

The Relation between the anatomical characters of five different cucumber cultivars leaves and *Tetranychus urticae* Koch (acarina: actenididea: tetranychidae:) infestation under filed conditions

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ABSTRACT

The relative population densities of *Tetranychus urticae* Koch (Acarina: Actenidida : Tetranychidae) movable stages infesting leaves of five cucumber cultivars (Impress F1, Yaaqube, Prince 3, Madina 2 and Sahn) during 2009 and 2010 seasons was investigated at Qalyubia Governorate. The results indicated significant differences between the tested cultivars in their relative susceptibility to *T. urticae* infestation. In the two tested seasons the five cucumber cultivars were grouped into four groups, as the highly infested cultivars were Impress F1 and Yaaqybe while the lowest infested group included Sahn cultivar, which was characterized by somewhat the thickest layer of the upper & lower epidermis and palisade tissue and the thinnest layer of spongy tissues. While, leaves of Impress manifested approximately the thinnest layers of the upper & lower epidermis and palisade tissue) and the largest diameter of Spongy tissue. Insignificant negative correlation coefficient values were calculated between the mean abundance of *T. urticae* individuals infesting different cultivars and the relation of thickness of the upper & lower epidermis, and palisade tissues while the relation with the spongy layers was positive *i.e.*, cultivars characterized by thicker layers of the previously mentioned three layers were less susceptible to this pest infestation and subsequently, infested by fewer population of the two spotted spider mite and vice versa.

Key words: Cucumber, Cultivars, *Tetranychus urticae*, susceptibility, anatomy of leaves, resistance.

INTRODUCTION

Leaf structure has been showed to be related to mite damage or to symptoms commonly associated with damage. The highest density of phytophagus mites occurred on leaves which, in addition to having higher total nitrogen content, had a thicker palisade mesophyll. In this connection, size of the leaf is also important. So that the leaf surface texture, and contours (ridges, depressions) are important in the reproductive potential of a resident phytophagus mites has long been recognized. Many studies were done to clarify the relation between mite infestation and leaf structure. Some varieties of Pelargonium with thicker cuticle and epidermis were more resistant to spider mite. Besides that, the upper leaf surface was less preferred by mites, because its cuticle and epidermis were, thicker than that of the lower surface (Kou *et al.*, 1972 and Luczynski *et al.* 1990). Kielkiewicz, 1994 and Magali, 1997 stated that, leaf trichomes contributed to the reduction of *T. cinnabrinus* density at beginning of mite feeding and on tomato and bean varieties. Adults of *T. urticae* could feed through the spongy and part of the palisade parenchyma of the leaf, while immature *T. urticae* could feed only through the spongy parenchyma (Park and Lee, 2002). Also, the length, density and thickness of leaf trichomes may be considered as another factors affecting the host plant resistance to infestation by *T. urticae* (El-Saiedy

2003). A negative relationship between the thickness of the upper epidermis and spongy tissue of leaf of the 7 cucumber varieties and the abundance of *T. urticae* movable stages. While, it was positive in case of palisade tissue (Hanafy, 2004). Moreover, *T. urticae* preferred the lower leaf surface of the plants due to the very thin cuticular layer, (Abo-Bakr and Ali, 2005). Also, the more thickness of the cuticle of the epidermis especially that of the lower surface could be considered as a physical resistance factor (Azouz, 2005). Resistant varieties possess thicker on either upper or lower leaf surface than susceptible ones. The more thickness of the cuticle epidermis especially that the lower surface could be considered as a physical tolerance factor against mechanism of spider mit (El-Sanady *et al.*, 2008).

The present work aims to evaluate the relative susceptibility of five cucumber cultivars to the spider mite, *T. urticae* infestation with relation to the anatomical characters and mite level infestation.

MATERIALS AND METHODS

For the evaluation of the susceptibility of some cucumber cultivars the two-spotted spider mite, *T. urticae* infestation, five different cucumber cultivars (Impress F1, Yaaqube, Prince 3, Madina 2 and Sahn) were cultivated in an area of about 175 m² in Qalyubiya Governorate during two successive seasons 2009 and 2010. The seeds were sown in hills every season on 15th April. The experimental area was divided into 15 plots, each plot area was about 50m². Each tested cultivar was represented by three replicates which arranged in a complete randomized block design.

