POPULATION DYNAMICS OF TWO MEALYBUG SPECIES, *FERRISIA VIRGATA* COCKERELL AND *MACONELLICOCCUS HIRSUTIS* GREEN (PSEUDOCOCCIDAE: HOMOPTERA) ASSOCIATED WITH GRAPEVINE IN FAYOUM GOVERNORATE- EGYPT

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ABSTRACT

The presented work was carried out in a grapevine farms, at Fayoum Governorate, to shed the light on seasonal fluctuation at the population density of the striped mealybug, *Ferrisia virgata* Cockerell and the pink hibisicus mealybug, *Maconellicoccus hirsutis* Green (Pseudococcidae: Homoptera) as well as the effects of the main weather factors on the two insect population. Regular biweekly samples were taken for two successive years, from Nov. 2015 to Oct. 2017.

The results indicated that all counted stages of the striped mealybug, *F. virgata* in the first season had two peaks on leaves of grapevine; 1st peak was recorded at the end of Aug. and 2nd one was recorded at the end of Sep. Regarding bunches of grapevines, only one peak was recorded in the first season at the end of Sep., in the second year, two peaks were recorded; the first peak was recorded at end of Jul. and the second one was recorded at the end of Aug..

The population of *M. hirsutis* nymphs recorded one peak 130 nymphs/10 bunches at end of Sep.. Also, adult females recorded one peak at end of Aug. with 53 adult females/ 10 bunches while the total population of the mealybug recorded two peaks (in mid- Aug. and end of Sep.) to record 58 and 133 individuals/10 bunches. The results indicated that maximum and minimum temperatures had negative insignificant effects on nymphs, while showed positive insignificant effect on adult females and all individuals.

Key words: Mealybugs, *Ferrisia virgata*, *Maconellicoccus hirsutis*, population dynamics, weather factors, grapevines, population fluctuation.

INTRODUCTION

The common grapevine, *Vitis vinifera* L., is native to the Mediterranean region, central Europe, and southwestern Asia. There are currently between 5,000 and 10,000 varieties of *V. vinifera* grapes, but only a few are of commercial significance as table varieties.

Vineyards in Egypt are usually infested by several insect pests such as butterflies, scale insects, mealybugs, aphids and thrips (**Dawood,1971; El-Serafi *et al.*,2004** and **Ghanim *et al.*,2013**). Mealybugs (subfamily: Pseudococcinae) are considered of the most important pests of grape area cultivating. Several mealybug species have risen to the level of economically damaging invasive species, e.g., *Pseudococcus viburni* Signoret, *P. longispinus* Targioni, *P. calceolariae* Maskell, *Planococcus ficus* Signoret, *Pl. citri* Risso and *Maconellicoccus hirsutus* Green **(Daane *et al.*, 2018).**

Ferrisia virgata is the most widespread species, it is a small, highly polyphagous insect reproduces quite rapidly in tropical conditions but also tolerates either subtropical or to some extent temperate conditions (**Kaydan and Gullan 2012)**. The striped mealybug has also achieved economic significance as a pest of several agricultural crops, including citrus, cocoa and cotton **(Ammar *et al*., 1979; Oliveira *et al*., 2014 and Adly *et al*., 2016).**

The pink hibiscus mealybug, *M. hirsutus*, is a serious pest of many plants in tropical and subtropical regions.; *M. hirsutus* is responsible for serious damage causing withering of plants, crinkling of leaves and deforming buds, shoots and fruits owing to the toxicity of the mealy bug's saliva, however, leaves sometimes are curling and. resetting, similar to characteristic caused by viruses **(Almeida *et al*., 2014; Jones *et al*., 2015; Awadalla and Ghanim, 2016).** In Egypt, the nymphs of *M. hirsute* were found on leaves and twigs in most months of the year while they were found on twigs only in winter months. The immature stages and adult females had four peaks, **(Yossef, 1991; Bakry, 2009; Amin *et al*., 2019)**.

