RESULTS

RESULTS

I- The isolated fungi and their frequencies:

The data in **Table (4)** indicated that, *Macrophomina phasiolina* was the most dominant followed by *Fusarium* spp., *Rhizoctonia solani* and *Sclerotium rolfsii.* Out of the total number of fungi i.e., 1806 which have been isolated from different locations 1166 were *M. phaseolina* (65.2%), 453 were *Fusarium* spp. (25.0%), 147 were *R. solani* (7.6%), and only 40 were *S. rolfsii* (2.2%). *Macrophomina phaseolina* and *Fusarium* spp. were isolated from all 27 locations while *R. solani* and *S. rolfsii* were isolated from 21 and 7 locations, respectively. Seven locations i.e., Menia-1, Menia-2, Menia–3, Qalubia-1, Sharkia-2 and Behira-1 yielded *M. phaseolina* (72.6-94.0%) and *Fusarium* spp. (6.0-27.4%) only. However, 14 location i.e., Fayoum-1, Fayoum-2, Fayoum-3, Beni-Suef-1, Beni-Suef-3, Asuit-1, Sohage-1, Sohage-2, Sharkia-1, Behira-2, Domiate, Suez-1, Suez-2, and Monofia yielded the three fungi i.e., *M. phaseolina* (28.8-88.9%), *Fusarium* spp. (9.3-52.3%) and *R. solani* (1.6-37.5%). While the rest of locations i.e., Giza-1, Giza-2, Beni-Suef-2, Asuit-2, Qalubia-2, Ismaelia-1, and Ismaelia-2 yielded the four fungi *M. phaseolina* (44.8-73.8%), *Fusarium* spp. (16.4-34.6%), *R. solani* 3.2-23.3), and *S. rolfsii* (3.6-18.5%). The highest frequencies of *M. phaseolina* (94.0%), *Fusarium* spp. (52.3%), *R. solani* (37.5%), and *S. rolfsii* (18.5%) were recorded in Menia-1, Domiate, Monofia, and Qalubia-2, respectively.

Macrophomina phaseolina shows, in general, the highest frequency in most locations followed by *Fusarium* spp., then if present, *R. solani* and *S. rolfsii*. In locations of Ismaelia-1 "Ezz-Eldin" and Ismaelia-2 "El-Kassasin", *S. rolfsii* came in the third rank. However, *Fusarium* spp. ranked first in Domiatte (52.3%) followed by *M. phaseolina* (36.4%) and *R. solani* (11.3%). In monofia, *R. solani* records the highest frequency (37.5%) followed by *Fusarium* spp. (33.8%) and *M. phaseolina* (28.8%). *Sclerotium rolfsii* was not isolated from the later two locations.

Generally, *M. phaseolina* and *Fusarium* spp. were isolated from all location, while, *R. solani* was not isolated from plant materials that collected from the six locations i.e.,, Menia "Samalot, Abo-Qerqas and Maghagha", Qalubia "Shebien El-Qanter", Sharkia "Belbeis" and Behira "El-Tahrir". *Sclerotium rolfsii* was isolated from the seven locations, Giza "El-Saff and Giza", Beni-Suif "Beba", Asuit "Asuit", Qalubia "Qaha" and Ismaelia "Ezz-El-Din and Qassasin".

Comparative studies on *Macrophomina phaseolina* isolates:
1- Characters of mycelial growth and sclerotial formation:

The data in **Table (5)** showed that the examined isolates of *M. phaseolina* were significantly differed in their growth nature, mycelial color, linear growth and sclerotial production. Most isolates exhibited extensive and profusely aerial hyphae except isolates M1, M2, M15, M21, M23 and M24 which produced very poor and scanty aerial hyphae. As for linear growth, isolate M2 was significantly varied and produce the lowest linear growth i.e., 30.3 mm followed by M15 (73.3

mm), M24 (75.0 mm), M10 and M19 (75.5 mm) and M20 (76.8 mm). However, isolates M3, M5, M6, M7, M9, M12, M13, M14, M16, M17, M22, and M23 were significantly equal and produced the highest linear growth (83.3-85.0 mm).

Table (4): Frequency of fungi isolated from roots of sesame plants and some other oil **crops (a, b, c and d) grown at different locations.

Location	Total number of isolated fungi	Number and frequency of isolated fungi								
		M. phaseolina			*Fusarium spp.*		*Rhizoctonia solani*		*Sclerotium rolfsii*	
			No.	%	No.	%	No.	%	No.	%
El-Saff *	94	M1	68	72.3	19	20.2	3	3.2	4	4.3
Giza	55	M2	36	65.5	15	27.3	2	3.6	2	3.6
Etesa *	72	M3	40	55.6	28	38.9	4	5.6	-	-
Epsheway	64	M4	44	68.8	14	21.9	6	9.4	-	-
Fayoum	63	M5	46	73.0	15	23.8	2	3.2	-	-
Beba	58	M6	26	44.8	20	34.5	4	6.9	8	13.8
Somosta *	63	M7	42	66.7	20	31.8	1	1.5	-	-
Somosta * (a)	83	M8	65	78.3	10	12.0	8	9.6	-	-
Samalot *	50	M9	47	94.0	3	6.0	-	-	-	-
Abo-Qerqas	62	M10	45	72.6	17	27.4	-	-	-	-
Maghagha *	60	M11	48	80.0	12	20.0	-	-	-	-
El-Ghanaiem	54	M12	48	88.9	5	9.3	1	1.8	-	-
Asuit (b)	60	M13	31	51.7	12	20.0	14	23.3	3	5.0
Shandaweel	80	M14	34	42.5	31	38.8	15	18.8	-	-
Tema	78	M15	43	55.1	22	28.2	13	16.7	-	-
Shebien-El-Qanater	62	M16	54	87.1	8	12.9	-	-	-	-
Qaha (c)	81	M17	31	38.3	22	27.2	13	16.0	15	18.5
Abo-Hamad	84	M18	49	58.3	26	31.0	9	10.7	-	-
Belbeis *	62	M19	58	93.6	4	6.4	-	-	-	-
El-Tahrir *	65	M20	60	92.3	5	7.7	-	--	-	-
Nobaria *	83	M21	60	72.3	22	26.5	1	1.2	-	-
New Domiat	44	M22	16	36.4	23	52.3	5	11.3	--	-
Ezz-Eldin *	61	M23	45	73.8	10	16.4	2	3.3	4	6.6
Qassasin	55	M24	29	52.7	19	34.6	3	5.5	4	7.3
Ataka *	59	M25	32	54.2	21	35.6	6	10.2	-	-
Ganaien	74	M26	46	62.2	23	31.0	5	6.8	-	-
Menouf (d)	80	M27	23	28.8	27	33.8	30	37.5	-	-
Total number	1806		1166	65.2	453	25.0	147	7.6	40	2.2

* New land

** a, b, c, and d means that the fungi were isolated from Peanut, Soybean, Sunflower and Cotton, respectively.

Also, sclerotial formation was greatly and significantly differed between isolates of *M. phaseolina* (0.3-127.0 sclerotia per microscopic field "X10"). The highest numbers of sclerotia i.e., 127.0, 115.3, 113.5 and 102.0 sclerotia per microscopic field were produced by isolates M17, M13, M22 and M10, respectively. In general, the examined isolates could be classified based on number of sclerotia as following:

1- Isolates produced very fewer numbers of sclerotia (up to 20 sclerotia) as in isolates M23, M14, M16, M15, and M24. These isolates produced 0.3, 2.3, 2.5, 5.3, and 10.3 sclerotia, respectively.

2- Isolates produced 20<40 sclerotia as in isolates M25, M26, and M5 which produced 25.5, 36.5, 37.8 sclerotia, respectively.

3- Isolates produced 40<60 sclerotia: as in isolates M11, M20, M21, M9, M2, and M8 which produced 45.3, 46.3, 48.3, 50.5, 53.3 and 54.5 sclerotia, respectively.

4- Isolates produced 60<80 sclerotia: as in isolates M6, M19, M3, and M7 which produced 62.8, 66.3, 72.0, and 78.3 sclerotia, respectively.

5- Isolates produced 80<100 sclerotia: This includes isolates M18, M1, M4, M27, and M12 which produced 81.0, 86.3, 86.3, 87.8 and 91.0 sclerotia, respectively.

6- Isolates produced 100<120 sclerotia: This includes isolates M10, M22, and M13. These isolates produced 102.0, 113.5, 115.3 sclerotia, respectively.

