Comparative Performance of Two Predatory Mites in Managing Western Flower Thrips in Protected Rose Flower Farms in Central Ethiopia

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Abstract

The application of pesticides has been causing economic, health and environmental impact in the rose flower industry. To mitigate this, introduction of biological control agents was promoted and was successful in reducing spider mites, which used to require application of pesticides every three days in the worst case scenarios. But when this major pest of roses was effectively controlled using the introduced bio control agents, secondary pest outbreak became common. This included citrus mealybug, western flower thrips (WFT), aphids and bollworms. The WFT is a quarantine pest in most of the importing countries. Therefore biological control agents should have been evaluated on WFT. To this effect, two predatory mites (*Amblyseus cucumeries* and *A. swiriskii*) were compared. The two predators were released in separate greenhouses alone or in combination with either compatible pesticides or yellow sticky traps. It was found that *A. cucumeries* effectively controlled WFT than the other predatory species. The use of compatible pesticide reduced the pest population near to zero. Beside this the hanging of sticky traps in big number also reduced the pest population significantly. There was also farm-wide verification of *A. cucumeries,* in which significant reduction of WFT was recorded over the sampling period. Therefore the use of *A. cucumeries* and the yellow sticky traps could be promoted with application of soft or compatible pesticides to effectively control the WFT.

Key Words: Western flower thrips, A. Cucumeries and A. Swirskii, Protected farms

Introduction

Protected agriculture is a new venture in Ethiopia and is getting acceptance by the government as one area wherein foreign exchange earnings could be maximized. But it requires significant input to increase the productivity of the sector. The most commonly used external inputs include fertigation and chemigation. The application of chemicals is mainly the use of pesticides to control insects and pathogens causing economic damage.

Protected farms are environments where pest control is complicated by the virtually year-round culture of crops in humid and warm environments in the absence of natural enemies. These conditions provide excellent opportunities for the survival and development of a pest or disease once it has invaded the protected farm (Pimentel, 2002). Protected crops are affected worldwide by a number of insect and mite pests, mostly whiteflies, aphids, dipteran leaf miners, caterpillars, and spiders, eriophyid, and tarsonemid mites (Pimentel, 2002). They are also affected by different diseases that include soil-borne diseases (damping-off, black root rot, and several other root rots and wilts caused by

Fusarium and Phytophthera and foliar and stem diseases (gray mold, powdery mildew, early blight, soft rot, and several other fungal and viral diseases) (Greer and Diver 1999).

Chemical control is still the prevalent method of pest control in protected farms (Pimentel, 2002).While pesticides are important tools used in managing protected farm pests, their use in enclosed spaces increases the potential for worker exposure during and after application. Unfortunately, the enclosed conditions expose protected farm workers to levels of plant protection products higher than general agricultural workers (Cerruto et al. 2007).

The controlled environment of protected farms, the high value of the crops, and the limited number of registered insecticides and fungicides offer a unique niche for the biological control of insect pests and plant diseases (Pimentel, 2002 and Paulitz and Bélanger, 2001). This is because biological pest control is a reliable method and an economically profitable endeavor for growers of protected farm crops. Therefore fast evaluation and introduction of a number of natural enemies in situations where chemical control was insufficient, impossible or undesired is a powerful option in pest control(Van Lenteren, 1992).

The routine use of pesticides as first choice for managing pests in the protected farms in Ethiopia has not been found sustainable. This is mainly because the country has to import the required pesticides in larger quantities and types. This has however been creating the accumulation of unused pesticides hence increasing the obsolete pesticide stock in the country. Application of pesticides has been causing ailments on the workers and damaging the environment (reference?); it has also been reducing the output of the farms due to restrictions of entry into sprayed greenhouses wherein flowers that were ready for harvest overage and become unfit for the flower market. Therefore, in protected agriculture use of biological control incorporated in integrated pest management (IPM) program is important considering the multiple benefits that can be accrued from the use of such pest management approach.

