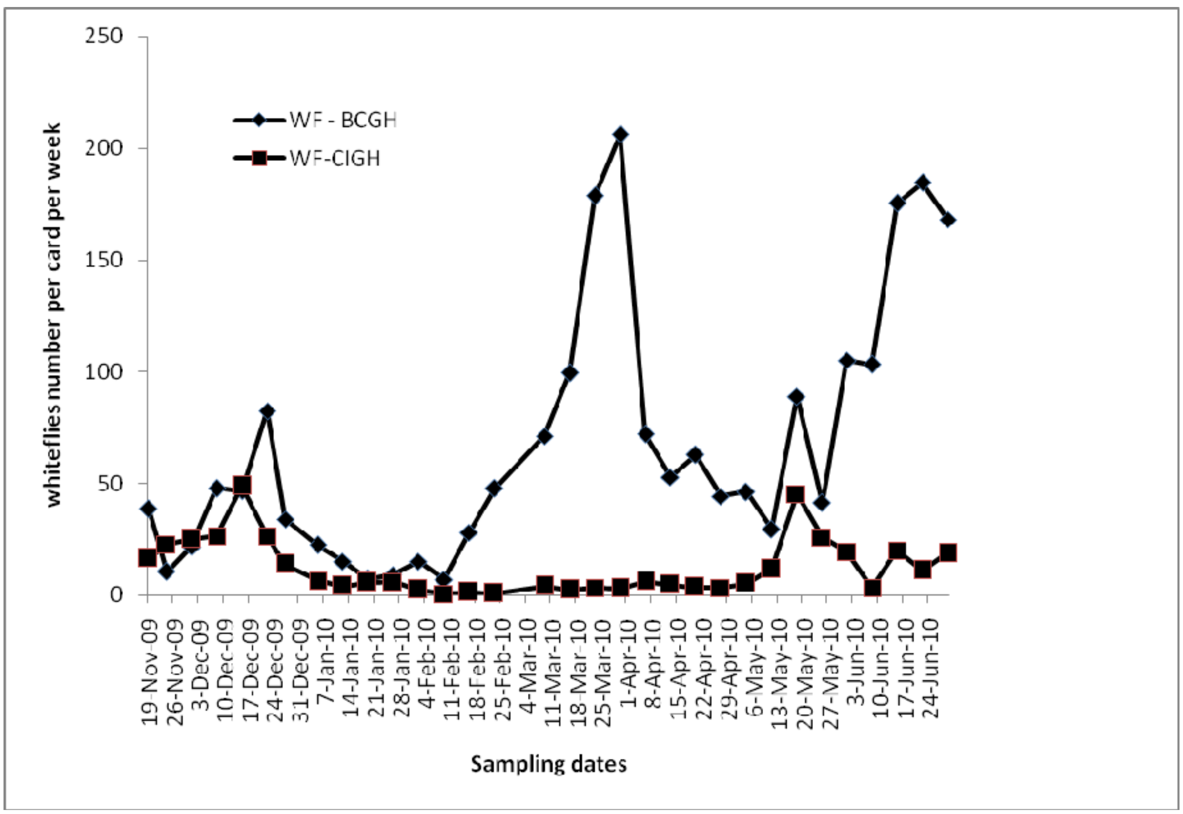

Figure-2. Mean white fly number trapped by yellow sticky card on herbs from BCGH (ercal and swirski released) and CIGH (conventional insecticides applied green house).

Means of thrips and white fly population of the two green houses were compared using t- test and results are presented in Table-2. Thrips population was initially higher in BCGH than CIGH which was reversed later; between 6 April and 29 June, and thrips population was significantly lower in BCGH than CIGH. On the other hand, white fly population was consistently higher in BCGH than CIGH and differences were significant in 23 out of 33 weeks. Figure-3 shows overall mean population of thrips and white flies in both green houses

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Table-2. Significance of differences in thrips and whiteflies number in biocontrol (BCGH) and conventional insecticides sprayed green house (CIGH).

