RESULTS

1. Disease survey:

The disease survey during the period extending from June to November 1997 and 1998 revealed was shown in **Table (4).** Tomato powdery mildew was most severe in both Ismailia (on Castle rock, Super strain-B and Ty-70 cvs) and El-Fayoum (on Castle rock, Ty-20 and Ty-70 cvs) Governorates. The mean percent severity rangedfrom33.9% at Sannores (El-Fayoum) to 48.0% at Fayed (Ismailia). Intermediate disease severity was recorded in 12 localities belonging to the middle and upper Egypt Governorates, Giza (on Strain-B and Castle rock cvs), Beni-Suef and El-Minia (on Castle rock, Super Strain-B cvs) and Sohag (on Castle rock and improved Castle rock cvs) as the disease severity ranged from 18.5% at El-Wasta to 28.9% at Beni Mazar. whereas the least percent severity was recorded in Delta 6 localities belonging to Qalubia and El-Minufiya (on Castle rock, Super strain-B cvs), which ranged from 14.0% at Qaha (Qalubia) to 18.8% at Shebin El-Koum (Minufiya) respectively.

Effect of atmospheric elements on disease incidence and development of tomato powdery mildew:

Results presented in **Table (5)** and **Fig. (1)** indicate that during season 1997, the percent of disease severity was low at Qalubia, El-Minufiya and Beni Suef, where the average of temperature ranged from 24.2-24.9°C and relative humidity from 59.5 to 66.5%. On the other hand, the percent of severity was

Table (4): The average percentage of tomato powdery mildew disease severity in different locations during the period extended from June to November (1997 and 1998).

Governornrate	Locations	Powdery mildew severity %		
		1997	1998	Mean
El-Fayoum	Tameya	45.7	49.4	47.6
	Sannores	43.1	24.6	33.9
	Ebshway	51.5	32.9	42.2
Ismailia	Fayed	38.9	57.1	48.0
	Abu-Sware	38.4	42.5	40.5
	Kassasin	39.5	42.8	41.2
El-Minufiya	El-Bagour	20.7	16.4	18.6
	Shebin El-Koum	16.7	20.9	18.8
	Ashmoun	13.0	15.2	14.1
Qalubia	Qaluib	19.7	13.0	16.4
	Qaha	12.4	15.5	14.0
	Benha	20.4	16.9	18.7
Giza	El-Ayatt	22.7	29.5	26.1
	El-Badrashen¦El-Saff	27.4	24.4	25.9
		22.0	22.2	22.1
Beni Suef	El-Wasta	13.6	23.4	18.5
	Beba	19.1	23.9	21.5
	El-Fashn	22.6	31.3	27.0
El-Minia	Beni Mazar	25.0	32.8	28.9
	Mattay	33.0	41.4	27.2
	Mallawy	30.0	19.3	24.7
Sohag	Sohag	19.1	18.5	18.8
	Girga	32.0	19.8	25.9
	El-Balyana	27.1	17.5	22.3
Mean		27.23	27.13	
L.S.D. at 5% for: Locations (L) = 1.6 Years (Y) = N.S. (L) X (Y) = N.S.				

significantly higher in Ismailia (38.9%) and El-Fayoum (46.8%) when the average of temperature ranged from 25.7 to 25.8°C and relative humidity ranged from 56.5 to 59% respectively.

Table (5): Severity of tomato powdery mildew recorded monthly during the period extended from June to November, 1997 at the surveyed Governorates.

Months / Governorate	Percentage of powdery mildew severity (1997)						
	June	July	Aug.	Sept.	Oct.	Nov.	Mean
El-Fayoum	38.2	46.9	52.1	62.4	48.9	32.1	46.8
Ismailia	29.3	28.3	42.0	54.4	47.8	31.7	38.9
El-Minufiya	16.6	22.6	17.6	19.3	17.1	7.5	16.8
Qalubia	13.9	17.9	17.7	22.7	17.2	15.4	17.5
Giza	21.0	23.6	25.2	32.6	23.1	18.8	24.0
Beni Suef	13.8	18.3	18.2	26.9	18.2	15.3	18.5
El-Minia	22.0	34.3	32.5	36.9	27.8	22.1	30.2
Sohag	15.1	27.5	31.2	35.6	28.6	18.4	26.1
Mean	21.2	27.4	29.6	36.4	28.6	20.2	27.2
General Mean	27.2						
L.S.D. at 5% for Governorates (G)			4.37				
Months (M)			(N.S.)				
(G) X (M)			6.06				

These results was confirmed during season 1998 as the highest percent of disease severity was recorded at Ismailia (47.4%) and El-Fayoum (35.7%) when the average of temperature was between 27.4-28.7°C and relative humidity ranged from 51.3-57.7%, respectively **(Table 6)**. On the other hand, the lower percent severity was in 1998 at El-Minufiya (17.5%), Qalubia (15.1%) and Sohag (18.7%), when the

temperature ranged from 25.3 to 26.7°C and the relative humidity ranged from 56.3 to 64%. Generally, the percentage of disease severity was higher during 1997 and 1998 at El-Fayoum and Ismailia.

During seasons 1997 and 1998, the obtained results (**Tables 5 & 6**) clearly indicated that the percentage of disease severity was increased in El-Fayoum and Ismailia (on Castle rock and Ty-70 cvs.) from June until reached its maximum during September where the average of temperature ranged from 26.2°C to 29°C and relative humidity from 56% - 60%, and the disease severity gradually decreased until November when the average of temperature ranged from 18.9°C to 23.6°C and relative humidity ranged from 54 to 62%. The percentage of disease severity was obviously low in El-Minufiya, Qalubia and Beni Suef (on Castle rock and Super strain-B cvs) during June and November.

Data also revealed that in El-Fayoum (on Castle rock, Ty-20 and Ty-70 cvs.), the percentage of disease severity reached its maximum during September, 1998 when the average temperature was 30.1°C and relative humidity was 57%. After

Table (6): Severity of tomato powdery mildew recorded monthly during the period extended from June to November, 1998 at the surveyed Governorates.

Months / Governorate	Percentage of powdery mildew severity (1998)						
	June	July	Aug.	Sept.	Oct.	Nov.	Aver.
El-Fayoum	32.3	34.2	37.8	52.8	36.5	20.3	35.7
Ismailia	36.2	49.0	50.9	55.1	60.7	32.7	47.4
El-Minufiya	18.6	22.5	10.5	20.2	20.7	12.6	17.5
Qalubia	9.9	14.2	17.0	22.8	15.4	11.5	15.1
Giza	18.0	28.5	30.0	30.8	25.7	18.5	25.3
Beni Suef	21.5	27.0	30.3	36.4	27.1	15.1	26.2
El-Minia	23.0	32.4	37.2	42.5	28.8	22.9	31.1
Sohag	12.2	16.4	18.9	22.3	22.9	19.2	18.7
Mean	21.5	28.0	29.1	35.4	29.7	19.1	27.1
General Mean	27.1						
L.S.D. at 5% for Governorates (G)	6.77						
Months (M)	2.14						
(G) X (M)	6.05						

that, it was decreased until November when the average of temperature was 21.8°C and relative humidity was 64%, whilst in Ismailia (on Castle rock, Super strain-B and Ty-70 cvs), the percentage of disease severity reached its maximum in October as the average of temperature was 25.5°C and relative humidity was 52% then it decreased until November.

Generally, in all other Governorates, the percentage of severity reached its maximum in September during the two seasons 1997 and 1998 where the average of temperature ranged from 24.2 to 26.2°C and relative humidity 48-66%. The low percentage of severity was recorded in El-Minufiya and Qalubia Governorates.

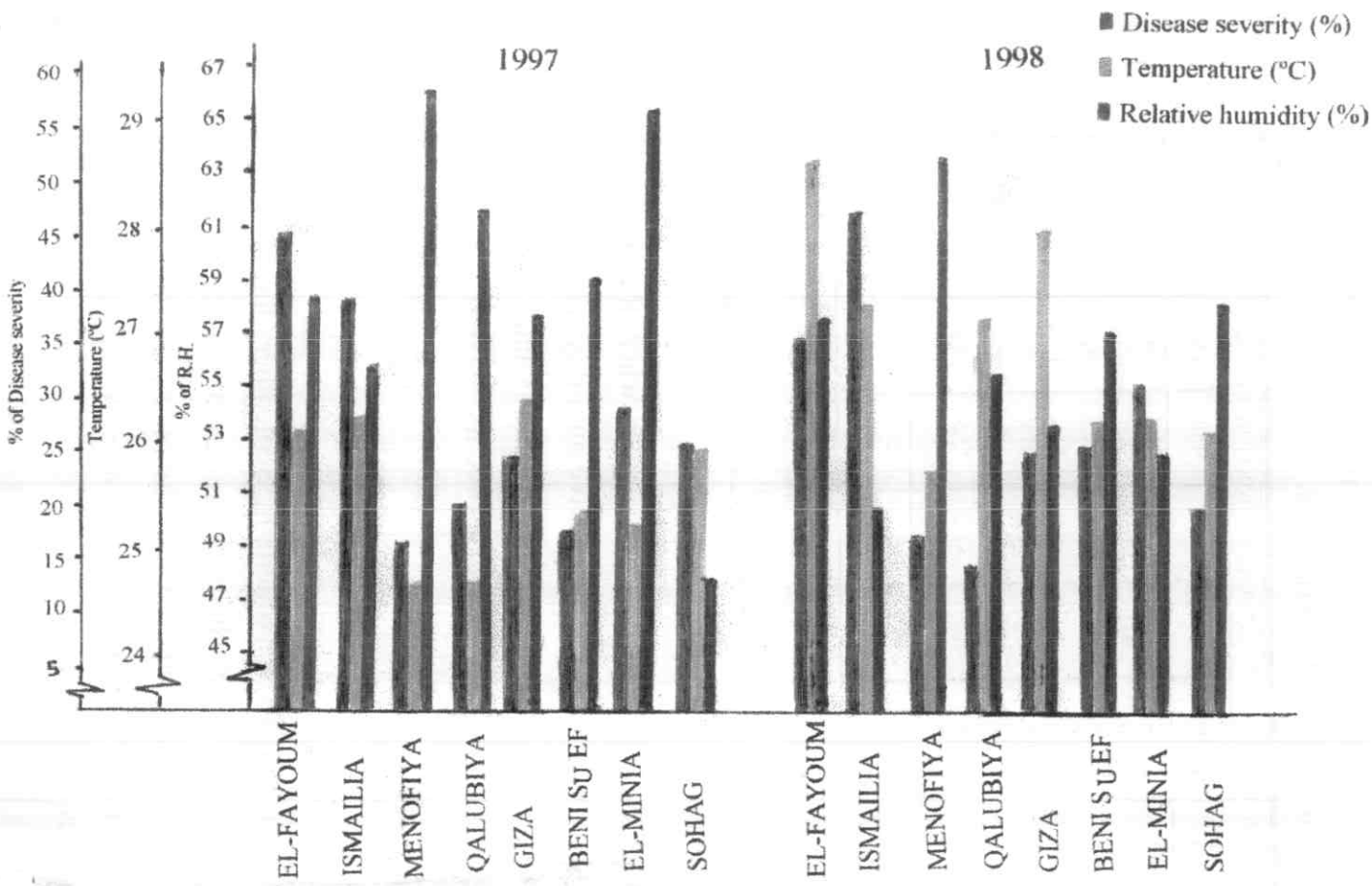


Fig. (1): illustrates the relationship between temperature, relative humidity and tomato powdery mildew disease severity at different Governorates.

