Diurnal Fluctuation of Occurring *Tetranychus urticae* Koch on Water Melon Plants During Two Summer Seasons in EL-Beheira , Egypt

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Key words : day times , population densities and correlation.

ABSTRACT

Water melon *Citrulus lanatus* is a favorable host for *Tetranychus urticae* Koch. Mites are found associated with the plants all over the growing season. Results declared the fluctuation of the mite numbers found on each of the inspected leaf surfaces within the day during the season .

The estimated population densities of mites showed an obvious increase in the majority of the investigation periods. The population densities of mites through day inspections appeared in the following descending order ; at 9 am , at 7 p.m. and at 2 p.m. in most of the inspection days. Analysis of variance showed a significant difference between mite numbers on the upper surfaces of leaves at 9 a.m. and 2 p.m..

Simple correlations coefficient showed that the total number of mites on the upper and the lower surfaces had strong positive correlations with air temperature but significant negative correlations with humidity.

INTRODUCTION

In Egypt , the area cultivated with water melon , *Citrulus lanatus* , has increased in the recent years because of its high and fast economic gain compared with the traditional crops like cotton (Abou-Zaid *et al.* , 2009) . So, it has become among the most important crops for local consumption and export . *T. urticae* is a dangerous pest for many crops (Osakabe, 2002, Castagnoli *et al.* , 2005 , Ansaloni *et al.* , 2008 , Goff *et al.* , 2009 and Leeuwen *et al.* , 2010).

T. urticae populations fluctuate through day and season influenced by many factors , in particular ; temperature , humidity and light.

Daily oviposition rate and net reproductive rate depend on temperature (Moraes and Mcmurtry,1987). Temperature has several effects on biological parameters (survival and duration of developmental stages, fecundity and longevity of females and sex ratio) of *Tetranychus evansi* (Bonato,1999). Temperature has a significant effect on immature development; total immature development requires 7–26 days depending

on temperatures (Jeong - Soo *et al.* , 2001). Development periods of immature stages of *T. urticae* varied between 6.5 and 15.5 days at 35℃ and 20℃, respectively, for females, and between 5.9 and 14.5 days at 35℃ and 20℃, respectively, for males (Kasap , 2004).

Light has a role in the life cycle of *T. urticae*. The development of deutonymphs is delayed under a diapause-inducing photoperiod. Diapause inducing photoperiods may suppress an increase in the *T. urticae* population, by slowing down development and reproduction (Suzuki *et al.* 2007). Photoperiod may affect the percentage of females that enter diapause (So and Takafuji 1992). A nonlinear relationship is found between temperature and feeding activity of *T. urticae*. But no difference could be found in the feeding intensity of mites kept at permanent darkness or permanent light.(Candolfi *et al.*,1991).

So, more effort has to be done to study the behaviour of mites associated with that plant. The present study aims to determine the periodical times of mite increase or decrease on plants within the day during growing season , in addition to the time of mite densely presence on the upper surface of leaves .The practical utility of this study could be developed to help farmers to choose the most suitable time through day and growing season to spray contact acaricides worthily on the infested plants.

MATERIALS AND METHODS

1 - Field studies

An area of twelve carats, In Kafr El-dawar , E l - Beheira province, was cultivated with water melon plants (specialized for getting seeds). The normal agricultural practices were applied without using pesticides. Three leaves located in three randomly chosen plants were chosen and marked for inspection at weekly intervals . The number of *T. urticae* individuals on each of the upper and the lower surfaces of the marked leaves was counted and recorded using a 10 x lens three times within the day at ,i.e.; 9 a.m. , 2 p.m. and 7 p.m. under field conditions. Mites inspection started after 30 days of planting and continued for thirteen weeks through May , June and July in both growing seasons of 2009 and 2010.

2 - Data of environmental factors:

During the field study , data of environmental factors, mainly air temperature ℃ and relative humidity (R.H.%) were obtained from the meteorological station at El-Beheira and recorded in Table (1).

Table (1): Mean degrees of temperature and relative humidity in the seasons of 2009 and 2010 as obtained from the Meteorological Station in Behera .

