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RELEASE OF *Stethorus gilvifrons* (MULS.) (COLEOPTERA: COCCINELLIDAE) AS A BIOLOGICAL CONTROL AGENT OF THE TWO-SPOTTED RED SPIDER MITE, *Tetranychus urticae* KOCH ON SOYBEAN PLANTATIONS UNDER FIELD CAGE CONDITIONS.

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ABSTRACT

This study was outlined to declare the effect of releases of *Stethorus gilvifrons* (Muls.) adults at different predator: prey ratios (P: p) to control the two-spotted red spider mite, *Tetranychus urticae* Koch on soybean plants under field cage conditions during summer season of 2007.

Effective control of *T. urticae* was gained after nine day from introducing the adult of the coccinellid predator when the P: p ratio was 1:10 or 1:20. Meanwhile at higher ratios (1:40 and 1: 50), the two-spotted red spider mite numbers were decreased after 12 days from the release.

The numbers of the two-spotted red spider mite were decreased by 85 and 79.75% at 1:10 and 1:20 P: p ratios, respectively when adults of the coccinelld released. The number of the two-spotted red spider mite remained zero for a period of 12 days after the release. At the predator: prey ratio of 1:40, the reduction percentage of the two-spotted red spider mite was 10.13 and 40.37% after one and three days. Whereas, at the higher ratios 1:50 the reduction percentage was 8.5 and 32.0, 51.4, 67.2 and 86.70% after one , three, six, nine and 12 days from the release, respectively. After nine days from release P: p of 1:10, 1:20, 1:30, 1:40 and 1:50, the reduction percentage was 85.0, 79.75, 76.87, 76.33 and 67.20 %. After 12 days where as the reduction percentages were 100,100, 92.33, 91.75 and 86.7, respectively. The reduction rate was increased with lower P: p ratios and vice versa.

Keywords: *Stethorus gilvifrons*, release, predator: prey ratio, *Tetranychus urticae*.

INTRODUCTION

In recent years, the two-spotted red spider mite, *Tetranychus urticae*, (Tetranychidae) has become a serious mite of several economic vegetable crops including soybean. Reduced plant vigor, stunting and deformed plant parts are common symptoms of mite infestations (Mirdul *et al*., 2002).

Rising costs of insecticides, widespread insecticides resistance and increasing restrictions on insecticides use have spurred interest in an insect management by other means, including biological control. Biological control is the cornerstone in every satisfactory program in an integrated pest management. Control of insect pests by predators is operationally defined as the action of predators that maintains a pest population at a lower level than would occur in the absence of the predators. It involves the manipulation of

trophic interactions to achieve a reduction in pest density (Hodek *et al*., 1972; Ehler, 1996). Theory and practice of biological control suggest that generalist predators can be effective control agents. Field studies show that generalist predator species can reduce pest numbers by a significant degree and in some cases reduce or prevent crop damage. This evidence is mainly from semi-field conditions (field cage) and providing that predator: prey ratios and the timing of releases are optimized (Symondson *et al*., 2002). Generalist insect predators are frequently abundant in annual crops including vegetable crops and have been identified as important in suppression populations of damaging insects (Rosenheim *et al*., 1995).

Several methods have been used to measure the effect of predators on the two-spotted red spider mite populations. One common technique is to use field cage conditions to enclose known numbers of predatory species with artificially known numbers of mite species. Shands *et al.* (1972) used this technique and found that releases of *Chrysopa* spp., *Coccinella septempuntata* L., and *Coccinella transversoguttata* Brown larvae reduced *Myzus persicae* (Sulz.) populations.

Therefore, the aims of the current study were: to evaluate the optimal predator: prey ratio for the release of adult on soybean plants under field cage conditions and the average of increasing numbers of *T. urticae* under field cages condition on soybean plants.

MATERIALS AND METHODS

The experimental traits were conducted at the farm of Economic Entomology Department, Faculty of Agriculture, Mansoura University during the summer of 2007. The soybean variety was Giza111. The soybean plants were transplanted on the 1st of May, 2007. The plants received the normal agricultural practices.

Adults of *S. gilvifrons* were collected from the experimental farm of the Economic Entomology Department. The eggs laid by each female of predator were removed daily and monitored until hatching. The hatched larvae were reared individually to avoid cannibalism on the two-spotted red spider mites in tubes (10 cm. in diameter) until adult emergence.