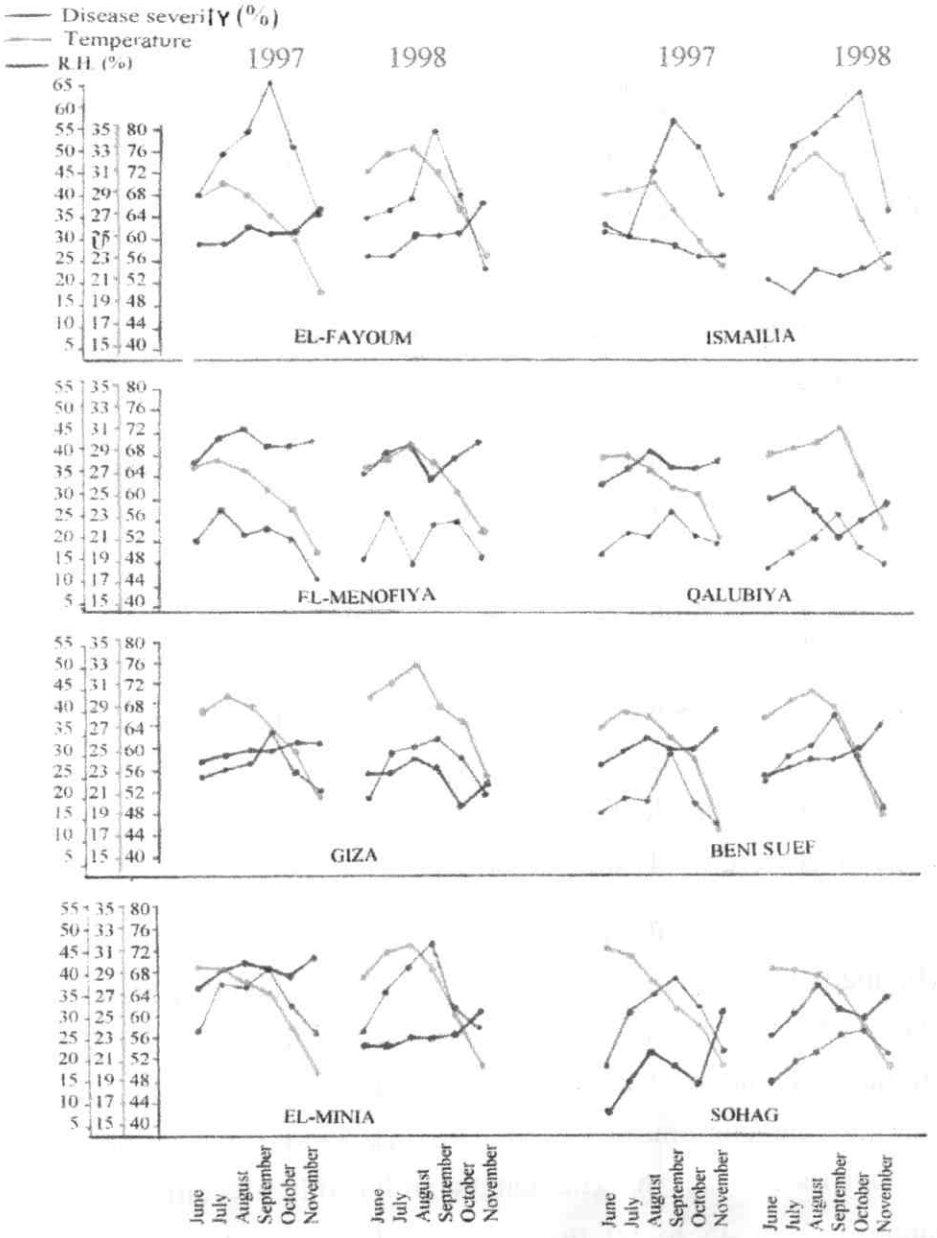


Fig. (2): Shows tomato powdery mildew disease severity in eight Governorates in relation to mean temperature (°C) and relative humidity (%)during June to September in 1997 and 1998.

The disease development during the surveyed period in the different Governorates was illustrated in **Fig. (2)**. The illustration data indicate very clear that in most cases, the disease development increased gradually reaching its maximum in September then gradually decreased.

Morphological characters of the disease-causal organism:

Typical tomato powdery mildew disease symptoms colud be observed in form of light green to bright yellow lesions on the upper leaf surface however, light powdery fungal sporulation was seen on the lower leaf surface. The fine white powdery masses of conidiophores and conidia coalesce. Finally golden yellow lesions were observed on the upper surface. As the disease develops, the lesions become necrotic and if they are severe, the whole leaf dies and may defoliate (**Fig. 3**). These symptoms were rarely noticed on young tomato plants.

Microscopical examination to the epidermal strips obtained from the tomato-infected leaves revealed that branched and un-branched conidiophores arise singly or in clusters from stomata of the lower leaf surface. A conidiophore was observed bearing one conidium. Conidia are long, colourless, cylindrical or pyriform in form. The length and width of conidia were ranged from 45 to 60 µm (average 52.3 µm) 10 to 15 µm (average 10.8 µm), respectively. A conidiophore length ranged from 70 to 250 µm with average 143.8 µm and its width ranged from 5 to 10 µm with average 8 µm. The mycelium is septate.

Table (8): Reaction of different hosts against *L. taurica* obtained from tomato plants.

Host and Cultivar	Family	Disease severity %
Tomato cv. Strain-B	Solanaceae	24.9
Eggplant cv. Black Beauty	Solanaceae	22.9
Artichoke cv. Balady	Compositae	23.4
Pepper cv. California Wonder	Solanaceae	19.9
Common bramble	Convolvulaceae	18.7
Egyptian mallow	Malvaceae	17.1
Hollyhock	Malvaceae	15.5
Roselle	Malvaceae	12.4
Kenaf	Malvaceae	10.4
Nasturtium	Tropaeolaceae	8.4
L.S.D. at 5% level	- -	3.76

Percentages of disease severity were 8.4%, 10.4% and 12.4% on these three hosts , respectively without significant differences in between. However the highest disease severity i.e. 24.9%, 22.9% and 23.4% was significantly equal on tomato cv. Strain-B, eggplant cv. Black Beauty and artichoke cv. Balady, respectively. The fungus caused moderate infection on pepper cv. California Wonder (19.9%) and common bramble (18%). Less infection was occurred on Egyptian mallow (17.1%) and hollyhock (15.5).

4. Cross inoculation between different plant genera and different isolates of *L. taurica*:

The reactions of six host plant genera representing four plant families were tested against six different isolates of *L.*

taurica. It was generally noticed that symptoms appeared on inoculated plants 7-10 days of inoculation.

Regardless fungal isolates, the data in **Table (9)** proved that tomato Supermarmande cv. was the most susceptible host (26.65%), meanwhile pepper California Wonder cv. (7.83%) and Common bramble (8.57%) were the lowest susceptible hosts to infection with powdery mildew caused by *L. taurica*. The other three tested hosts i.e. Artichoke Balady cv., Hollyhock, Eggplant Black beauty cv. showed intermediate disease severity (10.0-10.97%).

Regarding the isolates of *L. taurica*, the same data indicated that the fungus obtained from Artichoke was the most virulent as it induced the highest average of disease severity (average 12.7%) meanwhile the fungus introduced from Eggplant and Hollyhock caused the lowest disease severity i.e. 8.53% and 8.88%, respectively. Isolates of *Leveillula taurica* obtained from tomato, pepper, and common bramble was moderately virulent. The percentages of disease severity caused by the latter isolates ranged between 9.06-10.73%.

Regarding interaction between host plants and fungal isolates, the same data showed the following:

1- Tomato isolate was more virulent on tomato plants (21.9%) and less virulent on pepper (5.0%), common bramble (6.2%) and hollyhock (8.7%). However, artichoke and eggplant were moderately infected with this isolate (10.6-11.9%).

2- Pepper isolate induced the highest disease incidence on tomato (14.4%) and pepper (13.8%) plants. While eggplant and

common bramble showed the least infection with this isolate i.e. 6.3% on both hosts without significant difference in between. Both artichoke and hollyhock showed moderate infection with this isolate (9.3-9.4%).

3- Eggplant isolate caused the highest disease severity on both artichoke (13.7%) and eggplant (12.5%). Pepper plant seems to be highly resistant or immune to infection with this isolate (0.0%). However, the lowest disease incidence incited by this isolate has occurred on common bramble (5.6%) followed by hollyhock (9.4%).

4- Common bramble isolate was more virulent on common bramble (16.9%) and tomato plants (14.4%) than eggplant (10.0%). The lowest infection with this isolate was observed on pepper plants (5.0%) while it seems to be non pathogenic to artichoke plants (0.0%).

5- Artichoke isolate induced the highest disease incidence on artichoke plants (18.1%) followed by eggplant (16.3%). Tomato (8.8%) and comon bramble (10.0%) were the least susceptible hosts. Meanwhile hollyhock (11.2%) and pepper (11.9%) seemed to be moderately susceptible to this isolate.

6- Hollyhock isolate caused the highest disease severity on hollyhock (13.8%) and pepper (11.3%) plants. Tomato plants showed the lowest disease incidence caused by this isolate (5.1%) while common bramble, artichoke and eggplant were intermediate (6.3-8.7%).

Table (9): Powdery mildew disease severity % as affected by interaction between six plant genera and six different isolates of *L. taurica*.

Host plant genera	Isolates of *L. taurica* from						
	Tomato	Pepper	Eggplant	Common bramble	Artichoke	Hollyhock	Mean
Tomato (1)	21.9	14.4	10.0	14.4	8.8	5.1	12.43
Pepper (2)	5.0	13.8	0.0	5.0	11.9	11.3	7.83
Eggplant (3)	11.9	6.3	12.5	10.0	16.3	8.7	10.97
Common bramble	6.2	6.3	5.6	16.9	10.0	6.3	8.57
Artichoke (4)	10.6	9.4	13.7	0.0	18.1	8.1	10.00
Hollyhock	8.7	9.3	9.4	8.1	11.2	13.8	10.08
Mean	10.7	9.92	8.53	9.06	12.7	8.88	
L.S.D. at 5% level for: Genera (G) = 2.1 Isolates (I) = 2.1 (G) X (I) = 5.1							

1= Tomato Supermarmande cv.; 2= Pepper California Wander cv.; 3= Eggplant Black beauty cv.); 4= Artichoke Balady cv.

