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Resistance in *Lycopersicon* spp. to the two spotted spider mite, *Tetranychus urticae* (Koch)

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ABSTRACT

Resistance to the two-spotted spider mite *Tetranychus urticae* (Koch) was observed in the greenhouse in accessions of tomato, *Lycopersicon pennellii*, *L. hirsutum*, *L. hirsutum f. glabratum* and *L. esculentum*. Survival, mortality, avoidance and fecundity of the mites were related to type VI Trichome density and/or other covariants of leaflets development. In general, Type VI density *L. hirsutum* and *pennellii* leaflets were more resistant than those of *L. esculentum*. Mite mortalities were associated with the presence of *Lycopersicon* spp., Type VI Trichome and mite avoidance were associated with other factors that covaired with *Lycopersicon* spp. leaflet development and leaflet surface. Also, *hirsutum* and *pennellii* accessions were more resistance to mites (*T. urticae*) than *esculentum*. Spider mite resistance was correlated with Type VI Trichome density on *Lycopersicon* spp. Mortality of mites in topical application was higher with wild tomato species than the cultivated tomato species.

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* (Koch) is of the most distructive pests of cultivated tomatoes. It causes destruction and servere damage to the vegetative growth and consequently reduces the yield. Crops must be protected with acaricides during the seasons that favor severe outbreaks of this mite. Wild tomato species *Lycopersicon hirsutum*, *L. hirsutum f. glabratum* and *L. pennellii* are resistant to many pests that attack cultivated tomato *L. esculentum* (Gentile *et al.*, 1968 and 1969; Rick, 1973; Williams *et al.*, 1980; Kennedy and Dimock, 1983; Weston *et al.*, 1989 and Neima *et al.*, 1994).

Host plant resistance of tomato to phytophagus mites and insects has been attributed to both quantitative and qulitative aspects of trichomes characterized as Type VI. Type VI trichome which occurs in all species of *Lycopersicon* is 0.1 to 0.5 mm in tall, and possesses a glandular head of 2 to 4 cells (Lukwell, 1943). Stoner (1970) reported that type VI trichomes

entrapped mites. Glandular trichome densities and the presence of volatile compounds in trichome gland secretion have been implicated as factors mediating resistance (Kennedy *et al.*, 1981; Dimock and Kennedy, 1983; Snyder and Carter, 1984; El-Moghazy *et al.*, 1995 and Eigenbrode *et al.*, 1996).

The present study reports a comparison of *Lycopersicon* spp. for resistance to spider mites *Tetranychus urticae* (Koch) under greenhouse conditions.

MATERIALS AND METHODS

The accessions of *L. hirsutum*, *L. hirsutum f. glabratum* and *L. pennellii* were furnished by Charles M. Rick, University of California, Davis. The cultivated tomato varieties of *L. esculentum* were obtained from the Ministry of Agriculture, Egypt, A.R.E.

Mites used in the tests were derived from populations of the two-spotted spider mites, reared on sweet potato, *Ipomoea batatus* lam. Seeds of the tomato accessions were grown under greenhouse conditions.

Controls were ten seedlings of each accession and varieties were transplanted in a 6-in plastic pot filled with a mixture of peat, vermiculite and fertilizer. Infestations were accomplished when the plants were in the 5^{th} or 6^{th} true-leaf stage.

For tests of resistance in relation to Type VI density, a tanglefoot ring, 2 cm in diameter, was drown around the center of each leaflet. Ten teneral female two-spotted spider mites were placed on each leaflet by using a small brush to transfer mites to the area within the tanglefoot ring while observing the mites and leaflets under a dissecting microscope. The leaflets were then placed on moist paper towels in ventilated, clear plastic boxes (Snyder and Carter, 1984).

For each inoculation area, mite survival (number alive), morality (number dead), avoidance (number in tanglefoot) and fecundity (number of eggs) were determined at 24-hour intervals for 4 days. The relationship between the density of glandular hairs and the fecundity of mites was studied by cutting 3-mm diameter discs from 10 young leaves from each

accession and variety. Then dissecting microscope was used to count the glandular hairs present in the lower surface of each disc. Also, scanning electron microscope of the upper and lower surface of tomato leaves were made to wild and cultivated tomato species.