The present study aims to monitor seasonal fluctuation of the two mealybugs, *F. virgata* and *M. hirsutus* in Fayoum Governorate regarding these importance of those pest species to grape cultivations.

MATERIAL AND METHODS

1. Ecological studies

Ecological studies on the tested mealybugs on grapevine were carried out at a groove about two feddans. This groove is located at Feddemin village, Fayoum Governorate. The variety Ghribi was cultivated and no control measures were done. The grapevines were two meters apart and 20 years old and this groove was irrigated with flooding irrigation system, all the grapevines received the same agricultural practices.

To determine the seasonal fluctuation in the population density, number and duration of generations as well as the effects of the main weather factors on the insect population, ten grapevines, *V. vinifera*, var. Ghribi of the same size, height, shape and vegetation were tested to represent the whole groove. Regular biweekly samples were taken for two successive years, from the first of Nov. 2015 to the second of Oct. 2017

A tree bark was peeled off in an area of 30 cm of the vine trunk to maintian the accurate inspection. Colonies of mealybugs were first counted in situ then removed by a fine brush, bagged in PVC containers and then transferred to laboratory for examination. Samples of 30 leaves and 10 bunches were collected randomly from the selected grapevines and were put in polyethylene bags and transferred to the laboratory for counting under a stereomicroscope. The counting was carried out on the whole area for both leaves and bunches and kept for different alive stages, *i.e.* immature (1^{st} , 2^{nd} and 3^{rd} nymphal instars) and mature females (including; non-ovipositing and ovipositing females (**Abdel-Fattah., 1976; Amin and Emam, 1996; Abd-El-Said, 1997; Abbas., 1999** and **Adly *et al.*, 2016).**

For roots samples from Dec. to Jan.; mealybugs were surveyed on vine roots by digging to a depth of 30 cm in the region of the main stem in close proximity to vines.

Obtained mealybugs were preserved in ethanol 70% +5% glycerin identified to species category which was done at Plant Protection Research Institute, Agriculture Research Centre .

Records of the meteorological factors, mainly the daily means of maximum and minimum temperature as well as mean relative humidity were obtained from the nearest meteorological station at Fayoum Governorate. The daily records of these factors were grouped into biweekly averages to corresponding with sampling.

2. Statistical analysis

Obtained data was subjected to statistical analysis to determine simple correlation, simple regression and partial regression between nymphal stage, adult females and total population of *F. virgata* and *M. hirsutus* and bi-weekly weather factors (max. temp., min. temp. and relative humidity). Correlation and regression analyses were following **Senedecor and Cochran 1980** and by using **SPSS program Version 16.**

RESULTS AND DISCCUTION

1. Population dynamics of the striped mealybug, *Ferrisia virgate*

Data in Fig. (2) show the seasonal variation in *F. virgata* population on grapevines' leaves and bunches during 2015-2016 years. Nymphal stages completely disappeared until the end of Aug., while adult females were recorded on leaves earlier in mid- Aug. Nymphs, adult females and total population had two peaks throughout the season. The 1st peak was recorded at the end of Aug. with 12, 4 and 16 individuals for nymphs, adult females and total population /30 leaves, respectively. After decreasing, the population increased rapidly to reach its 2nd peak at the end of Sep. with 31, 11 and 42 individuals / 30 leaves for nymphs, adult females and total population /30 leaves respectively. Nymphal stage was dominant on leaves representing 72.8% of the total population while adult females represented 27.2% of the total population.

In 2nd season (2016-2017), as showed in Fig. (2) neither nymphs nor adult females were detected on leaves till 15th Sep. The mealybug nymphs were recorded in few numbers from the end of Sep. to the end of Oct. Only two individuals of non-ovipositing females were detected during this season.