From the above results it could be concluded that tomato plants were more sensitive to the fungus obtained from tomato (21.9%) followed by those obtained from pepper and common bramble (14.4%), eggplant (10.0%), artichoke (8.8%) and hollyhock (5.1%).

3- In Vitro studies:

1- Germination of *Leveillula taurica*-conidia:

It is very clear from data in **Table (10)** that the germination of *L. taurica* conidia was significantly higher on the epidermal strips of tomato leaves (35.2%) than on dry slides (20.0%). The lowest conidial germination was occurred in tap water (13.0%).

Table (10): Percentage of *L. taurica* conidial germination using three methods.

Methods of conidial germination	% of conidial germination
Epidermal strips	35.2
Dry slides	20.0
Tap water	13.0
L.S.D. at 1% level	8.218

1. Effect of some plant extracts, plant oils and mineral oils on conidial germination:

Data in **Table (11)** show that the lowest averages of conidial germination of *L. taurica* was induced by clove oil (average 6.3%), clove extract (average 8.0%) and garlic extract (average 12.3%). While the rest of the tested plant extracts, oils and mineral oils have increased spore germination to different extents (22.4-66.7%) compared with 17.5% in check (water) treatment. The lowest average increases were induced by nigella oil, rue extract, henna extract Misrona oil and ginger extract

Table (11): Effect of some plant extracts, plant oils and mineral oils on *L. taurica* conidial germination.

Plant extract or oil	Average of conidial germination %												
	Concentrations (%)												
	0.2	0.4	0.8	1.0	5.0	10.0	15.0	20.0	25.0	50.0	75.0	100	**Mean**
Clove oil	19.4	16.5	12.1	8.9	6.2	4.8	3.7	2.2	1.3	0.0	0.0	0.0	**6.3**
Clove extract	23.7	20.6	14.2	10.2	7.8	5.8	4.7	3.4	2.1	1.8	1.3	0.0	**8.0**
Garlic extract	28.1	25.0	22.6	18.2	15.1	12.5	8.3	6.8	4.5	3.1	2.3	0.9	**12.3**
Nigella oil	38.9	37.9	34.5	32.3	28.1	25.2	23.1	19.2	12.0	8.6	6.1	3.2	**22.4**
Rue extract	46.0	43.2	41.1	37.3	35.1	31.5	27.1	19.3	13.6	7.2	5.1	2.3	**25.7**
Manufactured Misrona oil	53.8	51.1	47.6	41.1	38.2	32.0	29.1	23.6	22.2	10.2	6.9	3.5	**29.9**
Henna extract	38.4	37.9	37.3	33.3	31.2	28.1	25.0	21.2	18.1	7.8	3.4	1.2	**23.6**
Ginger extract	54.3	52.2	49.9	48.6	46.0	43.7	39.9	37.0	30.2	13.2	6.1	2.3	**32.3**
Manufactured Natrlo oil	57.2	55.7	53.9	51.3	47.7	45.8	42.8	37.1	23.0	11.2	5.3	2.7	**36.1**
Triology oil	64.9	62.3	60.4	57.2	52.2	47.2	43.4	39.1	35.0	22.8	13.1	3.6	**41.8**
Thyme extract	61.1	60.3	60.5	57.3	53.0	47.0	41.3	31.7	25.6	13.1	7.8	5.2	**38.7**
Eucalyptus	70.7	66.2	63.3	61.2	53.9	48.3	43.2	38.0	33.1	27.0	23.0	20.2	**45.7**
Mustard oil	83.2	78.2	75.0	72.3	69.1	62.1	57.1	51.4	43.5	33.0	25.0	16.7	**55.5**
Onion oil	86.4	81.2	80.9	79.0	72.2	69.1	61.3	57.1	47.1	29.1	17.8	5.1	**57.2**
Caraway oil	91.4	88.0	87.1	83.1	81.3	72.5	63.8	51.0	48.3	33.1	30.0	25.0	**63.0**
Fennel oil	93.9	92.1	90.0	87.7	83.4	73.1	67.4	57.5	51.4	37.2	23.7	18.1	**64.6**
Hohoba oil	96.6	94.2	92.1	87.0	82.1	77.1	71.8	67.6	67.5	35.0	17.2	12.1	**66.7**
Check (water)	17.5	17.5	17.5	17.5	17.0	17.5	17.5	17.5	17.5	17.5	17.5	17.5	**17.5**
Mean	**57.0**	**54.5**	**52.2**	**49.1**	**45.6**	**41.3**	**37.2**	**32.2**	**27.6**	**17.3**	**11.8**	**7.8**	

L.S.D. at 5% for : Extracts or oils (O) = 1.2
Concentrations (C) = 0.8
Interaction between (O) X (C) = 3.5.

(22.4-32.3%); Natrlo oil; triology oil, thyme extract and eucalyptus (36.0-45.7%); mustard oil and onion oil (55.5-57.2%); caraway oil, fennel oil and hohoba oil ((63.0-66.7%).

However, average of conidial germination was significantly decreased by increasing concentrations of a particular tested material from 0.2 to 100.0%. Compared with the highest concentration. The lowest significant reduction in conidial germination was induced by clove oil at concentration of 15.0%, clove extract at 20.0%, garlic extract at 50.0%; nigella oil, rue extract, manufactured Misrona oil, henna extract, ginger extract, and triology oil at 75%. Onion oil only caused the highest inhibition of conidial germination when used at concentration of 100.0% while the rest of the tested materials showed no significant effect on conidial germination even at the highest tested concentration compared with check treatment.

2. Effect of some fungicides on conidial germination:

Data presented in **Table (12)** showed that no one of the tested fungicides lead to complete inhibition of conidial germination of *L. taurica* even it was used at its highest tested concentrations (i.e. 150% of the recommended dose). It is clear that delmite was the most effective fungicide in inhibition of *L. taurica* conidial germination (3.68%) followed by microthiol-80 (13.73%), flint (14.14%), thiophate-14 (14.5%) and domark (15.74%) without significant difference between the last 4 fungicides.

Table (12): Effect of different fungicides at different concentrations i.e. 50%, 75%, 100% and 150% of the recommended dose of each fungicide on *L., taurica* spore germination directly (without cellophane sheet) or indirectly (with cellophane sheet) contacted with the fungicidal solutions or indirectly contacted with it by cellophane sheet under laboratory conditions.

Fungicides	Recmmended dose/100L	Percentage of conidial germination: Indirect exposing to 50%	75%	100%*	150%	Mean	Direct exposing to 50%	75%	100%*	150%	Mean	Grend Mean
Delmite	250 cc	9.5	4.0	2.1	1.0	4.15	5.9	3.4	3.0	0.5	3.2	3.68
Microthiol-80	250 g	12.7	12.6	12.0	3.7	10.25	26.2	24.0	14.3	4.3	17.2	13.73
Flint	20 g	30.2	27.8	18.3	11.6	21.98	9.6	7.6	4.4	3.6	6.3	14.14
Thiophate-14	250 g	27.6	16.7	12.8	10.3	16.85	16.8	14.1	12.8	4.9	12.15	14.50
Domark	50 cc	19.7	19.4	13.2	10.4	15.68	23.5	15.8	15.2	9.7	15.80	15.74
Sumi-8	50 cc	22.4	15.4	13.7	11.8	12.83	29.2	23.4	19.8	11.0	20.85	16.84
Golf	35 cc	26.4	24.9	22.0	14.1	21.85	19.3	12.7	11.9	10.6	13.63	17.74
Bayfidan	20 cc	37.8	28.7	15.3	8.9	22.68	20.7	17.9	16.7	13.5	17.20	19.94
Topas-200	25 cc	28.0	27.6	22.4	18.0	24.00	22.7	17.8	12.8	7.0	16.08	20.04
Bellkute	50 g	50.5	29.6	27.8	22.2	32.53	25.6	11.7	10.9	9.2	14.35	23.44
Rubigan	25 cc	32.1	30.2	29.9	20.3	28.13	41.8	30.9	18.7	17.3	27.18	27.66
Check (water)	-	-	-	32.5	-	32.50	-	-	28.1	-	28.10	30.3
Mean		27.08	21.54	17.23	12.03		21.94	16.30	12.77	8.33		
General Mean		19.47					14.84					

L.S.D. at 1%

Fungicides (F) = 3.06 F x E = 3.40
Exposing (E) = 1.03 F x C = 6.63
Concentrations (C) = 2.00 E x C = 2.83 F x E x C = 9.38

* Calculated as % of the recommended dose (see Table 3 in materials and methods).

Reverse correlation was detected between the fungicidal concentration and the inhibitory effect of the fungicide. The more concentration was used, the lower percentage of spore germination was resulted. This trend was true whether conidia were placed directly in fungicidal solution or above cellophane sheets floated on these fungicidal solutions. Regardless fungicides, average of conidial germination was significantly lower in case of direct exposure (14.84%) compared with exposure to the fungicide solution through cellophane sheets (19.47%). Conidial germination due to applying Delmite and Domark fungicides was significantly equal in both exposure methods. Direct exposure to solutions of the other tested fungicides, resulted in significant decrease in conidial germination compared with exposure through cellophane sheets.

3. Number of stomata and epidermal hairs:

Data in Table (13) show that, the number of stomata and simple and glandular hairs per microscopic field (100X) have greatly differed in tested tomato varieties. The average number of stomata/field was ranged between 20-33 and 2.5-8.5 on the lower and upper tomato leaf surfaces, respectively. Average numbers are generally higher in the highly, Supermarmande, Strain-B, Marconi and Super green (23.3-33.0) and (6.5-8.5) and moderately (Peto-86 and Castle rock) susceptible tomato cultivars (23- 29) and (4-7.5) and than the least infected ones, UC 97/3, Cal-Ace, Ace and Super strain-B (20-26.8) and (3.5-4.5). The more susceptibility of tomato cultivars to L. taurica, the higher the number of stomata is found in both leaf surfaces. It is also clear that the stomata are much higher in the lower surface than in the upper one.

Table (13): Average number of stomata and leaf epidermal hairs per microscopic field (100X) on both upper and lower leaf surfaces of different tomato cultivars.

