The Effectiveness of Phytochemical Components and Climatic Factors on Population Fluctuation of the Spider Mite, *Tetranychus urticae* Koch on Sweet Pea and Pea Crops

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Abstract: Studies were conducted to define the level infestations of sweet pea and pea crops to the infestation of the spider mite, *Tetranychus urticae* Koch, and its predatory mite *Amblyseius swirskii* (Athias-Henriot) during two successive seasons (2016-2017 and 2016-2017) at El- Ayyat - Giza Governorate. Results appeared that the infestation of two cultivars by *T. urticae* was begun in the first week of October under greenhouse conditions. Progressively increased till its peaks in the third week of June for (sweet pea) and in the first week of February for (pea) during the two successive seasons. Through two consecutive seasons, sweet pea cultivar was the most highly sensitive than pea, arranged in a descending order as follows: sweet pea (75.58, 74.37 and 74.19%), (76.30, 75.87 and 74.95%) and pea (24.41, 25.62 and 25.80%), (23.96, 23.51 and 25.04%). Subsequently, sweet pea cultivar highly susceptible (36.62±3.236), (47.75±4.395) and (45.73±4.193) adult, immature and egg, respectively in season 2017-2018 and the lowest infested are pea cultivar (10.71±1.249) (13.66±1.632) and (14.61±1.729) adult, immature and egg, respectively in season 2016-2017. Cultivars (sweet pea and pea) contain remarkable rates of the predatory mite, *A. swirskii* through two successive seasons. Phytochemical contents were evaluated in uninfested and infested leaves at peak infestation and the final season of 2017. In addition, there is a positive relationship between mite infestation levels and total carbohydrates and nitrogen in sweet pea and pea leaves, however a negative relationship found with total phenolic compounds. Infested leaves of sweet pea and pea cultivars contained a low concentration of phosphate and potassium (1.065, 2.165) & (0.54, 1.17) at the late season.

Keywords: Climatic factors, phytochemical leaf, Sweet pea and *Tetranychus urticae*

INTRODUCTION

Pea *Pisum sativum* is a vital crop. It has many nutritional values such as high content of protein, carbohydrates, phosphorus, iron, calcium and vitamins A and B (Hassan, 1997). In addition, it is a rich source of a prevalence of minerals and vitamin C (Bhat *et al*., 2013). Thus, pea is used as a fresh and frozen.

Moreover, the total cultivated area for pea in Egypt was 42524 fed. and produced total yields about 181.000 tons with average 4.24 ton/fed. (Dep., Agric., Statistics, Ministry of Agriculture, Giza, Egypt, 2013).

Recently, the successful cultivation for pea (Lincoln cultivar) and sweet pea (snap pea cultivar) are threatened by several pests. For instance, there are a two spotted spider mites (TSSM) *Tetranychus urticae* Koch**,** blue oat mite (*Penthaleus major*) and red-legged earth mite (*Halotydeus destructor*). Further, *Tetranychus urticae* is a polyphagous herbivore which feeding on more than 1,100 plant species (Grbic *et al*., 2011). *Tetranychus urticae* Koch was a serious polyphagous, cosmopolitan pest on majority of economic yields, which is easily spread on the wind. Under optimum conditions (Cvidanes *et al.,* 1990).

Consequently, (TSSM) is considered the most important pest that causes an economic damage to vegetables crops in Egypt. Furthermore, it is considered a serious problem to plants worldwide, attacking crops. When mites' injury crops of economic importance the impacts can be felt globally. Mites are amongst the most diverse and succeeded, of invertebrates. TSSM has a very rapid population growth, short developmental time, high birth rate and long adult survival (Clotuche, 2011).

In the recent years, the environmental priority of varied vegetable crop pests has obtained a significant importance in pest control. However, some studies were achieved with regard to the effect of climatic factors in the population dynamics of damage as well as controlling pests infesting vegetable crops which studied by many authors, **(**El-Kawass, 2000; Abou-Zaid, 2003). On the other hand, the red spider mite spread to all parts of the plant as the population increases especially during dry period and produce webbing over the entire plants. However, Moderate population may greatly affect on crop production and heavy infestation results in death of the plant. Therefore, Chemical contents which normally vary from variety to another, may affect the population level of mites (Abdallah *et al.,* 2009).

Thus, the present research work is conducted to achieve some objectives. Firstly; evaluate the population fluctuations of *T. urticae* and associated its predatory mite, (*Amblyseius swiriski* Athias-Henriot) on each of pea and sweet pea crops during two years 2016-2017 and 2017-2018. Secondly; leaf chemical contents. Finally, correlation with certain weather factor on population of (TSSM) *Tetranychus urticae* Koch.