Regarding grapevine bunches, as previously mentioned, *F. virgata* was the dominant species on bunches during the first season, however, it was observed that the infested bunches with *F. virgata* was rarely infested with *Planococcus* individuals, this could be due to a competitive displacement between the two species.

In the 1st season (2015-2016), nymphs of *F. virgata* were found by the end of Sep., while adult females existed with relatively high density (47 adult females/10 bunches) in mid of Sep. The mealybug recorded only one peak of all counted stages however; recorded at the end of Sep. with 91, 42 and 133 individuals / 10 bunches for nymphs, adult females and total population, respectively. The percentage of all females represented 55.1% of the total population while nymphs represented 44.9% of the total population.

In the 2nd season (2016-2017), the mealybug individuals appeared early at the end of Jun. Nymphs, adult females and total population had two peaks. The 1st peak was noticed at the end of Jul. with 14, 3 and 17 individuals for nymphs, adult females and total population, respectively.The 2nd and the lowest peak of the counted stages was recorded at the end of Aug. with 6, 3 and 9 individuals/10bunches for nymphs, adult females and total population respectively. Then, the mealybug population decreased and completely disappeared at mid- Oct.

Those results indicated that all counted stages of the striped mealybug *F. virgata* had two peaks on leaves of grapevine at the first season; the 1st peak was recorded at the end of Aug. and the 2nd and highest peak was recorded one month later at the end of Sep. Regarding bunches of grapevines, only one peak was recorded in the first season by the end of Sep. In the second year, 2 peaks were recorded; the first peak was recorded at the end of Jul. and the second one was recorded by the end of Aug. For our knowledge no data dealing with seasonal abundance of *F. virgata* on grapevine are available. The results are in agreement with those of obtained by **(Ata *et al*., 2019)** who mentioned that the striped mealybug *F. virgata* showed its highest population in Sep. and Nov. throughout two successive years in Egypt on corn shrubs, *Dracena fragrans*.

F. virgata density on *Dahlia pinnata* **(Dawood, 1971);** *Lantana camara* **(Abd El-Said, 1997)** and *Nerium oleander* **(El-Shazly, 2006)** showing two annual peaks; the 1st appeared around Jul. and the 2nd is through Sep. to Oct**. Ammar *et al*. (1979)** reported that *F. virgata* had three peaks per year on *Acalypha* sp. were recorded in early Jun. early Jul. and early Aug. **El-Serafi *et al*. (2004)** reported that *F. virgata* had three peaks per year on guava trees in Egypt and the highest peak was found by late Aug. and other two peaks were recorded at the beginning of Jan. and the end of Oct.**. (Amin *et al*., 2019)** mentioned that *F. virgata* had four peaks in the 4th week of Nov. 4th week of Dec. 1st week of Jan. and 4th week of Jan. on Guava trees. The highest of this insect was found at the 1st week of Jan.

Lapis (1970) found that the *F. virgata* is a major pest of several vegetables and ornamental plants in the Philippines. It was most abundant from Feb. to May. However, **Brettlje (1966)** reported that in Aden, *F. virgata* can achieve quite high populations in winter, on such ornamental plants as caesalpinia and cleander. **Nada (1987)** mentioned that the degree of infestation *F. virgate* varied considerably with time of year in Egypt. **Rawat and Modi, 1969** in Madras (India) and **Dawood, 1971** in Egypt**)** reported that *F. virgata* overwintered in an active form particularly young nymphs on Dahlia plants.

Effects of climatic factors on the population fluctuation of *F. virgata* on leaves and bunches of grapevines:

Maximum temperature:

Climatic factor showed positive insignificant effects on all counted stages of the mealybug on leaves during the 1st season. The simple regression coefficient was also positive and insignificant during this season. On the other hand, the "P. reg." was negative and insignificant. In the second season, this factor showed negative and

insignificant effect on different stages of the tested mealybug and P.reg of adult female was positive and insignificant. Concerning bunches of grapevines; the effect of mean maximum temperature was positive and insignificant on nymphs in both seasons. The partial regression coefficient showed negative insignificant effect during first season and positive insignificant effect in the second season. Also, the effect of this factor on adult females was positive and insignificant on nymphs in both seasons. The partial regression coefficient showed negative insignificant effect during first season and positive insignificant effect in the second season. The effect of mean maximum temperature on total individuals of the mealybug took the trend for nymphs and adult females being positive and insignificant in the 1st season. The partial regression coefficient showed negative insignificant effect during first season and positive insignificant effect in the second one.

