# Population fluctuations of *Tetranychus urticae* Koch and the associated predatory mite, *Euseius scutalis* (A.-H.) on three soybean cultivars at Gharbia governorate

**Helmy A. Anber[1], Ahlam A. Younes[2], Ghada M. El-Shafei[1] & Mohamed R. Ammar[2]**

[1]*Plant Protection Department, Faculty of Agriculture, Tanta University. E-mail, Helmyanber96@gmail.com*
[2]*Cotton and Field Crops Acarology Department, Plant Protection Research Institute, ARC. E-mail, EngAmmar85@yahoo.com*

## ABSTRACT

The population fluctuations of *Tetranychus urticae* Koch and the associated phytoseiid mite, *Euseius scutalis* (A.-H.) on three soybean cultivars at Gharbia Governorate were studied during two successive seasons of 2015 and 2016. The results indicated significant differences in the *T. urticae* infestations through 2015 and 2016 seasons. Giza 35 variety harbored the highest infestation recorded 552.56 and 440.5 motile stages/10 leaflets for the two successive seasons, as compared with Giza 21 and Giza 83 varieties. Giza 21 variety was the most tolerant one recorded 130.38 and 174.88 motile stages/10 leaflets for two successive seasons. Significant positive correlations occurred between the *T. urticae* population and *E. scutalis* in all soybean varieties. The predatory mite was the main important predator for suppressing population density of *T. urticae* population during the two successive seasons. The insignificant positive effect of maximum and minimum temperatures on the population of *T. urticae* infested the three soybean varieties during 2015 and 2016. The combined effect of the tested weather factors (max temp., mini temp. and R.H. %) and the plant age together on *T. urticae* population were studied. The plant age and phenology were more effective on *T. urticae* population as compared with the weather factors.

**Keywords:** ecology, spider mite, susceptibility, weather factors, *Glycine max*.

## INTRODUCTION

Soybean (*Glycine max* (L.) Merr., Fabaceae) is the major oil-seed crop grown and consumed in the world, with a worldwide production of 336.11 million metric tons in the 2019/2020 cropping season, 37% of which were grown in Brazil (USDA 2020). Among many arthropod pests attacking soybean crops in the tropical/subtropical region, the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) stands out due to its high potential to cause damage (Roggia et al. 2008).

The population densities of spider mite, *Tetranychus cucurbitacerum* on three soybean varieties Giza 21, Giza 22 and Giza 111 at Kafr-El-Sheikh Governorate were studied over two successive seasons. The results showed that in the first season the highest population of the *T. cucurbitacerum* was recorded on Giza 111, whereas Giza 21 harbored the least number. In the second season insignificant differences were recorded between the three varieties. They also showed that the population was not significantly affected by prevailing temperature and relative humidity during the two seasons (Magouz et al. 2006). The populations did not vary in the same way among soybean cultivars over time, which is attributed to differences among the cultivars with respect to their phenology and response to spider mites. The *T. urticae* densities varied significantly with cultivar and time. Also the highest growth rates for mites on soybean cultivars in both locations were occurred after the beginning of flowering, when the plants shifted from the vegetative to reproductive stages, about 3 weeks before reaching the peak densities (Arnemann et al. 2015). In Romania *T. urticae* is one of the most dangerous pests for soybean crop. Under climatic conditions of the Romania, this pest presents 5-6 generations per year. For soybean crop, the third and fourth generations are dangerous. Damages produced by pests of soybean crop, ranged from 3 to 21%, every year. In case of lack of the control measures, damages may increase to reach 70-100% (Georgescu et al. 2016).

Soybean cultivars differ in terms of their susceptibility to spider mite infestation. The soybean variety Giza 35 was the most susceptible variety with significant difference between the mean numbers of *T. urticae* as compared with other varieties. The mean rate of infestation was 11.89 individuals/25 $cm^2$ of leaves, while the mean numbers of *T. urticae* was 7.11 and 3.54 individuals/25 $cm^2$ of leaves for Giza 111 and Giza 82 without significant difference. Giza 22 recorded the lowest mean number of *T. urticae*, (1.53 individuals/25 $cm^2$ of leaves) (Heikal and Abo-Taka 2019).

The objective of the present study is to elucidate the population fluctuation of *T. urticae* and its associated predatory mite, *Eusieus scutalis* (A.-H) (Acari: Phytoseiidae) inhabiting soybean at Gharbia governorate in relation to prevailing weather factors.