Date	Thrips			White flies		
	BCGH	CIGH	P - val	BCGH	CIGH	P - val
19 Nov	5.6	14.4	0.0875	38.5	16.4	0.0173
24 Nov	10	10.8	0.8805	10.6	22.6	0.1138
1 Dec	9.3	4.2	0.1849	21.6	25.1	0.6862
8 Dec	2.4	0.2	0.0701	47.8	26.3	0.2485
15 Dec	4.5	0.4	0.0698	46.6	48.7	0.9112
22 Dec	9.7	8.7	0.813	82.4	26.4	0.0404
27 Dec	10	2.8	0.0372	33.9	13.8	0.0808
5 Jan	9.8	1.1	0.0018	22.3	6.5	0.019
12 Jan	5.6	0.8	0.0018	15	3.9	0.0337
19 Jan	7.7	1	0.0018	7.2	5.7	0.7457
26 Jan	9.8	3.8	0.2141	9.1	5.9	0.5123
2 Feb	10	2.6	0.0478	15	2.4	0.0032
9Feb	8	0.6	0.073	7	0.5	0.0016
16 Feb	16.7	3.8	0.0549	28.1	1.4	0.0023
23 Feb	19.4	6.9	0.1102	47.7	0.9	0.0006
2 Mar	27.5	5.9	0.0153	18.8	2.7	0.0352
9 Mar	18.8	3.6	0.0177	71.1	4	0.0046
16 Mar	10.7	2.5	0.0064	99.4	2.3	0.0006
23 Mar	30.2	16.2	0.2065	178.6	3.3	0.0042
30 Mar	19	41.7	0.1755	205.9	2.9	0.0067
6 Apr	3	43.8	0.023	71.8	6.2	0.0045
13 apr	4.3	45.2	0.023	52.7	4.6	0.0004
20 Apr	4	27	0.023	62.8	3.4	0.0104
27 Apr	4.8	32.2	0.023	44.1	3.3	0.0041
4 May	11.5	66.4	0.023	46.2	5.2	0.0101
11 May	12.2	72.3	0.023	29.5	11.7	0.1039
18 May	9.7	106.3	0.023	88.8	45.2	0.1382
25 may	4.5	66.7	0.023	41.1	25.9	0.324
1 Jun	11.1	68.4	0.0066	105	19.4	0.001
8 Jun	4.6	58.1	0.0068	103.2	3.2	0.0011
15 Jun	20.9	61.5	0.0521	175.3	20	0.0006
22 Jun	6.9	63.8	0.0058	184.5	11	<0.0001
29 Jun	11	60.4	0.0127	168.1	18.7	0.0006