MATERIALS AND METHODS

Experimental design and Counting

This investigation was carried out in El- Ayyat - Giza Governorate, Egypt. Pea and sweet pea (*Pisum sativum*) (Lincoln cultivar) and sweet peas (*Pisum sativum* var. macrocarpon) (snap pea cultivar) crops were cultivated in greenhouse during the two seasons

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2016-2017 and 2017-2018. The greenhouse (50×70 m^2) was divided into 6 equal plots. Each plot was replicated. Each replicate was 500 m^2. The plots were arranged in a randomized complete block design (RBCD) for each cultivar. Experiential plots were given the standard cultivation practices including organic and mineral fertilization, drip irrigation and mechanical control was applied to remove weeds. Pesticides were avoided completely. The first season began from 25th September 2016 up to 15th March 2017; while second season began from 27th September 2017 up to 21st March 2018. Each Sample of 30 leaves was weekly collected from every peas cultivar and examined for Adult, immature stages and the eggs of *T. urticae* occasion. The collected samples of the two spotted spider mite were identified and sorted to the stage and counted bi- weekly for each stage on each plant using stereoscopic binocular microscope (Zaher, 1984). While, the predatory mites were counted in the whole leaf area as reported by Poe (1980).

Definition of phytochemical leaf components of the two cultivars

Chemical analysis was carried out in the growing season of the two pea cultivars during the vegetation growth period. The sweet pea and Pea leaves were collected and prepared for chemical analysis at laboratory of the Faculty of Agriculture Research Park, Cairo Univ. for chemical analysis. (Nitrogen was determined and calculated according method described by Sadasivam and Manickam (1991). Furthermore, Potassium and total phenols contents were conducted by method of Chapman and Pratt (1961). Finally, total of carbohydrates and proteins were estimated and conducted according to method of Bradford (1976).

Statistical analysis:

The statistical analysis (ANOVA, Simple correlation and partial regression) of the obtained data were performed by using SAS program (SAS Institute, 1988). Also, the difference between means was conducted by using Duncan's multiple range tests in this program. The reduction percentages in the number of pests were calculated by using equation of Henderson and Tilton (1955).

RESULTS AND DISCUSSION

Population fluctuation of the two spotted spider mites, *Tetranychus urticae* and predatory mite, *Amblyseius swirskii* (Athias-Henriot) on leaves of sweet pea and pea cultivars for two seasons 2016-2017 and 2017-2018 are shown in Tables (1, 2 and 3) and Figure (1). Data illustrated that initial growth of population increases as the plant grows. Thus, the susceptibility of two Pea cultivars to the adult, immature and egg stages of *T. urticae* started in the first week of October, gradually increased and reached its peaks in the 3rd week of June. The elevated numbers of adults, immature and eggs of spider mite averaged (52.71, 70.14 and 68.11), (58.66, 80.11 and 76.11) individuals/leaf on sweet pea cultivar during two successive seasons, respectively, While, in the pea cultivar the infestation started in the Last week of October, but increased gradually till reached its peaks in the first week of February. The mean values were recorded for the same stages (18.98, 25.11 and 26.11), (19.24, 27.1 and 27.13) individuals/leaf, respectively. Thus, the population has dropped in the fourth week of March. Finally, the mean numbers of *T. urticae* and infestation adult, immature, eggs percentages (Tables 1, 2 and 3) during the two successive seasons. It could be arranged in a descending order as follows: sweet pea (75.58, 74.37 and 74.19%), (76.30, 75.87 and 74.95%) and pea (24.41, 25.62 and 25.80%), (23.96, 23.51 and 25.04%). Subsequently, sweet pea cultivar was highly susceptible whereas, it harbored (36.62±3.236), (47.75±4.395) and (45.73±4.193) adult, immature and eggs, respectively in the season 2017-2018 and the lowest infested are pea cultivar (10.71±1.249), (13.66±1.632) and (14.61±1.729) adult, immature and eggs, respectively in season 2016-2017. Statistical analysis show that the average numbers of the *T. urticae* was significantly high on the sweet pea leaves comparing with pea leaves. There is a significant variation in the population of *T. urticae* between the two seasons, where, population increased gradually with plant age during the two seasons, then decreased gradually to reach the lowest rate at the end of inspections. Moreover, this result clearly indicated that young fresh plants are more suitable for *T. urticae*.