7- Isolates produced >120 sclerotia: This includes isolate M17 only (127.0 sclerotia).

Table (5): Growth nature, mycelial color, linear growth and sclerotial formation of the different *M. phaseolina* isolates (*in vitro*).

Isolate No .and host plant	Growth nature and Mycelial color	Linear growth (mm.)	Sclerotial formation*
M1 [S]	Gray -	80.0	86.3
M2 [S]	Light gray -	30.3	53.3
M3 [S]	Gray +	85.0	72.0
M4 [S]	Gray +	79.0	86.3
M5 [S]	Light gray +	85.0	37.8
M6 [S]	Gray +	85.0	62.8
M7 [S]	Black gray +	83.3	78.3
M8 [Peanut]	Light gray +	80.5	54.5
M9 [S]	Light gray +	85.0	50.5
M10 [S]	Black gray +	75.5	102.0
M11 [S]	Gray +	82.0	45.3
M12 [S]	Gray +	85.0	91.0
M13 [Soybean]	Black gray +	83.3	115.3
M14 [S]	White +	84.3	2.3
M15 [S]	Light gray -	73.3	5.3
M16 [S]	White +	84.3	2.5
M17 [Sunflower]	Black +	85.0	127.0
M18 [S]	Gray +	81.3	81.0
M19 [S]	Gray +	75.5	66.3
M20 [S]	Gray +	76.8	46.3
M21 [S]	Light gray -	82.3	48.3
M22 [S]	Black gray +	85.0	113.5
M23 [S]	White -	85.0	0.3
M24 [S]	Light gray -	75.0	10.3
M25 [S]	Light gray +	78.0	25.5
M26 [S]	Gray +	80.8	36.5
M27 [Cotton]	Black gray +	80.0	87.8
L.S.D. at 0.05		1.82	5.55

* Number of sclerotia was counted under field microscopic X10

- = Scanty aerial growth, + = Profusely aerial growth

The color of mycelial growth of a given isolate of *M. phaseolina* seems to be correlated with density of sclorotial formation. The color of mycelial growth of isolate M17, which produced the highest number of sclerotia, was black meanwhile it was white in isolates M14, 16, and 23 which produced the lowest numbers of sclerotia **(Fig. 1)**.

2- Bioassaying cultural filtrates of the different *M. phaseolina* isolates:

A – Effect of culture filtrates on germination of sesame seeds:

The data in **Table (6-A)** proved that, germination of sesame seeds was significantly reduced by culture filtrates of the tested *M. phaseolina* isolates (average 30.0-95.0%) compared with control treatment (100.0%). The highest effect on sesame seed germination was induced by culture filtrates of isolates M18, M10, M16, M6, M23 and M24 as they reduced percentage of seed germination to 30.0, 38.3, 46.7, 48.3, 50.0 and 51.7%, respectively. While culture filtrates of isolate M2 shows no harmful effect on seed germination (95.0%) followed by isolate M1 (90.0%). The cultural filtrates of the rest tested isolates reduced average seed germination to 56.7-85%.

Seed germination in the non-autoclaved culture filtrate "NACF" was significantly lower (66.2%) than in the autoclaved culture filtrates "ACF" (70.0%). The NACF of isolates M16, M18, and M23 and the ACF of isolates M24, M19, and M14, respectively produced the lowest seed germination i.e., 3.3-6.7%

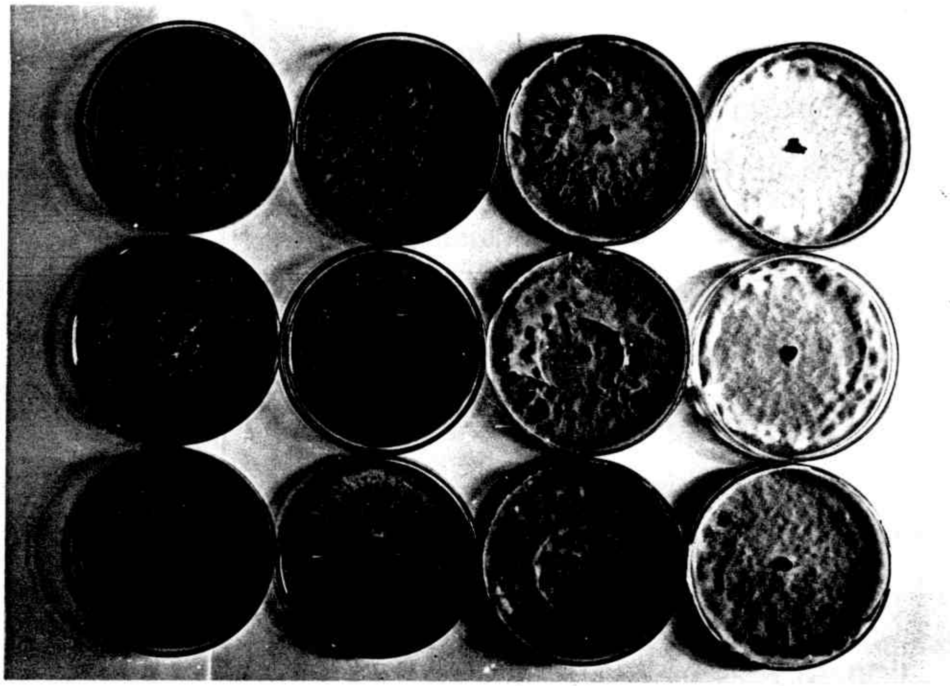


Fig (1): Shown mycelial color of different *M. phaseolina* isolates which varied from black, gray to white colour.

and 40.0-46.7% compared with the other isolates. In general, seed germination was affected differently by the interaction between types of culture filtrates (ACF and NACF) and isolate of *M. phaseolina* as following:

1- Seed germination in ACF and NACF was significantly equal as in isolates M1, M2, M5, M11, M12, M13, M15, M21, and M26. Both ACF and NACF of these isolates, except M1 and M2 reduced seed germination significantly. Both ACF and NACF in isolate *M2* and the NACF only in isolate M1 showed no significant effect on seed germination compared with control.

2- Seed germination was significantly higher in NACF than ACF as in isolates M3, M4, M9, M14, M19, M22, M24 and M27.

3- Seed germination was significantly lower in NACF than ACF as in isolates M6, M7, M8, M10, M16, M17, M18, M20, M23 and M25.

B - Effect of culture filtrates on lengths of shoots and roots of sesame seedlings:

The data in **Table (6-B)** illustrated that both shoot and root lengths of sesame seedlings were reduced significantly by the cultural filtrates of all tested *M. phaseolina* isolates compared with control (distilled water) treatment. The lengths of both shoot and root were significantly shorter in the ACF than in the NACF.

Table (6-A): Effect of the non-autoclaved and autoclaved culture filtrate of different *M. phaseolina* isolates on % of sesame seed germination.

Isolate and No.and host plant	Seed germination %		
	Non-autoclaved	Autoclaved	Mean
M1 [Sesame]	93.3	86.7	90.0
M2 [Sesame]	96.7	93.3	95.0
M3 [Sesame]	86.7	56.7	71.7
M4 [Sesame]	73.3	63.3	68.3
M5 [Sesame]	63.3	66.7	65.0
M6 [Sesame]	43.3	53.3	48.3
M7 [Sesame]	60.0	83.3	71.7
M8 **[Peanut]**	76.7	86.7	81.7
M9 [Sesame]	93.3	56.7	75.0
M10 [Sesame]	23.3	53.3	38.3
M11 [Sesame]	63.3	66.7	65.0
M12 [Sesame]	56.7	56.7	56.7
M13 **[Soybean]**	86.7	83.3	85.0
M14 [Sesame]	83.3	46.7	65.0
M15 [Sesame]	76.7	73.3	75.0
M16 [Sesame]	6.7	86.7	46.7
M17 **[Sunflower]**	66.7	96.7	81.7
M18 [Sesame]	3.3	56.7	30.0
M19 [Sesame]	73.3	43.3	58.3
M20 [Sesame]	53.3	66.7	60.0
M21 [Sesame]	66.7	63.3	65.0
M22 [Sesame]	90.0	53.3	71.7
M23 [Sesame]	6.7	93.3	50.0
M24 [Sesame]	63.3	40.0	51.7
M25 [Sesame]	66.7	93.3	80.0
M26 [Sesame]	83.3	86.7	85.0
M27 **[Cotton]**	96.7	53.3	75.0
Control	100	100.0	100.0
Mean	66.2	70.0	68.1

L.S.D. at 5% for

Isolates	6.86
Sterilization	1.83
Interaction	9.70

The average of reduction was greatly varied and dependent upon the tested isolates of *M. phaseolina* and kind of cultural filtrates. The highest reduction in lengths of shoot (aver.