Toxicity of the contents of Type VI glandular tips to spider mites was determined by topical application (Aina *et al.*, 1972). Teneral female mites were placed dorsal surface down in rows of 5 on double sticky tape on microscope slides. Trichome tips and exudate of 3 Type VI Trichomes from *esculentum* and *hirsutum* were collected on a brush moistened with 95 % ethanol and were applied to each mite or solvent alone as a control was applied. Data were determined as number of dead mites per row after 24hr. Analysis of variance and comparisons of treatment means were conducted on the transformed variable ytr = (y + 0.5)1/2 where y= dead mites per row (Aina *et al.*, 1972).

RESULTS AND DISCUSSION

Mite resistance was analyzed initially in relation to Type VI density, plant species and leaflet surface. Because results were similar after the 24 intervales, only the data obtained at 72 hr are presented. Mite survival was variable for all species and tended to be less for wild tomato species. Other mite responses were also variable.

After 72 hour on lower surface of leaves, there were more live mites on *L. esculentum* species (*Ty – Gs – Castle* and *Florida*) than on wild species (*hirsutum – glabratum* and *pennellii*) (Table 1). Also, data showed that mite numbers were very low on *L. pennellii* than *L. hirsutum* and *L. hirsutum glabratum*. Conversely, there were fewer dead mites and fewer mites in tanglefoot on *L. esculentum* species than on wild species (avoidance). On the lower surface, there were more dead mites on *pennellii* than on *hirsutum* and *glabratum*. Fewer live than dead mites were observed in lower surfaces of *L. esculentum* species. These results indicated that the lower surface of the leaves seemed to have a more detrimental effect on mite survival than that of the upper surface. Type VI trichome density was a significant variance component of mite survival (Table 2). Analysis of mortality and avoidance can provide clarification of the effects of Type VI density, species and leaflets surface on mites survival. Mortality increased as Type VI density increased on both wild and cultivated tomato species, but the Type VI trichome or covariate of Type VI density was more effective on

wild species than the cultivated ones. The quantitative or specific effect was also indicated by the greater mean mortality on wild than on cultivated species at equivalent Type VI densities (Tables 1 and 2). Average mite mortality, adjusted for covariance with density, was nearly 3 times greater on *hirsutum*, *glabratum* and *pennellii* wild species than on *Ty.*, *Gs.*, *Castle* and *Florida* (*esculentum* cultivars).

On the other hand, ovipostion was much greater on *L. esculentum* species than on wild species on leaf lower surface (Table 1). Data shows that female of *T. urticae* laid fewer eggs on *L. hirsutum* and *L. hirstum f. glabratum* than on the other cultivated tomatoes (*Ty – Gs – Florida* and *Castle*). Whereas, mite female laid significantly fewer eggs on *L. pennelli* (Table 1).

Table (1): Average number of live, dead and Tanglefooted mites, as well as, number of eggs / live mite on tomato cultivars.

Species	No. of mites [1]			Egg /live mite
	Alive	Dead	In Tanglefoot	
L. hirsutum	1.0 ± 0.65 a	5.2 ± 0.75 a	3.6 ± 0.49 a	0.6 ± 0.80 a
L. h hirsutum . f.glabratum	2.0 ± 0.63 b	4.6 ± 0.48 a	3.2 ± 0.40 a	1.6 ± 0.80 a
L. pennellii	0.4 ± 0.49 a	6.2 ± 0.74 a	3.8 ± 0.75 a	0.2 ± 0.40 b
L. esculentum TY	6.4 ± 0.50 cd	2.0 ± 0.63 b	1.0 ± 0.63 b	10.4 ± 1.02 c
L. esculentum Gs	6.0 ± 0.63 c	2.6 ± 0.80 b	1.2 ± 0.75 b	7.6 ± 1.5 d
L. esculentum Castle	7.0 ± 0.72 d	1.6 ± 0.49 c	1.2 ± 0.75 b	8.2 ± 1.33 d
L. esculentum Florida	7.0 ± 0.89 d	1.6 ± 0.52 c	0.6 ± 0.48 b	7.8 ± 2.04 d

[1] Means followed by the same letter don't differ at 0.05 level of significance, as determined by LSD of the adjusted means.