Table (1): Evaluation of two peas crops for their relative susceptibility to immatures of *T. urticae* during (2016-2018) seasons

Cultivars	Mean number of *T. urticae* Adult/leaf			
	2016-2017		2017-2018	
	Mean±S.E	Infestation%	Mean±S.E	Infestation%
Sweetpeas.A	33.15 ^{a}±2.923	75.58%	36.62^{a}±3.236	76.30%
peas.A	10.71^{b}±1.249	24.41%	11.54^{b}±1.352	23.96%
LSD value at 0.05	6.392		6.834	

- Means with same letter are not significantly different

Table (2): Evaluation of two peas crops for their relative susceptibility to adult stages of *T. urticae* during (2016-2018) seasons

Cultivars	Mean number of *T. urticae* Immature /leaf			
	2016-2017		2017-2018	
	Mean±S.E	Infestation%	Mean±S.E	Infestation%
Sweet peas. A	39.65[a]±3.745	74.37%	47.75[a]±4.395	75.87%
peas. A	13.66[b] ±1.632	25.62%	14.68[b]±1.709	23.51%
LSD value at 0.05	8.214		9.153	

- Means with same letter are not significantly different

Table (3): Evaluation of two peas crops for their relative susceptibility to eggs of *T. urticae* during (2016-2018) season

Cultivars	Mean number of *T. urticae* Immature /leaf			
	2016-2017		2017-2018	
	Mean±S.E	Infestation%	Mean±S.E	Infestation%
Sweet peas. A	42.01[a]±3.877	74.19%	45.73[a]±4.193	74.95%
peas. A	14.61[b]±1.729	25.80%	15.28[b]±1.800	25.04%
LSD value at 0.05	8.535		8.851	

- Means with same letter are not significantly different

Thus, the outcome of this study point out that the population of *T. urticae* was a considerable increase between November and April month. This result agree with Fisher and Mourrut (2005) and Fawzy *et al.* (2004), where found that concerning the mite, population of *T. urticae* descend abruptly on peppermint after arriving a peak during April and the population dynamics of *T. ludeni* on okra appeared in the first of November and their peak was recorded in April. Identical conclusion was attained by Croft *et al*. (2005). *T. urticae* population was affected by seasons, where most of the mites remain in the field all over the year with minimum level during winter season (Sharma and Pati, 2012; Kanika and Geroh, 2016). Tripathi *et al.* (2013) who found that with high population of *T. urticae* in June and July and lower to negligible mite population was encountered through December, January and February months.

Correlation Coefficient "r" between *T. urtica* population and both of Temperature and Relative humidity:

The effect of climatic factors on the appearance of *T. urticae* on cultivars was also addressed. Tables (4 and 5) are shown the correlation coefficient "r" revealed that significant positive correlations between phytophagous mite, *T. urticae* (adult, immature, egg) *population* and both of maximum temperature (r=0.895, 0.866 and 0.895) (r=0.776, 0.798 and 0.802) on sweet pea respectively in seasons 2016-2017 and 2017-2018. On the other hand, Data of pea cultivar was (r=0.928, 0.921 and 0.928) (r=0.715, 0.634 and 0.625), respectively in the same seasons. Whereas, minimum temperature was insignificant positive influence on the population. While, relative humidity (R.H) appears strongly significantly negative correlation.

The relation was looked between the daily mean relative humidity and *T. urtica* population, (r= -0.489, -0.486 and -0.495), (r= -0.291, -0.286 and -0.284) and (r= -0.346, -0.357and -0.347), (r= -0.192,-0.141 and -0.126) on sweet pea and pea during 1st and 2nd seasons, respectively.

The fractional regression analysis for the influence of maximum and minimum temperature on the population shows significant positive influence on two seasons; whereas, relative humidity have a significant positive effect.

Table (4): Interaction between climatic factors of two pea cultivars leaves and *T. urticae* population (2016-2017)

Cultivars	Correlation coefficient values								
	2016-2017								
	Temperature						Relative humidity		
	Max	Min	Max	Min	Max	Min	Ault	immature	Egg
	Adult		Immature		Egg				
Sweet pea	0.895	0.845	0.866	0.822	0.895	0.867	-0.495	-0.486	-0.489
pea	0.928	0.947	0.921	0.941	0.928	0.944	-0.346	-0.347	-0.357

Table (5): Interaction between climatic factors of two pea cultivars leaves and *T. urticae* population (2017-2018)

Cultivars	Correlation coefficient values								
	2016-2017								
	Temperature						Relative humidity		
	Max	Min	Max	Min	Max	Min	Ault	immature	Egg
	Adult		Immature		Egg				
Sweet pea	0.776	0.891	0.798	0.901	0.802	0.897	-0.291	-0.286	-0.489
pea	0.715	0.928	0.634	0.91	0.625	0.924	-0.192	-0.141	-0.357

Temperature was the most extensively studied of all-climatic factors and it appears to have large effects (Haque *et al.,* 2011). Hanafy *et al.* (2014) who found that temperature had a positive effect on mite population on many vegetable crops such as lady's finger, cucumber, tomato, eggplant, bottle gourd and bean. Comparable correlations between temperature and population density of *T. arabicus* on eggplant (Pratt *el al.,* 2003). The population of *Tetranychus ludeni* on eggplants raise was related with periods of lower relative humidity and higher mean temperatures.