87.1-92.4%) and root (aver. 98.5-98.7%) was caused by the culture filtrates of sesame isolates M10, M18 and M24. However, the cultural filtrates of isolates M2, M5 and M15 caused the lowest reduction in shoot length (aver. 17.1-18.9%) while those of M1, M2 and M15 caused the lowest reduction in root length (aver. 62.2-66.3%) compared with control (0.0%). As for isolates of *M. phaseolina* that isolated from other oil crops, the obtained results indicated that the culture filtrates of isolate M17 (from sunflower) and M27 (from cotton) were significantly equal and more effective in reducing shoot length followed by isolates M13 (from soybean) and M8 (from peanut). These four isolates reduced shoot length by 41.4%, 48.8%, 32.3%, and 52.4% and root length by 77.6, 90.3%, 71.8% and 90.8%, respectively compared with control (0.0%).

The obtained results indicated also that, both shoot and root lengths of sesame seedlings were affected differently by the interaction between isolates and status of their culture filtrates. Based on significant differences in shoot and/or root lengths as affected by the ACF and NACF, the tested isolates *M. phaseolina* could be classified into three distinct groups as following:

The first group of isolates including isolates in which the reduction in shoot and/or root lengths that caused by their NACF and ACF was significantly equal. For examples, isolates M25, M2 and M5 in case of shoot length and isolates M10, M11, M17 (from sunflower), M18, M20, M23, M24 and M25 in case of root length. However, the NACF and ACF of isolate M25 caused the highest decrease in shoot length (50.2 and 50.4 mm) followed by M2 (97.2 and 97.8 mm) and M5 (103.6 and 95.4 mm). The NACF and ACF of isolates M10, M18 and M24 caused the highest decreases in root length (1.6 and 2.0 mm), (0.8 and 2.4 mm) and (2.2 and 1.2 mm), respectively compared with isolates M11 (26.2 and 27.6 mm) and M17 that was isolated from sunflower (35.0 and 30.0 mm).

In the second group of isolates, the ACF was significantly more effective in decreasing shoot and/or root lengths than the NACF. This group including the isolates M24, M3, M14, M27, M8 (from peanut), M22, M20, M26, M13 (from soybean), M21, M1, M9 and M15 in case of shoot length and M1, M2, M4. M5, M9, M13 (from soybean), M14, M15, M19, M21, M22, M26 and M27 (from cotton) in case of root length. As for shoot length, the highest significant decrease was caused by the ACF of isolates M24 (6.6 mm), M3 (9.8 mm) and M14 (14.6 mm) without significant differences in between. However, both ACF and NACF of isolate M15 caused the lowest significant decrease in shoot length i.e., 85.0 and 109.6 mm, respectively. Regarding with root length, the highest significant decrease was produced by the NACF of the cotton isolate M27 (17.0 mm) and ACF of isolates M3 (2.0 mm), M14 (3.0 mm) and M27 (6.2 mm) comparing with both filtrates of isolates M1, M2 and M15.

The third group of isolates including the isolates in which the NACF decreased shoot and/or root lengths more significantly than their ACF. This response was observed in isolates M4, M6, M7, M10, M11, M12, M16, M17 (from sunflower), M18, M19, and M23 in case of shoot length and isolates M16, M6, M7 and M12 in case of root length. The NACF of isolates M18 caused the highest decrease in shoot length (2.2 mm) followed by isolate M16 (3.2 mm) and isolate M10 (6.8 mm) meanwhile the ACF of the same isolates decreased the shoot length to 19.0, 81.0, and 11.4 mm, respectively. The NACF and ACFof isolates M4, M11, M17 (from sunflower) and M19 caused the lowest significant decrease while those of isolates M6, M7, M12, M16 and M23 were intermediate. As for root length, it was decreased to 1.2, 7.0, 10.0 and 18.0 mm by the NACF and to 44.0, 39.0, 32.6 and 32.8 mm, by ACF of isolates, M16, M6, M7 and M12, respectively.

The present results clarify that, the root length might be more sensitive and favorable for assaying toxicity of both types of cultural filtrates than shoot length, while seed germination test was less sensitive.

Table (6-B): Effect of the non-autoclaved and autoclaved culture filtrate of different *M. phaseolina* isolates on root and shoot length of sesame seedlings (*in vitro*).

Isolate and host plant	Shoot length "mm"				Root length "mm"			
	Non-autoclaved	Autocl-aved	Mean	% Reduction	Non-autoclaved	Autocl-aved	Mean	% Reduction
M1 [Sesame]	96.2	70.0	83.1	30.8	51.0	30.0	40.5	66.3
M2 [Sesame]	97.2	97.8	97.5	18.8	55.2	35.6	45.4	62.2
M3 [Sesame]	86.8	9.8	48.3	59.8	55.8	2.0	28.9	75.9
M4 [Sesame]	57.0	99.0	78.0	35.0	36.2	27.6	31.9	73.4
M5 [Sesame]	103.6	95.4	99.5	17.0	41.4	31.0	36.2	69.8
M6 [Sesame]	30.2	80.4	55.3	53.9	7.0	39.0	23.0	80.8
M7 [Sesame]	39.0	72.0	55.5	53.4	10.0	32.6	21.3	82.3
M8 **[Peanut]**	70.8	43.4	57.1	52.4	15.2	7.6	11.4	90.8
M9 [Sesame]	108.4	70.6	89.5	25.4	52.8	21.0	36.9	69.3
M10 [Sesame]	6.8	11.4	9.1	92.4	1.6	2.0	1.8	98.5
M11 [Sesame]	60.0	86.4	73.2	39.0	35.0	30.8	32.9	72.6
M12 [Sesame]	43.0	74.6	58.8	51.0	18.0	32.8	25.4	78.8
M13 **[Soybean]**	95.8	66.8	81.3	32.3	47.6	20.2	33.9	71.8
M14 [Sesame]	64.0	14.6	39.3	67.3	38.4	3.0	20.7	82.8
M15 [Sesame]	109.6	85.0	97.3	18.9	51.0	31.6	41.3	65.6
M16 [Sesame]	3.2	81.0	42.1	64.9	1.2	44.0	22.6	81.2
M17 **[Sunflower]**	54.2	86.4	70.3	41.4	26.2	27.6	26.9	77.6
M18 [Sesame]	2.2	19.0	10.6	91.2	0.8	2.4	1.6	98.7
M19 [Sesame]	65.0	85.2	75.1	37.4	35.0	25.0	30.0	75.0
M20 [Sesame]	77.2	63.2	70.2	41.5	25.0	27.4	26.2	78.2
M21 [Sesame]	109.0	68.6	88.8	26.0	42.6	19.4	31.0	74.2
M22 [Sesame]	94.4	49.0	71.7	40.3	37.4	17.6	27.5	77.1
M23 [Sesame]	20.4	41.4	30.9	74.3	7.6	15.4	11.5	90.4
M24 [Sesame]	24.4	6.6	15.5	87.1	2.2	1.2	1.7	98.6
M25 [Sesame]	50.2	50.4	50.3	58.1	20.0	21.6	20.8	82.7
M26 [Sesame]	113.0	65.0	89.0	25.8	47.8	32.0	39.9	66.8
M27 **[Cotton]**	103.6	19.2	61.4	48.8	17.0	6.2	11.6	90.3
Control	120.0	120.0	120.0	0.0	71.0	71.0	71.0	0.0
Mean	68.0	61.9	65.0		30.4	23.5	26.9	

L.S.D. at 5% for	Shoot length	Root length
Isolates	6.66	5.50
Sterilization	1.78	1.47
Interaction	9.42	7.77

3- Pathogenicity tests for different isolates of *M. phaseolina*:

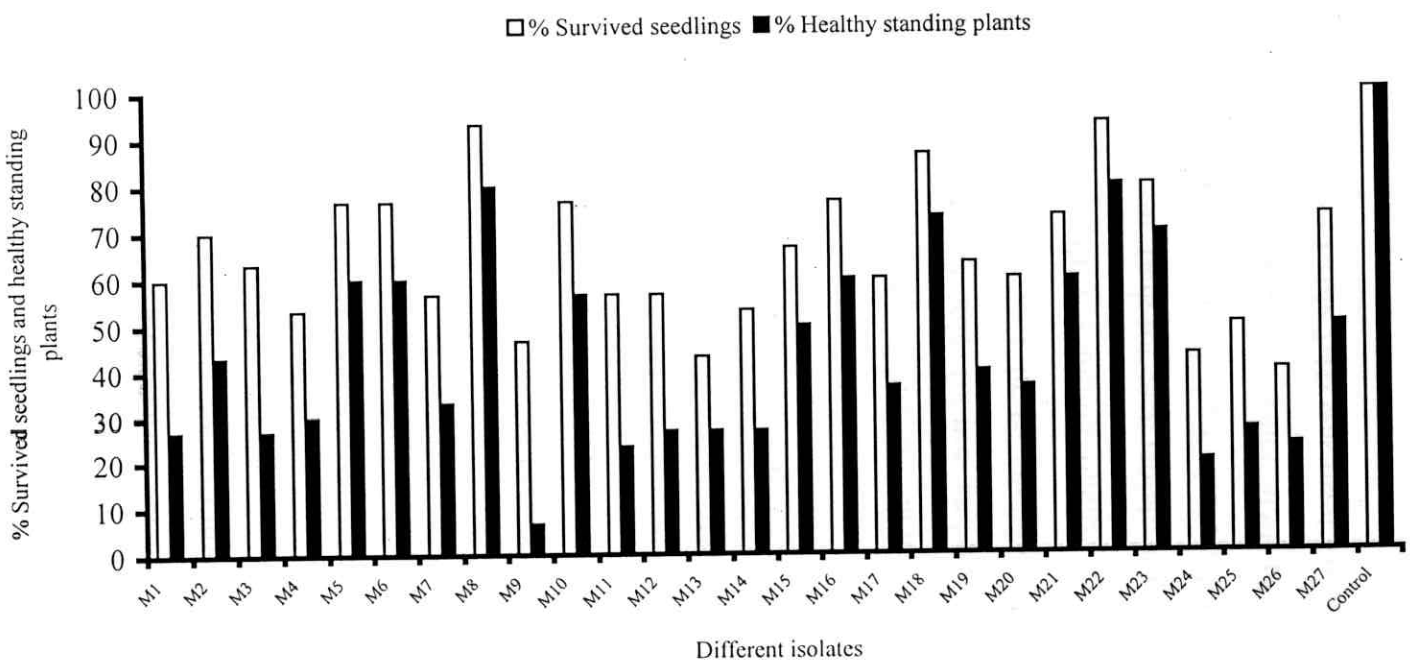
A- Using soil infestation technique:

The data in **Table (7-A)** proved that the tested *M. phaseolina* isolates were significantly varied in inducing different criteria of disease incidence. The highest incidence of pre-emergence damping-off was induced by isolate M26 (36.7%), followed by isolate M9 (33.3%), and isolates M13 (from soybean) and M25 (30.0%). Meanwhile, isolate M24 induced the highest incidence of post emergence damping-off (33.3%) followed by isolates M4, M13 (from soybean), M15, and M20 (26.7%). The pre-emergence damping-off stage caused by isolates M5, M6, M8 (from peanut), M10, M15, M16, M17, M18, M21, M22, M23 and cotton isolate M27 (0.0-10.0%) and the post-emergence damping-off caused by isolates M8 (from peanut), M17, M18, M22 and M23 (3.3-10.0%) were not significantly varied if compared with control.

Survival percentages (40.0-93.3%) were also varied between tested isolates **(Fig. 2)**. Isolates M26, M13 (from soybean), M24, and M9 were the most pathogenic as they produced the lowest % survived seedlings i.e., 40.0%, 43.3%, 43.4%, and 46.7%, respectively, meanwhile isolates M8 and M22 exhibited no significant effect in this respect (93.3%).

With regard to charcoal rot disease incidence, *M. phaseolina* isolate M9 was the most virulent (40.0%) followed by isolates M3 (36.7%), M1 (33.3%), M11 (33.3%) and M12 (30.0%) without significant differences in between. However, the isolates M8, M18, M21, and M22 were the least pathogenic (13.3%) meanwhile isolate M23 (10.0%) was not pathogenic at

Fig. (2): Effect of different *M. phaseolina* isolates on % survived seedlings and healthy plants of Giza 32 cv. (soil infestation technique).



this stage and not varied significantly when compared with the control (0.0%).

As for % healthy plants **(Fig. 2)**, the highest significant decrease was induced by isolate M9 (6.7%) followed by isolate M24 (20.0%) without significant variation between them. While the lowest significant decreases in the healthy standing plants were produced by isolates M8 and M22 (80.0%) followed by isolates M18 (73.3%) and M23 (70.0%).

These results indicated that the harmful effects that induced by the different tested *M. phaseolina* isolates were occurred actually during the pre- and/or post-emergence stages as well as during development of charcoal rot. Because wide variations between isolates of *M. phaseolina* during these different stages of disease development, the following procedure was innovated to facilitate quantitative comparisons between the present 27 isolates.

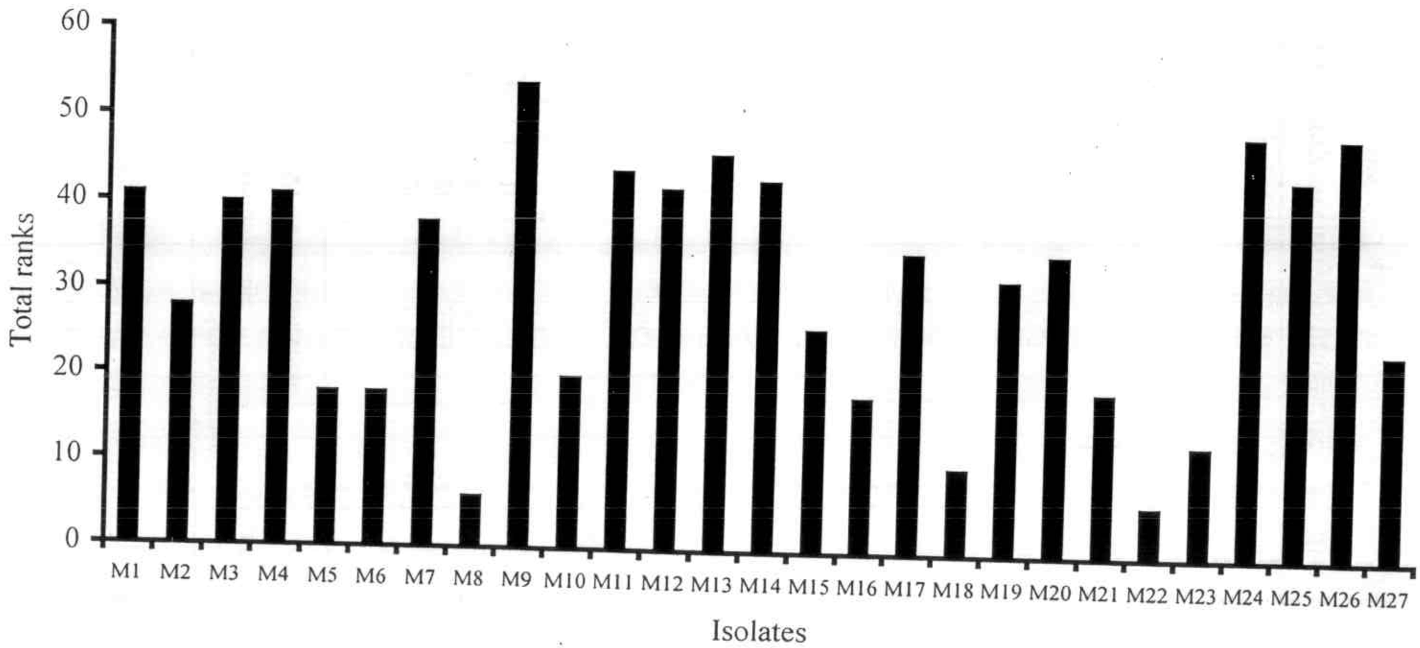
At the first step of this procedure, the data in **Table (7-A)** were rearranged in ascending order for pre- and post-emergence damping-off and charcoal-rot and in descending order for both survived seedlings and healthy standing plants. In the second step, the actual numerical rank for each isolate in each of these five disease criteria was recorded then, the total number of different ranks for each isolate was calculated. The final total number of disease ranks **(Table 7-B)** was used for determining quantitative virulence of the different isolates **(Fig. 3)**. Accordingly the tested *M. phaseolina* could be classify into 7 groups as follow:

Table (7-A): Pathogenicity test for different *M. phaseolina* isolates on Giza 32 sesame cv using soil infestation technique.