Weeks	Environmental factors			
	Mean air temperature ℃		Mean relative humidity R.H.%	
	2009	2010	2009	2010
1st week (1 May)	20.9	20.5	63	51.7
2nd	21.7	21.9	62.7	50.3
3rd	23.1	20.9	59.7	51.0
4th	25.0	20.2	57.7	51.0
5th	24.8	22.8	55.7	50.4
6th	25.2	23.9	55.4	50.0
7th	25.5	27.2	54.8	50.3
8th	26.8	27.4	53.0	47.9
9th	26.7	26.6	52.1	48.1
10th	27.5	26.6	54.5	48.0
11th	27.1	27.5	54.5	49.9
12th	27.6	28.4	54.7	50.4
13th week (24 july)	27.7	28.1	54.4	50.4

3 - STATISTICAL ANALYSES:

Data were subjected to the analysis of variance test (ANOVA) with mean separation at the 5% levels of significance. Computer Programs COSTAT and Duncan's Multiple Range Tests were used to compare the average numbers of counted mites (on upper, lower and upper + lower leaf surfaces) in the three adopted times of inspection.

Statistical coefficient analyses between each environmental factor (air temperature and relative humidity) and the mites counted (on the upper and the lower surfaces) during both seasons of 2009 and 2010 were calculated and discussed.

RESULTS AND DISCUSSION

1. Population densities:

The calculated mean numbers of counted mites in the adopted three day inspection times through the growing seasons of 2009 and 2010 are shown in Tables (2) and (3) respectively.

Table (2): Mean numbers of counted mites through the three periodical day inspection times in 2009.

Date of inspection (week)	Mean numbers of mites *								
	Upper surface			Lower surface			Grand Total		
	9 a.m.	2 p.m.	7 p.m.	9 a.m.	2 p.m.	7 p.m.	9 a.m.	2 p.m.	7 p.m.
1st week (1 May)	1	1	1	1	1. 3	1.3	2	2.3	2.3
2nd	1.3	2	2.3	1. 7	3	3.3	3	5	5.7
3rd	2. 7	2	2. 7	3. 3	3.3	4	6	5.3	6.7
4th	2. 7	2	2. 7	3. 7	4	4	6.3	6	6.7
5th	3. 7	3.3	4	4. 3	6	5.3	8	9.3	9
6th	4. 7	3. 7	5	6. 3	8	7	11	11. 7	12
7th	3. 3	2.3	3	9	8. 7	8. 7	12.3	11	11.7
8th	2. 7	1	2.3	8	8. 7	7. 7	10. 7	9. 7	10
9th	3	0. 3	2.3	10. 7	11	9. 7	13. 7	11.3	12
10th	4	0.3	1. 7	16. 3	17. 3	16. 3	20. 3	17. 7	18
11th	4	0.3	1. 3	19	17. 3	17. 7	23	17. 7	19
12th	4. 3	0. 7	1	20. 3	17. 7	19. 3	24. 7	18.3	20
13th week (24 July)	5. 7	0.3	1. 3	20. 7	21. 3	21. 7	26. 3	21. 7	23
Grand Total #	43.1 a	19.2 b	30.6 ab	124.3 a	127.6 a	126 a	167.3 a	147 a	156.1 a
L S D (5%)		22.35			45.69			66.39	
Mean	3.3	1.5	2.4	9. 6	9.8	9.7	12.9	11.3	12
Ratio	2.2	1	1.6	1	1.02	1.01	1.14	1	1.06

* Sample based on three replicates , each of one leaf.
# Means followed by a common letter are not significantly different at the 5 % level.

Table (3) : Mean numbers of counted mites through the three periodical day inspection times in 2010.

Date of inspection (week)	Mean numbers of mites *								
	Upper surface			Lower surface			Grand Total		
	9 a.m.	2 p.m.	7 p.m.	9 a.m.	2 p.m.	7 p.m.	9 a.m.	2 p.m.	7 p.m.
1st week (1 May)	2.7	2	2.3	1	1.3	1	3.7	3.3	3.3
2nd	2.7	1.3	2	1	1	1.3	3.7	2.3	3.3
3rd	3.3	2.7	3	5	4.7	5	8.3	7.3	8
4th	3.7	2	2.7	6	6	6.3	9.7	8	9
5th	4	1.7	2.3	8.3	7.3	7.7	12.3	9	10
6th	4	2.7	3.7	11.7	11	10.7	15.7	13.7	14.3
7th	4.3	1.7	2	13.7	12	12.3	18	13.7	14.3
8th	2.3	1.3	1.7	13.3	11.3	11.7	15.7	12.7	13.3
9th	1.7	0.7	1.3	11.7	10	10	13.3	10.7	11.3
10th	1.7	0.7	1.3	12.7	10.7	10.7	14.3	11.3	12
11th	2	1	1.7	13	11.7	11.7	15	12.7	13.3
12th	2.3	1.7	2	13.7	12.7	13	16	14.3	15
13th week (24 July)	4.7	2.3	2.3	14.3	13.7	13.7	19	16	16
Grand Total#	39.4 a	21.8 b	28.3 ab	125.4 a	113.4 a	115.1 a	164.7 a	135 a	143.1 a
L S D (5%)		12.62			37.58			45.39	
Mean	3	1.7	2.2	9.6	8.7	8.9	12.7	10.4	11
Ratio	1.76	1	1.29	1.10	1	1.02	1.22	1	1.05