Predacious mites *Amblyseius swirskii* (Athias-Henriot)

A. swirskii was a useful predatory mite epidemic to the Eastern Mediterranean region. *A. swirskii* has attracted as a biological control agent of mites, thrips and whiteflies in greenhouse.

Several studies have announced that phytoseiids have a role to play in the control of acarine pests (Sano Soo and Palk, 1999; Rasmy *et al.*, 2003). Therefore, the population fluctuation of *A. swirskii* predators was studied during the two successive seasons 2016-2017, 2017-2018.

Furthermore, the common trends in the appearance and the abundance of the predator mite *A. swirskii* is given in Fig (1). It was predominant in Sweet pea and was found in (76.22%), (73.96) of leaf samples pea cultivar came second in the abundance forming 23.77%, 26.03 of the total samples, respectively. Therefore, predators were also see in higher numbers on plants infested with whiteflies than on uninfected ones especially *A. swirskii* (Nomikou *et al.,* 2002).

The population intensity began to increase in November, and then oscillated till reached a peak in Marsh. These facts mention that prey probably play an important role of the predator diet. The information is in accordance to Abou-Awad *et al.* (2017).

However, it is difficult to explain the accurate reasons for variation of predacious mites and their numbers because of the intricacy involved in the multiple predator – prey relationships. Phytoseiid mites like *A. hibisci* (Chant) (McMurtry *et al.,* 1970) and *A. swirskii* Athias-Henriot (Abou-Awad *et al.,* 2000) were reported to use eriophyids as a food source, but they do not reduce them , due to they do well on tetranychid species, such as *T. urticae* Koch (Mc-Murtry and Scriven, 1964).

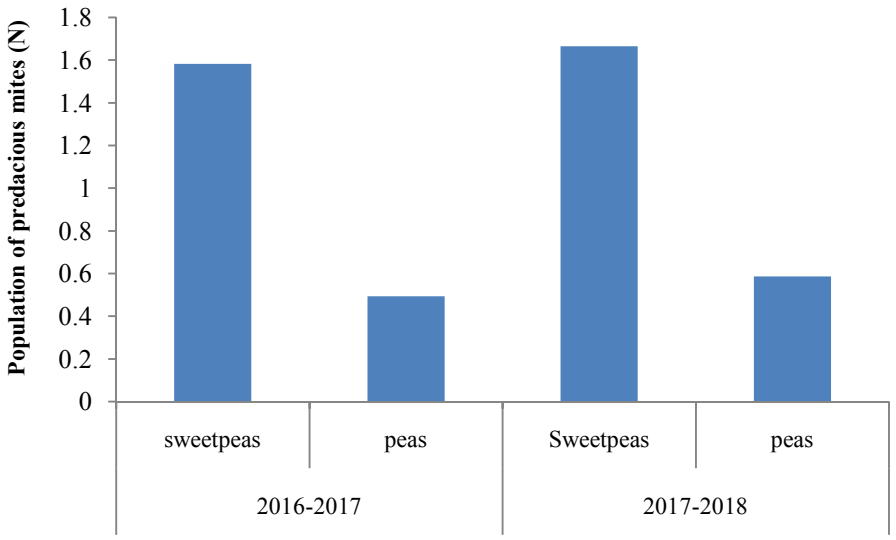

Fig. (1): Population density of the predatory mite, *A. swirskii* on two cultivars sweet peas and peas during two seasons, (2016-2017 and 2017-2018)

Phytochemical components and population of spider mites, *Tetranychus urticae*

The Data of phytochemical analysis at the time of infestation peak and the end of season during 2017, determine that there were higher changes happened in the phytochemical contents of the invaded leaves of the two pea cultivars. As we are familiar with, leaf chemical contents are knew one of most important factors which play a role in the susceptibility of sweet pea and pea cultivars to *T. urticae* infestation.

Data indicated that there was a positive relationship between mite infestation levels and total carbohydrates in sweet pea and pea leaves, while a negative relationship found with total phenolic compounds (Table 6). Infested leaves of sweet pea and pea cultivars contained decreased concentrations of phosphate and potassium (1.065, 2.165) and (0.54, 1.17) at the late season.