Mite fecundity declined as Type VI density increased (Table 2). On wild species, female of mites laid fewer eggs on *L. hirsutum* and *L. hirsutum f. glabratum*, and significantly fewer eggs on *L. pennellii*. Whereas, mite females laid more eggs on *L. esculentum* cultivars, being 3.3, 2.94, 2.84 and 2.45 eggs / female on *L. esculentum. Ty, Castle, Gs* and *Florida,* respectively (Table 2). The calculated correlation coefficient between mite progeny and glandular hairs illustrated in Table (2) was 0.575, 0.375, 0.395, for wild species and was - 0.102, -0.329, -0.476 and 0.074 for cultivated cultivars.

Table (2): Average fecundity per female and average number of glandular hairs on the lower surface of *Lycopersicon* spp.

Species	Mean no. of offsprings [a] (eggs + nymphs) / mite	Mean no.[b] glandular hairs	R[c]
L. hirsutum	0.99 ± 0.36 a	14.2 ± 0.49	-0.575
L. hirsutum. f. glabratum	1.43 ± 0.26 b	8.2 ± 1.49	+0.375
L. pennellii	0.41 ± 0.20 c	27.8 ± 2.79	+0.395
L. esculentum TY	3.30 ± 0.50 d	5.2 ± 0.75	-0.102
L. esculentum Gs	2.84 ± 0.26 d	6.6 ± 1.02	-0.329
L. esculentum Castle	2.94 ± 0.23 cd	4.6 ± 0.80	-0.476
L. esculentum Florida	2.45 ± 0.26 e	6.4 ± 1.02	+0.074

[a] Mean followed by the same letter are not significantly different the 5% level of confidence, Duncan's multiple rang test. Data converted to $\sqrt{eggs + nymphs + 0.5}$ for analysis.

[b] Average number of glandular hairs of *Lycopersicon* spp. (avg. from 10 foliar discs 3 mm in diam).

[c] Correlation between mite progeny and glandular hairs.

Scanning electron micrograghs of the surfaces showes a higher density of glandular hairs on the lower leaf surface than on the upper surface especially in wild tomato species than the other tomato cultivars (Fig. 1 and 2).

These findings are in coincidence with Rodriguez *et al.*, (1972) who observed, in studying the morphological features of tomato species PI 251303 leaf, that the microhabitat of the lower surface appear to be most hostle to mites than the upper surface. The scanning of the surfaces showed a higher density of glandular hairs on the lower surface than the upper surface. Luckwill (1943) have also found that the glandular hairs of *Lycopersicon* spp. differed from species to species within the genus.

Toxicity of Type VI trichome tips was studied in wild and cultivated tomato species by topical application of Type VI trichome tips and exudate to mites immobilized on glass slide (Table 3). Application of VI tips from *L. hirsutum; L. hirsutum f. glabratum* and *L. pennellii* resulted in greater mite mortality than application of *esculentum* cultivars tips.