* Sample based on three replicates , each of one leaf.
# Means followed by a common letter are not significantly different at the 5 % level.

Tables (2) and (3), showed a comparison among the interaction effects of inspection time on the population densities of T. *urticae* in the seasons of 2009 and 2010. , The mean mite numbers in both growing seasons , on the upper surfaces of leaves , have a significant difference only between the inspection times at 9 a.m. and 2 p.m. while there were no significant differences among the estimated mean numbers of mites occurring on the lower surface of the inspected leaves allover the three

times of inspections. Also , there were no significant differences among the mean numbers of the total mites found on both of the upper and lower surfaces of leaves at the three times of inspections.

Summations of all the counted mites through the investigations during summer seasons of 2009 and 2010 respectively are graphically illustrated in Figs. (1) and (2) .

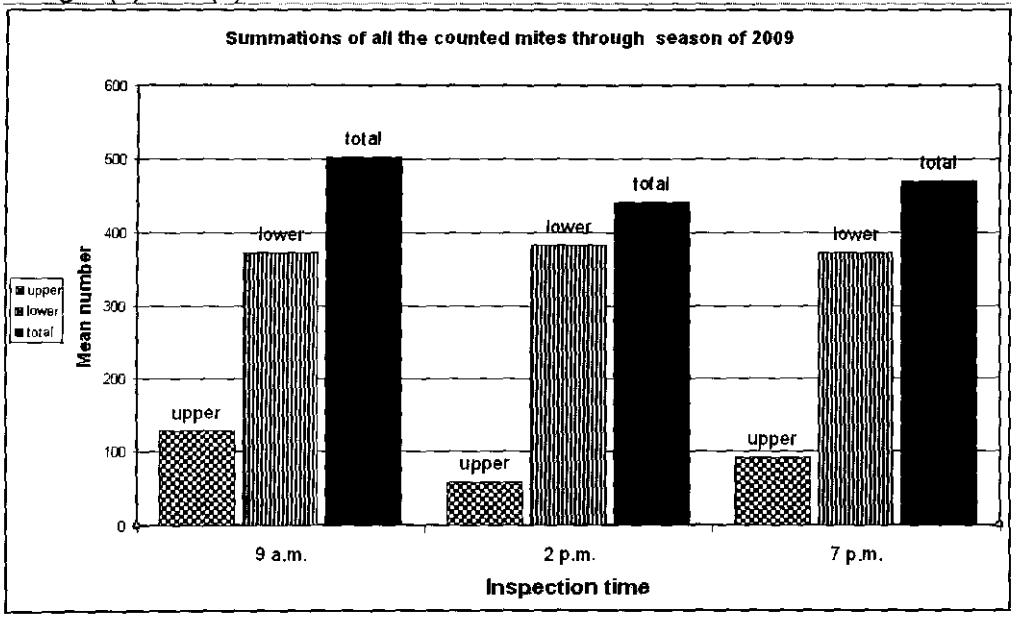

Fig. (1) : Summations of all the counted mites during summer season of 2009 .