Isolate No. and source host plant	Disease incidence				
	At seedling stage			At mature stage	
	% Pre	% Post	% Survival	% Charcoal rot	% Healthy
M1 [Sesame]	16.7	23.3	60.0	33.3	26.7
M2 [Sesame]	13.3	16.7	70.0	26.7	43.3
M3 [Sesame]	16.7	20.0	63.3	36.7	26.7
M4 [Sesame]	20.0	26.7	53.3	23.3	30.0
M5 [Sesame]	10.0	13.3	76.7	16.7	60.0
M6 [Sesame]	6.7	16.7	76.7	16.7	60.0
M7 [Sesame]	20.0	23.3	56.7	23.3	33.3
M8 **[Peanut]**	3.3	3.3	93.3	13.3	80.0
M9 [Sesame]	33.3	20.0	46.7	40.0	6.7
M10 [Sesame]	10.0	13.3	76.7	20.0	56.7
M11 [Sesame]	20.0	23.3	56.7	33.3	23.3
M12 [Sesame]	23.3	20.0	56.7	30.0	26.7
M13 **[Soybean]**	30.0	26.7	43.3	16.7	26.7
M14 [Sesame]	23.3	23.3	53.3	26.7	26.7
M15 [Sesame]	6.7	26.7	66.7	16.7	50.0
M16 [Sesame]	10.0	13.3	76.7	16.7	60.0
M17 **[Sunflower]**	26.7	13.3	60.0	23.3	36.7
M18 [Sesame]	3.3	10.0	86.7	13.3	73.3
M19 [Sesame]	26.7	10.0	63.3	23.3	40.0
M20 [Sesame]	13.3	26.7	60.0	23.3	36.7
M21 [Sesame]	6.7	20.0	73.3	13.3	60.0
M22 [Sesame]	0.0	6.7	93.3	13.3	80.0
M23 [Sesame]	10.0	10.0	80.0	10.0	70.0
M24 [Sesame]	23.3	33.3	43.3	23.3	20.0
M25 [Sesame]	30.0	20.0	50.0	23.3	26.7
M26 [Sesame]	36.7	23.3	40.0	16.7	23.3
M27 **[Cotton]**	10.0	16.7	73.3	23.3	50.0
Control	0.0	0.0	100.0	0.0	100.0
LSD. at 5%	11.46	13.08	12.26	12.05	16.33

Group 1: includes very weakly pathogenic isolates with total number of disease ranks <10 as in isolates M8 and M22. The

Fig. (3): Accumulative effect for the different *M. phaseolina* isolates “based on specific disease ranks in the five examined disease criteria”.



total number of disease ranks for both isolates is 6. The pre- and post-emergence damping-off as well as survival seedlings were not affected significantly by these two isolates compared with control.

Group 2: includes weakly pathogenic isolates with total number of disease rank 10 to <20 as in isolates M18, M23, M5, M6, M16 and M19, which gave total disease ranks of 10, 13, 18, 18, 18, and 19, respectively. All these isolates caused no significant effect on % pre-emergence damping off. The post-emergence damping-off in isolates M18 and M23 and survived seedlings were not significantly differed than control.

Group 3: includes moderately pathogenic isolates with total number of disease rank 20 to <30 as in isolates M10, M27 (from cotton), M15, and M2. The total disease ranks for these isolates were 20, 24, 26 and 28, respectively. The first 3 isolates have no obvious significant effect pre-emergence damping-off. All the other examined disease criteria were affected significantly by the later isolate M2.

Group 4: includes highly pathogenic isolates with total number of disease rank 30 to <40. This group includes isolates M19, M17 (from sunflower), M20, M7 and M3. The total disease ranks for these 4 isolates were 32, 35, 35, 38 and 40, respectively. All examined disease criteria were affected significantly by these isolates.

Table (7-B): Accumulative effect for the different isolates of *M. phaseolina* "based on specific disease ranks in the five examined disease criteria" (The present data were derived from **Table 7-A #**).

Isolate No. and host plant	Ranking in different criteria of disease incidence					**Total rank**	Pathogenicity
	Pre	Post-	**Survival**	charcoal rot	Healthy plants		
M1 [Sesame]	5	7	**9**	8	12	41	Severe
M2 [Sesame]	4	5	**6**	6	7	28	Moderate
M3 [Sesame]	5	6	**8**	9	12	40	Severe
M4 [Sesame]	6	8	**11**	5	11	41	Severe
M5 [Sesame]	3	4	**4**	3	4	18	Weak
M6 [Sesame]	2	5	4	3	4	18	Weak
M7 [Sesame]	6	7	**10**	5	10	38	Highly
M8 [Peanut]	1	1	**1**	2	1	6	Very weak
M9 [Sesame]	10	6	**13**	10	15	54	Destructive
M10 [Sesame]	3	4	**4**	4	5	20	Moderate
M11 [Sesame]	6	7	**10**	8	13	44	Severe
M12 [Sesame]	7	6	**10**	7	12	42	Severe
M13 [Soybean]	9	8	**14**	3	12	46	Severe
M14 [Sesame]	7	7	**11**	6	12	43	Severe
M15 [Sesame]	2	8	**7**	3	6	26	Moderate
M16 [Sesame]	3	4	**4**	3	4	18	Weak
M17 [Sunflower]	8	4	**9**	5	9	35	Highly
M18 [Sesame]	1	3	**2**	2	2	10	Weak
M19 [Sesame]	8	3	**8**	5	8	32	Highly
M20 [Sesame]	4	8	**9**	5	9	35	Highly
M21 [Sesame]	2	6	**5**	2	4	19	Weak
M22 [Sesame]	0	2	**1**	2	1	6	Very weak
M23 [Sesame]	3	3	**3**	1	3	13	Weak
M24 [Sesame]	7	9	**14**	5	14	49	Severe
M25 [Sesame]	9	6	**12**	5	12	44	Severe
M26 [Sesame]	11	7	**15**	3	13	49	Severe
M27 [Cotton]	3	5	**5**	5	6	24	Moderate

The data in Table (7-a) were arranged in ascending order for pre- and post-emergence and charcoal rot and in descending order for survival and healthy standing plants.

Group 5: includes severe isolates with total number of disease rank 40 to <50 as in isolates M4, M1, M12, M14, M25, M11, M13 (from soybean), M26 and M24. The total disease ranks for the three isolates were 41, 41, 42, 43, 44, 44, 46, 49 and 49, respectively. This group of isolates exerted significant harmful effect on all examined disease criteria especially isolate M26, which caused highest percentages of pre-emergence damping-off.

Group 6: includes destructive isolates with total number of disease rank >50 as in isolate M9 (total numbers of disease ranks is 54). This isolate caused the highest percentages of both pre-emergence damping-off and charcoal-rot and the lowest percentage of the healthy plants.

B- Using stem pricking technique for screening *M. phaseolina* isolates:

Charcoal rot disease was successfully induced by pricking stems of sesame plants with toothpicks carrying fungal growth of the different isolates of *M. phaseolina*. The length of diseased stem portions above and below the site of inoculation was depended on fungal isolate and plant age as well as interaction between fungal isolate and plant age **Fig. (4-A, B, C, D, & E)**. Data in **Table (8)** declared that, *Macrophomina phaseolina* isolates M9 and M4 were the most pathogenic as they caused the highest significant increases in length of diseased stem portion (average 40.5-40.6 cm). Meanwhile, isolates M1, M2, M5, M8,