Minimum temperature

This factor had negative insignificant effect on nymphs of the mealybug in both seasons on leaves. The partial regression coefficient was positive and insignificant in both tested seasons. The effect of this factor on adult females was positive insignificant in the first season while it was negative insignificant in the second season. Regarding the effect on total individuals, this factor had negative insignificant effect in both seasons. The P. reg. was positive and insignificant in both seasons.

Concerning bunches, the effects of minimum temperature on nymphs and adult females were positive and insignificant in both seasons. The partial regression coefficient was also positive and insignificant in both seasons. Regarding the effect of this factor on total individuals of the mealybug, positive insignificant effect was shown in the first season and positive significant effect in the second season. Partial regression coefficient was also positive and insignificant in both seasons.

Relative humidity

Unlike this factor showed positive significant effect on nymphs of the tested mealybug on leaves of grapevine during first season and positive insignificant effect in the second one. Positive significant effect of this factor was revealed with total females during 1st season had negative insignificant effect on adult females during second season. Regarding total individuals of the mealybug, the effects of relative humidity was positive and significant in the 1st season while it was positive and insignificant during the 2nd one. Concerning bunches, the effect of relative humidity on nymphs, adult females and total individuals were positive and insignificant in both seasons. The numerical relation between different stages of *F. virgata* and weather factors on bunches and leaves of grapevine were expressed in regression equation. Generally, this numerical relation was insignificant in both seasons on leaves and bunches of grapevines.

On bunches, the effect of maximum and minimum temperatures were positive on all counted stages of the mealy bug during both seasons. These results are in partially agreement with those of **Ammar *et al.*, (1979)** they showed that significant positive correlation was found between population density of *F. virgata* and daily maximum and minimum temperatures. **Ata *et al.*, (2019)** mentioned that the correlation between

mean maximum temperature and *F. virgata* individuals was positive and insignificant in spring and autumn, while the relation was insignificant negative in summer and winter, contrarily with present findings they added that the relation between minimum temperature and population activity of *F. virgata* was insignificant positive in the four seasons.

Noticeably, the effect of relative humidity was positive on different stages of *F. vibrate* on leaves and bunches of grapevine in both seasons that agrees with those of **Ata *et al.*, (2019)** who mentioned that relative humidity gave an insignificant positive effect during the fall, winter and summer. Some studies showed the same effects of this meteorological parameter on the population activities of mealybugs,e.g. **Nabil *et al,* (2013)** and **Raut, *et al.*, (2013).**