## MATERIALS AND METHODS

### Ecological studies

A field experiments were carried out at Kafr Alzaiat, Gharbia governorate, Egypt, during 2015 and 2016 seasons.

### Population fluctuation of *Tetranychus urticae* Koch and its predatory mites inhabiting soybean at Gharbia governorate during the two successive seasons 2015–2016

Area of one feddan was generally used for cultivation of three soybean cultivars (i.e., Giza 21, Giza 35 and Giza 83) at Kafr Alzaiat, Gharbia governorate during two season of 2015-2016. This area was divided into 9 plots, each one (1/100 feddan). After 30 days post plantation, weekly sample of 10 leaflets presented for each variety. They were put in polyethylene bags and directly transported to the laboratory. Motile stages of *T. urticae* and the predacious mites on both lower and upper surface of leaves were counted. Maximum and Minimum temperatures (ºC) and average relative humidity (RH) prevailing in the area during the current study, were recorded. All the recommended agricultural practices were carried out as the need of the cultivated plants. Also, the experimental area was kept free from any pesticide treatments. On the other direction, the plants were left to the natural infestation and no artificial infestation was conducted (Elhalawany et al. 2020).

### Statistical analysis

Correlations between different factors were estimated. Data were analyzed by using one-way analysis of variance (ANOVA) and mean comparisons were conducted using Tukeys' HSD. Obtained data was analyzed using Procs Corr, Reg and ANOVA in SAS (Anonymous 2003). The partial regression used to obtain the amount of variability in the pest activity which could be attributed to the percentages of explained variance (EV %) as combined effect of the climatic factors. The combined effect of weather factors and plant age was considered as multiple polynomial regression, presented as $Y=a\pm b_1$ Temp_max$\pm b_2$ Temp_min$\pm b_3$ RH$\pm b_4$ Age$\pm b_5$ Age$^2\pm$b6 Age$^3$.

## RESULTS AND DISCUSSION

### Ecological studies

### Population fluctuation of *T. urticae* during 2015-2016 growing seasons

Illustrated results (Figures 1 and 2) showed that, *T. urticae* occurred during the two seasons from 2$^{nd}$ Jun. to 15$^{th}$ Sept. on soybean crops. During the first season, the infestation with mite motile stages occurred in moderate numbers after 30 days of plantation date on all tested varieties. A definite trend in population fluctuation was observed, the population gradually increased until reaching a peak in late June as: 170; 633 and 280 individuals/ 10 leaflets at maximum, minimum temperatures of 32.7º; 22.2°C and 47.0% relative humidity on Giza 21, Giza 35 and Giza 83, respectively. The peak continued till the third week of July on Giza 21 and Giza 83 varieties recording 205 and 560 individuals/10 leaflets. While, during the fourth week of July on Giza 35, 707 individuals/10 leaflets at maximum temperature 36.4°C and minimum temperature 23.9°C and relative humidity 45.4% was recorded. After that, the number of mites gradually decreased until the end of the season. The mean numbers of motile stages of *T. urticae* during the first season were 130.38, 552.56 and 366.75 individuals/10 leaflets for Giza 21, Giza 35 and Giza 83, respectively.

In the second season of 2016 the spider mite appeared in moderately numbers in early June as 96, 277 and 133 individuals/10 leaflets for Giza 21, Giza 35 and Giza 83, respectively. After that the population of spider mite gradually increased in numbers and reached its peak in 7 of July as 340 and 801 individuals/10 leaflets on Giza 21 and Giza 35, respectively, when the maximum, minimum temperatures and averaged relative humidity were 34.6º, 24.7°C and 58.7%; while the maximum number in mid-July was 582 individuals/10 leaflets for Giza 83 (Figure 2).

The results indicated that the tested soybean varieties were significantly differed in their *T. urticae* infestations according to the mean numbers of motile stages through 2015 and 2016 seasons. Giza 35 variety harboured the highest population significantly recorded of 552.56 and 440.5 motile stages/10 leaflets for the two successive seasons, whereas Giza 21 variety was

the most tolerant variety recorded 130.38 and 174.88 motile stages/10 leaflets (Table 1).