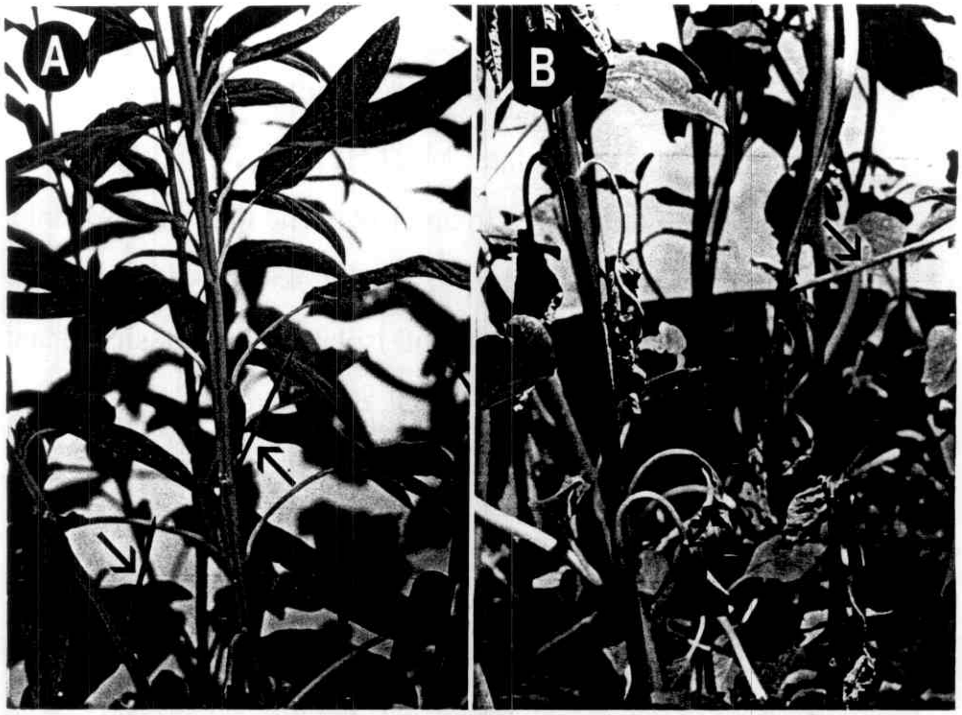


Fig (4 a&b): Show pricking stems of sesame plants with toothpicks carrying fungal growth of *M. phaseolina* isolates "b" and

Fig (4 c): Showing charcoal rot symptoms that incidence by isolates of *M. phaseolina* after 30 days using stem pricking technique on sesame Giza 32 cv (M1-M9).

Fig (4 d): Show the pathogenicity test of *M. phaseolina* isolates (M10-M18) using pricking technique on stems of sesame plants Giza

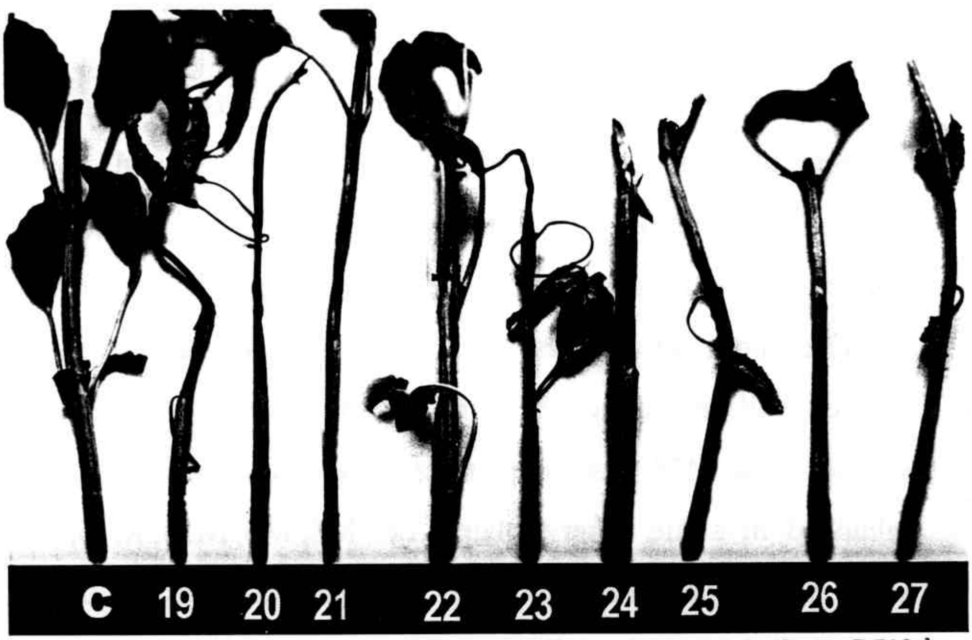


Fig (4 e): Show the pathogenicity test of *M. phaseolina* isolates (M19-M27) using pricking technique on stems of sesame plants Giza 32 cv.

M10, M13, M22, M24 and M25 seemed to be less pathogenic when tested by this technique where the length of diseased stem portion was less than 10.0 cm.

Out of the tested 27 isolates, 12 isolates increased the length of diseased stem portion proportionally and significantly with increase in plant aging from 30 to 90 days. Thus, the older plants seemed to be more susceptible to these isolates than the younger one. On the other hand, isolates M5 and M25 were more pathogenic on the youngest plants (30 days old) while isolates M1, M2, M15, M17, M18, and M27 were more pathogenic on plants of 60 days old. Plants at 30 and 60 days old only exhibited appreciable but significant increase in length of diseased stem portion when pierced with toothpicks carrying inocula of isolates M24 and M2, respectively.

As for incidence of charcoal rot, the disease level incited by stem pricking with toothpicks was more or less parallel with artificial inoculation in infested soil (**Table 7-A**). The sesame isolate M9 exhibited the highest disease incidence through applying both techniques. Compared with disease levels in infested soil technique, the virulence of some isolates i.e., M1, M2, M24 and M25 was conspicuously retarded meanwhile it was enhanced in some other isolates i.e., M5, M6, M15, M16, and M23 when they were tested by stem pricking technique. In nature, the charcoal rot disease symptoms, in most cases, started from roots and extended to upwardly through plant stem.

Wounds caused in stem through applying toothpick pricking technique might be necessary for accelerating stem infection with some isolates and might be retarded it in some other isolates.

Table (8): Pathogenicity of different *M. phaseolina* isolates expressed as length of stem charcoal-rotted portion (cm) on Giza 32 sesame cultivar inoculated at different ages using stem pricking technique.

Isolate No. and host plant	Age of sesame plants			Mean
	30 days	60 days	90 days	
M1 [Sesame]	6.7	9.4	2.1	6.1
M2 [Sesame]	1.6	5.7	0.6	2.6
M3 [Sesame]	9.9	21.5	24.0	18.5
M4 [Sesame]	15.4	35.5	70.6	40.5
M5 [Sesame]	8.9	4.0	1.8	4.9
M6 [Sesame]	11.5	15.9	59.6	29.0
M7 [Sesame]	13.4	26.3	44.4	28.0
M8 [Peanut]	1.6	1.1	0.70	1.10
M9 [Sesame]	16.7	35.1	70.1	40.6
M10 [Sesame]	0.0	0.6	0.0	0.2
M11 [Sesame]	7.2	33.8	41.4	27.5
M12 [Sesame]	13.2	30.6	48.4	30.7
M13 [Soybean]	3.0	6.4	1.2	3.5
M14 [Sesame]	5.5	4.3	32.1	14.0
M15 [Sesame]	11.4	30.0	20.2	20.5
M16 [Sesame]	11.2	19.8	36.4	22.5
M17 [Sunflower]	10.7	24.8	38.7	24.7
M18 [Sesame]	0.0	27.3	4.0	10.4
M19 [Sesame]	11.7	8.2	15.6	11.8
M20 [Sesame]	11.7	29.2	31.1	24.0
M21 [Sesame]	3.0	2.0	42.6	15.9
M22 [Sesame]	0.0	0.5	0.0	0.2
M23 [Sesame]	13.6	23.9	49.7	29.1
M24 [Sesame]	3.8	1.6	0.9	2.1
M25 [Sesame]	5.7	4.2	0.6	3.5
M26 [Sesame]	1.5	3.7	33.5	12.9
M27 [Cotton]	13.5	25.5	1.6	13.5
Control	0.0	0.0	0.0	0.0
Mean	7.6	15.4	24.0	

L.S.D 5% for: Isolates = 1.51 Plant age = 0.49 Interaction = 2.61

4- Electrophoretic patterns protein of some *M. phaseolina* isolates:

Protein bands derived from the gel electrophoretic of soluble proteins extracted from fungal growth of 11 isolates of *M. phaseolina* as well as similarities between these isolates are illustrated in **Fig. (5-A & -B)**. The position of each band was recorded by densitometry scanning as rate of flow. The obtained results indicated that the 11 tested isolates of *M. phaseolina* were belonged to distinct clusters.