Tomato cultivars	Varietal mildew response *	Upper surface				Lower surface			
		Average No. of stomata	Average No. of hairs			Average No. of stomata	Average No. of hairs		
			Simple	Glandular	Total		Simple	Glandular	Total
Supermarmande	H.I.	8.5	5.3	11.5	16.8	33.0	10.5	14.8	25.3
Strain-B	H.I.	8.0	9.0	6.0	15.0	28.8	11.7	14.7	26.4
Marconi	H.I.	7.5	14.0	10.0	24.0	24.0	17.3	11.0	28.3
Super green	H.I.	6.5	20.5	8.8	29.3	23.3	12.5	24.3	36.8
Peto-86	M.I.	7.5	13.5	12.5	26.0	23.0	25.0	10.5	35.5
Castle rock	M.I.	4.0	12.8	12.8	25.6	29.0	11.3	22.3	33.6
UC- 97/3	L.I.	4.5	12.5	15.0	27.5	26.8	38.0	20.0	58.0
Cal-Ace	L.I.	3.0	38.2	14.3	52.5	22.0	27.5	24.3	51.8
Ace	L.I.	2.5	27.7	16.0	43.7	21.5	27.0	25.0	52.0
Super strain-B	L.I.	3.5	30.0	18.5	48.5	20.0	32.5	29.0	61.5
L.S.D. at 1%		1.6	7.2	2.7	6.4	5.1	7.3	4.5	7.1

* H.I., M.I., and L.I. means highly infected, moderately infected, and least infected, respectively.

The same data proved that the average total numbers of both simple and glandular hairs was obviously low (15.0-52.5) per microscopic field on the upper leaf surface compared with (25.3-61.5) per microscopic field on the lower one. In general, number of simple hairs found in the epidermal layers of both surfaces was abundantly higher in the least susceptible cultivars than in the moderately and highly susceptible ones. There is a satisfactory reverse relationship between the varietal reaction against infection with powdery mildew **(Table 7)** and the number of glandular hairs. In general, the more susceptible tomato cultivars to infection with powdery mildew possessed the fewer number of glandular hairs. However, the total hairs showed the same trend of simple hairs.

Biochamical studies associated with disease development:

1- Chlorophyll and carotene contents:

Data in **Table (14)** and **fig (5)** showed amounts of chlorophyll (a), chlorophyll (b) and carotene in tomato leaves as affected by powdery mildew infection. It is very clear that all these pigments were reduced to different extents in diseased leaves compared with the healthy one. Percentage of reduction was ranged between 46.0-87.5% for chlorophyll (a), 56.0-77.1% for chlorophyll (b) and 17.9-45.7% for carotene pigments. The highest reduction in leaf pigments was associated, in general, with more susceptible tomato cultivars.

Table (14): Effect of *L. taurica* infection on chlorophyll (A), chlorophyll (B) and carotene contents as mg/10 cm² of the leaf area of ten tomato cultivars.

	Chlorophyll (A)		% of reduction	Chlorophyll (B)		% of reduction	Chlorophyll (A + B)		% of reduction	Carotene		% of reduction	Total pigments		General reduction	% of disease severity
Tomato cvs.	D	H		D	H		D	H		D	H		D	H		
Supermarmande	1.215	9.744	87.5	3.185	13.878	77.1	4.400	23.622	81.4	0.964	1.774	45.7	5.364	25.396	78.9	26.7
Strain-B	2.625	10.525	75.1	3.595	14.836	75.8	6.220	25.361	75.5	0.620	1.884	42.8	6.841	26.445	74.1	25.9
Marconi	3.161	9.919	68.1	4.361	14.795	68.7	7.522	24.714	68.5	0.602	1.006	40.2	8.394	25.720	67.4	23.4
Super-green	3.361	11.029	67.1	6.316	16.447	61.6	9.677	27.476	64.8	0.698	1.119	37.6	10.380	28.595	63.7	21.8
Peto-86	3.513	10.743	67.3	6.189	15.996	61.3	9.702	26.739	63.7	0.639	1.462	35.8	10.346	28.201	63.3	20.1
Castle rock	3.747	10.911	65.7	6.496	16.712	61.1	10.243	27.623	62.9	0.670	1.043	35.8	10.913	28.666	61.9	19.4
UC-97/3	5.567	10.743	48.2	5.639	16.017	58.8	11.206	26.760	58.4	0.855	1.091	21.6	11.994	27.851	56.9	12.8
Cal -Ace	4.978	9.687	48.6	6.598	15.711	58.1	11.576	25.398	54.1	0.836	1.069	21.8	12.412	26.467	53.1	12.2
Ace	5.451	10.208	46.6	6.208	14.682	57.7	11.659	24.890	53.2	0.793	0.999	20.6	12.452	25.889	51.9	11.4
Super strain-B	5.082	9.415	46.0	6.783	15.416	56.0	11.865	24.831	52.2	1.370	1.669	17.9	13.235	26.500	50.1	10.5

D = Diseased plants. H = Healthy plants.

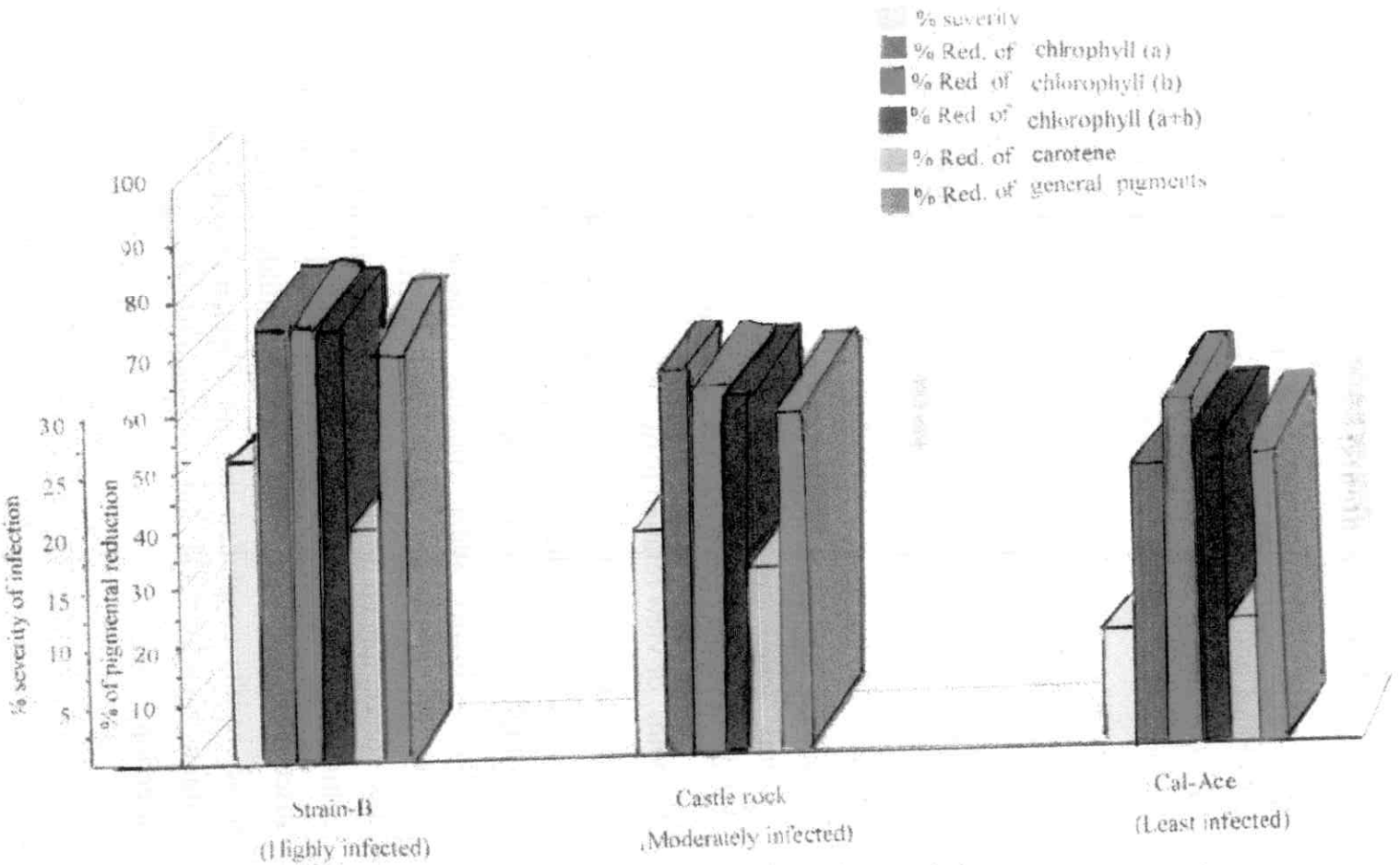


Fig (5|): Relation between powdery mildew disease severity and reduction of pigments

2- Sugar contents:

Data in **Table (15)** and **fig (6)** illustrated reducing, non-reducing and total sugars in both healthy and mildewed leaves of ten tomato cultivars. It is clear that these sugar contents were responded differently against infection with powdery mildew. Reducing sugars were considerably increased in mildewed leaves of some tomato cultivars specially Marconi, Peto-86 and UC 97/3 cvs. Meanwhile it was considerably decreased in some others i.e. Supermarmande and Strain-B cvs (**Fig 6**).

Similar trend was also noticed in case of the non-reducing sugars. The mildewed leaves of Strain-B, Marconi, Castle rock contained higher amounts of non-reducing sugars than the healthy one meanwhile the opposite was observed in Supermarmande, UC 97/3, Ace, and Super strain-B.

In point of view relation between the host reaction and the level of sugar contents in leaves of the evaluated tomato cultivars, the obtained results indicated that the healthy and infected leaves of the highest susceptible tomato (Supermarmande, Strain-B) contained higher sugar contents compared with the lowest susceptible cultivars (Ace and Super strain-B). Unfortunately this correlation could not be generalized in all tested tomato cultivars as sugar contents were increased in the intermediate susceptible cultivars due to powdery mildew infection. From these results concluded that no correlation between powdery mildew severity level and the quantity of sugar content after infection.

Table (15): Effect of *L. taurica* infection on sugar content as mg glucose/1 g fresh weight of ten tomato cultivars.