**Population fluctuation of *E. scutalis* during 2015–2016 growing seasons**

Seasonal fluctuation of the predaceous mite, *E. scutalis* collected with *T. urticae* during the studying period from Jun. 2, 2015 to Sept. 15, 2016 on soybean cultivars (Figures 1 and 2).

The predatory mites population fluctuation started with scarce numbers in mid-June then gradually increased in number reached its peak in late July with 28 individuals/10 leaflets on Giza 21, in the second week of Aug. 47 individuals/10 leaflets on Giza 35 and in early Aug. 30 individuals/10 leaflets on Giza 83 were recorded. Later on, the population gradually decreased in number until the end of the season in the first season 2015 in all soybean verities. The general mean numbers of predator mite were 18.50, 30.81 and 19.06 individuals/10 leaflets for Giza 21, Giza 35 and Giza 83, respectively.

In the second year, the predatory mite recorded few numbers in early June 2016 and gradually increased in number in mid-July with 35 individuals/10 leaflets on Giza 21, and in the third week of July 51 and 41 individuals/10 leaflets were recorded Giza 35 and Giza 83. After that the population of predatory mite sharply decreased gradually in number until the end of the season 2016 (Figure 2). The general mean numbers of predatory mite were 21.81; 32.06 and 27.56 individuals/10 leaflets for Giza 21, Giza 35 and Giza 83, respectively.

Wholly in agreement with the results obtained by (Magouz et al. 2006; Arnemann et al. 2015 and Georgescu et al. 2016). Also, Kalmosh et al. (2017) they found that population fluctuations of certain mites associated with soybean and cotton plants are depeated both the prevailing biotic and abiotic factors. In soybean plants, the population of phytophagous mite, *T. urticae* was recorded in high number in 2nd season than the 1st one, whereby represented by 272.83 and 202.69 individuals, respectively. Heikal and Abo-Taka (2019) reported that Giza 35 variety was the most susceptible variety with significant difference between the mean numbers of *T. urticae* compared with other varieties. The population dynamics of *T. urticae* showed that infestation increased gradually from mid-June day reached its maximum at the end of July, and then decreased gradually at the beginning of Aug., reached its minimum number at the beginning of Sept. before the harvest time.

Padilha et al. (2020) reported the reduction of soybean grain yield caused by *T. urticae* damage. The population density of one *T. urticae* per $cm^2$ of leaf area caused the following reductions: one pod per plant, two grains per plant, 0.7 g of 1,000-grain weight, and 0.35 g of grain yield per plant or 42 kg $ha^{-1}$.

**Efficiency of the predatory mite, *Euseius scutalis* on the *T. urticae* population**

Statically analysis presented in (Table 2) indicated that, highly significant positive correlation were recorded between the *T. urticae* population and the predatory mite, *Euseius scutalis* in all soybean varieties in the first season 2015 (0.91***, 0.80** and 0.66*).

**Table 1.** Mean populations of *Tetranychus urticae* on soybean cultivars during seasons 2015–2016

| Varieties / Season | Average number of *T. urticae*/ 10 leaves | | | LSD |
|---|---|---|---|---|
| | Giza 21 | Giza 35 | Giza 83 | |
| 2015 | 130.38[c] | 552.56[a] | 366.75[b] | 2.82 |
| 2016 | 174.88[c] | 440.50[a] | 315.5[b] | 2.82 |

Means with the same letters at the same row are not significantly different (P> 0.05).

**Table 2.** Correlation coefficient between population fluctuation of predatory mite, *Euseius scutalis* with relation to *Tetranychus urticae,* on three soybean cultivars during 2015–2016 seasons

| Varieties / Season | Giza 21 | Giza 35 | Giza 83 |
|---|---|---|---|
| 2015 | 0.91*** | 0.80** | 0.66* |
| 2016 | 0.96*** | 0.43 ns | 0.89*** |