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.

To clarify the relative susceptibility of five cucumber varieties to *T. urticae* infestation in relation the anatomical characters of their leaves, samples of each variety were taken during 2009 and 2010 growing seasons at (seedling and flowering + fruiting) stages and placed in the fixed solution FAA four 48 hours then transferred to 70% alcohol. Then after, a transverse sections in there leaves were made by using the method described by Jackson (1976). The different measurements (in micron) of the thickness of upper epidermis layer, palisade tissue, spongy tissue and lower epidermis layer were determined by using of Compu Eye, Leaf & Symptom Area program by Bakr (2005).

Sampling technique:

Three weeks after sowing of the open field cucumber seeds, ten randomly chosen leaves from different levels of plants were picked up from each replicate and then kept in tightly closed paper bags and transferred to the laboratory at the same day where the number of eggs, immature and adult stages of *T. urticae* were estimated by counting the total number per two randomize chosen square inches on the low surface of the leaves with the aid of a stereomicroscope. Samples were taken weekly, 7 days intervals, for each experiment. Then the sampling continued for 12 weeks.

Statistical analysis:

The statistical analysis (ANOVA and Simple correlation) of the obtained data were performed by using SAS program (SAS Institute, 1988) which run under WIN. Also the difference between means was conducted by using Duncan's multiple range tests in this program.

RESULTS AND DISCUSSION

Relative susceptibility of five cucumber cultivars to spider mite, *T. urticae* the infestation:

The relative population densities of *T. urticae* movable stages infesting leaves of five cucumber cultivars (Impress F1, Yaaqube, Prince 3, Madina 2 and Sahn) during 2009 and 2010 seasons in Qalyubia Governorate are shown in Tables (1&2).

Table 1: Population fluctuation of the moving stages of *Tetranychus urticae* / inch², counted on leaves of five cucumber cultivars in the field during 2009 seasons in Qalyubia Governorate

Inspections date Cultivars	Impress F1	Yaaqube	Prince 3	Madina 2	Sahn
May, 5 th	1.55	3.84	0.52	7.21	0.93
12 th	12.65	5.19	4.95	16.97	2.29
19 th	14.34	10.01	16.50	13.43	11.92
26 th	26.42	35.45	19.52	24.00	18.09
June, 6 th	34.41	26.04	34.41	20.62	18.76
9 th	180.03	62.04	125.27	45.34	32.19
16 th	155.56	135.54	86.38	83.36	120.10
23 rd	213.30	248.86	182.21	129.93	77.58
30 th	135.17	160.11	101.66	83.16	39.49
July, 7 th	17.41	32.41	31.87	32.34	12.33
14 th	2.41	7.39	2.33	7.49	1.46
21 th	0.63	2.10	1.00	0.20	0.20
Total	793.88	728.98	606.62	464.05	335.34
Mean	66.16 a	60.75 a	50.55 b	38.67 c	27.95 d
F value (5% level)	2.46				
LSD	9.3				

During 2009 season, the obtained results revealed that the mean seasonal numbers of *T. urticae* movable stages that found on leaves of cucumber cultivars; Impress F1, Yaaqube, Prince 3, Madina 2 and sahm were 66.16, 60.75, 50.55, 38.67 and 27.95 individuals/ inch², respectively. The corresponding counts for the second season, 2010, were 82.10, 52.47, 66.25, 30.41 and 41.42 95 individuals/ inch², respectively.