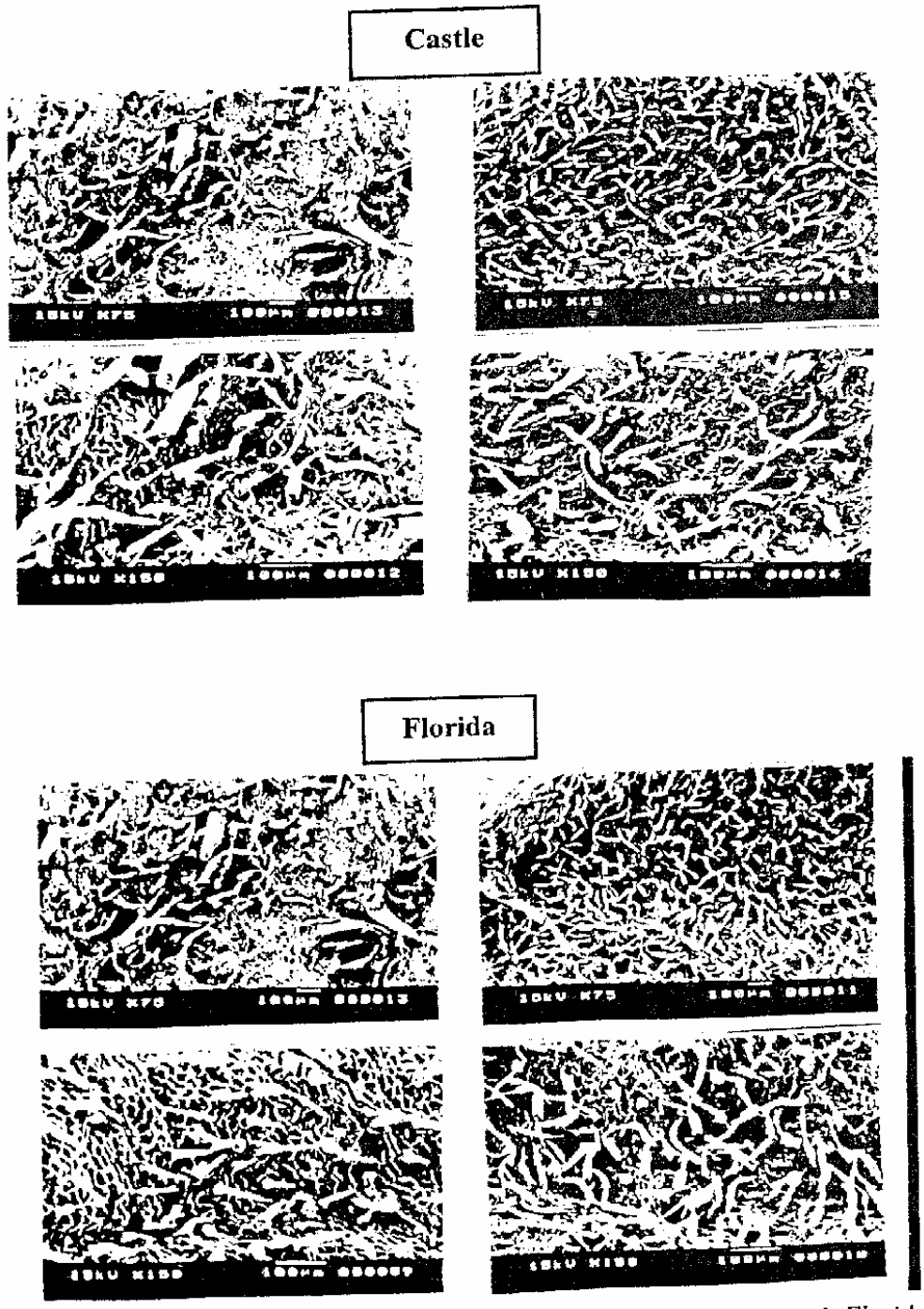

Fig. (1): Scanning electron micrograghs of *L. esculentum*, *Castle* and *Florida* to pgraghy. Top photos (75 x): left, lower surface: right, upper surface. Bottom photos (150 x): left, lower surface: right, upper surface.