In commercial rose flower farms in Ethiopia, before the introduction of predatory mites, spider mites have been the most serious pest requiring frequent application of miticides. After the introduction of predatory mites to control spider mites in commercial rose flower farms previously least important pests started emerging as serious pests and the most notable are the citrus mealybug, *Pseudococcicitri* followed, very recently, by the western flower thrips, *Frankliniellaoccidentalis (Thysanoptera: Thripidae)*. Two biological control agents (*Cryptolaemusmontrouzieri* (predatory beetle) and *Anagyruspseudococci* (solitary parasitoid)) were evaluated earlier and the predatory beetle effectively checked the citrus mealybug population in rose flower farms (Bayeh, 2010, unpublished data). Similar decision was made by introducing biocontrol agent from Real IPM in Kenya and BioBee in Israel.

The predatory mite from Kenya, RealAmblyseius®,*Amblyseiuscucumeris*(Oudemans), is a type III generalist predator and a biocontrol agent widely used for the control of various species of thrips on cucumber and pepper in greenhouses through preventive, mass releases and also to control thrips on ornamentals in greenhouses with varying degrees of success. Some of the species they could devour include: the western flower thrips(*Frankliniella occidentalis*); the flower thrips or eastern flower thrips (*F. tritici*); the onion thrips (*Thrips tabaci*); the greenhouse thrips (*Heliothrips haemorrhoidalis*); and possibly the melon thrips (*Thrips palmi*), too. Other pests which can be impacted by these predators include cyclamen mites (*Phtyodromus =Steneotarsonemus pallidus*), broad mites (*Polyphagotarsenomus =Hemitarsonemus latus*) and, to a slight degree, tomato russet mite (*Aculops lycopersici*). And, as *Neoseiulus spp*., these predators may prey on other pests as well (CABI, 2007).

The biocontrol agent introduced from BioBee in Israel, BioSwirskii®, *A.swirskii* (Athias-Henriot) is a polyphagous predator and its primary preys are eggs and crawlers of whitefly species *Bemisiatabaci*, *Trialeurodesvaporariprum,* and young larvae of *Frankliniellaoccidentalis*. Secondary preys are: *Tetranychusurticae*, *T. cinnabarinus* and *Polyphagotarsonemuslatus*.

Non target effect (cannibalism on its own protonyphs and interspecific predation on *Agistemusexertus* and *Eusiusscutalis*predatary mites) is only recorded under laboratory conditions.

Western flower thrips (WFT) is native to North America. It is widespread from sea level to sub-alpine altitudes and is naturally abundant in many wild flowers along the mountain range of western North America from southern California (and presumably Mexico) into Canada (Waterhouse and Norris, 1989). It is also established in Europe,Israel, the highlands of eastern Africa, New Zealand, Australia and Brazil (Monteiro et al., 1995), and also in the CameronHighlands of Peninsular Malaysia (Fauziah and Saharan, 1991). It is not usually found in lowland tropical countries; for example it is not yet reported from Taiwan despite the intense horticultural trade of that country. In Costa Rica and Colombia, although abundant in greenhouses where chrysanthemums are grown it is rare outside on native plants or crops, whereas in Guatemala it has been reported as a field pest (Fauziah and Saharan, 1991).

Western flower thrips have a broad host range of more than 500 species in 50 plant families and are associated with many cultivated crops and ornamentals. Crops attacked by this pest include beans, burdock (gobo), capsicum, cucumber, eggplant, lettuce, onion, tomatoes and watermelon. Ornamental crops include carnation, chrysanthemum, orchids, pikake, rose and tuberose (Yudin *et al.*, (1986). It did not become a serious pest until the mid seventies when sporadic and economically significant outbreaks occurred, particularly on lettuce and chrysanthemums (Waterhouse and Norris, 1989).

In Ethiopia,it was reported first in 2005 from Debre Berhan Research center on onions grown in the Shewa Robit area (reviewed by Gashawbez et al. 2010). It is however currently recorded as an important pest in the protected farms including roses.