Concerning the statistical analysis of the obtained data by using the least significant differences (L.S.D.) between the previously mentioned means, the results indicated that there are significant differences between the tested cultivars in their infestation by *T. urticae*. For the first season 2009, L.S.D. and F values were 2.46 and 9.3, respectively, clearing that the five cucumber cultivars were grouped into four groups as following: **a**- the highly infested; Impress F1 and Yaaqube cultivars, **b** -the moderately harbored ones; represented by 50.55 cultivar, while Madina 2 cultivar, represented by (**c**) group and **d**-the lowest infested group included Sahn cultivar. In the subsequent season 2010, the same four categories were observed (L.S.D = 17.93& F= 10.03) but the significant difference between the means were less as there were no significant difference between Impress F1 and Yaaqube cultivars as they were classified as the most susceptible to *T. urticae* infestation (**a** group) followed by Prince 3 and Madina 2 cultivars (moderately infested category, **bc** and **cd**), comes next Sahn cultivar which was more resistance to *T. urticae* infestation (**d** group).(Table, 2)

Table 2: Population fluctuation of the moving stages of *Tetranychus urticae* / inch², counted on leaves of five cucumber cultivars in the field during 2010 season in Qalyubia Governorate.

Inspections date Cultivars	Impress F1	Yaaqube	Prince 3	Madina 2	Sahm
May, 5 th	11.92	4.61	8.59	6.57	2.16
12 th	29.30	32.82	21.41	24.81	11.73
19 th	48.50	51.66	27.05	40.02	21.32
26 th	87.65	73.70	51.73	54.63	31.23
June, 6 th	83.97	95.49	69.13	47.34	29.94
9 th	122.60	80.15	80.77	63.70	34.75
16 th	191.96	123.96	94.64	78.24	34.08
23 rd	168.05	117.43	104.47	73.67	98.63
30 th	100.34	128.50	80.33	57.00	63.80
July, 7 th	86.17	61.75	49.01	31.51	21.35
14 th	44.33	23.41	34.43	19.31	13.50
21 th	10.39	1.55	8.14	0.22	2.37
Total	985.18	795.03	629.70	497.02	364.86
Mean	82.10 a	66.25 ab	52.47 bc	41.42 cd	30.41 d
F value (at 5% level)	10.03				
LSD	17.93				

Relation between anatomical characters of leaves from different cucumber cultivars and the two-spotted spider mite infestation:

Thickness of leaf is a character that contributes towards resistance and hence effects the mite pest population. So the susceptibility of the five tested cucumber varieties (Impress F1, Yaaqube, Prince 3, Madina 2, and Sahm) to the infestation with moving stages of red-spider mite was related to the anatomical characters of leaves of each variety, such as the thickness of the leaf layers (upper epidermis, palisade, spongy tissues and lower epidermis). This part of study was done to discover the correlation between these layers and the mean population density of movable stages of *T. urticae* during two growth stages during the two studied seasons, seedling stage in May, 26th and flowering + fruiting in July, 21st. Tables (3&4) give both of the means count on each variety and mean thickness of each of the 4 tested layers and the correlation coefficient values between these tested factors.

The lowest determination of *T. urticae*' infestation (25.08 individuals / inch²) were observed on Sahm cultivar. Such cultivar was characterized by somewhat the thickest layer of the upper & lower epidermis and palisade tissue (17.48 & 14.98 and 110.67 micron, respectively) and the thinnest layer of spongy tissues (52.56 micron), while leaves of Impress F1 which harbored the highest number of *T. urticae* manifested approximately the thinnest layers (12.12, 89.51 and 10.76 micron for the upper & lower epidermis and palisade tissue) and the largest diameter of Spongy tissue (84.25 microns). The same observations were recorded for Yaaqube cultivars which had no significant difference with Sahm cultivar in its infestation with this pest, as the mean diameters of its leaf were 14.44, 89.12, 75.78, and 12.70 μm for upper epidermis, palisade tissue, spongy tissue during 2009, respectively.

Data tabulated in Table (3) showed that, the differences between means of infestation rates by *T. tabaci* to cucumber leaves of the experimented five cultivars are either significant or insignificant. Insignificant negative correlation coefficient values were calculated between the mean abundance of *T. urticae* individuals infesting different cultivars in relation to thickness of upper & lower epidermis, and palisade tissues ($r = -0.38$, -0.31 & -0.42 , respectively) while the relation with the spongy layers was positive ($r = 0.13$); *i.e.*, cultivars characterized by thicker layers of the

previously mentioned three layers were less susceptible to this pest infestation and subsequently, infested by fewer population of the two spotted spider mite and vice versa.