Twenty cages (100x50x90 cm) were covered with muslin and prepared with one meter long zipper to facilitate counting of the two-spotted red spider mites and predator stages. Soybean plants under cages were sprayed with Malathion 57%. E.C. to kill any pests on the plants before releasing the predator. Two weeks after spraying, artificial infestation from adults of the two-spotted red spider mite was made at the following numbers: 10, 20, 30, 40, and 50/plant. The introduction of adult of the coccinellid predator was done by fine camel brush.

The coccinellid predator was released into the cages as early newly emerged adults. The following predator: prey ratios: 1:10, 1:20, 1:30, 1:40, and 1:50 were used. Four replicates were used at each predator: prey ratio and four replicates for check (without releasing). The number of the two-spotted red spider mites and the predator stages were carefully counted every three days to measure the success of the release rate.

Data analysis:

The two-spotted red spider mite numbers at predator: prey ratios were subjected to one way analysis of variance (ANOVA) and the means separated using Duncan's Multiple Range Test (Costat, 2004). In addition, simple linear regression between predator: prey ratio and reduction percentage was run. The reduction percentage was calculated according to Abbott's formula (Abbott, 1925).

$$\text{Reduction\%} = \left(1 - \frac{\text{No. of mites in treated after treatment}}{\text{No. of mites in control after treatment}}\right) * 100$$

RESULTS

An effective control of the two-spotted red spider mite populations was achieved after nine days from release of the coccinellid adult with the predator: prey ratio of 1:10 and1:20 (Table 1). The reduction percentage of these ratios was 31.0 and 18.75 after one day, 49.50 and 49.0 after three days, 69.60 and 64.87 after six days and 85.0 and 79.75 % after nine days, respectively. It was observed that the number of the two-spotted red spider mite at these ratios remained zero for a period of 12 days after release of the predator adults.

When the predator: prey ratios was 1:30, the reduction percentage was 12.66 , 44.66, 63.0 after one, three and six days, 76.87 and 92.33, % after nine and 12 days from introducing the predator adults, then the two-spotted red spider mite numbers remained zero after 15 days from release. Whereas, at 1:40 and 1:50, the two-spotted red spider mite reduced by 10.13 and 8.5% after one days, 40.37 and 32.0 after three days, 63.0 and 51.4 after six days, 76.33 and 67.2% after nine day, 91.75 and 86.7% after 12 days (Table 1).

From the above results, effective control of *T. urticae* was gained after nine day from introducing the adult of the coccinellid predator when the P: p ratio was 1:10 or 1:20. The statistical analysis showed that there was a significant decrease of the two-spotted red spider mite numbers of predator: prey ratios and days after release of *S. gilvifrons* adults.

Table 1 : Reduction percentage of *T. urticae* after release of *S. gilvifrons* adults at different predator: prey ratios under field cage conditions on soybean plants.

Days after release	P: p ratio				
	1:10	1:20	1:30	1:40	1: 50
1	31.00	18.75	12.66	10.13	8.50
3	49.50	49.00	44.66	40.37	32.00
6	69.60	64.87	63.00	63.00	51.40
9	85.00	79.75	76.87	76.33	67.20
12	100.00	100.00	92.33	91.75	86.70
15	-	-	100.00	100,00	100.00

The regression equations between predator: prey ratios of the coccinellid adult (as independent variable X) and reduction percentages of the two-spotted red spider mite (as dependent variable Y). Based on simple linear regression between P: p ratios of *S. gilvifrons* adults and reduction percentage of the two-spotted red spider mites, there were negatively strong relationship after one, three and six days from the release of the coccinellid adults. The regression equations were Y =32.295 -0.5363x, Y =54.695 -0.4063x, Y =74.28 -0.4252x +, Y =88.736 -0.3902x and, Y =104.61 -0.3485x, respectively. The values of R^2 were 0.8603, 0.9135, 0.9577, 0.9059, and 0.913 in succession (Figures 1,2,3,4 and 5).

