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European Journal of Zoological Research, 2014, 3 (1):136-141
(http://scholarsresearchlibrary.com/archive.html)

ISSN: 2278–7356

Evaluation of the effectiveness of predatory bug *Deraeocoris lutescens* for the green peach aphid control in greenhouse conditions and its economic justification

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ABSTRACT

The present research aimed to study the greenhouse experiments were carried out in order to confirm the efficiency of Deraeocoris lutescens Schilling (Hemiptera: Miridae) for the biological control of Myzus persicae (Sulzer) on protected sugar beet plants at 25 °C temperature. The aphid feeds on hundreds of host plants in over 40 plant families. Three aluminum cages was designed and built for testing. In each cage was placed four pots of sugar beet and Cages was named (control, treatment 1 and 2). The predatory bug has been successfully fed, reproduced and established on sugar beet plants under greenhouse conditions with M. persicae as prey during the greenhouse experiment. During the greenhouse experiment, the mean number of the aphid individuals per plant was significantly higher in the control treatment than in the treatments with D. lutescens. The total number of the prey had decreased gradually till it reached zero in the 5th week. Also, the nymphs population increase has stopped in the last week. The present result indicated that the population of the aphid effects on the predator population, while the predatory bug able to reproduce on sugar beet plants in the absence of prey. Thus, biological control of aphids using natural enemies, seems to be a successfully control allowing the amount of insecticides to be reduced, is needed to create sustainable agriculture development. In this regard, not only to control the world market production but also, It is important to the quality of products.

Key words: biological control, *Deraeocoris lutescens*, economic justification, greenhouse, *Myzus persicae*,

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INTRODUCTION

Aphids (Homoptera: Aphidoidea) are economically one of the most important agricultural pests. In the last years, some of aphids such as *Myzus persicae* (Sulzer) has been very important pest species of many greenhouse and field plants in Iran. The aphids are yellowish or greenish in color. They measure about 1.7 to 2.0 mm in length. A medial and lateral green stripes may be present. The cornicles are moderately long, unevenly swollen along their length, and match the body in color. The appendages are pale. The rate of reproduction is positively correlated with temperature, with the developmental threshold estimated to be about 4.3º C. They are phytophage cosmopolitan and polyphagous species that sucking of plant phloem sap and transmission of plant viruses [6,8]. Green peach aphid feeds on hundreds of host plants in over 40 plant families. In addition to attacking plants in the field, green peach aphid readily infests vegetables and ornamental plants grown in greenhouses. Moreover, aphids easily develop insecticide resistance [3,4]. Nowadays, environmental hazard due to regular and rather intensive chemical insecticide spraying is a growing concern. Thus, biological control of aphids using natural enemies, seems to be a successfully control allowing the amount of insecticides to be reduced, is needed to create sustainable agriculture development [7]. The sustainable agricultural is policies development and operational that it will ensure people's ability to produce food and clothing, without natural resources are degraded and however it will maintain the economic and social values and agricultural trade.

Today, there are many different biological agents, which are suitable for a biological control of aphids. Several natural enemies are active on the pests, including predators (Lacewings, Ladybirds, predatory bugs), parasitoids and pathogens. The predators of Family miridae, including *Deraeocoris lutescens* Schilling (Hemiptera: Miridae) is a predatory bug found commonly on a wide variety of plants across Middle East and Europe, that feeds on a wide range of arthropod pests such as aphids, small caterpillars, mites and insect eggs [5]. Interest in biological control has increased considerably as a response to the various effects of pesticides on the environment and as a result of new international trends, which favors conservation and the sustainable use of biological resources. International food production policies increasingly demand alternatives to the use of chemical control, and biological control resurfaces with new energy in this scenario by means of techniques that make it viable to be used economically [2]. The ability of a natural enemy not only in terms of its predatory potential but also in its adaptability to different environmental conditions are the essential prerequisites for the successful utilization in biological control programs. Therefore, the present work aimed to study the greenhouse experiments were carried out in order to confirm the efficiency of *D. lutescens* for the biological control of *M. persicae* on protected sugar beet plants. Also it was considered investigation of the survival and reproduction of the predatory bug with feeding of aphids on sugar beet leaves in greenhouse.

MATERIALS AND METHODS

Rearing of the green peach aphid

The stock cultures of aphid *M. persicae* on cabbage plants were established with individuals obtained from stock cultures available at a greenhouse. For obtaining of individuals in the desired age, aphid species was kept in a climatically controlled chamber at 25±1°C temperature, relative humidity of 60±10% and a photoperiod of 16:8 h (L:D) on broad bean leaves in the round plastic Petri dishes (6 cm diameter) that were filled with 2 cm-thick-layer of 0.7% agar gel.