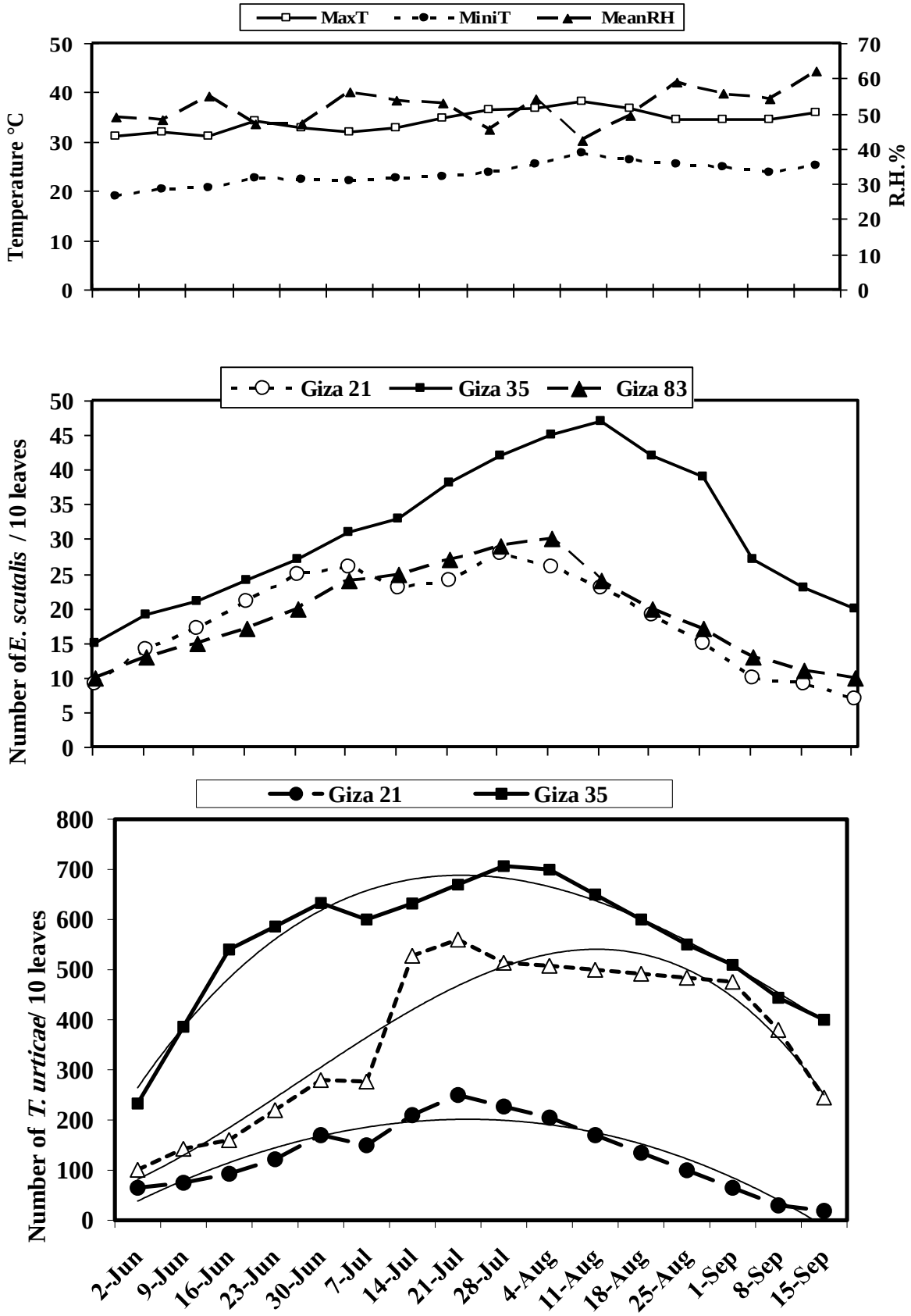


**Figure 1.** Population fluctuation of *Tetranychus urticae* and *Euseius scutalis* on three soybean cultivars at Kafr Alzaiat, Gharbia governorate during season 2015.