Since the introduction and use of biological control incorporated IPM, which has become effective in most of the farms where it has been introduced for the control of spider mites, more growers are turning their face towards the technology. In order to strengthen this system of control in the protected agriculture, it was deemed necessary that a biocontrol agent that could check at the WFT populations in rose flower farms be incorporated. Based on this, the two biological control agents *Amblyseiuscucumeris*(Oudemans) and *A.swirskii* (Athias-Henriot) were introduced from Real IPM in Kenya and BioBee International in Israel, respectively and were evaluated for their efficacy in controlling the Western flower thrips at Linssen cut roses farm, which is located in West Shewa zone after the town of Addis Alem.

Materials and Methods

Arrangements were made with Linssen flower farm, which has been practicing biological control incorporated IPM on spider mites in the entire farm, onhehow ???of releasing thea gents.The farm provided two greenhouses, each 2.5 ha wide, to verify the two bio agents separately. Each greenhouse was then subdivided into three equal parts and received different treatments. For the Real Amblyseius, the treatments included sole predator release, predator release plus application of compatible pesticide (which one?) and compatible pesticide spraying alone. For the BioSwirskii (*A. swiriskii*) the treatments included predator release, predator release plus hanging of yellow sticky traps (YT) at intervals (ten per bay) and compatible pesticide spraying. Seven and four well dispersed release were made following the rates specified below (Table 1). The first release was made two weeks after the entire farm was sprayed with pesticides in order to reduce the high population of WFT present at the time.

Table 1. Release schedule used to introduce the two predatory mites in verification plots in the Linssen flower farm in 2012.

Real Amblyseius (*A. cucumeris*)		**BioSwirskii (*A. swirskii*)**	
Release date	Number per m^2	Release date	Number per m^2
10/02/2012	50	10/02/2012	100
17/02/2012	50	17/02/2012	0
25/02/2012	50	25/02/2012	0
11//03/2012	200	06//03/2012	100
25/03/2012	200	20/03/2012	300
31/03/2012	200	31/03/2012	300
02/04/2012	200	02/04/2012	0

Data collection

The populations of the two predatory mites were found very difficult to assess due to their cryptic nature, i.e., their habit of concealing themselves deep in the flower buds. Because of this, the sampling every week was focused on counting the WFT present on tender leaf branches and in flower buds. Follow-ups and collection of data had been done ten times on weekly interval and each time, the number of thrips present on the top tender leaf branches of 25 randomly selected plants and on 25 randomly picked flowers were counted. Beside this, the numbers of healthy and damaged flowers were recorded by taking randomly ten flowers per 100m row length in a total of 700m row length per treatment and was done for eight weeks on weekly interval. The inspection on flowers was made by destructive sampling. The collected data were subjected to one way ANOVA in count form or after converted into percentage values.

Verification of farm wide performance of *A. cucumeries*

Based on the recorded performance of *A. cucumeries,* farm wide verification was conducted by releasing it in the entire farm. It was released at 200 individuals per m^2 and monitoring had been done to see the shift in the flower damage by taking sample flowers on seven rows of 100m long per tunnel.

Results

Thrips on tender leaf branches

In the greenhouse tunnels wherein *A. cucumeris* was released, the number of thrips on the tender leaves branches of sampled plants were very low at the start of the counting, but increased t o about two thrips per branch in the tenth week in the bays wherein the predator was released alone. On the other hand, in the bays wherein either pesticide alone or the predator was released together with compatible pesticide, the population of the WFT did not reach even to one thrip per branch (Figure 1). The population dynamics of the WFT in the top tender leaf branches in the bays wherein BioSwirskii (*A. swirskii*) has been released was increasing and reached to above 2 thrips per leaf branch during nine of the ten weeks of sampling when the predator was applied alone. In contras,t the population of the thrips remained below one per branch during the entire sampling period in the bays wherein the predator was used together with yellow sticky trap or when only the compatible pesticide was sprayed (Fig 1).