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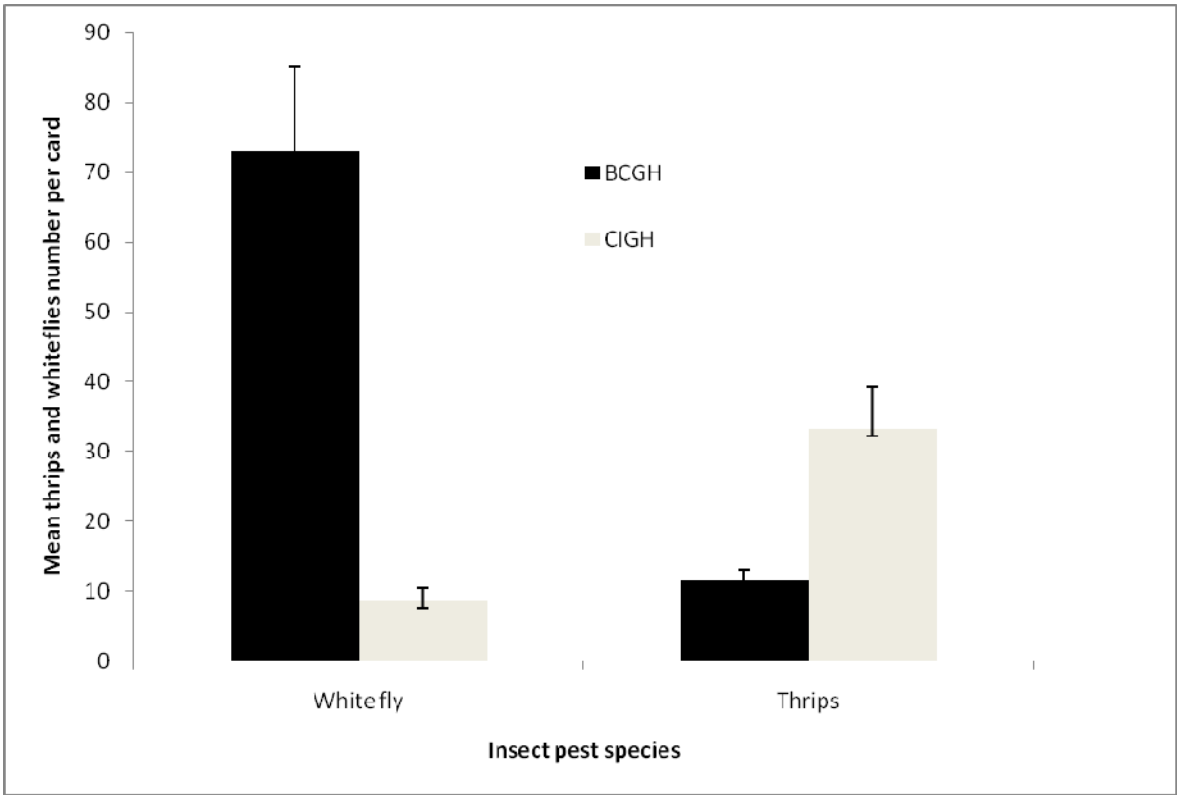

Figure-3. Overall mean population of whiteflies and thrips on yellow sticky card from biocontrol agents released (BCGH) and conventional insecticide sprayed (CIGH) green houses at Florensis in 2009/10.

Monitoring of immature and biocontrol agents (Plant sampling)

Results for thrips and the predator swirski mite are shown in Figure-4. Results for white fly and the parasitoid ercal are shown in Figure-5. Proportion of plants with thrips was generally lower throughout the season (slightly higher in BCGH initially and reversed later). Proportion of plants with swirski mite showed a sharp increase after December and remained higher there after (Figure-4). Proportion of whitefly infestation showed an increasing trend in BCGH. In the control green house (CIGH), it remained low throughout the season. The parasitoid (ercal) population was very low throughout (Figure-5). Over all mean population of both insect pests in the two green houses are shown in Figure-6.