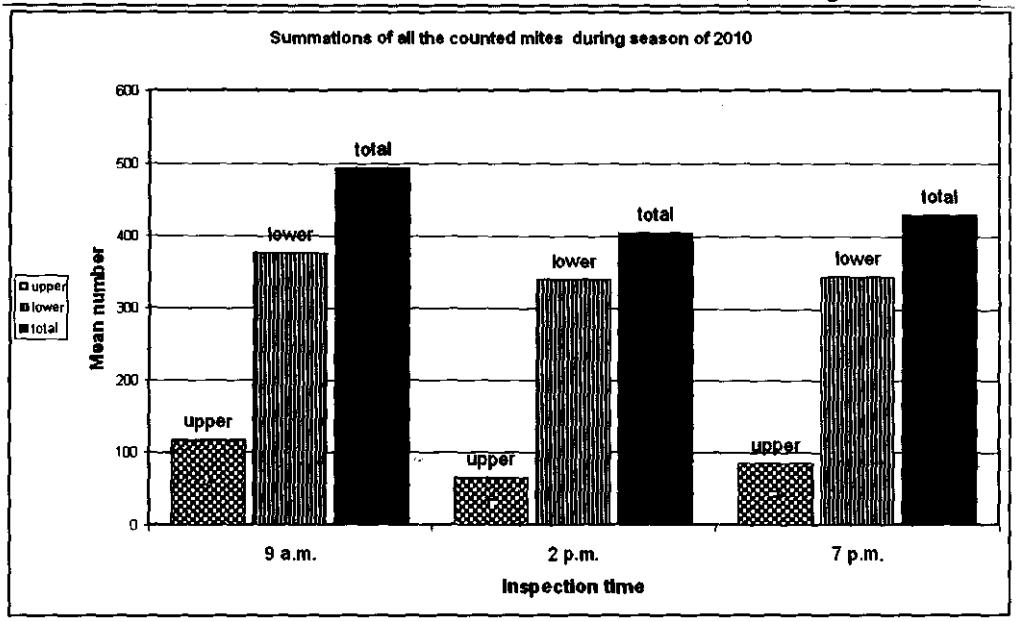

Fig. (2) Summations of all the counted mites during summer season of 2010.

1-1- Population dynamics of mites on the upper surfaces of leaves :

Data in Tables (2) and (3) revealed that the mean numbers of *T. urticae* on the upper surfaces of the inspected leaves at the three inspection times altered through the investigation period with a peak in the 6th week in season of 2009. Whereas , a peak in the 7th week at the inspection time of 9 a.m. , and two peaks in the 3rd and the 6 th weeks at the inspection times of 2 p.m. and 7 p.m. in the season of 2010. Generally , Population densities differed through day intervals and appeared in descending mean values at 9 a.m. , at 7 p.m. and at 2 p.m. beginning from the 7 th week to the end of the season of 2009 , while they occurred in the same descending order allover the growing season of 2010 Table (3).

The mean numbers of the mites on the upper surfaces at 9 a.m. , 2 p.m. , 7 p.m. had the ratio, 2.2 : 1 : 1.6 respectively in the season of 2009. While had the ratio, 1.67 : 1 : 1.29 in the season of 2010. , that disagrees with (El-laithy , 1996) who mentioned that relative humidity under 30% during mid-day time in the plastic houses favours population build up of the two spotted spider mite T. *urticae* Koch that increase on the growing top of cucumber plants while predatory mites do not migrate to the apical leaves which are too warm and dry.

1 - 2- Population dynamics of mites on the lower surfaces of leaves :

Data in Tables (2) and (3) elucidate that the mean numbers of counted mites on the lower surfaces showed an obvious increase through the periods of investigation with some exceptions like in the 8 th week (last of June) in the season of 2009 and the 8 th & 9 th weeks (last of June and beginning of July) in the season of 2010, wherein the numbers decreased at the three inspection times . In other words , mites which were found on both surfaces of leaves at the beginning of infestation preferred to live on the lower surfaces of leaves at the later weeks of the season when heat increases.The mean numbers of the mites on the lower surfaces at 9 a.m. , 2 p.m. , 7 p.m. had the ratio , 1 : 1.02 : 1.01 respectively in the season of 2009. While , had the ratio ,1.10 : 1 : 1.02 in the season of 2010.

The increase of the mite's population densities may attributed to the prevailing hygrothermic conditions of higher temperatures and relative humidity Table (1).