Table 3: Relation between anatomy of leaves of five cucumber cultivars and *T. urticae* moving stages infestation during 2009 season.

Cultivars	Plant stage	<i>T. urticae</i> mean count	Mean diameters of leaf layers(μ)			
			Upper epidermis	Palisade tissue	Spongy tissue	Lower epidermis
Impress F1	1 st	13.74	14.95	94.16	83.05	12.07
	2 nd	87.41	9.29	84.85	85.45	9.44
Mean		50.58 a	12.12 b	89.51 b	84.25 a	10.76 c
Yaaqube	1 st	13.62	17.45	65.42	68.03	13.86
	2 nd	97.73	11.43	112.82	83.53	11.53
Mean		55.68 a	14.44 b	89.12 b	75.78 a	12.70 b
Prince 3	1 st	10.37	19.04	75.08	59.19	12.70
	2 nd	67.57	16.25	98.77	49.27	14.22
Mean		38.97b	17.64 a	86.93 b	54.23 b	13.46 ab
Madina 2	1 st	15.40	14.38	109.45	71.48	13.43
	2 nd	56.08	13.52	85.41	44.82	14.14
Mean		35.74 b	13.95 b	97.43 ab	58.15 b	13.79 ab
Sahm	1 st	8.31	19.48	105.13	46.58	13.47
	2 nd	41.86	15.48	116.20	58.54	16.50
Mean		25.08 c	17.48 a	110.67 a	52.56 b	14.98 a
F value		0.80	5.87	2.61	16.47	6.89
L.S.D.		9.68	2.87	17.58	10.18	1.74
R			-0.38	-0.42	0.13	-0.31
EV%			75.47			

r: Correlation coefficient& E.V.% : Explained variance

The cultivars with the same litters at the same column are not significantly different at alpha=0.05 level

The amount of variability that could be attributed to the combined effect of leaf anatomical characters of cultivars on the different stages of *T. urticae* population on the five tested cucumber cultivars were more than 70% for the first season 2009, as the overall explained variance (E.V.%) was 75.47 (Table 3).

Statistical analysis of data as shown in Table (4) revealed that the seasonal mean rate of infestation by *T. urticae* moving stages to leaves of 5 cucumber cultivars showed insignificant correlation with the thickness of the upper & lower epidermis, and palisade tissues, beside that, they were also negative (- 0.07 & - 0.27 and - 0.32, respectively), on the other hand, a significantly positive relation with the spongy tissue (r = 0.70).

The negative correlation between seasonal mean population density and upper and lower epidermis layers during 2010 season could be noticed with Impress F1 cultivar which was heavily infested by *T. urticae* moving stages (72.27 individuals/in²) and manifested the thinnest layer (14.96 and 13.39 micron), while Sahm cultivar which showed lower infestation rates (27.78 individuals / in²) were characterized by thicker upper & lower epidermis layers and Palisade tissue (17.03 & 15.65 and 110.45 micron, receptively). Also, the positive correlation with thickness of the spongy tissue were clear in cases of Impress F1 and Yaaqube cultivars which showed the highest infestation rates (72.27 and 58.40 individuals/ inch²), combined with the spongy tissue thick of 81.70 and 75.07 micron, respectively. In the same direction, Prince 3 showed moderate infestation of the movable stages (44.52 individual/in²) had the moderate

diameters of the tested leaf layers (16.19, 13.59, 92.41 and 64.06 μm for upper & lower epidermis, palisade and spongy tissue, respectively. (Table 4).

Table 4: Relation between anatomy of leaves of five cucumber cultivars and *T. urticae* moving stages infestation during 2010 season.