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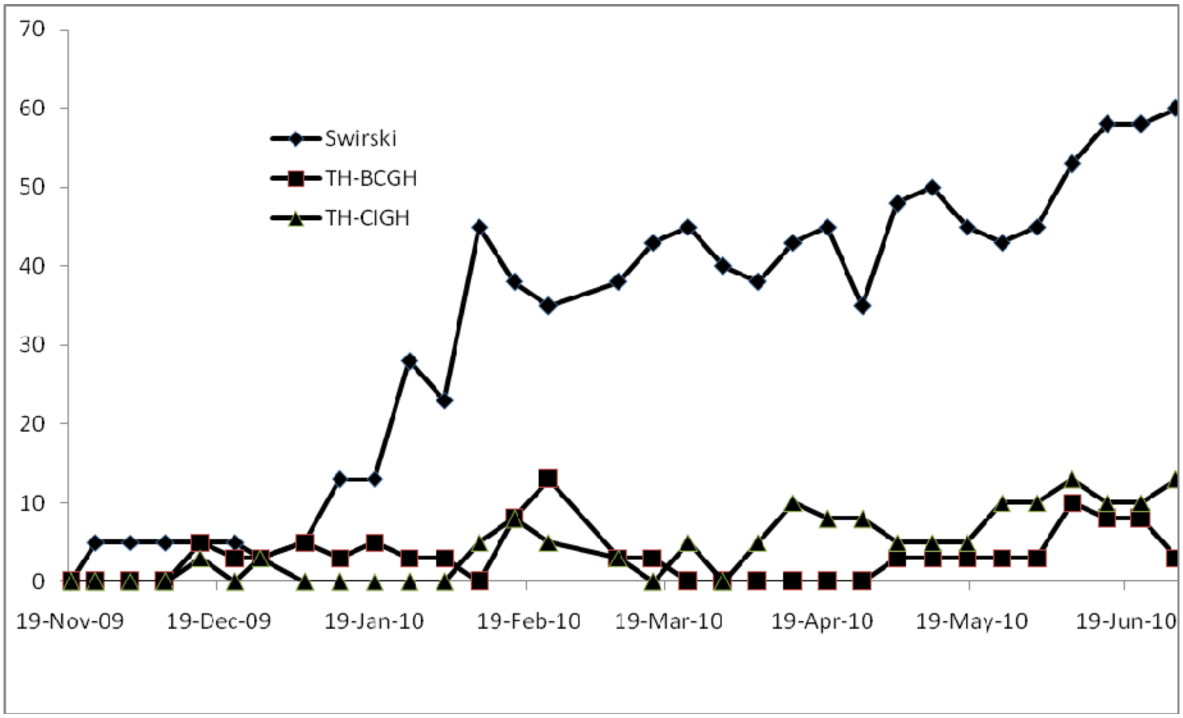

Figure-4. Percentage of plants with adult thrips and swirski on herbs from biocontrol agents released (BCGH) and conventional insecticide applied (CIGH) at Florensis, 2009/10.