1- 3 - Population dynamics of mean numbers of total counted mites on both of the upper and lower surfaces of leaves:

The mean numbers of the total inspected mites on the upper and lower surfaces at 9 a.m. , 2 p.m. , 7 p.m. had the ratio, 1.14 : 1: 1.06 respectively in the season of 2009. While had the ratio, 1.22 : 1 : 1.05 in the season of 2010 ,Tables (2) and (3). Moreover it can be revealed that the population densities of *T. urticae* increased generally along all the weeks of the two seasons. The increase of the population densities may refer to the mite's activity under the favorable prevailing hygrothermic conditions in field . While, the population densities decreased slightly in the 8 th week (last of June) in the season of 2009 and in the 2 nd & 9 th weeks (mid of May and last of June) in the season of 2010. That agrees with (Gotoh and Gomi , 2000) who found that the seasonal occurrence of mite populations had different peaks.

The estimated population densities of occurring mites at 9 a.m., 2 p.m. and 7 p.m. varied in the season of 2009 from time to another .

Thus, at 9 a.m. through the first six weeks of the investigation , mite's population densities were somewhat the lowest, compared with others at 2 p.m. and 7 p.m. except , in the third week wherein the calculated mean

values exceeded the population densities of 2 p.m. slightly. Meanwhile , they mean values were the highest in the period beginning from the 7 th week up to the end of the season.

At 2 p.m. population densities were the lowest throughout the whole investigation period except in the first week wherein they exceeded the population densities of 9 p.m. and equaled the population densities of 7 p.m. , in the 2 nd week wherein exceeded the population densities of 9 p.m. , in the 5 th week , wherein equaled the population densities of 7 p.m. and in the 6 th week wherein exceeded the population densities of 9 a.m..

At 7 p.m. population densities were the highest through the first six weeks of the investigation except in the first and the 5 th weeks, where they were equal to those of 2 p.m.. Population densities at 7 p.m. were higher than the others of 2 p.m. and lower than the others of 9 p.m. throughout the following weeks of the investigation.

Herein, population densities altered through day. Mean values of the inspected mites appeared in the descending order ;at 9 am , at 7 p.m. and at 2 p.m. beginning from the 7 th week till the end of the season of 2009, Table (2).

Identically, Mean values of the inspected mites appeared in the descending order ; at 9 am , at 7 p.m. and at 2 p.m. allover the season of 2010 except in the first week and the last week wherein the numbers of mites at 2 p.m. and 7 p.m. were the same, Table (3).

2. Simple correlations coefficient between the mite numbers and some environmental factors:

Data of statistical correlations among the environmental factors (air temperature and relative humidity) and numbers of inspected mites (on the upper surface , on the lower surface and the total numbers on both surfaces) at each of the three followed inspection times are demonstrated in Tables (4) and (5) .

In the season of 2009 , mite numbers on the upper surfaces of the inspected leaves showed a strong significant positive correlation with air temperature at 9a.m. inspection but positive correlations at the other two inspection times. Numbers showed strong negative correlations with humidity at 9 a.m. and 7 p.m. inspections but a positive correlation at 2 p.m. inspection.

The correlated numbers of mites found on the lower surface of the examined leaves, In the three times of inspection , showed a strong significant positive correlation with air temperature . But , showed a significant negative correlation with humidity. Table (4)

The total number of the detected mites on the upper and lower surfaces showed a strong significant positive correlation with air temperature . That agrees with each of (Kim and Lee , 2003) who found that the longevity and fecundity of overwintered T. *urticae* are affected largely by temperature,(Raworth , 2007) who found that the rate of development from winter diapause to initial oviposition for *T. urticae* on strawberry in southwestern British Columbia, Canada, was linearly related to temperature. and Gotoh *et al.* (2010) who found that increasing temperatures between 15 and 32.5℃ significantly increased the developmental rate of the red spider mite *Tetranychus evansi* .

Strong negative correlations with relative humidity were clear. That agrees with Duso *et al.* (2004) who found a reduction of *T. urticae* populations in the humidified area.

Meanwhile , In the season of 2010 statistical correlations showed results similar to those of 2009 , except that mite numbers on the upper surfaces of leaves showed a weak insignificant negative correlation with air temperature but a positive moderate correlation with relative humidity at 9 a.m. inspection, Tables (5).

Table(4) :Simple correlation coefficient among the numbers of mite and some environmental factors during 2009.