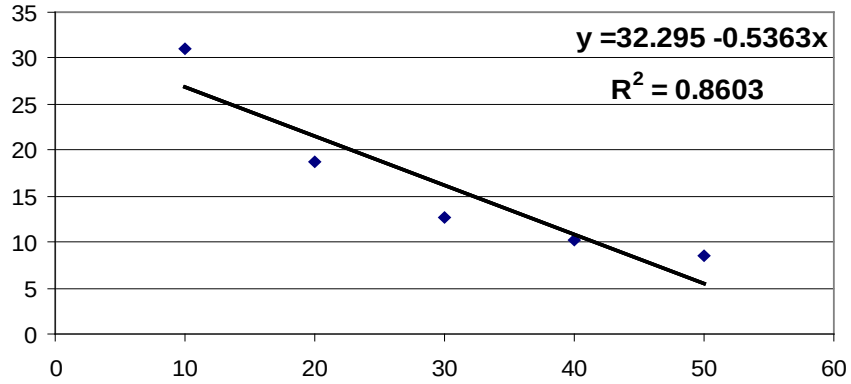

Figure 1: Simple linear regression between predator: prey ratios 1:10) (X) and the reduction percentages (Y) of *S. gilvifrns* adults under field cage conditions.

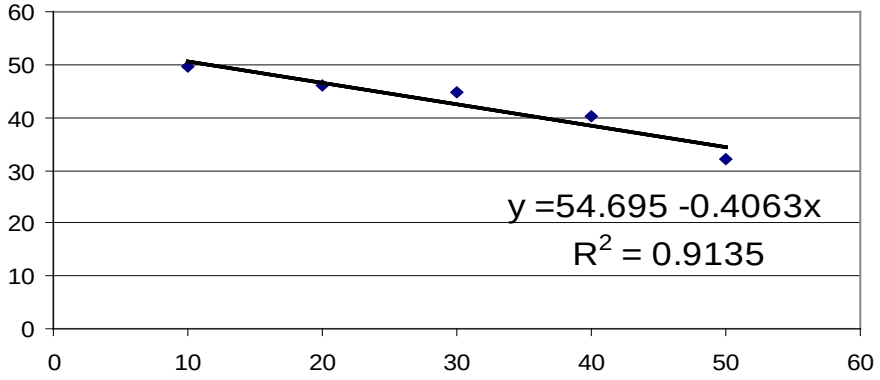

Figure 2: Simple linear regression between predator: prey ratios (1:20) (X) and the reduction percentages (Y) of *S. gilvifrns* adults under field cage conditions.

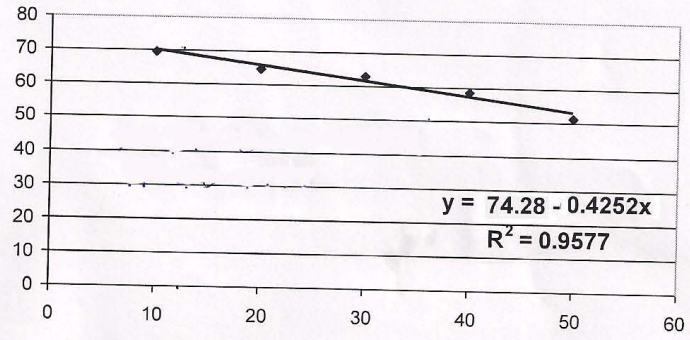

Figure 3. Simple linear regression between predator: prey ratios (1:30) (X) and the reduction percentages (Y) of *S. gilvifrns* adults under field cage conditions.

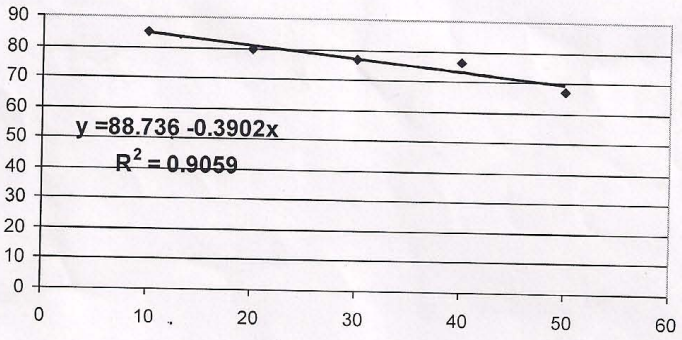

Figure 4. Simple linear regression between predator: prey ratios (1:40) (X) and the reduction percentages (Y) of *S. gilvifrns* adults under field cage conditions.