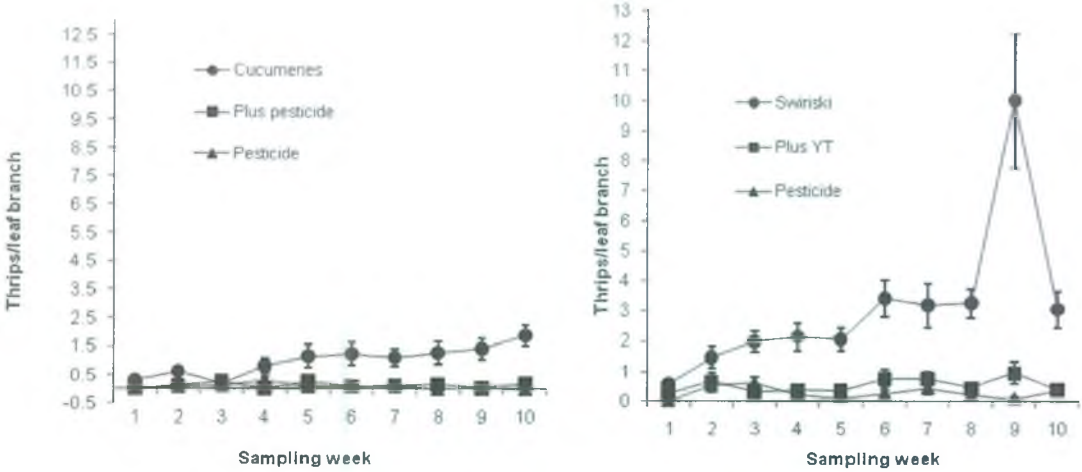

Fig 1. Population of WFT as affected by the different treatments over the sampling weeks (YT= Yelow sticky trap)

Thrips in flower buds

The number of WFT in the flower buds also showed a similar trend, but the number of thrips per flower increased from the seventh week on to above two individuals per flower bud in the bay that received the *A. cucumeries* alone. In contrast, in the bays that received the predator together with a compatible pesticide and only the pesticide, the population of the predator remained very low (Figure 2).On the contrary, the WFT population dynamics in the growing flower buds has been increasing from the third week on and reached above 6 thrips per flower head in the last sampling week in the bays wherein the *A. swiriskii*was was released alone whereas in the bays wherein it was used with yellow sticky trap or compatible pesticides were used, the thrips population in the growing flower buds remained very low during the entire sampling period and was as low as below 1 thrip per flower (Fig 2).

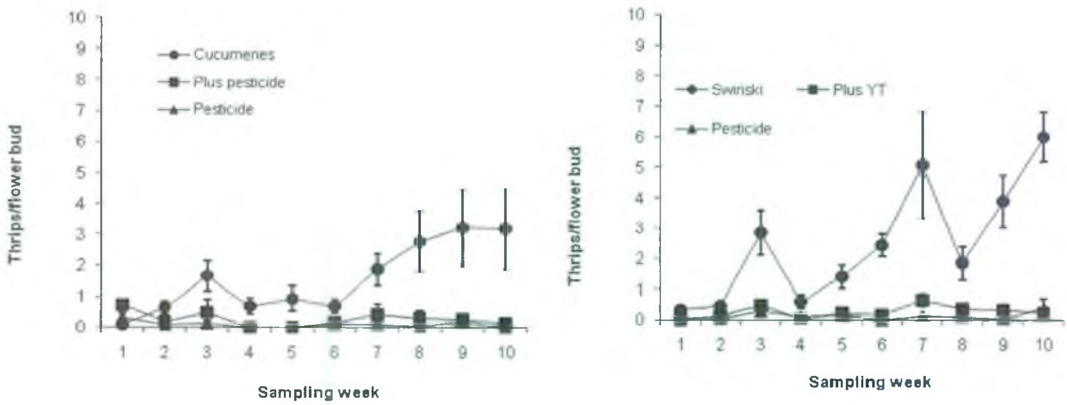

Fig 2. Population of WFT as affected by te different treatments over sampling weeks)