Rearing of the predatory bug, D. lutescens

The predatory bug, *D. lutescens* was originally obtained from the experimental teaching garden of Shahid Bahonar University of Kerman, Iran. This species was identified by department of insect taxonomy research, Iranian research institute of plant protection, Tehran, Iran. They were reared in a climatically controlled chamber, as above. Broad bean leaves were used as oviposition substrate in the round plastic Petri dishes (6 cm diameter) filled with 2 cm thick-layer of 0.7% agar gel. The bugs were offered daily 40 of one or two day-old individuals of *M. persicae* as prey. Adult mated females were transferred separately to round plastic Petri dishes for oviposition. After 48h, the adult females were moved to other round plastic Petri dishes and the laid eggs were incubated until egg hatching. These leaves and N1 nymphs were placed into other Petri dishes to start the pre-imaginal rearing.

The Petri dishes were kept in an incubator under the same condition mentioned above until *D. lutescens* reached the adult stage. To maintain adequate prey supply continuously, the substrates infested with the prey species were frequently replaced inside the Petri dishes. All the populations were reared in the laboratory for five to seven generation before the start of the experiment.

Greenhouse experiments

The experiment was conducted in greenhouse conditions with a temperature of 25 °C. The release and evaluation of effectiveness of *D. lutescens* as biological control agent of aphid *M. persicae* was conducted on sugar beet plants into cages. In designing the experiment, the sugar beet plant pots ready for planting in the greenhouse environment. The sugar beet seeds were sown in earthen pots. Three aluminum cages with dimensions of 65 × 65 × 70 cm was designed and built for testing. The pots, watering and care was taken and they were transferred to cages, with grow of plants to eight-leaf stage. In each cage was placed four pots of sugar beet and Cages was named (Control, treatment 1 and treatment 2). In the first week, on each sugar pot into cages were released number 10 adult aphid of *M. persicae* (total of 40 adult aphids per cage). In the second week, the population of aphids per cage (control and treatments) were taken recorded. The recorded was performed as relative counts with separate one sheet of each pot into cages with the same characteristics and counting aphids on detached leaves.

Then, five newly fertilized females of predatory bug was released in treatment 1. In the third week, aphid population in cages was counted by the mentioned method. The number of eggs, nymphs and adults of predator was assessed and recorded at treatment 1. This week five newly fertilized females of predator was released at treatment 2. In the fourth and fifth weeks was evaluated and recorded aphid populations in total cages and egg, nymph and adult predator at treatments 1 and 2. The experiment continued for seven weeks till all the plants were tested.

Statistical analysis

For statistical comparison among several means, all the data from the greenhouse studies on the aphids biological control by predatory bug were subjected to a one-way analysis of variance (ANOVA) followed by a Tukey Test.

RESULTS

The predatory bug *D. lutescens* has been successfully fed, reproduced and established on sugar beet plants under greenhouse conditions with *M. persicae* as prey during the greenhouse experiment.

The effect of predatory bug on the green peach aphid populations is shown in the greenhouse in Figure 1. The results indicate that growth of aphid population is different clearly in the control at compared with other treatments, during the five weeks. The growth of aphid population in the control increased at two steps with different slopes. But it was the release of natural enemies in treatment 1, no increasing trend fell in the end of fifth week.

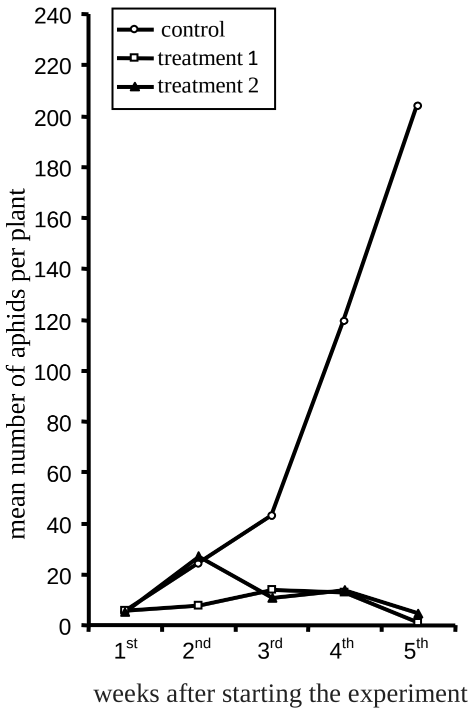

Figure 1: Mean number of *M. persicae* on sugar beet leaves in the presence and absence of *D. lutescens* in greenhouse