Tomato cultivars	Healthy leaves			Diseased leaves			% of disease severity
	Reducing sugars	Non reducing sugars	Total sugars	Reducing sugars	Non reducing sugars	Total Sugars	
Supermarmande	2.85	2.95	5.80	1.65	1.94	3.59	26.7
Strain-B	2.44	2.72	5.16	1.13	3.32	4.45	25.9
Marconi	1.86	1.99	3.85	2.32	2.33	4.65	23.4
Super green	1.52	1.89	3.41	1.78	1.97	3.75	21.8
Peto-86	1.88	2.63	4.51	2.61	2.80	5.41	20.2
Castle rock	2.10	1.95	4.05	1.55	2.75	4.30	19.4
UC 97/3	0.90	2.54	3.44	2.01	1.95	3.96	12.8
Cal-Ace	1.52	1.75	3.27	1.96	1.90	3.81	12.2
Ace	0.83	2.13	2.96	0.79	1.94	2.73	11.4
Super strain-B	0.65	1.45	2.10	0.58	1.41	1.99	10.5

3- Phenol contents:

Phenolic contents in healthy and infected leaves of ten tomato cultivars are presented in **Table (16)**. One of the most inportant result shown that the leaves of healthy tomato cvs. Ace and Super strain- B (least infected) contained higher levels of free phenols than higher susceptible cvs. Strain-B and Supermarmande. Meanwhile, the rest cvs. (moderately infected) contained intermediate amounts of free phenols. Data indicated that, the free, conjugated and total phenolic contents, in most cases, were higher in the mildewed than the healthy leaves of all

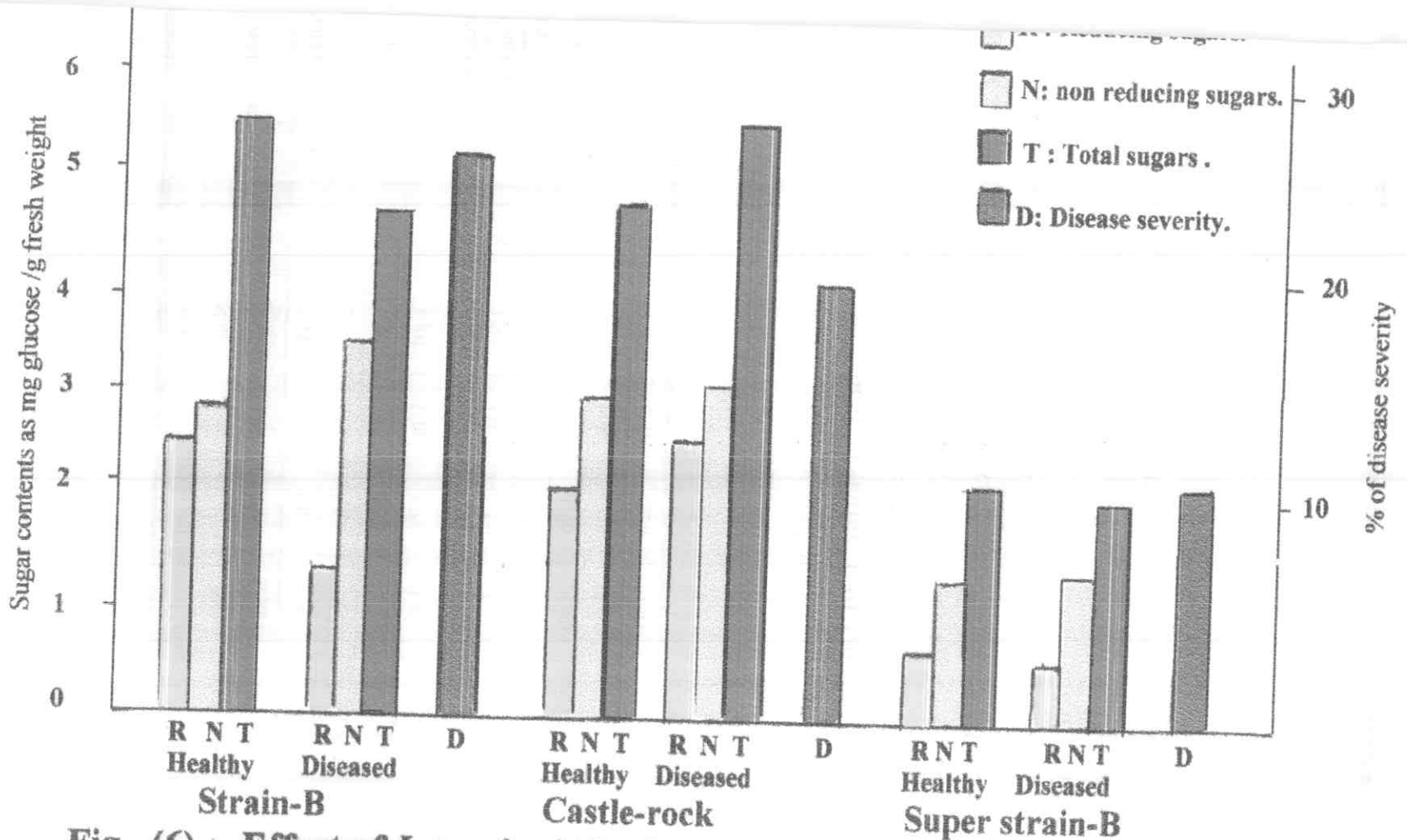


Fig . (6) :- Effect of *L.taurica* infection on sugar contents as mg glucose /g fresh weight of three tomato cultivars .

Table (16): Effect of *L. taurica* infection on phenol content of healthy and diseased tomato cultivars as milligrams of catechol/1 g fresh weight.

Tomato cvs.	Healthy leaves			Diseased leaves			% Increase *		% of disease severity
	Free	Conj	Total	Free	Conj	Total	Free phenols	Total phenols	
Supermarmande	0.169	0.169	0.338	0.185	0.166	0.351	9.5	3.8	26.7
Strain-B	0.163	0.130	0 293	0.179	0.153	0.332	9.8	13.3	25.9
Marconi	0.176	0.128	0.304	0.182	0.126	0.308	3.4	1.3	23.4
Super green	0.179	0.133	0.312	0.185	0.147	0.332	3.4	6.4	21.8
Peto-86	0.150	0.159	0.309	0.166	0.167	0.333	10.7	7.8	20.2
Castle rock	0.172	0.072	0.244	0.203	0.194	0.397	18.0	62.7	19.4
UC 97/3	0.176	0.092	0.268	0.215	0.169	0.384	22.2	54.5	12.8
Cal Ace	0.182	0.241	0.310	0.234	0.189	0.423	28.6	36.5	12.2
Ace	0.208	0.137	0.345	0.256	0.160	0.416	23.1	20.6	11.4
Super strain-B	0.200	0.145	0.345	0.262	0.186	0.448	31.0	29.8	10.5

*% increase= amount in diseased leaves - amount in healthy leaves / amount in healthy leaves X 100

tested tomato cultivars. In case of tomato cultivars Supermarmande, Marconi, and Cal-Ace only, the conjugated phenols were slightly lower in the mildewed than healthy leaves. The present results showed clearly that powdery mildew infection increased both free and total phenol contents in all tested cultivars, but with different rates. In infected leaves, free and total phenol contents were increased by 3.4-31.0% and 1.3-62.7%, respectively. The highest increase was associated with the least and moderately infected cultivars.

4- Free amino acid contents:

Data shown in **Table (17 a & b)** presented that all tested tomato cultivars were clearly differed in their amino acid contents. In healthy tomato leaves of the tested cvs. There was no correlation between the total free amine acids content and their own susceptibility with infection.

In healthy cvs., the sulphuric and aromatic amino acids were higher in the cvs. showed less infection and reverse was true in the cvs. showed higher infection. However, reverse reaction was recorded according to hydroxylic, alephatic and emino.

Total amino acids in most varieties were obviously decreased in the mildewed leaves compared with the healthy one. Total amino acids content was ranged between 1.733-10.986 mg/g fresh weight and 1.04-5.317 mg/g fresh weight of healthy and mildewed leaves, respectively. Percentage of reduction in total amino acids content ranged between 8.0% (in Marconi cv.) to 83.0% (in Peto-86 cv.). In Super green tomato

Table (17-a): Quantitative analysis of free amino acids estimated as mgs /gram fresh weight of healthy (H) and diseases (D) leaves of tomato cultivars, Supermarmande, Strain-B, Marconi, Super green and Peto-86.

Free amino Acids	Tomato cultivars									
	Super marmande		Strain-B		Marconi		Super green		Peto-86	
	D	H	D	H	D	H	D	H	D	H
Sulphoric group										
L. Cystine DL.-methionine	0.894 0.137	2.649 0.257	- 0.244	2.089 0.325	1.112 -	1.359 -	1.931 -	1.050 -	0.702 -	2.584 0.098
Total	1.031	2.906	0.244	2.414	1.112	1.359	1.931	1.050	0.702	2.682
Hydroxy group										
DL. thrionine L. tyrosine (3,4) dihydroxy alanine	0.601 - 0.358	0.796 - 0.959	0.293 - 0.536	0.195 - 0.536	0.767 - 0.221	0.371 - 0.280	0.322 - -	0.244 - 0.091	0.254 - 0.182	1.056 - 0.423
Total	0.959	1.755	0.829	0.731	0.988	0.651	0.322	0.335	0.436	1.479
Nonpolar alephatic										
DL-valine DL-isoleucine DL-norleucine DL-α alanine Glycine	0.228 - 0.041 0.228 0.293	0.060 - 0.130 0.358 -	- - - 0.260 -	- 0.106 - 0.163 1.095	0.049 0.085 - - 0.406	0.021 0.143 - - 0.199	- 0.121 - - -	0.023 0.156 - - -	- 0.075 - 0.085 0.137	0.228 - 0.098 0.683 1.186
Total	0.790	0.548	0.260	1.364	0.540	0.363	0.121	0.179	0.297	2.195
Aromatic group										
DL-Phenyl-alanine DL-tryptophan	- 0.315	- 0.569	- 0.406	- 0.322	- 0.137	0.176 0.146	- -	- -	- 0.325	0.731 0.601
Total	0.315	0.569	0.406	0.322	0.137	0.322	-	-	0.325	1.332
Amino group										
L-glutamic α amino n-butyric	0.138 0.185	0.130 0.260	0.130 0.333	0.374 0.124	0.055 0.085	0.200 0.276	0.044 0.150	0.049 0.120	0.021 0.085	0.171 0.202
Total	0.323	0.390	0.463	0.498	0.140	0.476	0.194	0.169	0.106	0.373
Imino group										
L-Proline	0.650	2.243	1.398	0.878	-	-	-	-	-	2.925
Total	0.650	2.243	1.398	0.878	-	-	-	-	-	2.925
Grand Total	4.068	8.411	3.600	6.207	2.917	3.171	2.568	1.733	1.866	10.99
% reduction in relation to healthy	51.6%		42.0%		8.0%		+ 32.5%		83.0%	
% of diseae severity	26.71	-	25.91	-	23.4	-	21.8	-	20.21	-

Table (17-b continued): Quantitative analysis of free amino acids estimated as mgs/gram fresh weight of healthy (H) and diseased (D) leaves of tomato cultivars, Castle rock, UC-97/3, Cal Ace, Ace and Super strain-B.