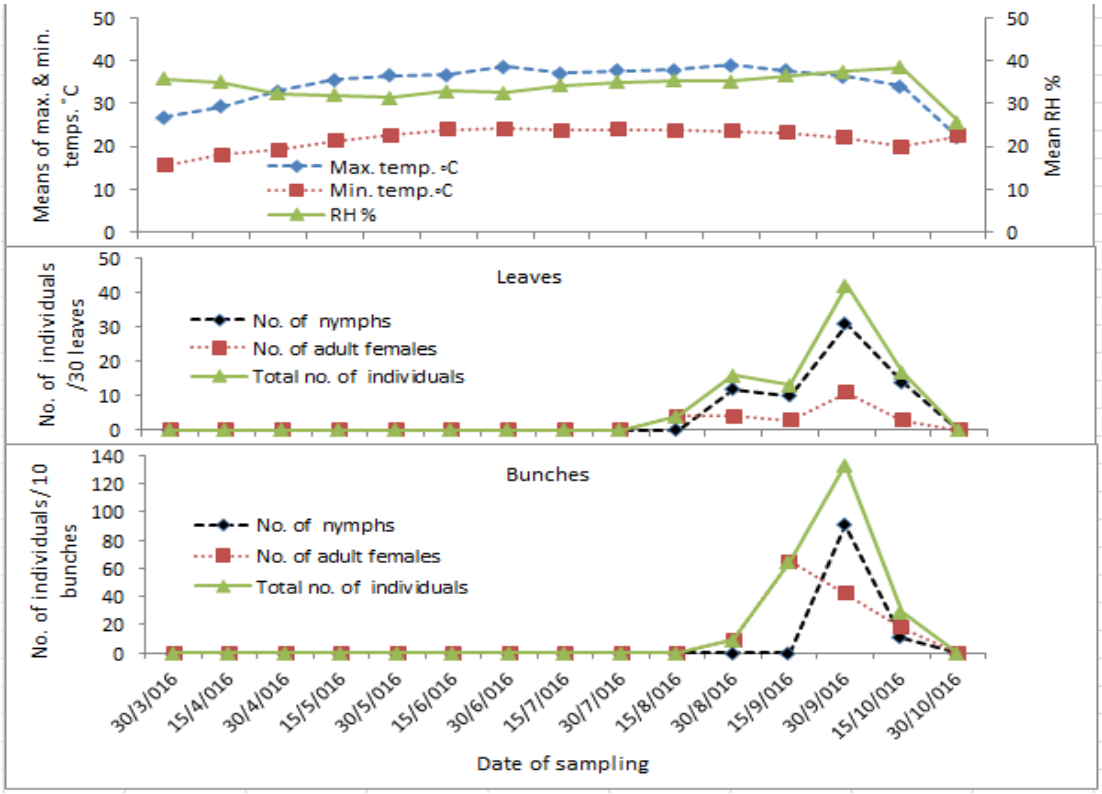

Fig. (1): Bi-weekly counts of nymphal and adult stages of *F. virgata* on leaves and bunches of grapevines at Fayoum Governorate (2015-2016 season).