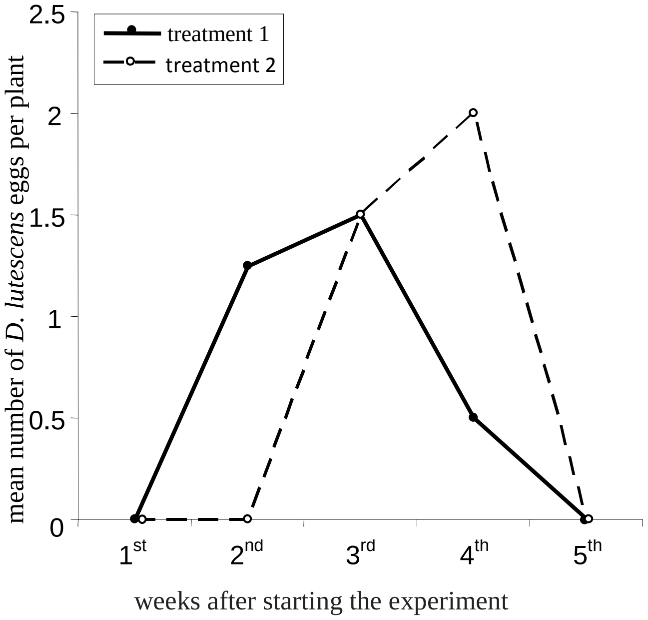

Figure 2: Mean number of *D. lutescens* eggs on sugar beet leaves in greenhouse

In treatment 2 until was not released the predatory bug, population growth was increasing in accordance with diagram slope of control. But after the release of natural enemies, the total number of the prey had decreased gradually till it reached zero in the 5th week.

With investigation the number of predator eggs in treatments 1 and 2, the highest rates of eggs was observed on leaves after the release of natural enemies in the first and second weeks. But in the next weeks, the number of eggs on the leaves reduce to gradually and it reached zero eventually (Figure 2).

At first the number of predator nymphs showed a considerably increase at treatment 1, but it decreased to fifth week. Also the number of predator nymphs increased in the 2 treatment, primarily. However, the population increase has stopped in the last week (Figure 3).

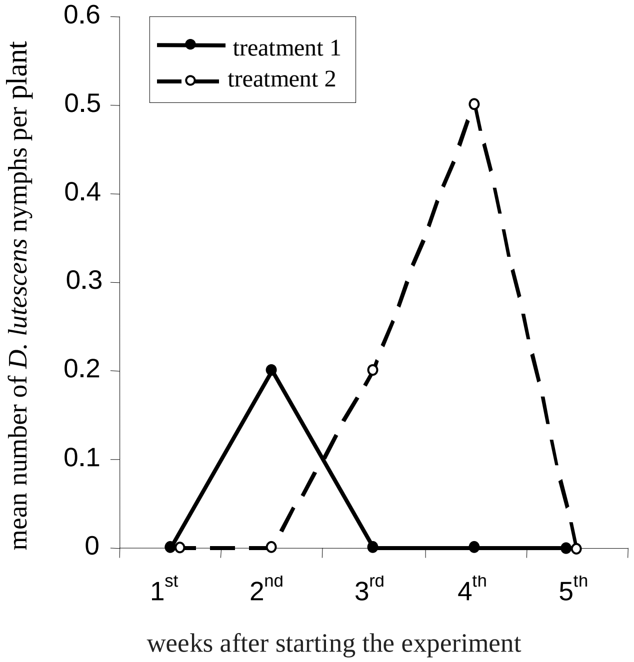

Figure 3: Mean number of *D. lutescens* nymphs on sugar beet leaves in greenhouse

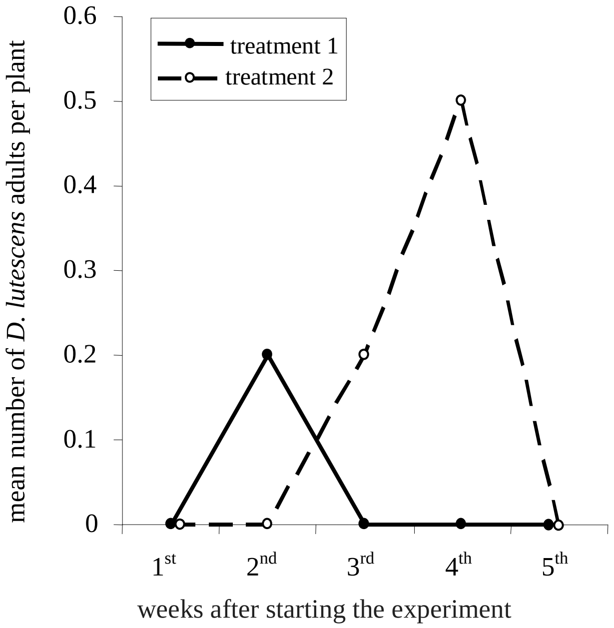

Figure 4: Mean number of *D. lutescens* adults on sugar beet leaves in greenhouse

The mature predators on leaves were observed in treatments 1 and 2 in the Weeks after the release of natural enemies. But they were not observed on leaves in the third week (Figure 4).