Improvement of quality of flowers

The WFT presence in flower buds is a serious impediment to the export of cut rose flowers to upscale markets worldwide. Because of this sampling of the quality of flowers was carried out. In the bays wherein *A. cucumeris* was released alone, the proportion of thrips damaged flowers was 50% at the start of taking samples and was reduced significantly to about 20% and remained the same between the third and sixth weeks and showed an increase afterwards. In contrast, the proportion of damaged flowers remained very low when either *A. cucumeris* was released with the application of compatible pesticides or in bays wherein compatible pesticides were used alone (Figure 3). In the bays wherein *A. swirskii* was released alone, the proportion of damaged flowers was 30% at the start of sampling (3rd week) and decreased to above 20% in the subsequent three weeks and increased significantly to above 40% in the 7th week and reached 75% on the 8th week and then declined back to 45%. On the other hand, in the bays wherein the predator was released in the presence of sticky traps or where the compatible pesticide was sprayed, the proportion of damaged flowers remained relatively very low (Fig 3).

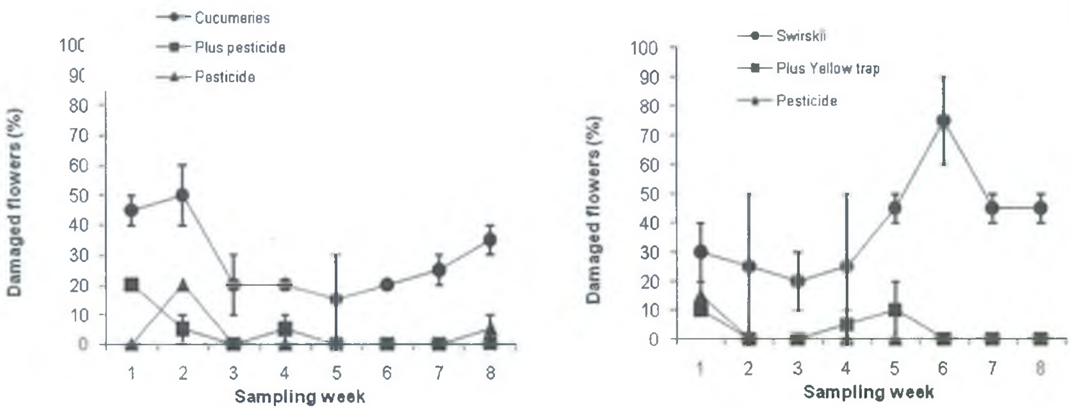

Fig 3. Proportion of WFT damaged flower buds over eight weeks of sampling after the release of natural enermies

Verification of farmwide performance of *A. cucumeries*

The results obtained showed that the introduced predator significantly reduced proportion of damaged flowers over the sampling period (Fig 4).