Free amino Acids	Tomato cultivars									
	Castle rock		UC 97/3		Cal-Ace		Ace		Super strain-B	
	D	H	D	H	D	H	D	H	D	H
Sulphoric group										
L. Cystine DL-methionine	0.974 0.325	2.389 0.309	- -	- -	0.761 -	1.702 1.140	- -	2.554 0.221	2.050 0.205	3.269 0.172
Total	1.299	2.698	-	-	0.761	2.842	-	2.775	2.255	3.441
Hydroxy group										
DL. thrionine L. tyrosine (3,4) dihydroxy alanine	0.601 - 0.696	0.325 - 1.008	0.234 0.083 0.231	0.332 0.112 -	0.302 - 0.221	0.488 0.146 0.302	0.205 - -	0.351 - 0.182	0.254 - 0.315	0.100 - 0.280
Total	1.297	1.333	0.548	0.444	0.523	0.936	0.205	0.533	0.569	0.680
Nonpolar alephatic										
DL-valine DL-isoleucine DL-norleucine DL-α alanine Glycine	0.060 - - 0.309 -	- - - 0.390 0.406	0.059 0.094 - - 0.199	0.046 0.127 - 0.232 -	0.049 0.088 - - 0.234	0.055 0.137 - - 0.137	- - - 0.114 0.199	0.052 0.072 - - 0.208	- 0.068 - - 0.208	0.052 0.104 - - 0.182
Total	0.369	0.796	0.352	0.405	0.371	0.329	0.313	0.332	0.276	0.338
Aromatic group										
DL-Phenyl-alanine DL-tryptophan	- 0.666	- 0.878	- 0.291	- 0.996	- 0.356	- 1.273	- 0.486	- 1.315	- 0.293	- 1.542
Total	0.666	0.878	0.291	0.996	0.356	1.273	0.486	1.315	0.293	1.542
Amino group										
L-glutamic α amino n-butyric	0.073 0.150	0.163 0.088	0.039 0.101	- 0.156	0.033 0.098	0.036 0.202	0.036 -	0.042 0.296	0.033 0.146	0.039 0.283
Total	0.223	0.251	0.140	0.156	0.131	0.238	0.036	0.338	0.179	0.322
Imino group										
L-Proline	1.463	2.210	-	-	-	-	-	-	-	1.108
Total	1.463	2.210	-	-	-	-	-	-	-	1.108
Grand Total	5.317	8.166	1.331	2.001	2.142	5.618	1.040	5.293	3.572	7.431
% reduction in relation to healthy	34.9%		33.5%		61.9%		80.4%		51.9%	
% of disease severity	19.4	-	12.8	-	12.2	-	11.4	-	10.5	-

cultivar only, the amino acids content was increased in diseased leaves by 32.5% compared with its healthy leaves. Peto-86, Supermarmande and Castle rock were the highest, whereas UC-97/3, Cal-Ace, Ace and Super green were the lowest. In general, the infection decreased the total free amino acids in all tomato cultivars except in Super green cultivar.

The present data also indicated that, the amino acids L-cysteine (sulphuric group); DL-serine (hydroxy group); L-leucine (nonpolar alephatic group); DL-phenyl-alanine (aromatic group); DL-aspartic (amino group); L-hydroxy proline (imino group) L-lysine HCl, L-arginine HCl, L-histidine HCl, and DL-ornithine (Basic amino acids group) were not detected in all tested healthy or diseased tomato cultivars.

One of the most noticeable result that the least susceptible cultivars (Super strain-B, Ace and Cal-Ace) contained higher concentrations of sulphoric amino acid group than the highly susceptible cultivars (Super-marmande, Strain-B and Marconi) especially cystine and the reverse was true according to hydroxylic, aliphatic and Imino (especially proline) groups. Tryptophan (aromatic amino acid) was detected in higher concentrations in healthy leaves of the least susceptible cultivars than healthy ones of the high susceptible cultivars. However, this amino acid was clearly decreased in the powdery mildewed plants than the check in all cultivars particularly in the relatively least infected cultivars.

5- Ascorbic acid contents (vitamin c):

It is very clear from data in **Table (18)** that healthy leaves of the least infected cultivar, Super strain-B contained the highest level of ascorbic acid (20.6 mg/100 g fresh tomato leaves). The highly susceptible cultivar, Strain-B behaved otherwise. Meanwhile, the moderately infected cultivar Castle rock contained intermediate amounts of vitamin C.

Table (18): Effect of tomato powdery mildew infection on ascorbic acid content (vitamin c) as mg/100 g fresh tomato leaves.

Tomato cultivars	Ascorbic acid content in			
	Diseased leaves	Healthy leaves	% Loss due to infection	% of disease severity
Strain-B	13.11	18.10	27.57	25.9
Castle rock	9.14	19.2	52.39	19.4
Super strain-B	6.4	20.6	68.93	10.5

Powdery mildew infection decreased ascorbic acid content in all tomato cultivars but to different levels. The infection decreased ascorbic acid content in the least infected cultivar, Super strain-B by more than 68% of the content found in its healthy leaves, whereas the infection decreased only 27.57% of ascorbic acid content in the infected leaf tissues of the highly infected cultivar, Strain-B. Also, the disease decreased about 52.39% of vitamin c content of healthy moderately infected leaf tissues of Castle rock. So, it could be resulted that there is a negative correlation between the varietal susceptibility

with powdery mildew and the percent of reduction of vitamin c due to infection.

6- Growth regulator contents:

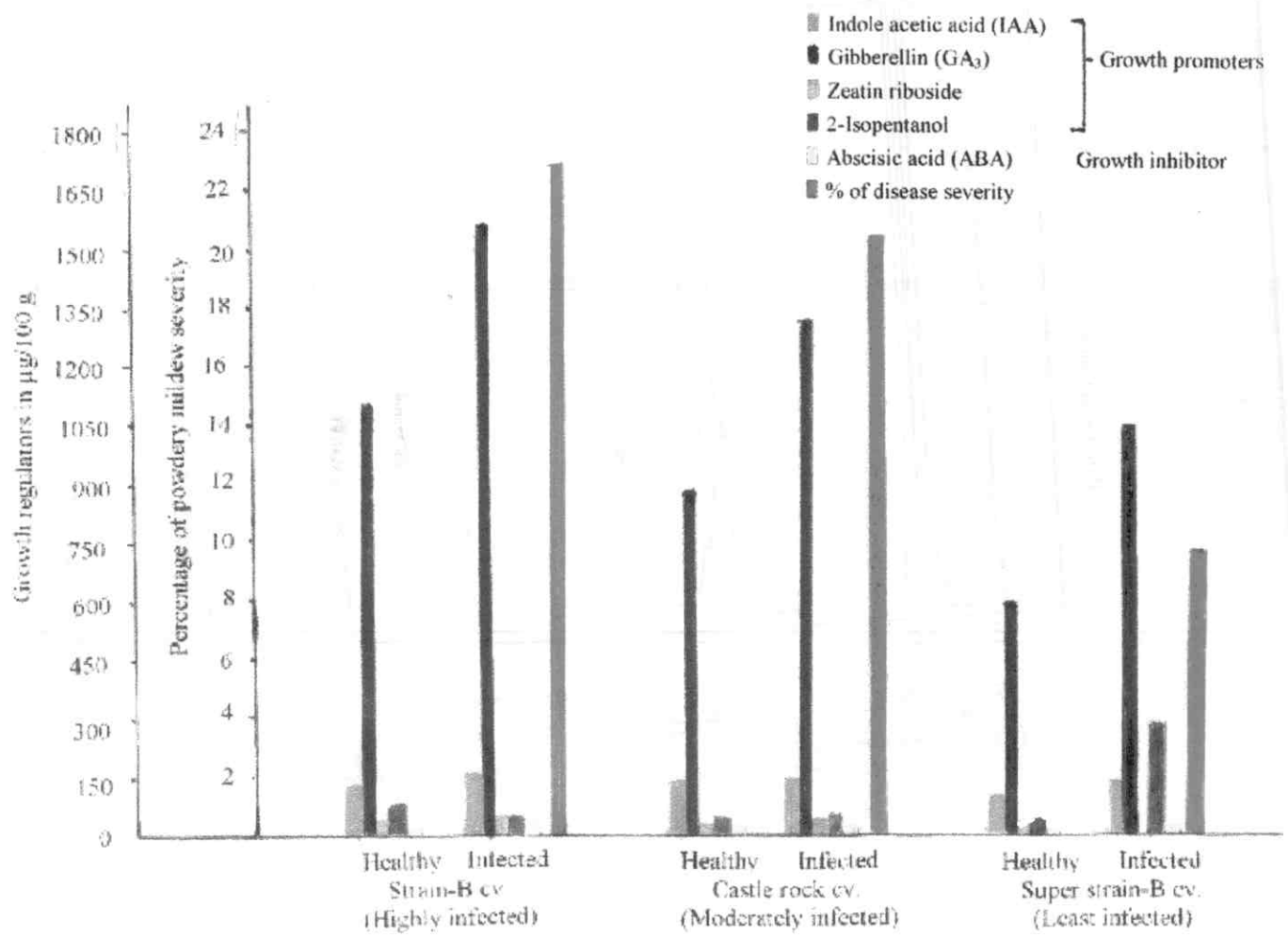
It is very clear from **Table (19)** and **Fig. (7, 8 and 9)** that, the healthy leaf tissues of the tested tomato cultivars, Strain-B (highly infected), Castle rock (moderately infected) and Super strain-B (least infected) contained different concentrations of the growth promoters, indole acetic acid (IAA), gibberellic acid (GA_3), cytokinins (Zeatin riboside and 2-isopentanol (2 iP). Healthy leaves of the highly susceptible cultivar, Strain-B, contained the highest levels of mentioned growth promotors followed by the moderately infected cultivar, Castle rock. The least infected cultivar, Super strain-B contained the least amounts of the mentioned promoters. Data indicate clearly that GA_3 is present with a huge concentration if compared with total of other growth promoters of each tested tomato cultivar. It is also clear that powdery mildew infection increased all mentioned growth promoters especially gibberellic acid (GA_3).

The same data stated also that, the healthy leaves of the tested tomato cultivars, Strain-B, Castle rock and Super strain-B contained different amounts of the growth inhibitor, abscisic acid (ABA). The Castle rock cultivar contained the higher amounts of it, followed by the Strain-B cultivar, whilst the Super strain-B cultivar contained the least concentration of ABA. It is very clear that powdery mildew infection increased either the mentioned growth promoters or the growth inhibitor in most cases except in the cases of (2 IP) in Strain-B and Super strain-B cultivars.

Table (19): Effect of powdery mildew infection (*L. taurica*) on plant hormones of some tomato cultivars (µg/100 g fresh leaves).