Cultivars	Plant stage	<i>T. urticae</i> mean counts	Mean diameters of leaf layers(μ)			
			Upper epidermis	Palisade tissue	Spongy tissue	Lower epidermis
Impress F1	1 st	44.34	16.21	72.96	74.76	11.97
	2 nd	100.20	13.70	97.38	88.63	14.81
Mean		72.27 a	14.96 b	85.17 c	81.70 a	13.39 b
Yaaqube	1 st	40.70	14.04	93.18	65.92	13.29
	2 nd	76.10	17.55	95.45	84.21	14.27
Mean		58.40 ab	15.79 ab	94.31 bc	75.07 a	13.78 b
Prince 3	1 st	27.20	16.73	72.35	61.66	13.02
	2 nd	61.84	15.64	112.47	66.47	14.15
Mean		44.52 bc	16.19 ab	92.41 bc	64.06 b	13.59 b
Madina 2	1 st	31.51	14.84	110.40	73.28	15.23
	2 nd	43.32	14.95	99.04	54.57	12.83
Mean		37.42 bc	14.89 b	104.72 ab	63.93 b	14.03 b
Sahm	1 st	16.61	18.14	99.15	54.80	15.37
	2 nd	38.95	15.93	121.75	62.83	15.94
Mean		27.78 c	17.03 a	110.45 a	58.82 b	15.65 a
F value		4.94	1.62	3.54	8.92	2.89
L.S.D.		22.98	2.05	15.62	9.14	1.55
R			-0.07	-0.32	0.70*	-0.27
EV%			57.22			

The obtained results revealed that, significant effect for the combined effect of the tested leaf layers on the pest activity during second season 2010, as the amount of variability, attributed to the combined effect of the four layers on the two-spotted mite population on the five cucumber cultivars was 57.22%.

In a conclusion, the result regarding correlation between some anatomical cucumber leaf characters and mite population revealed that most of the combinations were found to be negative. This means that Thickness of leaf is a character that contributes towards resistance and hence effects the mite pest population. As it was obvious from data packed from the previous information that, the maximum thickness of leaf upper and lower epidermis (μm) was recorded on Sahm cultivar which statistically infested with lowest numbers of *T. urticae* among other tested cultivars, while Impress F1 had the lowest leaf diameters and highest number of individuals.

This means that, leaf thickness is very important factor influencing mite population and showed significantly negative correlation with mite population. The results agree with Saber and Momen, 2005 & El-Sanady *et al.*, 2008 and Shakoor *et al.*, 2010 who reported that leaf toughness and thickness are very important factors, which affect the reproduction and development of mite population.

REFERENCES

- Abo-Bakr, M. H. A. and F. S. Ali (2005). Life structure effects on the life cycle and reproduction of two tetranychid species. J. Agric. Sci. Mansoura Univ., 30(12): 88153-8166.