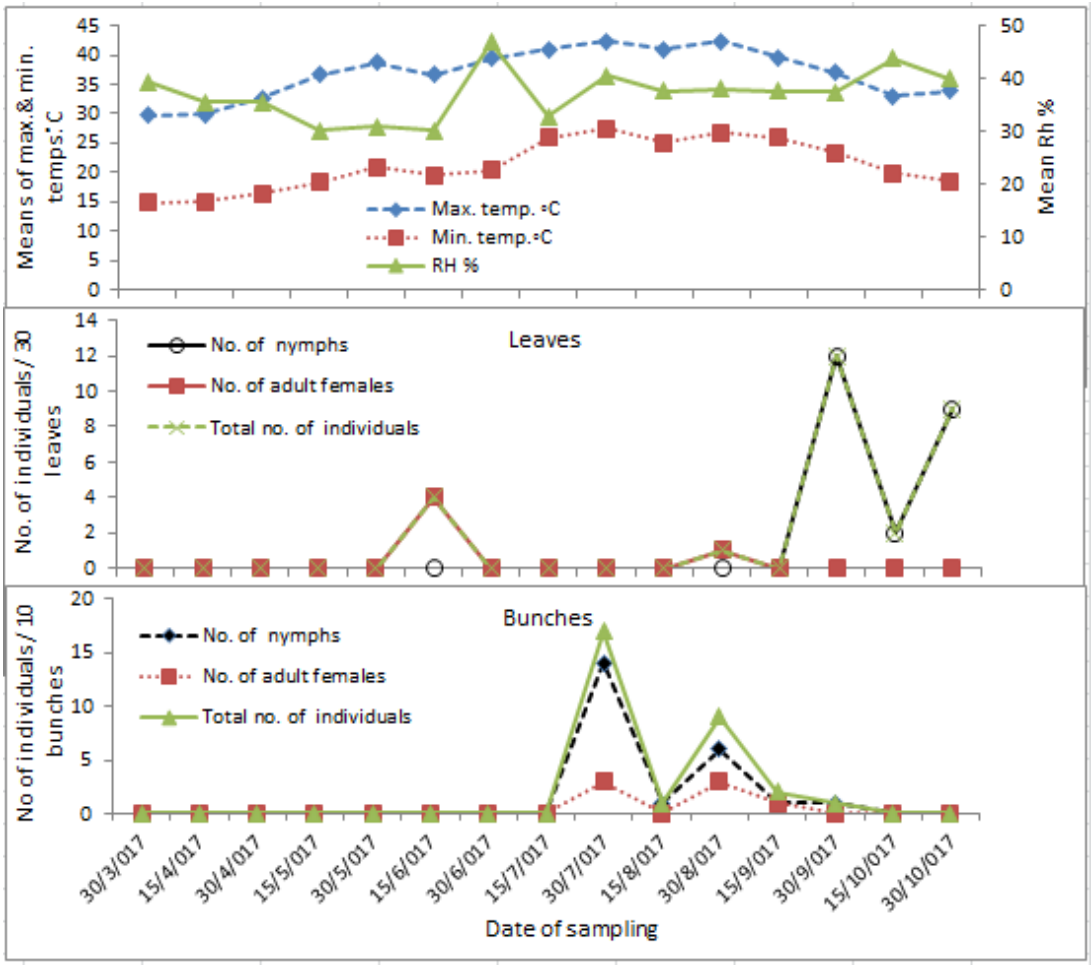

Fig. (2): Bi-weekly counts of nymphal and adult stages of *F. virgata* on leaves and bunches of grapevines with corresponding mean of weather factors during 2016-2017 season at Fayoum Governorate

2. The pink hibisicus mealybug, *Maconellicoccus hirsutis*

The infestation of bunches with *M. hirsutis* appeared during the 2nd season, 2016-2017, in mid-Aug. (Fig.,3). The population of nymphs showed one peak (130 nymphs/10 bunches) at the end of Sep. While, adult females had one peak at end of Aug. with 53 adult females/ 10 bunches. The total population of this tested mealybug had two peaks; the 1st peak was recorded in mid- Aug. being 58 individuals/10 bunches, however, the 2nd peak was recorded at the end of Sep. being 133 individuals /10 bunches then the population of the mealy bug decline gradually until the end of the season.The present results are in a partial agreement with certain findings, in India **Manjunath (1985)** who found that *M. hirsutis* had to main generations in India on grapevine. The first one was from Feb. to March and the second one was recorded

from Nov. to Feb.. **Babu and Azam (1987),** found that this pest was found infesting vegetative parts of the crop from early Jun. to the end of Dec. in India. During the first of Sep. to second of Oct., the female adult population decreased largely due to pruning operation. The mealy bug again became active during Jan. and increased as the grape cluster developed and was abundant by March when the fruits were at ripening stage

In contrary, **Youssef (1991)** in Egypt mentioned that nymphal instars were found on leaves and twigs at most months of the year while they were found on twigs only throughout winter months. The immature stages had 4 peaks, the first was at 1st Jul., the second at the 1st Nov., the third was in the 1st Feb. and the fourth was in mid-May. Also, adult females had 4peaks of abundance, the first one was in the 1st Jul., the second was at mid-Oct., the third was at 1st of Jan. and the fourth was in mid-May. **Balikai, 1999,** reported that the mealy bug population started to increase from Jan. and reached peak during Feb.-March before harvesting. After harvesting, the mealy bug population remained low from May to Dec.. **Goolsby *et al*., 2002** reported that the pest populations were low during the rainy winter season and peaked during the summer months. **Kulkarni *et al*., (2008)** reported that mealybug population was distributed sporadically and the highest population during the last week of Feb. to the last week of March coincided with the fruiting and harvesting season. Similarly, **Angu *et al*. (2017)** indicated that the population of mealybug on grapevine started increasing from the first week of Jan. and a continued increasing till the harvest of berries. Lowest population was recorded at Jul. to the second week of Jan.