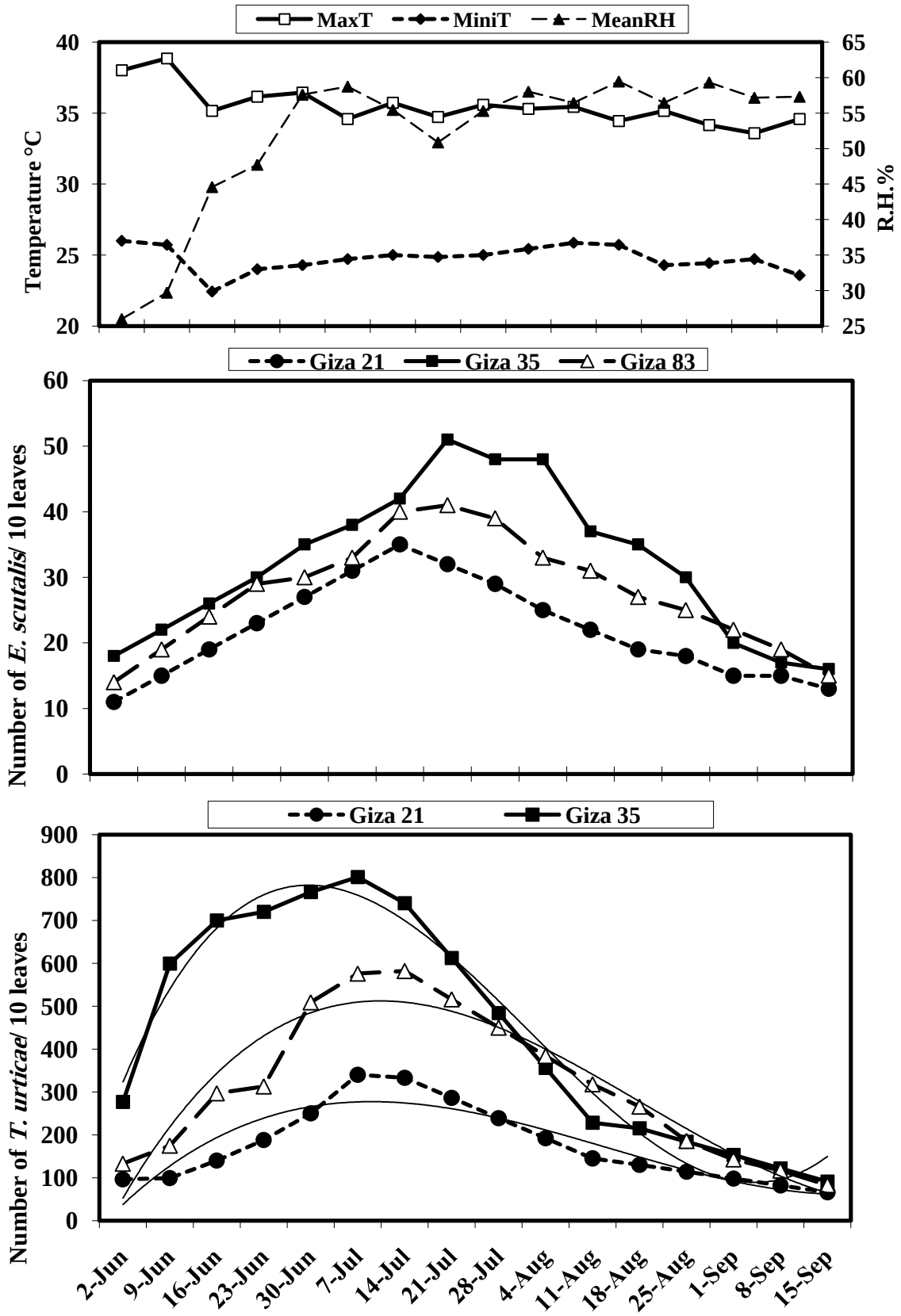


**Figure 2.** Population fluctuation of *Tetranychus urticae* and *Euseius scutalis* on three soybean cultivars at Kafr Alzaiat, Gharbia governorate during season 2016.

In the second season of 2016, highly significant positive correlations on Giza 21 and Giza 83 (0.96*** and 0.89***), but insignificant positive correlation on Giza 35 (0.43) between the number of spider mite and the phytoseiid one. These results mentioned that the predatory mite, *Euseius scutalis* was the main important predator for suppressing population density of *T. urticae* population during the two successive seasons. These results are consistent with findings from previous studies (Heikal and Abo-Taka 2019), they showed that the mean number of predatory mite, *Agistemus exsertus* was the highest on Giza 35 (2.46 individuals/25 $cm^2$) followed by Giza 22 (2.13 individuals/25 $cm^2$), but the number of mites on Giza 82 and Giza 111 were 1.99, and 1.91 individuals/25 $cm^2$.

**The effect of tested varieties on the relation between *T. urticae* and *E. scutalis***

Data in Table (3) showed that the population ratio of the predatory mite, *E. scutalis* per *T. urticae* was significantly differenced for the two seasons. In addition, it was significant different between the three soybean varieties. The Giza 21 was received high population of the predatory mite than other two varieties.