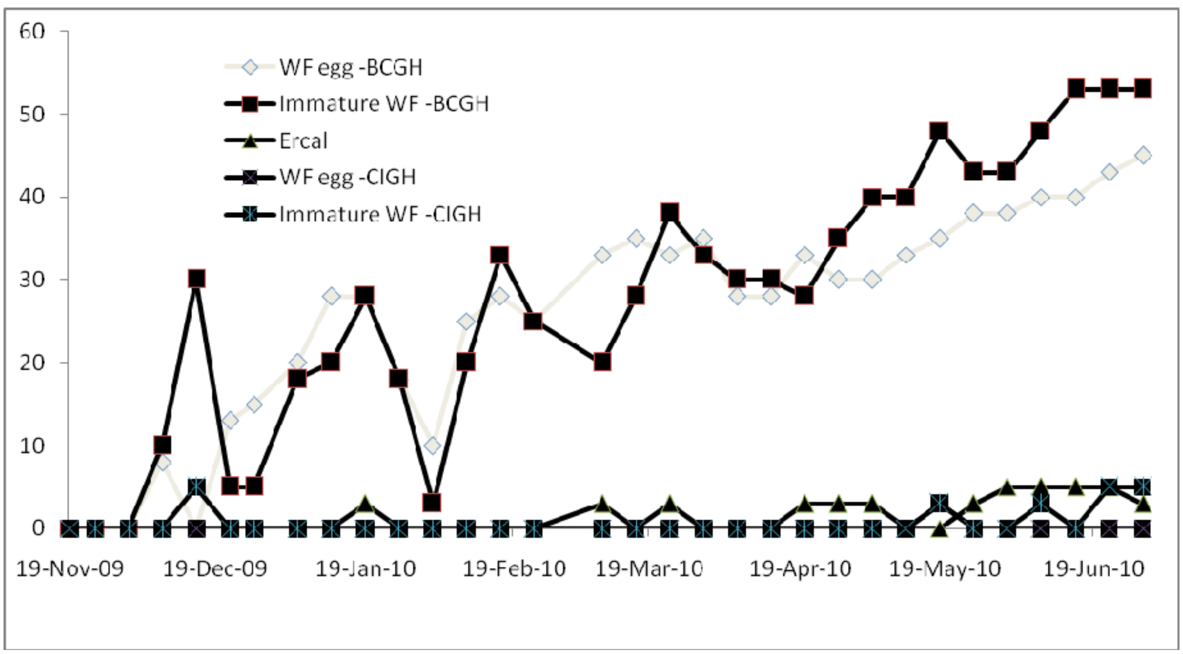

Figure-5. Percentage of plants with different life stages of white fly and its parasitoid ercal on herbs from biocontrol agents released (BCGH) and conventional insecticide applied (CIGH) at Florensis, 2009/10.

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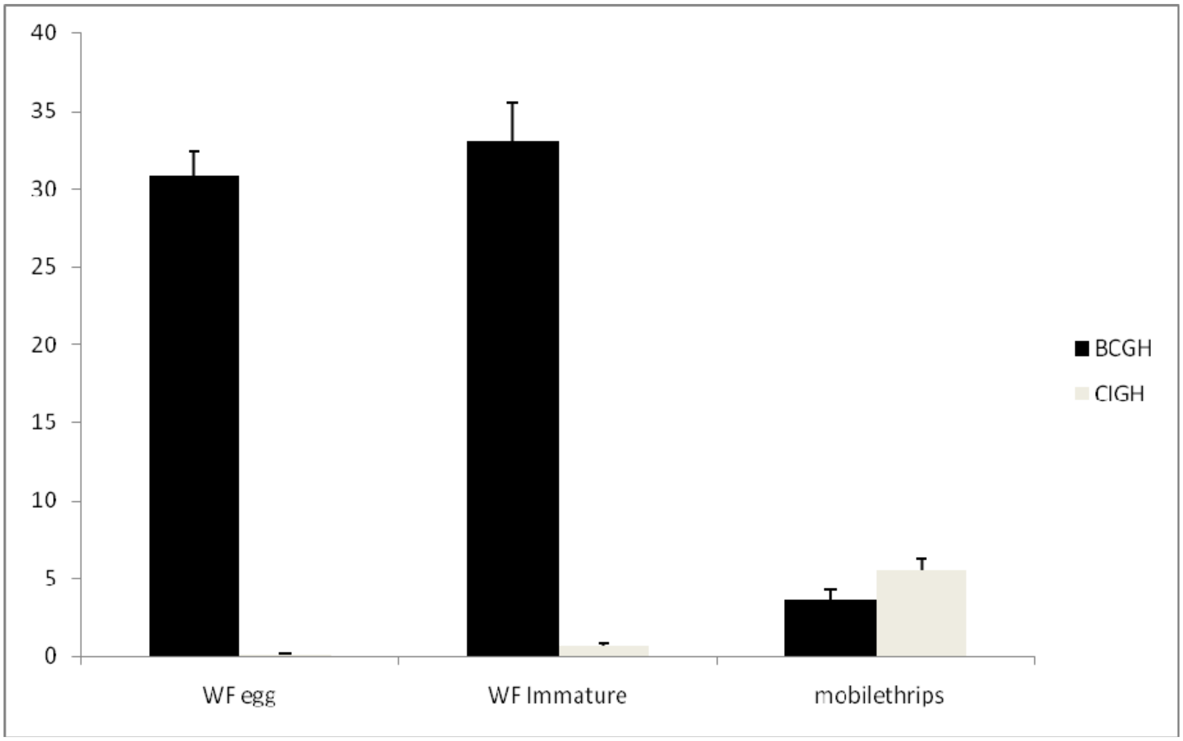
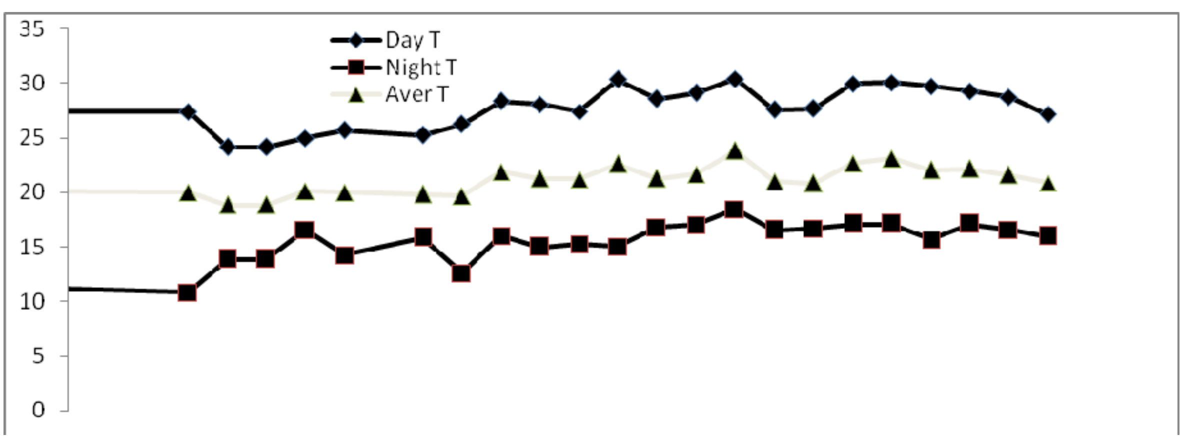