Effects of the main climatic factors on the population fluctuation of *M. hirsutis* on bunches of grapevines

Maximum temperature

This factor had a negative insignificant effect on nymphs of *M. hirsutis* where r= -0.174 and b= -1.685. Also, the partial regression coefficient was negative and insignificant. Regarding adult female's, this factor showed positive insignificant effect on these stages where r = 0.454 and 0.006, b = 1.745 and 0.060 for adult females and total individuals, respectively. The partial regression coefficient between this factor and adult females was positive and insignificant while the same factor had negative insignificant effect on total individuals where P. reg. = 1.913 and -2.670 for adult females and total individuals, respectively.

Minimum temperature

Minimum temperature had a negative insignificant effect on nymphs of the mealy bug (r = -0.110, b= -1.372). The partial regression coefficient of this factor was positive and insignificant where P. reg. = 4.429. Regarding adult females ad total individuals of the mealy bug, this factor showed positive insignificant effect on these stages where r = 0.371 and 0.037 and b = 1.826 and 0.544.The partial regression coefficient between this factor and adult females was negative and insignificant effect while was positive and insignificant with total individuals (P. reg. = -0.252 and 4.177 for adult females and total individuals, respectively).

Relative humidity

The simple correlation between this factor and nymphs of the mealy bug was negative and insignificant (r = -0.46) while simple regression and partial regression coefficients were positive and insignificant (b = 11.74 and P. reg. = 13.45). On the other hand, the effect of this factor on adult females was negative and insignificant where r= -0.08, b= -1.04 and P. reg= -1.22. Regarding total individuals of the mealy bug, this factor showed positive insignificant effect (r = 0.43, b= 10.700 and P. reg = 12.2).

The numerical relation between the different stages of *M. hirsutis* and weather factors on bunches of grapevine was expressed in regression equation was insignificant.

The obtained results indicated that maximum and minimum temperatures had negative insignificant effects on nymphs of the mealy bug while it has positive insignificant effects on adult females and total individuals which partially agreed with the findings of **Mani (1986)** who observed a positive and significant correlation of the grape mealy bug population with maximum temperature**. Katke *et al.* (2009)** mentioned that mealybug incidence correlated significantly and negatively with minimum temperature. **Angu *et al.* (2017)** mentioned that maximum temperature had significant positive effect on the incidence of the mealy bug while mean minimum temperature had negative nonsignificant effect on the mealybug.

Regarding the effect of relative humidity**,** the results showed negative insignificant effect of this factor on different stages of the mealybug which were in conformity with those of mentioned in certain studies **(Mani, 1986; Mani and Thontadarya, 1987; Koli, 2003; Angu *et al.*, 2017)** who reported that *M. hirsutis* was profoundly affected by weather factors where relative humidity had significant negative effect on its incidence.