The sesame isolate "M1" obtained from Giza location (lane-1) was located alone in the first cluster. While the other 10 isolates were located in three sub-clusters belonged to the second cluster. The first sub-cluster includes the more close isolates (similarity 98.59%) isolated from soybean "M13" (lane-8) and peanut "M8" (lane-9) grown at Assuit and Beni-Suif, respectively. The second sub cluster includes isolates obtained from cotton plants grown at Menofiya "M27" (lane-11) and sunflower plants grown at Qalubia "M17" (lane-10). Similarity between the later 2 isolates was 76.88%. These results indicated that, similarity was higher between isolates obtained from host plants grown in the warmer soils (as in the first sub-cluster) than those isolated from host plants grown in less warmed soils (as in the second sub-cluster). The third sub-cluster contains the other 6 sesame isolates. Again, degree of similarity between isolates in this sub-cluster (70.07-95.25) was depended also on warmth

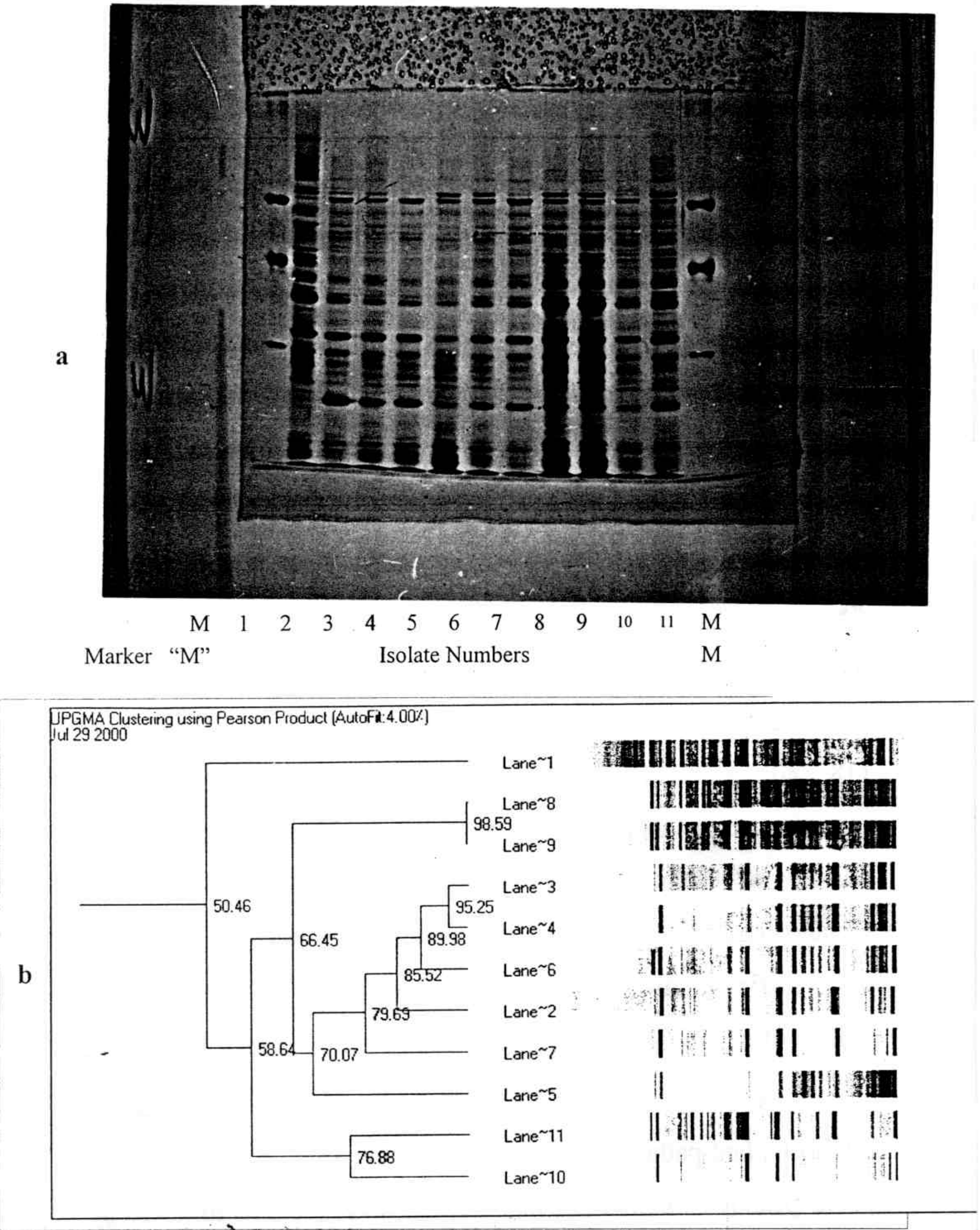


Fig. (5): SDS-PAGE protein patterns of 11 isolates of *M. phaseolina* (a) and phenograme showing similarity in between ("b"). The tested isolates were 1-El-Saff sesame isolate (Lane-1), 2-Ettesa sesame isolate (Lane-2), 3-Samalot sesame isolate (Lane-3), 4-Shandawiel sesame isolate (Lane-4), 5-New Domiate-sesame isolate (Lane-5), 6-Abo-Hamad -sesame isolate (Lane-6), 7-El-Tahrir-sesame isolate (Lane-7), 9-Assuit-soybean isolate (Lane-8), 9-Somosta peanut isolate (Lane-9), 10-Qaha -sunflower isolate (Lane-10), and 11-Menof-cotton isolate (Lane-11).

degree in soils in which the host plants (sesame) was grown. Similarity reached its maximum between isolates obtained from sesame grown in warmer soils i.e.,, Sohage "M14" (lane-4) and El-Minia "M9" (lane-3) and gradually decreased by decrease in degree of warm in soils prevailed in locations of El-Sharkia "M18" (lane-6), El-Fayoum "M3" (lane-2), El-Behira "M20" (lane-7) and Domiate "M22" (lane-5), respectively.

5- Effect of host-pathogen combination on charcoal rot disease incidence:

Data presented in **Table (9)** showed that, pre-emergence damping-off was significantly differed (6.7-22.7%) between tested host plants. Cotton plants showed the highest incidence of pre-emergence damping-off (22.7%) followed by soybean (18.7%), sesame and sunflower (12.0%) and peanut (6.7%). The pre-emergence damping-off was not significantly affected by variety of isolates of *M. phaseolina* or interaction between isolates and host plant. Post emergence damping-off also shows no significant differences due to variety of the tested host plant, isolate of *M. phaseolina* or interaction between them.

Percentage of survived seedlings was affected significantly by host plant-pathogen isolate combination **(Fig. 6)**. As for host plant, peanut exhibited the highest percentage (85.3%) followed by sunflower (74.7), sesame (70.7%), soybean (69.4%), and cotton (62.7) without significant differences between the later 4 hosts. As for isolates, the isolate M8 "from peanut" produce the highest %

survived seedlings (82.7%) followed by M27 “from cotton” (77.3%), M17 “from sunflower” (70.7%), M13 “from soybean” (68.0%) and M9 “from sesame” (64.0%).

Regarding to charcoal rot, the obtained results indicated that sunflower plants showed the highest disease incidence (41.3%) followed by sesame plants (24.0%), soybean plants (20.0%), cotton plants (12.0%) and peanut plants (5.3%). The highest incidence of charcoal rot was caused by isolate M13 ‘from soybean” (25.3%) followed by M9 “from sesame” (24.0%), M17 (from sunflower” (24.0%), M8 “from peanut” (17.3%), and M27 “from cotton” (12.0%). No significant differences were observed due to the interaction between host plants and the isolates of the pathogen. However, the isolates M9 “from sesame and M13 “from soybean” were more pathogenic on sesame plants (33.3%). While, the later isolate “M13” and isolate M17 “from sunflower” were the most pathogenic on sunflower plants (53.3%) and cotton plants, respectively. Unexpectedly, the isolate from soybean (M13) was more pathogenic than the isolate M17 “from sunflower” on sunflower plants. Thus, sunflower plants seemed to be very susceptible to infection with all isolates particularly isolate M13 “from soybean” meanwhile peanut plants seemed to be the most resistant to infection with the different tested isolates particularly isolates M17 and M27 (0.0% infection).

As for % healthy plants (**Fig. 6**), the present results indicated that this disease measurement might be the best criterion to reflect the significant effects of variety of host plant, source of pathogen-isolate and the interaction between them. Concerning with host plant, the highest significant difference in healthy standing plants was detected between peanut (80.0%) and sunflower (33.3%). The other hosts i.e., sesame (46.7%), soybean (49.3%) and cotton (50.7%) were significantly equal. As for pathogen isolates, the obtained results proved that, the isolates M9 "from sesame", M13 "from soybean", and M17 "from sunflower" were significantly equal and more pathogenic than M8 and M27 which were isolated from peanut and cotton, respectively. Peanut-isolate was more severe on peanut plants followed by sesame- and soybean-isolates. However, sunflower- and cotton-isolates seemed to be the least pathogenic to peanut plants.