Tomato cultivars	Case	Growth promotors					Growth regulators		% of disease severity
		IAA	GA_3	Cytokinins: Zeatin riboside	Cytokinins: 2 IP	Total of growth promotors	Growth inhibitor ABA	Total of Growth regulators	
Strain-B	Healthy	126	1107	45	87	1365	24	1389	-
	Infected	157	1574	60	61	1852	44	1896	25.9
Rate of change due to infection		24.6 (+)	42.2 (+)	33.3 (+)	29.9 (-)	35.7 (+)	83.3 (+)	36.5 (+)	
Castle rock	Healthy	122	881	36	51	1090	27	1117	-
	Infected	155	1339	55	51	1600	33	1633	19.4
Rate of change due to infection		27.1 (+)	52.0 (+)	34.5 (+)	0.0	31.9 (+)	18.2 (+)	46.2 (+)	
Super strain-B	Healthy	102	606	35	50	793	5	798	-
	Infected	133	1050	296	0	1479	28	1507	10.5
Rate of change due to infection		30.4 (+)	73.3 (+)	745.7 (+)	100.0 (-)	86.5 (+)	460.0 (+)	88.8 (+)	

Rate of change due to infection (+) ' (-) means % increase and decrease, respectively.
IAA : Indole acetic acid, GA_3 : Gibberellin, 2 IP : 2-Isopentanol. ABA: Abscisic acid.


Indole acetic acid (IAA)
Gibberellin (GA_3)
Zeatin riboside
2-Isopentanol
Growth promoters
Abscisic acid (ABA)
Growth inhibitor
% of disease severity
Growth regulators in µg/100 g
Percentage of powdery mildew severity
1800
1650
1500
1350
1200
1050
900
750
600
450
300
150
0
24
22
20
18
16
14
12
10
8
6
4
2
Healthy
Infected
Strain-B cv
(Highly infected)
Healthy
Infected
Castle rock cv.
(Moderately infected)
Healthy
Infected
Super strain-B cv.
(Least infected)

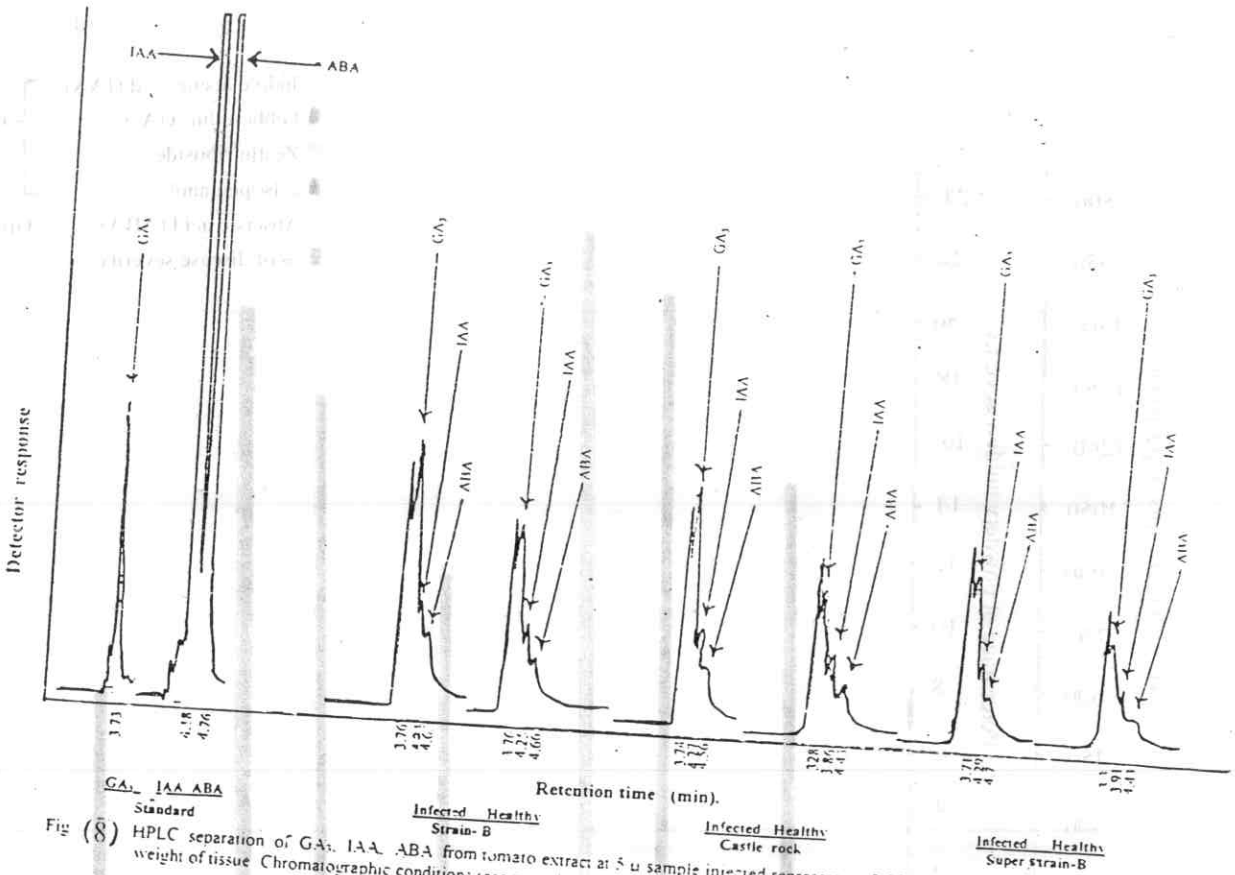


Fig (8) HPLC separation of GA_3, IAA, ABA from tomato extract at 5 u sample injected representing 0.05 g fresh weight of tissue Chromatographic conditions (see material and methods)

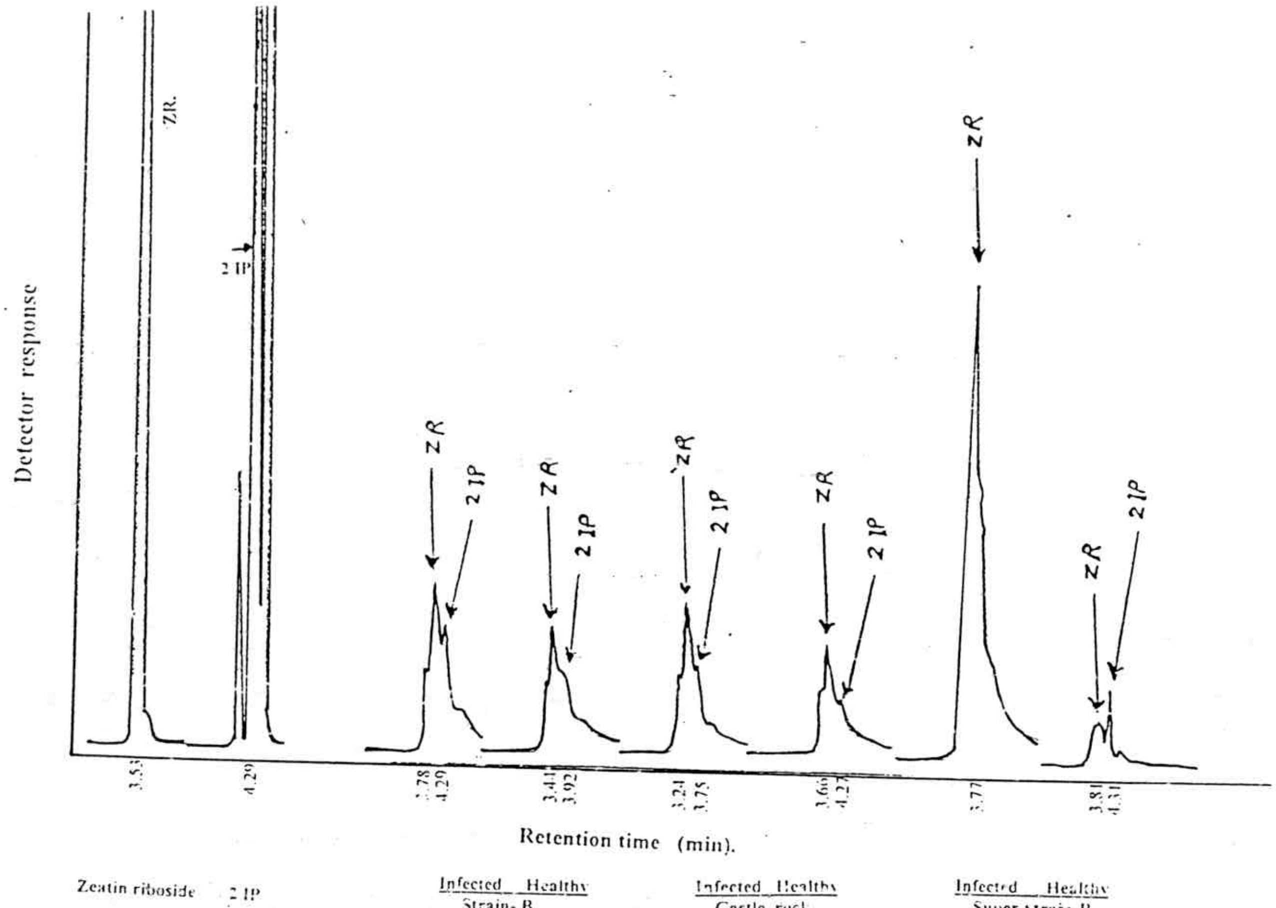


Fig (9) HPLC separation of ZR & 2IP from tomato extract at 5 u sample injected representing 0.05 g fresh weight of tissue Chromatographic conditions (see material and methods)

7- Oxidative enzyme activities:

Data in **Table (20)** indicate clearly that, the higher activity rate of all oxidative enzymes in healthy tomato cvs. the less infection was owned by the cultivar and it also clear that *L. taurica* infection increased the rate of activity/sec. of all oxidative enzymes (peroxidase, polyphenoloxidase, catalase and ascorbic acid oxidase) than each particular check plants. Positive correlation was detected between the rate of activity of each enzyme and the relative susceptibility of the three tested tomato cultivars. Strain-B, Castle rock and Super strain-B as the less susceptibility of the cultivar, the more rate of activity/sec. was resulted.

4- Disease control:

1. Effect of spraying with some plant products and extracts on powdery mildew severity in greenhouse:

Data in **Table (21)** indicate that, powdery mildew disease severity was significantly decreased by increasing concentration of any of the tested material from 0.2 (average 23.1%) to 100% (average 4.7%). It is clear also that, clove oil was the most effective for suppressing infection with powdery mildew of tomato (1.0%) followed by clove extract (3.0%), garlic extract (5.0%) and nigella oil (7.6%). However, Rue extract, Manufactured Misrona oil, Henna extract, Ginger extract, Manufactured Natrlo oil, and Thyme extract caused slight but significant reduction in disease severity (11.1-15.5%). Unfortunately, some of these effective materials were phytotoxic at the higher concentration. The following concentrations were

Table (20): Optical density and rate of activity/sec for the oxidative enzymes peroxidase, polyphenoloxidase, catalase and ascorbic acid oxidase in healthy and mildewed leaves of three tomato cultivars differed in their infection with *L. taurica*.