**Table 3.** Significant effect of tested varieties on the relation between *Tetranychus urticae* and *Euseius scutalis*

| Factor | Level | Mean |
|---|---|---|
| Year | 2015 | 0.094 b |
| | 2016 | 0.112 a |
| F | | 4.60 |
| P-value | | 0.0351 |
| HSD | | 0.016 |
| Variety | G21 | 0.152 a |
| | G35 | 0.076 b |
| | G83 | 0.082 b |
| F | | 33.74 |
| P-value | | 0.0001 |
| HSD | | 0.024 |

Means with the same letters at the same column within each factor are not significantly different (P > 0.05).

**Effect of weather factors and plant age on the population fluctuation of *T. urticae* on different soybean cultivars**

The effect of climatic factors and plant age on the population fluctuation of *T. urticae* infesting soybean plants during the two seasons 2015-2016, are presented (Tables 4 and 5). Simple correlation values for daily maximum, minimal and % R.H. ranged between -0.0001 and 0.722 with P-values between 0.141 and 0.997 (insignificant correlation) except in Giza83 variety data where it was 0.003 and 0.002 for daily maximum and minimum temperature, during 2015 season. During 2016 season correlation r values ranged between -0.046 to 0.333 (insignificant correlation), with P values between 0.253 and 0.885. This indicated no relation between weather factors over the growing seasons and *T. urticae* population dynamics. These results are confirmed by applying multiple regression analysis for the combined effect weather factors over the two seasons. No any factor showed significant effect within the weather factors (Tables 4 and 5). The explained variance over the first season ranged between 19.86 and 52.96, while it was 17.2 and 30.56 or the second season. The single effect of applying the third degree polynomial model using plant age revealed explained variance in the rage of 88.34 to 90.64 with P-value of <0.0001 (very high significant level) for the first season. Similar results were found in the second season. Obtained values were 83.37 to 97.26 for explained variance with P-value of <0.0001. The compiled effect of weather factors and plant age were not more significantly than plant age. This indicated that the change in the nutritional value of the host plant was more effective on mite population dynamics than weather factors.

**ACKNOWLEDGMENT**

Deepest gratitude to Prof. M.M. Abou-Setta (Plant Protection Research Institute, Agricultural Research Centre), for his help in the statistical analysis and revising the earlier draft of the current manuscript.

**Table 4.** Simple correlation coefficients and multiple regression values for the effect of weather factors and plant age on *T. urticae* populations during the growing season 2015 on soybean varieties.

| Variety | Factor | Level | Simple Correlation | | Multiple Regression | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | r | P | b | P | F | P | EV % |
| Giza 21 | Weather | Temp max | 0.268 | 0.316 | 13.92 | 0.5707 | 0.990 | 0.4298 | 19.86 |
| | | Temp min | 0.152 | 0.575 | -6.99 | 0.7594 | | | |
| | | RH | -0.38 | 0.141 | -4.11 | 0.3165 | | | |
| | Plant age | Age-Age$^3$ | - | - | - | - | 30.310 | <0.0001 | 88.34 |
| | Combined | | - | - | - | - | 29.110 | <0.0001 | 95.1 |
| Giza 35 | Weather | Temp max | 0.482 | 0.058 | -6.01 | 0.8850 | 1.700 | 0.22 | 29.82 |
| | | Temp min | 0.490 | 0.054 | 33.42 | 0.4001 | | | |
| | | RH | -0.22 | 0.415 | -6.34 | 0.3668 | | | |
| | Plant age | Age -Age$^3$ | - | - | - | - | 38.720 | <0.0001 | 90.64 |
| | Combined | | - | - | - | - | 38.150 | <0.0001 | 96.22 |
| Giza 83 | Weather | Temp max | 0.696 | 0.003 | 17.04 | 0.6851 | 4.500 | 0.0245 | 52.96 |
| | | Temp min | 0.722 | 0.002 | 35.01 | 0.6851 | | | |
| | | RH | -0.001 | 0.997 | 0.43 | 0.9501 | | | |
| | Plant age | Age -Age$^3$ | - | - | - | - | 38.720 | <0.0001 | 90.64 |
| | Combined | | - | - | - | - | 21.120 | <0.0001 | 93.37 |

**Table 5.** Simple correlation coefficients and multiple regression values for the effect of weather factors and plant age on *T. urticae* populations during the growing season 2016 on soybean varieties.