Figure-6. Overall mean proportion of plants with whiteflies and thrips in biocontrol agents released (BCGH) and conventional insecticide sprayed (CIGH) green houses at Florensis in 2009/10.

Relationship of pest density with released bio-control agents and environmental variables

Figure-7 presents weekly mean weather data of the season (data were available for dates between 5 January and 29 June 2010). Tables 3 and 4 show relationship of whiteflies and thrips, respectively with released bio-control agents and weather variables. Relationship between whitefly density and released parasitoids, and temperature were significant and positive (Table-3). On the other hand relationship of thrips density with both released bio-control agents as well as temperature was very weak and insignificant. Absence of positive relationship between thrips density and its predator (swirski mite) could be due to the collapse of thrips population after mid March and higher proportion of sampled plants with swirski mite during this period. On the other hand, the observed positive relationship between whiteflies and the bio-control agents could be due to unchecked increase of whitefly population throughout the experimental period suggesting poor performance of the released bio-control agents in reducing whitefly population.



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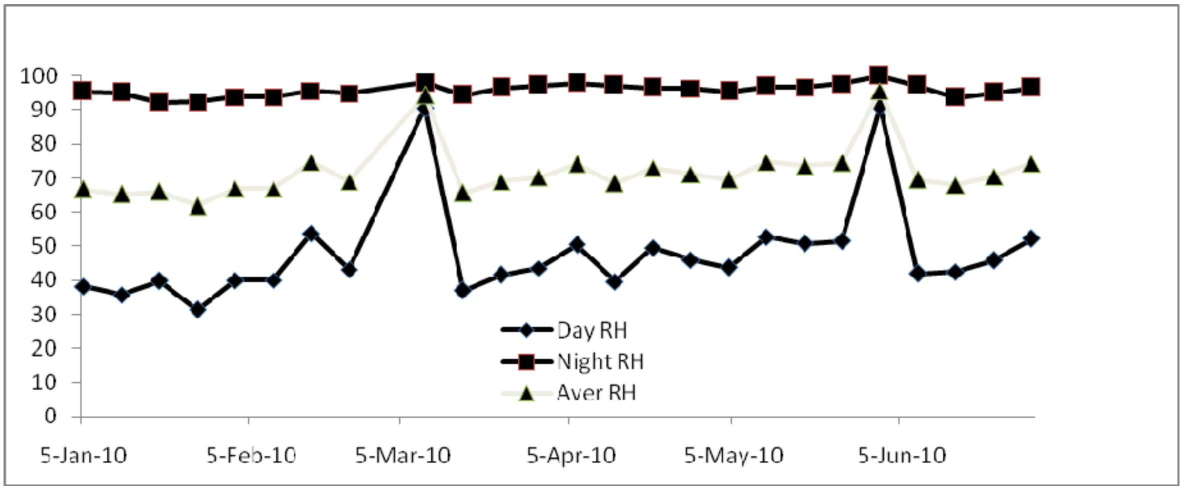

Figure-7. Mean weekly weather data at Florensis for the period between 5 January 2009 and 29 June 2010.