DISCUSSION

The results demonstrated that *D. lutescens* was able to successfully feed, reproduce and consume *M. persicae* under greenhouse conditions. During the greenhouse experiment, the mean number of the aphid individuals per plant was significantly higher in the control treatment than in the treatments with *D. lutescens*. Silveira et al. (2004) had tested the efficiency of *O. insidiosus* in reducing the population of *C. phaseoli* on chrysanthemum under greenhouse conditions. According their results, the number of the thrips per plant increased more than 3 fold (from 2.0 to 7.0 thrips/plant) in the absence of the predator between the first and the fifth week, whereas the numbers decreased more than 10 fold (from 2.0 to less than 0.2 thrips/plant) in the presence of *O. insidiosus*. Early releases of the predator when *M. persicae* appear on leaves, allow a good and effective establishment of the predators and the aphid control. Also, the current result mentioned that after two weeks of releasing the predatory bugs in both treatments (I and II) of the experiment, aphid population densities were dramatically lower in treatments with the predator than in the control.

In studies of Silveira et al. (2004) multiplication of *O. insidiosus* on chrysanthemum plant occurred quickly, and the offspring suppressed thrips populations already during the first weeks after their release. Similar trend in the number of *D. lutescens* was also found by current results, where the number of the predator increased speedily one week after release. It may be attributed to the duration of embryonic development of the predator, where it was ranged from 5.1 to 5.6 days at 25ºC with different aphid species as prey [9]. Therefore, it is very well possible that the number of *D. lutescens* used for *M. persicae* control on sugar beet plants under greenhouse conditions can be reduced, and this would result in lower cost of biological control without influencing its success. The present result indicated that the population of the aphid effects on the predator population, while the predatory bug able to reproduce on sugar beet plants in the absence of prey. In studies of Armer et al. (1998), the predatory bug *O. insidiosus* obtain water from the xylem, and may ingest small amounts of starches, sugars, and amino acids from the mesophyll. Their results suggest that facultative phytophagy by the predator primarily provides the insect with water, but also may provide some nutrients that supplement a prey diet and help the predator survive periods when prey are scarce.

During the experiment, the efficiency of *D. lutescens* in reducing the population of *M. persicae* was generally higher when the predator was released 1 week rather than 2 weeks after infestation with aphid. However, the results showed the predator to be strongly effective to control the aphid on sugar beet plant in both treatments (I and II).

In this discussion was evaluated the economic gains of usage biological control in greenhouse. In this regard, not only to control the world market production but also, It is important to the quality of products. Therefore, the task of policy makers, planners and managers should be towards compilation and providing of appropriate programs for stable development of agricultural products and enhance the products quality in order to health promotion and global market. One of the key points on the quality of agricultural products is lack of pesticide residues and their health. Therefore, valuation of products based on the amount of pesticide residues that could lead producers to further healthy products.

Human growing demand for plant products has led to further her approach to cropping culture from broad (Extensive) to narrow (Intensive). One of the methods cropping of Intensive is using of greenhouses that they have appropriate conditions to produce of products at compared to natural conditions. Often, the greenhouse conditions was appropriate for More damaging of pests. Thus control of pest in greenhouses is more important than the farm. One way to the seemingly easy and fast for control of pests is chemical control. But the dangers of using pesticides is obvious. Chemical control in greenhouse environment is more problematic for the following reasons: Better growth of pests in greenhouses, pests become resistant to pesticides faster, high risk of pesticide residues for consumers (due to fresh- eating products).

So, It's other methods of pest control such as protection and rearing from the third ring of the food chain for controlling pests or so-called " Biological control" are introduced. Biological control can include the creation of favorable conditions for better growth of population or the population increase in the release at environment.

It is most feel using other methods of pest control including biological control in greenhouses. Furthermore, They are the most successful biological control due to the limitation of greenhouse environments. The economic benefits of naturally occurring biological control have been repeatedly demonstrated in those cases where secondary pests became unmanageable as a result of overuse of chemical pesticides to control primary pests.

CONCLUSION

This predatory bug seems to be a promising predator to be used alone or integrated with some pesticides in an IPM program to provide a great level of different aphid species suppression. Under greenhouse conditions, *D. lutescens* could feed, survive and build up its population as well as cause up to 99% reduction in *M. persicae* population on sugar beet plants. However, there are still some points to be further investigated, for example, the suitability of the predator for the biological control of thrips and spider mites on different crops, impact of intraguild predation and selective insecticides on predation efficacy of the predator under greenhouse conditions as well as establishing a feasible method for the mass rearing of the predator.

Acknowledgements
This study was performed in insectology laboratory and greenhouse of Shahid Bahonar University of Kerman, Iran. so, It was supported by the Islamic Azad University of Rafsanjan. The authors wish to thank Dr kamal ahmadi (Department of Plant Protection, Faculty of Agriculture, Shahid Bahonar University) for providing valuable guidances.

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