| Variety | Factor | Level | Simple Correlation | | Multiple Regression | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | r | P | b | P | F | P | EV % |
| Giza 21 | Weather | Temp max | -0.059 | 0.827 | 36.19 | 0.2896 | 0.830 | 0.5022 | 17.2 |
| | | Temp min | 0.039 | 0.885 | -0.98 | 0.9721 | | | |
| | | R.H.% | 0.279 | 0.296 | 6.44 | 0.1488 | | | |
| | Plant age | Age -Age$^3$ | - | - | - | - | 20.050 | <.0001 | 83.37 |
| | Combined | | - | - | - | - | - | 11.610 | 0.0009 |
| Giza 35 | Weather | Temp max | 0.333 | 0.827 | 165.53 | 0.0821 | 1.760 | 0.2081 | 30.56 |
| | | Temp min | -0.219 | 0.416 | -122.24 | 0.1207 | | | |
| | | R.H.% | -0.174 | 0.520 | 11.69 | 0.3148 | | | |
| | Plant age | Age -Age$^3$ | - | - | - | - | 136.040 | <.0001 | 97.14 |
| | Combined | | - | - | - | - | - | 53.280 | <.0001 |
| Giza 83 | Weather | Temp max | -0.046 | 0.866 | 82.77 | 0.1918 | 1.180 | 0.3592 | 22.74 |
| | | Temp min | 0.046 | 0.866 | -3.79 | 0.9410 | | | |
| | | R.H.% | 0.304 | 0.253 | 14.16 | 0.0888 | | | |
| | Plant age | Age -Age$^3$ | - | - | - | - | 41.940 | <.0001 | 91.29 |
| | Combined | | - | - | - | - | - | 22.890 | <.0001 |

## REFERENCES


Anonymous. 2003. SAS Statistics and Graphics Guide, Release 9.1. SAS Institute, Cary, North Carolina, 275l3, USA.

Arnemann JA, Fiorin RA, Perini CR, Storck L, Curioletti LE, Nachman G, Guedes JVC. 2015. Density and growth rates of spider mites in relation to phenological stages of soybean cultivars in Brazil. *Experimental and Applied Acarology*, 67(3), 423–440.

Elhalawany AS, Sayed AA, Khalil AE. 2020. Biodiversity and population dynamics of mites inhabiting date palm trees in Qalyubia and New Valley Governorates, Egypt. *Egyptian Journal of Plant Protection Research Institute*, 3(1), 346–364.

Georgescu E, Cana L, Gargarita R, Rasnoveanu L. 2016. Researches concerning two spotted spider mite (*Tetranychus urticae*) control, at soybean crop, in south-east of the Romania. *Analele Institutului National de Cercetare-Dezvoltare Agricola Fundulea*, 84, 209–229.

Heikal HM, Abo-Taka SM. 2019. Susceptibility of soybean varieties to mites associated with some biological aspects. *African Entomology*, 27(1), 114–120.

Kalmosh FS, El-khayat EF, Rady GH, Mohamed OM, Abdel-Zahir TR. 2017. Population fluctuations of certain mites associated with soybean and cotton plants in relation to climatic factors and leaf phytochemical contents. *Egyptian Journal of Agriculture Research*, 95(2), 561–577.

Magouz RI, Saadoon SE, Kassem SA. 2006. Population density of *Tetranychus cucurbitacerum* (Sayed) and *Bemisia tabaci* (Genn.) on certain soybean varieties in relation to some weather factors and leaf chemical controls. *Journal of Agriculture Research, Tanata University*, 32(1), 90–102.

Padilha G, Fiorin RA, Filho AC, Pozebon H, Rogers J, Marques RP, Castilhos LB, Donatti A, Stefanelo L, Burtet LM, Stacke RF, Guedes JVC, Arnemann JA. 2020. Damage assessment and economic injury level of the two-spotted spider mite *Tetranychus urticae* in soybean. *Pesquisa Agropecuária Brasileira*, 55, 1–10.

Roggia S, Guedes JVC, Kuss RCR, Arnemann JA, Návia D. 2008. Spider mites associated to soybean in Rio Grande do Sul, Brazil. *Pesquisa Agropecuária Brasileira*, 43, 295–301.

USDA. 2020. United States Department of Agriculture. *World Agricultural Production*. Available from: https://apps.fas.usda.gov/psdonline/circulars/production.pdf