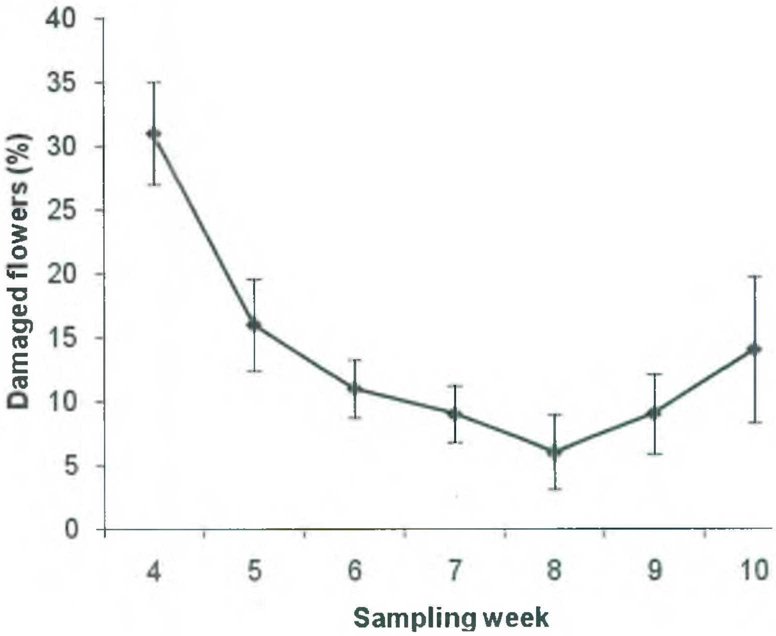

Fig. 4 Proportion of WFT damaged flower buds over the seven weeks sampling after farm wide release of Real Amblyseius (*A. cucumeris*)was made (Linssen flower farm, in 2012).

Mass trapping using yellow sticky traps

The yellow sticky traps that were hung in the presence of the predator caught significant number of adult thrips per week. The number caught ranged between 20 and 60 individuals per trap. The highest catches were in the 2^{nd}, 4^{th} and 5^{th} weeks of sampling. The thrips population caught declined to 30 on the 6^{th} week and did not increase afterwards (Fig 8).

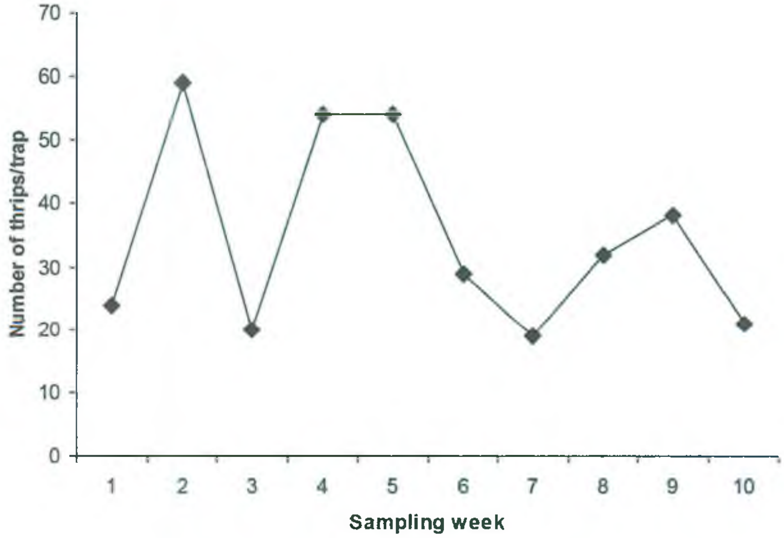

Fig 5. Mean number of WFT caught every week for ten weeks using yellow stick traps in bays wherein Bioswirskii (*A. swirskii*) was released (Linssen flower farm, 2012).

Discussion and Conclusion

On the tender leaf branches of roses, the number of thrips present at the times of sampling were below two individuals per trap in the greenhouse where Real Amblyseius (*A. cucumeris*) was released whereas in the greenhouses wherein BioSwirskii (*A. swiriskii)* was released, the number of WFT per branch was in general more than two individuals per leaf branch and even reached nine per branch on the ninth week.

The number of WFT per flower bud reached to a maximum of 3.5 per flower bud on the tenth sampling week in the greenhouse wherein Real Amblyseius (*A. cucumeris*) was released. On the other hand, in the greenhouse wherein BioSwirskii (*A. swirskii*) has been released the number of WFT per flower bud was above three in most of the sampling weeks and even has reached 6 individuals per flower bud on the tenth week. Moreover the damage to flowers remained significantly higher in the greenhouse wherein BioSwirskii (*A. swirskii*) has been released whereas in the greenhouse wherein Real Amblyseius (*A. cucumeris*) was released the reduction in the proportion of damaged flowers was significant and it remained significantly lower than that at the first week?. Beside this, the farmwide release of Real Amblyseius (*A. cucumeris*) reduced the proportion of damaged flowers from above 30 at the start of sampling to below 6%, and then started to increase reaching ca.13% in the last sampling date following the termination of the release of the predator.