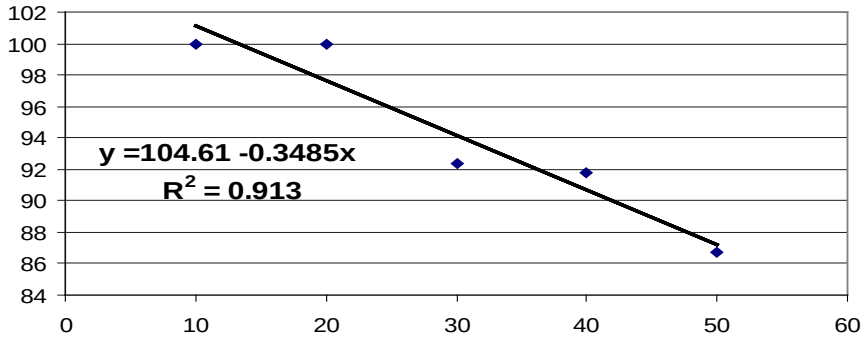

Figure 5: Simple linear regression between predator: prey ratios (1:50) (X) and the reduction percentages (Y) of *S. gilvifrns* adults under field cage conditions.

These equations indicated that there was a highly negative relationship between P: p ratios and reduction rates which mean that the reduction rate was increased with lower P: p ratios and vice versa.

In the check cages (without predator release), the number of the two-spotted red spider mite increased 100% after six day from initial artificial infestation at 20, 30, 40, and 50 mites/plant. After nine days, the mites increased rapidly to 140, 150.8, 155, 167, 158 mites/plant. Up to 1000%, increasing rate of the two-spotted red spider mite occurred after 12 days from initial artificial infestation (Figure 6). The number of mites increased sharply and heavily damaged the soybean plants. These results confirmed the effect of the predators in suppressing the number of the two-spotted red spider mite. Based on the regression analysis, there was a highly negative relationship between initial artificial infestation of *T. urticae* and average final of increasing number of the two-spotted red spider mite. The value of R^2 = 0.8527 (Figure. 6).

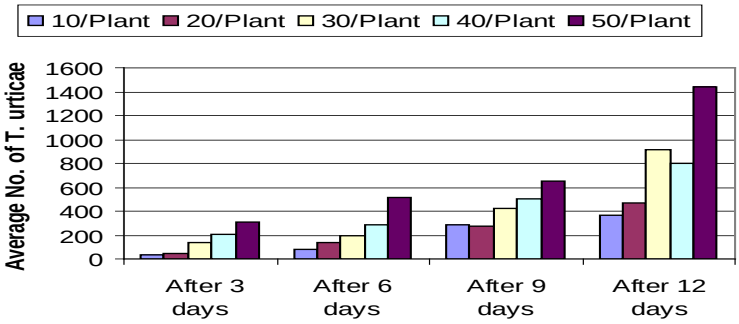

Figure 6: Average of increasing numbers of *T. urticae* under field cage conditions on soybean plants. Plants were initially inoculated with 10, 20, 30, 40 and 50 the two-spotted red spider mites/plant.

DISCUSSION

Biological control has a great potential for use against the two-spotted red spider mites*, T urticae* based on successes of biological control against other mite and the abundance of biological control agents (Rott and Ponsonby, 2000 b). Many potential predators have been identified against *T urticae* including *Stethorus punctillun* Weise) and Generalist mite, *Amblyseius californicus*. Both predators are active acariphagous in London fields due to their highly prey consumption rates, highly fecund, and highly searching rates (Rott and Ponsonby, 2000 b).

Naturally, occurring predators are usually not sufficient to control the two-spotted red spider mite populations and so augmentation release of predators into the agro-ecosystem would be necessary to gain successful biological control (Rott and Ponsonby, 2000 b). However, their food resources affect the performance of bio-control agents. Therefore, a proper predator: prey ratio should be determined. The results of the current study clearly demonstrated that the effective P: p ratios were 1:10 and 1:20 for the coccinellid predator, *S. gilivfrons* adults after nine day of release under field cage conditions. Moreover, the release of the predator at the rate of 1:30 could not possibly keep the population of the two-spotted red spider mite down to a satisfactory level after 12 days. Whereas, after 15 days, the reduction percentage was 100%. On the other hand, the predator: prey ratio at 1:15 could suppress the aphid populations down to a satisfactory level, but there was not enough prey left for the predators to build up its populations. These results are in completely agreement with the following reports. Gurney and Hussey (1970) gained good control of *M. persicae* by releasing second instar larvae of the coccinellid, *Cycloneda sanguinea* L. at a P: p ratio of 1:20. In contrary, Adashkevich (1975) reported that best control of aphids gained in 10 days when first instar larvae of *Coccinella septempunctata* L. were released against *A. gossypii* at P: p ratio of 1:50 and 1:100. Meanwhile, a similar trend with our results was obtained by Hämäläinen (1977) who found that larvae of *Adalia bipunctata* L. at ratio of 1:5 yielded a good control of *M. persicae*. By a release ratio 1:10, *A. bipunctata* larvae were also decreased aphid numbers by half in 10 days. Whereas, a release ratio of 1: 20 was inadequate to prevent aphids increase.