Enzyme	Tomato cv.	Enzyme activity after Sec. 15	60	90	Rate of Act./sec*	%of disease severity
Peroxidase	Strain-B					
	Diseased	0.182	0.196	0.198	21x10-5	25.9
	Healthy	0.073	0.080	0.084	15x10-5	
	Castle rock					
	Diseased	0.065	0.072	0.083	24x10-5	19.4
	Healthy	0.057	0.068	0.070	17x10-5	
	Super strain-B					
	Diseased	0.100	0.118	0.124	32x10-5	10.5
	Healthy	0.092	0.101	0.105	17x10-5	
Polyphenol oxidase	Strain-B					
	Diseased	0.504	0.559	0.587	55x10-5	25.9
	Healthy	0.315	0.358	0.380	43x10-5	
	Castle rock					
	Diseased	0.298	0.351	0.385	63x10-5	19.4
	Healthy	0.268	0.285	0.338	46x10-5	
	Super strain-B					
	Diseased	0.381	0.468	0.493	75x10-5	10.5
	Healthy	0.261	0.346	0.369	72x10-5	
Catalase	Strain-B					
	Diseased	0.175	0.180	0.187	16x10-5	25.9
	Healthy	0.050	0.051	0.054	5x10-5	
	Castle rock					
	Diseased	0.044	0.060	0.068	32x10-5	19.4
	Healthy	0.040	0.041	0.046	8x10-5	
	Super strain-B					
	Diseased	0.160	0.173	0.187	36x10-5	10.5
	Healthy	0.026	0.033	0.036	13x10-5	
Ascorbic acid oxidase	Strain-B					
	Diseased	0.143	0.189	0.215	96x10-5	25.9
	Healthy	0.023	0.054	0.060	49x10-5	
	Castle rock					
	Diseased	0.040	0.073	0.115	100x10-5	19.4
	Healthy	0.015	0.045	0.060	60x10-5	
	Super strain-B					
	Diseased	0.060	0.085	0.158	130x10-5	10.5
	Healthy	0.016	0.046	0.077	81x10-5	

- Rate of activity/sec = $\frac{\text{Optical density at 90 sec- Optical density at 15 sec}}{\text{75 seconds}}$

Table (21): Powdery mildew severity as affected by plant extracts and oils on 80 day – old Strain-B tomato plants after 2 weeks from inoculation under greenhouse conditions.

Plant extract or oil	Concentrations (%)												
	0.2	0.4	0.8	1.0	5.0	10.0	15.0	20.0	25.0	50.0	75.0	100	**Mean**
Clove oil	4.3	3.3	2.1	1.3	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**
Clove extract	6.3	5.6	5.0	4.5	3.5	2.8	2.3	2.3	2.5	1.6	0.0	0.0	**3.0**
Garlic extract	8.4	8.1	7.3	7.0	6.1	5.4	4.9	4.4	3.7	3.0	1.9	0.0	**5.0**
Nigella oil	13.1	12.0	11.2	10.6	9.7	9.1	7.9	6.4	5.4	3.2	2.2	0.0	**7.6**
Rue extract	17.2	16.6	16.0	15.1	14.6	13.0	11.9	10.8	8.7	6.3	3.1	0.0	**11.1**
Manufactured Misrona oil	18.9	18.4	17.8	16.7	15.4	13.5	12.2	11.4	10.8	8.3	3.3	0.0	**12.2**
Henna extract	17.0	16.2	15.7	15.0	13.7	13.1	11.9	11.1	105	7.1	4.5	1.2	**11.4**
Ginger extract	19.1	18.4	17.5	16.2	14.9	14.2	13.3	11.9	11.2	9.0	5.0	0.0	**12.6**
Manufactured Natrlo oil	21.2	20.1	19.2	18.7	17.9	16.9	14.5	13.2	11.9	9.6	4.0	0.0	**13.9**
Triology oil	24.1	23.4	22.9	22.2	20.5	18.5	16.9	15.2	14.6	12.0	6.5	0.0	**16.4**
Thyme extract	22.8	22.2	21.3	20.1	18.8	17.4	15.2	19.8	12.7	12.2	7.2	2.1	**15.5**
Eucalyptus	29.6	29.0	24.4	24.7	22.4	20.3	18.4	16.7	14.7	13.4	8.3	3.1	**18.8**
Mustard oil	34.0	33.4	31.3	28.3	25.0	23.4	21.6	19.9	18.7	17.1	13.1	6.8	**22.7**
Onion oil	37.4	36.1	34.1	32.9	30.3	28.9	25.0	22.8	20.1	19.2	16.3	9.2	**26.0**
Caraway oil	38.9	38.1	37.4	35.4	33.8	31.9	28.8	25.3	22.8	22.2	20.2	12.2	**28.9**
Fennel oil	43.3	42.3	41.2	39.8	38.0	34.5	30.8	27.9	24.3	23.4	21.4	15.2	**31.8**
Hohoba oil	45.1	44.6	13.4	40.9	38.3	35.7	34.2	31.4	28.0	26.4	23.1	19.0	**34.2**
Check (water)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	**16.0**
Mean	**23.1**	**22.4**	**21.3**	**20.3**	**18.9**	**17.5**	**15.85**	**13.9**	**12.4**	**11.7**	**8.7**	**4.7**	

L.S.D. at 5% for : Extracts or oils (O) = 0.4
Concentrations (C) = 0.5
Interaction between (O) X (C) = 2.1

* The underlined figures induced phytotoxic effect

phytotoxic: >0.8% of clove oil, >20.0% of Manufactured Natrlo oil, >25.0% of clove extract, and >25.0% of nigella oil. For avoiding phytotoxic effect and obtaining good control of powdery mildew the following treatments could be recommended: 0.8% of clove oil, 5.0% of clove extract or garlic extract, 50.0% of nigella oil, 75.0% of Rue extract or Manufactured Misrona oil without significant differences in between. On the other hand, Triology oil, Eucalyptus, Mustard oil, Onion oil, Caraway oil, Fennel oil, Hohoba oil might be encourage infection with powdery mildew of tomato as they caused significant increase in disease severity (18.8-34.2%) compared with check treatment (16.0%).

2. Effect of some fungicides on powdery mildew severity in greenhouse:

It was clear from data in **Table (22)** that all tested fungicides significant decrease disease severity (2.19-12.19%) in comparison with check plants (26.25%). In this regard Topas-200 was the most effective fungicide followed by Domark and Byfidan without significant differences in between. The efficacy of these 3 fungicides was 91.7%, 86.9% and 84.5%, respectively when compared with check treatment. However, Rubigan, Sumi-8, Flint, Bellkute, Golf, Microthiol-80, Delmite and Thiophate-14 in the listed order came the next. Efficacy of the latter fungicides was 80.9%, 79.8%, 73.8%, 71.4%, 67.8%, 59.5%, 54.7% and 53.6%, respectively.

Table (22): Effect of some fungicides against tomato powdery mildew disease.

Fungicides	Recommended dose/100 L of water	% of disease severity	% of fungicidal efficacy *
Delmite (L.)	250 ml	11.88	54.7
Microthiol-80 (W.G)	250 g	10.63	59.5
Golf (E.C)	35 ml	8.44	67.8
Sumi-8 (E.C)	35 ml	5.31	79.8
Flint (W.G)	20 g	6.88	73.8
Bayfidan (E.C)	20 ml	4.06	84.5
Domark (E.C)	50 ml	3.44	86.9
Topas-200 (W.P)	25 ml	2.19	91.7
Thiophate-14 (W.P)	250 g	12.19	53.6
Rubigan (E.C)	25 ml	5.00	80.9
Bellkute (W.P)	50 g	7.50	71.4
Check (water)	-	26.25	-
L.S.D. at 5%	-	1.81	-

* **Efficacy (%) =**

$$\frac{\text{\% of severity in check - \% of severity of treatment}}{\text{\% of severity in check}} \times 100$$

3. Effect of some fungicides on powdery mildew severity in open fields:

Disease severity and yield of tomato fruits as affected by spraying with the recommended doses of the tested fungicides (see **Table** 3) were illustrated in **Tables 23 and 24**. All tested fungicides have decreased disease severity and improved fruit yield significantly if compared with check treatment. Disease severity due to spraying fungicides was ranged between 2.51-

21.43% at El-Amra location and 2.83-18.59% at El-Gammalia location compared with 51.87% and 48.12% in check treatments at both locations, respectively. Efficacy of fungicides was fluctuated between 58.68-95.16% and 61.37-94.12% at both locations,

Table (23): Effect of some fungicides on tomato powdery mildew disease severity in Nili plantation at 2 locations in Dakahliya governorate, El-Manzalah Center, El-Amra and El-Gammalia.

	El-Amra		El-Gammalia	
Fungicides	Disease severity %	Fungicidal efficacy % *	Disease severity %	Fungicidal efficacy % *
Bayfidan (E.C)	7.80	84.96	7.69	84.02
Bellkute (W.P)	12.98	74.97	12.96	73.07
Delmite (L.)	21.43	58.68	18.59	61.37
Domark (E.C)	5.44	89.51	3.76	92.19
Flint(W.G)	9.43	81.82	8.15	83.06
Golf (E.C)	14.18	72.66	13.35	72.26
Microthiol-80 (W.G)	19.64	62.14	17.25	64.15
Rubigan (E.C)	9.82	81.07	8.14	83.06
Sumi-8 (E.C)	11.58	77.67	12.06	74.94
Thiophate-14 (W.P)	19.74	61.94	16.86	64.96
Topas-200 (W.P).	2.51	95.16	2.83	94.12
Check (Water)	51.87	-	48.12	-
L.S.D. at 5% level	1.77	-	1.95	-

$$\text{Efficacy (\%)} = \frac{\text{\% of severity in check - \% of severity of treatment}}{\text{\% of severity in check}} \times 100$$

Table (24): Effect of some fungicides on tomato yield Kg/plot (0.01 feddan) in Nili plantation at 2 locations in Dakahliya governorate, El-Manzalah Center, El-Amra and El-Gamalia.

Fungicides	Yield in Kg/plot at location	
	El-Amra	El-Gammalia
Bayfidan	222	220
Bellkute	183	185
Delmite	158	155
Domark	232	235
Flint	205	210
Golf	175	180
Microthiol-80	165	165
Rubigan	199	210
Sumi-8	188	200
Thiophate-14	168	175
Topas-200	248	243
Check	120	135
L.S.D. at 5% level	11.82	19.31

respectively. Among all tested fungicides Topas-200 was the best one as it induced the lowest disease severity and highest fruit yield at both locations i.e. El-Amra and El-Gammalia. Meanwhile, Delmite was the least effective fungicide at both locations.

Based on superiority of fungicides in suppressing infection with tomato powdery mildew and improvement in tomato fruit yield, the most effective fungicide was Topas-200 followed by domark, bayfidan, flint, rubigan, sumi-8, bellkute, golf, microthiol-80, thiophate-14, and delmite, respectively.