Table-3. Relationship of whitefly density with ercal, swirski mite and environmental variables on herbs at florensis flower farm, 2009/10.

	WF egg from plant	WF nymph from plant	Ercal	Swirski mite	Day temp.	Night temp.	Average temp.	Day RH	Night RH	Average RH
Whitefly (WF) from sticky card	0.72 (<0.0001)*	0.64 (0.0004)	0.48 (0.0121)	0.62 (0.0007)	0.39 (0.0450)	0.36 (0.0686)	0.41 (0.0377)	0.07 (0.7162)	0.23 (0.2516)	0.09 (0.6424)
WF egg from plant		0.88 (<0.0001)	0.65 (0.0003)	0.73 (<0.0001)	0.56 (0.0026)	0.58 (0.0019)	0.29 (0.1378)	0.27 (0.1705)	0.39 (0.0471)	0.56 (0.0027)
WF nymph from plant			0.62 (0.0007)	0.75 (<0.0001)	0.68 (0.0001)	0.68 (0.0001	0.70 (<0.0001)	0.16 (0.44)	0.33 (0.1010)	0.18 (0.3675)
Ercal				0.47 (0.0145)	0.58 (0.0017)	0.56 (0.0031)	0.59 (0.0012)	0.29 (0.1392)	0.16 (0.4138)	0.29 (0.1479)
Swirski mite					0.53 (0.0049)	0.71 (<0.0001)	0.63 (0.0006)	0.21 (0.2987)	0.32 (0.1140)	0.23 (0.2570)

*= Values in parenthesis are probability values or level of significance

Table-4. Relationship of thrips density with ercal, swirski mite and environmental variables on herbs at florensis flower farm, 2009/10.

	Thrips mobile	ERMICUS	SWIRSKI	Day temp.	Night temp	Average temp	Day RH	Night RH	Average RH
Thrips SC	0.15 (0.4751)	-0.04 (0.8327)	0.10105 (0.6233)	-0.15 (0.4655)	0.114 (0.5776)	0.27 (0.2231)	0.26 (0.1979)	0.07 (0.7139)	0.25 (0.2231)
Thrips mobile		0.23 (0.2561)	0.05 (0.7882)	-0.10 (0.6108)	-0.01 (0.9746)	-0.08 (0.7139)	-0.05 (0.7858)	-0.26 (0.2021)	-0.08 (0.6932)

*= Values in parenthesis are probability values or level of significance

CONCLUSIONS

The parasitoid, ercal, was introduced to control white flies and the predator swirski mite plus to control thrips on herbs. Population of both thrips and white flies in bio-control agents released and conventional insecticide applied green houses was compared to determine the efficacy of the released bio-control agents. Although thrips population was slightly higher in biocontrol agents released green house in the first three months, the trend was reversed latter and assumed to be due to the effect of the predator which established itself slowly. The concurrent increase in the number of the predator corroborates this. On the other hand the whitefly population was consistently higher in the bio-control agents released green house than the conventional insecticides applied green house. Moreover, the parasitoid population was almost nil throughout the study period indicating failure of establishment. Hence, the predator swirski mite is recommended for thrips management in herbs. Its use, however, entails the use of IPM compatible soft insecticides against both thrips and white flies in the first three to four months of the production cycle as well as availability of effective natural enemy against white flies which occur concurrently with the thrips suggesting the need to test a different parasitoid species against whiteflies on herbs.

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