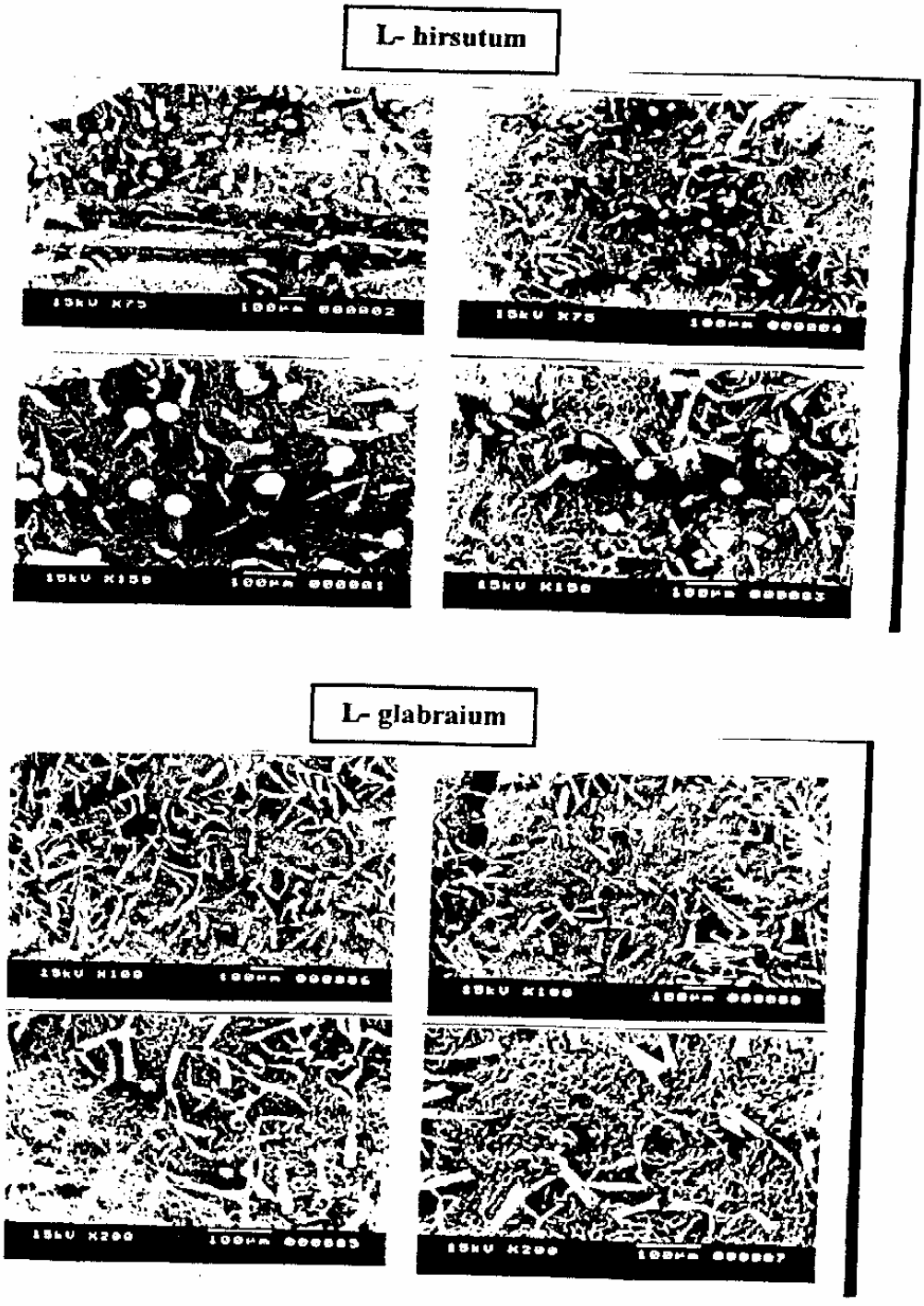

Fig. 2.- Scanning Fig. (2): Scanning electron micrograghs of *L. hirsutum* and *L. hirsutum f. glabratum* to pgraghy. Top photos (75 x): left, lower surface: right, upper surface. Bottom photos (150 x): left, lower surface: right upper surface for *L. hirsutum.*

Top photos (100 x): left, lower surface; right upper surface. Bottom photos (200 x): left, lower surface: right, upper surface for *L. hirsutum. f. glabratum.*

Mortality was 50.1 %, 35.8 %, and 76.64 % for *L. hirsutum, L. hirsutum. f. glabratum.* and *L. pennellii.*, respectively. Whereas it was 13.5 %, 10.8 %, 8.8 %, and 9.9 % for *L. esculentum, Ty, Gs, Castle* and *Florida*, respectively. These results indicated that *hirsutum* and *pennellii*. Type VI trichomes were more toxic to mites and were associated with greater mite mortality than equivalent number of *esculentum* Type VI trichomes. These agree with Williams *et al.*, (1980) who identified that 2-tridecanone as a compound having insecticidal properties in leaflets and trichome exudate of *L. hirsutum f. glabratum* is responsible for that action. Also, Carter (1982) reported that, *L. hirsutum* and *L. esculentum* one differ in Type VI morphology histochemistry and in densities of 3 other trichome types. These results agree with those obtained by Gentile *et al.*, (1969) who indicated that the density of the vesture of glandular hairs is stable in *L. pennellii* but it quite variable in the accessions of *L. hirsutum*. Therefore it should be possible to select plants from populations of *L. hirsutum* that are highly resistance to mites because of their heavy pubescence.