	Mite numbers								
	At 9 a. m.			At 2 p. m.			At 7 p . m.		
	# U	@ L	U+L	U	L	U+L	U	L	U+L
L	0.766 **			-0.604 *			-0.471 *		
U+L	0.827 **	0.994 **		-0.473 ns	0.986 **		-0.323 *	0.986 **	
C°	0.801 **	0.851 **	0.870 **	-0.421 ns	0.872 **	0.872 **	-0.118 ns	0.804 **	0.841 **
R.H.	-0.705 **	-0.664 *	-0.691 **	0.264 ns	-0.694 **	-0.713 **	-0.088 ns	-0.630 *	-0.691 **

Abbreviations :
U = number of mites on the upper surfaces of leaves.
@ L = number of mites on the lower surfaces of leaves.
U+L = summation of U and L
℃ = air temperature.
R.H. = relative humidity.
· = significant at 5 % level. ·· = significant at 1 % level.
ns = not significant at 5 % level.

Table(5) : Simple correlation coefficient among the numbers of mite and some environmental factors during 2010.

	Mite numbers								
	At 9 a. m.			At 2 p. m.			At 7 p. m.		
	U	L	U+L	U	L	U+L	U	L	U+L
L	0.007 ns			-0.156 ns			-0.229 ns		
U+L	0.214 ns	0.978 ··		-0.081 ns	0.987 ··		-0.076 ns	0.987 ··	
℃	-0.200 ns	0.904 ··	0.841 ··	-0.432 ns	0.887 ··	0.830 ··	-0.544 ns	0.888 ··	0.823 ··
R.H.	0.547 ns	-0.561 ·	-0.434 ns	0.695 ··	-0.482 ns	- 0.378 ns	0.619 ·	-0.483 ns	-0.396 ns

Abbreviations : As in Table (4)

CONCLUSION

According to the population dynamics of total mites on the upper and lower surfaces of water melon leaves , spraying contact acaricides for controlling *T. urticae* at the second half of growing season may be more effective when applied in the morning, but less effective when applied at noon . Spraying contact acaricides at sun set may give satisfying control results.

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الملخص العربى

التغير اليومى لأعداد العنكبوت الأحمر على نباتات البطيخ الجورمة ، بمحافظة البحيرة ، بمصر.

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أجرى هذا البحث فى مزرعة بكفر الدوار ، محافظة البحيرة ، حيث تم زراعة بطيخ الجورمة الذى يحصل منه على البذور.

أوضح تحليل التباين وجود اختلاف معنوى بين أعداد الأكاروس على السطح العلوى للأوراق الساعة التاسعة صباحاً و الساعة الثانية بعد الظهر. وظهرت أعداد الأكاروسات كما يلى:

1 – أعداد الأكاروسات على الأسطح العلوية للأوراق:

تنوعت الأعداد خلال فترة الدراسة مع ظهور زيادة ملحوظة فى الأسبوع السادس بموسم 2009 ، وفى الأسبوعين الثالث و السادس بموسم2010.عموماً ظهرت الأعداد بترتيب تنازلى فى المواعيد : التاسعة صباحاً و السابعة مساءً و الثانية بعد الظهر.

2 – أعداد الأكاروسات على الأسطح السفلية للأوراق:

تزايدت الأعداد بوضوح خلال فترة الدراسة فيما عدا الأسبوع الثامن (نهاية يوليو) بموسم 2009 و الأسبوع التاسع (بداية أغسطس) بموسم 2010 حيث انخفضت الأعداد فى مواعيد الفحص الثلاثة.

3 – الأعداد الكلية للأكاروسات على الأسطح العلوية و السفلية للأوراق:

– تزايدت الأعداد الكلية للأكاروسات تدريجياً خلال فترة البحث مع حدوث إنخفاض فى التعداد فى الأسبوع الثامن فقط (نهاية شهر يوليو) بموسم 2009و فى الأسابيع السابع ، الثامن و التاسع (الثانى من شهر يوليو و بداية شهر أغسطس) بموسم 2010 .

– اختلف تعداد الأكاروسات حسب مواعيد الفحص على نحو الترتيب التنازلى التالى : التاسعة صباحاً ، السابعة مساءً ، الثانية بعد الظهر فى النصف الثانى من موسم 2009 ، وخلال موسم 2010 بالكامل.

4 – الارتباط بين أعداد اللأكاروسات و العوامل البيئية أوضح وجود ارتباط قوى موجب بين عدد الأكاروسات على السطح السفلى للأوراق مع مجموع الأكاروسات على سطحى الأوراق ، و كذلك مع درجة حرارة الهواء.