Regarding sweet pea cultivar, it was observed that the higher contents of all leaf contents than other cultivar except on total phenols of 1.29. Also, it had the highest average mean of the *T. urticae* (121.25 mites/leaf) and the lowest content were recorded in pea cultivar (Table 4). On the other hand, there were increased concentrations in nitrogen (4.65, 3.245) contents in sweet pea and pea cultivars. These results are coincided with Maklad (2004), Abdallah *et al.* (2009), Aiad *et al.* (2014) and Fatma *et al.* (2015).

Table (6): Relationship between phytochemical components of two peas cultivars leaves and population of *Tetranychus urticae.*

Cultivars	Infestation	Mean of *T. urticae* movable stage	Phytochemical contents N	P	K	Total phenolic compounds g/100g	Total Protein compounds g/100g	Total Carbohydrates compounds g/100g
Sweet peas	low	3.2	4.32	1.02	1.99	1.35	24.44	57.98
	High	239.3	4.98	1.11	2.34	1.23	27.43	57.75
	Mean	121.25	4.65	1.065	2.165	1.29	25.935	57.865
Regu. peas	Low	0.01	2.73	0.49	1.23	2.02	13.23	42.37
	High	20.14	3.76	0.59	1.11	1.68	16.21	54.13
	Mean	10.075	3.245	0.54	1.17	1.85	14.72	48.25
	low	3.2	4.32	1.02	1.99	1.35	24.44	57.98

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فعالية المركبات الكيميائية والعوامل المناخية على تعداد أكاروس العنكبوت الأحمر لمحاصيل البازلاء السكرية والبازلاء

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أجريت الدراسات لتحديد مستوى الإصابة لمحاصيل البازلاء والبازلاء الحلوة بأكاروس العنكبوت الأحمر والاكاروس المفترس خلال موسمين (٢٠١٦-٢٠١٧ و ٢٠١٧- ٢٠١٨) في العياط بمحافظة الجيزة. أظهرت النتائج أن الإصابة باكاروس العنكبوت الأحمر بدأت في الأسبوع الأول من شهر أكتوبر داخل الصوب ثم ازداد تدريجيا حتى وصل إلى قمته في الأسبوع الثالث من شهر يونيو بالنسبة للبازلاء السكرية وفى الأسبوع الأول من شهر فبراير بالنسبة للبازلاء العادية. خلال الموسمين المتتاليين كان محصول البازلاء السكرية أكثر حساسية للإصابة عن البازلاء العادية وتم ترتيبه ترتيبا تنازليا على النحو التالي أولاً: البازلاء السكرية (٧٥.٥٨و٧٤.٣٧ و ٧٤.١٩%) و (٧٦.٣٠ و ٧٥.٧٨ و ٧٤.٩٥%) ثم البازلاء العادية (٢٤.٤١ و ٢٥.٦٢و ٢٥.٨٠%) و (٢٣.٩٦ و ٢٣.٥١ و ٢٥.٠٤%). وجد أن البازلاء السكرية شديدة الحساسية للأفراد البالغة والغير بالغة والبيض على التوالي: (٣٦.٦٢ ± ٣.٢٣٦) و (٤٧.٧٥ ± ٤.٣٩٥) و (٤٥.٧٣ ± ٤.١٩٣) خلال موسم ٢٠١٧- ٢٠١٨ وكانت أدنى إصابة في صنف البازلاء العادية (١٠.٧١ ± ١.٢٤٩) و (١٣.٦٦ ± ١.٦٣٢) و (١٤.١٦ ± ١.٧٢٩) للأفراد البالغة والغير بالغة والبيض خلال موسم ٢٠١٦-٢٠١٧ ويتواجد على البازلاء السكرية والعادية تعداد ملحوظ من الأكاروس المفترس *Amblyseius swirskii* (Athias-Henriot). تم تقييم محتويات المواد الكميائية النباتية في الأوراق السليمة والمصابة عند ذروة الإصابة وكان ذالك في أواخر ٢٠١٧ وقد وجد أن هناك علاقة ايجابية بين مستويات الإصابة بأكاروس العنكبوت الأحمر وبين كل من الكربوهيدرات الكلية والنيتروجين في أوراق البازلاء السكرية وعلاقة عكسية مع مجموع المركبات الفينولية في البازلاء العادية واحتوت البازلاء السكرية على تركيزات منخفضة من الفوسفات والبوتاسيوم (١.٠٦٥ و ٢.١٦٥) و (٠.٥٤ و ١.١٧) في آخر الموسم.