Table (3): Mortality of mites 72 hrs. after application of tomato cultivars extract.

Species	Mortality (%)
L. hirsutum	50.09 a
L. hirsutum. f. glabratum	35.76 b
L. pennellii	76.60 c
L. esculentum TY	13.48 d
L. esculentum Gs	10.78 d
L. esculentum Castle	8.79 d
L. esculentum Florida	9.97 d

Means followed by the same letter do not differ at the 5 % level of significance, as determined by LSD.

Stoner and Gentile (1968), found a similar relationship between glandular hairs on tomato and resistance to the carmine spider mite. Stoner *et al.*, (1983) stated that the surface differences on *esculentum* may indicate the presence of factors which effect fecundity. These factors which reduce

mite survival may be expected to lower fecundity by reducing mite fitness before death or avoidance reactions. On the other hand, Snyder and Carter (1984) reported that, the significance of Type VI density and the interaction between Type VI density and species in the analysis of mortality suggest to qualitative or toxicity differences in Type VI trichomes also exist between *hirsutum* and *esculentum*. Johnson (1956), found that the exudate of the glandular hairs on tomato leaves prevented aphids from becoming established on the tomato plants. Whereas, Luckwill (1943) described and illustrated the glandular hairs of *Lycopersicon* spp. and showed that they differed from species to species within the genus.

From the foregoing results, it could be concluded that the spider mite resistance varied with density of the Type VI trichome on both *hirsutum* and *esculentum*, but qualitative interspecific differences in Type VI toxicity and other factors seemed to be responsible for the greatest resistance of *hirsutum* compared to *esculentum*. Also, the data indicates that a qualitative or species specific factor in conjunction with Type VI density was associated with mite mortality.

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مقاومة بعض أصناف الطماطم لاكاروس العنكبوت الأحمر

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تم دراسة مقاومة بعض أصناف الطماطم البرية والمنزرعة لاكاروس العنكبوت الأحمر تحت ظروف الصوبه بمحافظة أسيوط – جمهورية مصر العربية.

وقد لوحظ أن أفراد الاكاروس قد توقفت حركتها عندما تعرضت للإفرازات اللزجة للشعيرات الموجودة علي بعض الأصناف وخاصة الأصناف البرية منها.

وأظهرت النتائج أن هناك علاقة بين كثافة النوع VI من الشعيرات الموجودة في أوراق أصناف الطماطم ومعدل المعيشة – معدل الموت – الكفاءة التناسلية للاكاروس. كما لوحظ وجود علاقة بين هذه المعدلات وتطور نمو الورقة.

وأظهرت النتائج أيضا أن كثافة النوع VI من الشعيرات الموجودة في أوراق الأصناف البرية *L. hirsutum* ، *L. pennellii* كانت اكثر مقاومة عن تلك الموجودة في الأصناف المنزرعة *L. esculentum* . ووجد أن معدل الموت للاكاروس مرتبط بوجود هذا النوع من الشعيرات في الأصناف خصوصا البرية.

ومن النتائج السابقة وجد أن أصناف *L. hirsutum* ، *L. pennellii* كانت اكثر مقاومة لاكاروس العنكبوت الأحمر عن الأصناف المنزرعة *L esculentum* . كما ان المقاومة لاكاروس العنكبوت الأحمر مرتبطة بكثافة هذا النوع من الشعيرات (Type VI) علي أصناف الطماطم البرية والمنزرعة.

من نتائج اختبارات السمية اتضح أن الأصناف البرية الثلاثة المختبرة *L. hirsutum* ، *L. pennellii* ، *L. hirsutum f. glabtatum* اكثر سمية للاكاروس عن الأصناف المنزرعة حيث أن نسبة الموت كانت ٥٠,١ %، ٣٥,٨ %، ٧٦,٦ % للأصناف الثلاثة علي التوالي بينما كانت نسبة الموت ١٣,٤ %، ١٠,٨ %، ٨,٨ %، ٩,٩ %، للأصناف *Ty*، *Gs*، *Castle*، *Florida* علي التوالي.