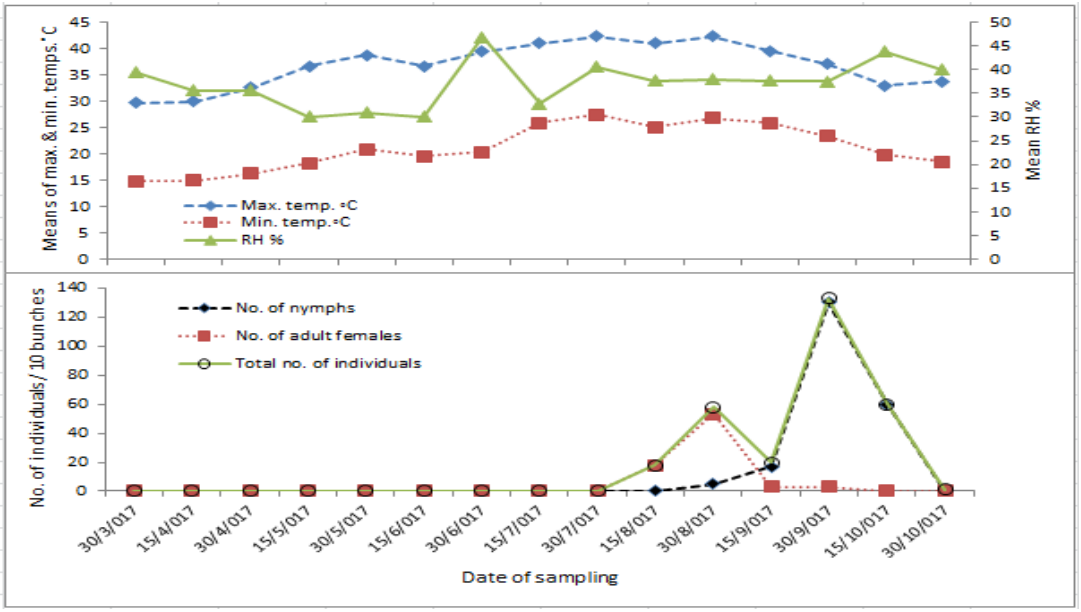

Fig. (3): Bi-weekly counts of *M. hirsutis* nymphs and adult stages on grapevine bunches with mean of weather factors during 2016-2017 at Fayoum Governorate

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تذبذب تعداد نوعين من البق الدقيقي(Pseudococcidae: Homoptera) *Ferrisia virgata* و *Maconellicoccus hirsutis* علي اشجار العنب في محافظة الفيوم - مصر

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بق الهبسكس الدقيقي ***Ferrisia virgata*** والبق الدقيقي المخطط ***Maconellicoccus hirsutis*** من الآفات المهمة التي تصيب العنب. وفي هذا العمل الذي اجري في محافظة الفيوم (قرية فيديمين) علي كرمات العنب (صنف غريبي) القي الضوء علي تقلبات الكثافة العددية وعدد و مدة أجيال بق العنب الدقيقي فضلا عن تأثير العوامل الجوية علي تعداد كلا النوعين. أخذت عينات نصف شهرية منتظمة من الجذوع و الاوراق و العناقيد لمدة عامين من نوفمبر ٢٠١٥ الي أكتوبر٢٠١٧.

اوضحت النتائج ان الاطوار المختلفة لبق الهبسكس الدقيقي ***F. virgata*** سجلت قمتين علي الاوراق خلال الموسم الاول، الاولي في نهاية اغسطس والثانية في نهاية سبتمبر اما علي جذوع العنب فقد سجلت قمة واحدة في نهاية سبتمبرفي الموسم الاول بينما سجلت قمتان خلال الموسم الثاني (نهاية يوليو ونهاية اغسطس).

سجلت قمة واحدة لحوريات البق الدقيقي المخطط ***M. hirsutis*** علي العنب في نهاية سبتمبر (١٣٠ حورية/ ١٠ فروع) كما سجلت قمة واحدة للاناث في نهاية اغسطس (٥٣ انثي/١٠فروع) اما التعداد الكلي للبق فقد سجل قمتين الاولي في منتصف اغسطس (٥٨ فردا/١٠فروع) والثانية في نهاية سبتمبر (١٣٣فرد/ ١٠فروع) وكان تأثير كلا من الحرارة العظمي و الصغري والرطوبة النسبية علي تعداد الحوريات للبق الدقيقي المخطط علي العنب سالبا و غير معنوي اما تأثير هذه العوامل علي الاناث والتعداد الكلي فقد كان موجبا وغير معنوي.