Therefore from the results obtained it can be concluded that there is a significant difference in the controlling effects of the two predators. Real Amblyseius (*A. cucumeris*) has shown a significant effect in suppressing the WFT population than BioSwirskii (*A. swirskii*) when the two species were used separately. The use of compatible pesticides has checked the population of WFT to a very minimum number, however its use cannot be encouraged due to the side effects it may have on the predatory species. The use of yellow sticky traps has also helped significantly by reducing the WFT population. Based on these results, the following recommendations were drawn: The predatory mite, Real Amblyseius (*A. cucumeris*) can be used for the control of WFT in roses; the use of yellow sticky traps has contributed significantly for the control of the WFT and hence its use should be encouraged in rose flower farms wherever they are located. Although found very effective in controlling the WFT population significantly the use of pesticides in rose flower farms targeting the WFT should be given a second thought before its application. Based on its efficacy *A. swirskii*s should not be considered as an agent to control the WFT.

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References

Cerruto E., Balsari P, Oggero G., Friso D., Guarella A. &Raffaelli M. Operator safety during pesticide application in greenhouse: a survey on Italian situation, ActaHorticulturae 801 (2), 2008 pp 1507-1514.

Fauziah and H.A. Saharan. 1991. Research on Thrips in Malaysia. Thrips in Southeast Asia Proceedings of a regional consultation workshop, Bangkok, Thailand, 13 March 1991.

GashawbezaAyalew, Bayeh Mulatu, Mulugeta Negeri, YashitelaMerene, Lidet Sitotaw, Ahimed Ibrahim and TadeleTefera. 2011. Review of research on insect and mite pests of vegetable crops in Ethiopia. In Abraham Tadesse (ed.): Increasing crop production through improved plant protection – Volume II. Proceedings of the 14th Annual Conference of the Plant Protection Society of Ethiopia, 19-22 Dec 2006. Addis Ababa, Ethiopia. PPSE and EIAR, Addis Ababa, Ethiopia.

Greer, L. and S. Diver. 1999. Integrated pest management for greenhouse crops. ATTRA–Natl. Sustainable Agr. Info. Serv. Publ. IP144. 17 Sept. 2008. <http://attra.ncat.org/attra-pub/gh-ipm.html#general/>.

Monteiro RC, Mound LA and Zucchi RA. 2001. Espécies de *Frankliniella* (Thysanoptera: Thripidae) de importânciaagrícola no Brasil. Neotropical Entomology 1: 65-71.

Paulitz, T.C. and Belanger, R.R. 2001. Biological control in greenhouse systems. Phytopathology 39: 103-133.

Pimentel, D. 2002. Encyclopedia of pest management. Cornell University, Itaca, New York, USA.

Tsedeke Abate. 1988. Insect and mite pests of horticultural miscellaneous plants in Ethiopia. Handbook, IAR Addis Ababa. 155 pp.

Van Lenteren, J.C., Benuzzi, M., Nicoli, G., Maini, S. 1992. Biological control in protected crops in Europ. In van Lenteren, J.C, Minks, A.K. and de Ponti, O.M.B. (eds.): Biological control and integrated crop protection towards environmentally safe agriculture. Pudoc, Wageningen, pp 77-84.

Waterhouse, D. F. and K. R. Norris. 1989. Chapter 4 *Frankliniellaoccidentalis* (Pergande). pp. 24-35. In: Biological Control Pacific Prospects - Supplement 1. Australian Centre for International Agriculture Research: Canberra. 123 pages.

Yudin, L. S, J. J. Cho and W. C. Mitchell. 1986. Host Range of Western Flower Thrips, *Frankliniellaoccidentalis*(Thysanoptera: Thripidae), with Special References to *Leucaenaglauca*. Environ. Ent. 15(6): 1292-1295.