Successful control reduction by at least 90% was obtained by release of *S. gilivfrons* adult after 12 days from release achieved 100% reduction in *T. urticae* at 1: 30, 1:40 and 1: 50 predator: prey ratio.

Meanwhile, Zibai and Hatami (2001) recorded that the predator: prey ratios of 1:30 and 1:90 significantly reduced the population of *A. gossypii*. At 1:30, there was no difference in efficacy between the use of the predators alone or in combination. At 1:90, control using *H. variegata* alone, or in combination with *C. carnea* was equally effective.

Based on regression analysis between P: p ratios of *S. gilivfrons* adult of the two-spotted red spider mite, there were negatively strong relationship after 1 and 12 days from the release of the predator. The reduction rate increased with lower P: p ratios and vice versa. This result closely matches with those of Rautapää (1977) who indicated that there was

a significantly negative relationship between P: p ratio of *C. septempunctata* and aphid indices and that a 50% decrease in the aphid, *Rhopalosiphum padi* (L.) is achieved when the initial P: p ratio is at least 1: 5.

In conclusion, *Stethorus gilvifrons* (Muls.) adults could be employed as the biological control agents against the two – spotted red spider mite, *T. urticae* under field cage conditions at the predator: prey ratios of 1: 15 and 1: 30.

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أطلاق المفترس أبو العيد ***Stethorus gilvifrons*** **Mulsant كوسيلة مكافحة بيولوجية للعنكبوت الأحمر على نباتات فول الصويا تحت ظروف الأقفاص الحقلية.**

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هدفت هذه الدراسة إلي تحديد تأثير إطلاق الحشرات الكاملة لمفترس أبو العيد *S. gilvifrons* و ذلك بنسب إطلاق مختلفة لمكافحة العنكبوت الأحمر على نباتات فول الصويا تحت ظروف الأقفاص الحقلية و ذلك خلال صيف 2007.

أظهرت الدراسة تحقيق مكافحة حيوية مؤثرة للعنكبوت الأحمر بعد 9أيام من الإطلاق في نسب الإطلاق 1: 10 ، 1: 20 بينما في نسب الإطلاق 1: 30 ، 1: 40 ، 50:1 انخفضت أعداد العنكبوت الأحمر بعد 12 يوم من نسب الإطلاق المختلفة و بناءا على تحليل جدول التباين اتضح وجود فرق معنوي بين أعداد العنكبوت الأحمر عند نسب الإطلاق المختلفة و كذلك بين النسب الزمنية (الأيام) بعد إطلاق الحشرة الكاملة لأبي العيد*S. gilvifrons* .

و أوضحت النتائج أن أعداد العنكبوت الأحمر قد انخفضت بنسبة 85.00،79.75 عند نسب الإطلاق 10:1 ، 20:1 على التوالي .و ذلك عندما تم إطلاق المفترس و لم تتواجد أي حشرة بعد 12 يوم من الإطلاق.

بينما عند نسب الإطلاق المرتفعة (30:1، 40:1 ، 50:1) كان معدل الانخفاض (92.33،91.75 ، 86.7 %) على التوالي بعد 12 يوم من الإطلاق.

و بناء على تحليل الانحدار بين نسب الإطلاق المختلفة للمفترس *S. gilvifrons* من ناحية ونسب الانخفاض في أعداد حشرة العنكبوت الأحمر من ناحية أخرى اتضح وجود علاقة قوية سالبة بينها وهذا يعنى أن نسب الانخفاض تتزايد مع نسب الإطلاق المنخفضة والعكس صحيح.

قام بتحكيم البحث

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