- Azouz, H. A. A. (2005). Ecological and biological studies on some mites associated with cotton and some field crops in Beni-Suef Governorate. Ph.D. Thesis, Fac. of Agric., Al-Azhar Univ. 185pp.
- Bakr, E. M. (2005). A new software for measuring leaf area, and area damaged by *Tetranychus urticae* Koch. Journal of Applied Entomology 129 (3): 173-175.
- El-Saiedy, E.M.A. (2003). Integrated control of red spider mite *Tetranychus urticae* Koch on strawberry plants. Ph.D. Thesis, Fac. of Agric. Cairo Univ. 171pp.
- El-Sanady, M.A.; S.M. Soliman and A.Y. Younis (2008). Field and laboratory studies to evaluation five soybean varieties for their relative susceptibility to the two spotted spider mite *Tetranychus urticae* Koch infestation (Acarina: Tetranychidae: Actenidida). Egypt. J. Agric.Res., 86(1): 77-88
- Hanafy, A. R. I. (2004). Studies on the most important cucumber pests in the open field and suitable control programs. Ph.D. Thesis. Fac. of Agric., Moshtohor, Zagazig Univ. 279pp.
- Jackson, G. (1976). Crystal violet and erythrosine in plant anatomy. Stain Technique. 1: 33-34.
- Kielkiewicz, M. (1994). The appearance of Phenolics in tomato leaf tissue exposed to spider mite attack. Acta Horticulture. 381: 687-690.
- Kou, K.P.C.K.; S.S. Robert and C. Richard (1972). Leaf characteristics of spider mite resistant and susceptible cultivars of *Pelargonium hortorum*. Entomology News. 83:181-197.
- Luczynski, A.; M.B. Isman; D.A. Raworth and C.K. Chan (1990). Chemical and morphological factors of resistance against the two-spotted spider mite in beach strawberry. J. Econ. Entomol., 83 (2): 564-569.
- Magali, K.M. (1997). Relative susceptibility of some snap bean cultivars to infestation by mites and aphids with reference to yield, yield components and hairs density. Egypt. J. Appl. Sci., 12 (11): 267-277.
- Park, Y.L. and J.H. Lee (2002). Leaf-cell and tissue damage of cucumber caused by two-spotted spider mite (Acari: Tetranychidae). J. Econ. Entomol. 95 (5): 952-957.
- Saber, S.A. and F. M. Momen (2005). Influence of plant leaf texture on the development, reproduction and life table parameters of the predacious mite *Cydnoiseius zaheiri* (Phytoseiidae: Acarina). Acta Phytopathologica et Entomologica Hungarica, 40: 177-184.
- SAS Institute, 1988. SAS / Stat user's guide, 6.03 ed. SAS institute, Cary, NC.
- Shakoor, A.; M. A. Sabr; , M. Afzal and M. H. Bashir (2010). Role of plant morphological characters towards resistance of some cultivars of tomato against phytophagous mites (acari) under green house conditions. Pak. j. life soc. Sci., 8(2): 131-136.

ARABIC SUMMARY

العلاقة بين التركيب التشريحي لأوراق خمس أصناف مختلفة من الخيار والإصابة بالعنكبوت الأحمر العادي تحت ظروف الحقل المفتوح

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أجريت تجربة حقلية لدراسة مدى قابلية خمسة أصناف من أصناف الخيار المختلفة وهي إمبرس F1، يعقوب، برنس3، مدينة2 و سهم للإصابة بالعنكبوت الأحمر العادي خلال موسمين متتاليين 2009 و 2010 بمحافظة القليوبية. وقد أظهرت النتائج أن هناك فروق معنوية للإصابة بين هذه الأصناف بالعنكبوت الأحمر خلال موسمي الزراعة حيث كانا الصنفين إمبرس F1 و يعقوب أعلى الأصناف إصابة بينما كان الصنف سهم الذي أصيبت أوراقه بأقل عدد من أفراد هذه الآفة. ولقد أظهر الصنفين برنس 3 ومدينة 2 درجات متوسطة من الإصابة. كما تم دراسة العلاقة بين درجات الإصابة والصفات التشريحية لأوراق هذه الأصناف لمحاولة تفسير أسباب الإصابة وذلك بعمل قطاع عرضي في نصل الأوراق أثناء مرحلتي الإنبات (البادرة والإزهار+الإثمار) حيث تم قياس طبقتي البشرة العليا والسفلى وكذلك النسيج العمادي والأسفنجي بالميكرون و ذلك لقياس درجة الارتباط بين الإصابة وهذه الصفات التشريحية. ولقد أوضحت النتائج وجود علاقة سالبة بين إصابة أوراق الخيار بالعنكبوت وسماك من البشرة العليا والسفلى وكذلك النسيج العمادي أي أن الإصابة تزيد كلما قل سمك هذه الطبقات في حين زاد تعداد أفراد العنكبوت على الأصناف التي سمك الطبقة الأسفنجية اسمك بمعنى أن الصنفين إمبرس F1 و يعقوب كان سمك طبقات البشرة العليا والسفلى وكذلك النسيج العمادي لأوراقهما الأقل سمكا لذلك كانت قابليتهم للإصابة أعلى بين الأصناف المختبرة بينما الصنف سهم كان سمك هذه الطبقات أكبر وبالتالي أظهرت أوراقه مقاومة للإصابة بالعنكبوت الأحمر العادي.