On sesame plants, sesame-isolate was the more pathogenic, followed by soybean- and sunflower-isolates without significant variations in between. As for soybean plants, the lowest % healthy standing plants was induced by sunflower-isolate followed by isolates of soybean, sesame, cotton, and peanut, respectively. On sunflower plants, the soybean-isolate was the most severe followed by sunflower-, sesame-, peanut- and cotton-isolates, respectively. Sesame- and sunflower-isolates were more pathogenic on cotton plants than the cotton-isolate. The present results conclude that, sunflower plants were affected by peanut-isolate more than peanut plants.

Fig. (6): Effect of different *M. phaseolina* isolates isolated from some host plants on % survived seedlings and healthy plants of different hosts.

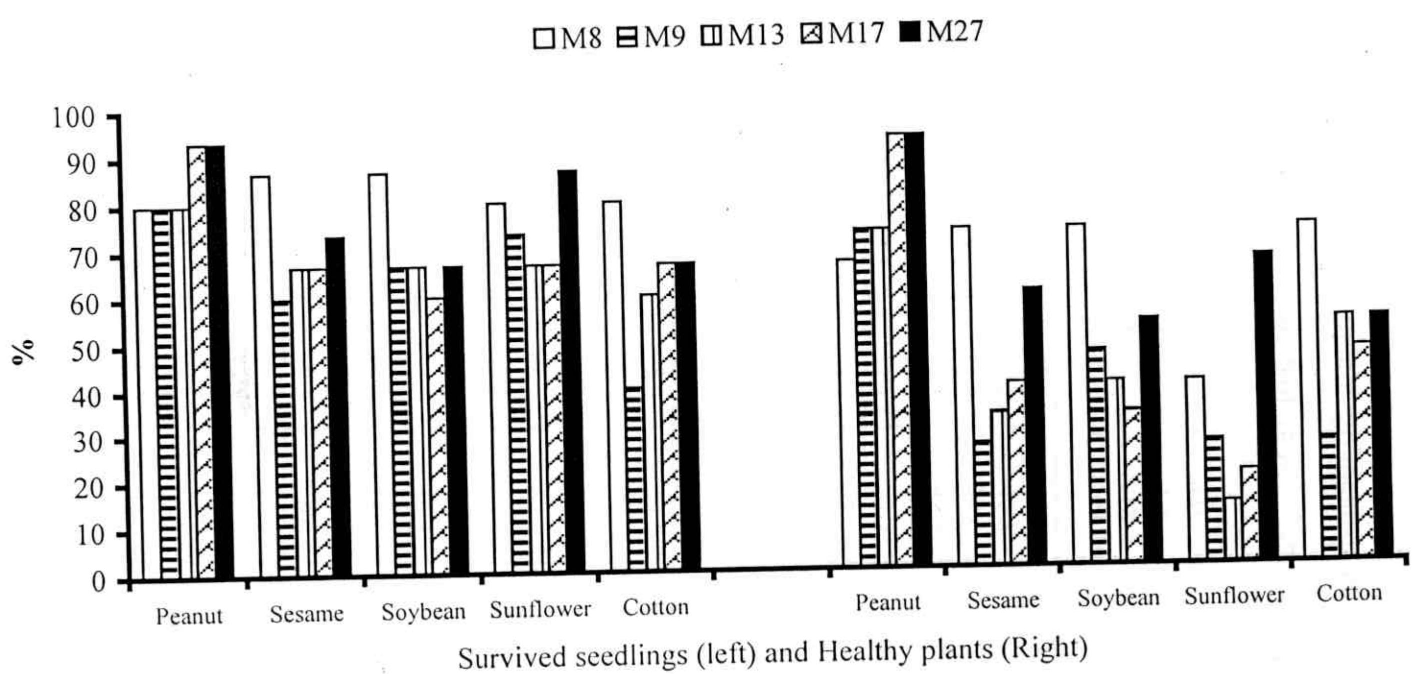


Table (9): Effect of different *M. phaseolina* isolates isolated from some host plants on damping-off and charcoal-rot diseases incidence on some oil crops.

Disease measurement	Tested host	Tested isolate M8	M9	M13	M17	M27	Mean
Pre-emergence %	Peanut	6.7	6.7	13.3	6.7	0.0	6.7
	Sesame	6.7	20.0	6.7	13.3	13.3	12.0
	Soybean	6.7	20.0	13.3	26.7	26.7	18.7
	Sunflower	6.7	13.3	20.0	13.3	6.7	12.0
	Cotton	13.3	33.3	26.7	20.0	20.0	22.7
Mean		8.0	18.7	16.0	16.0	13.3	-
Post-emergence %	Peanut	13.3	13.3	6.7	0.0	6.7	8.0
	Sesame	6.7	20.0	26.7	20.0	13.3	17.3
	Soybean	6.7	13.3	20.0	13.3	6.7	12.0
	Sunflower	13.3	13.3	13.3	20.0	6.7	13.3
	Cotton	6.7	26.7	13.3	13.3	13.3	14.7
Mean		9.3	17.3	16.0	13.3	9.3	-
Survivals %	Peanut	80.0	80.0	80.0	93.3	93.3	85.3
	Sesame	86.7	60.0	66.7	66.7	73.3	70.7
	Soybean	86.7	66.7	66.7	60.0	66.7	69.4
	Sunflower	80.0	73.3	66.7	66.7	86.7	74.7
	Cotton	80.0	40.0	60.0	66.7	66.7	62.7
Mean		82.7	64.0	68.0	70.7	77.3	-
Charcoal rot %	Peanut	13.3	6.7	6.7	0.0	0.0	5.3
	Sesame	13.3	33.3	33.3	26.7	13.3	24.0
	Soybean	13.3	20.0	26.7	26.7	13.3	20.0
	Sunflower	40.0	46.7	53.3	46.7	20.0	41.3
	Cotton	6.7	13.3	6.7	20.0	13.3	12.0
Mean		17.3	24.0	25.3	24.0	12.0	
Healthy plants %	Peanut	66.7	73.3	73.3	93.3	93.3	80.0
	Sesame	73.3	26.7	33.3	40.0	60.0	46.7
	Soybean	73.3	46.7	40.0	33.3	53.3	49.3
	Sunflower	40.0	26.7	13.3	20.0	66.7	33.3
	Cotton	73.3	26.7	53.3	46.7	53.3	50.7
Mean		65.3	40.0	42.6	46.7	65.3	

L.S.D. 5%	Pre-	Post-	Survival	Charcoal-rot	Healthy plants
Host	7.51	n.s.	10.7	7.52	9.76
Isolates	n.s.	n.s.	10.7	7.52	9.76
Interaction	n.s.	n.s.	n.s.	n.s.	21.82

The harmful effect of sesame-isolate was greater and similar on sesame, sunflower, and cotton plants. Soybean-isolate was more severe on sunflower and sesame plants than soybean plants. Among all tested host plants, peanut only seems to be not significantly affected by cotton-isolate. Effect of cotton-isolate on sesame, soybean, sunflower, and cotton plants was significantly equal.

The obtained results may be very important for planning strategy for integrated control of charcoal rot disease. Peanut seems to be the safest preceding host in sesame, soybean or cotton but not sunflower rotations. In rotation concerned with oil crops sowing sesame after sesame, sunflower or cotton must be prevented for minimizing disease incidence on sesame plants. Sunflower suffered great loss in healthy plants if it was sown after soybean.

III- Enzymological studies:

A- Activities of pectulolytic and cellulolytic enzymes *in vitro*:

Activities of some isolates of *M. phaseolina* in producing pectin methylestrase (PME), polygalacturonase (PG) and cellulase (Cx) enzymes in culture filtrates of 7, 15, 21 and 30 old days were determined. *M. phaseolina* isolates M9 (more virulent), M15 (moderate virulent) and M22 (weakly pathogenic) were used in this study.

Data presented in **Table (10)** show that, the three tested isolates of *M. phaseolina* were varied in production of PME and PG enzymes. Increasing age of culture from 7 to 30 days, in general, caused conspicuous and proportional increase in activities of these enzymes in culture filtrates. Also, increasing time of reaction from 5 to 60 minutes induced a similar increase in PG enzyme activity. The highly pathogenic isolate M9 shows the highest PME and PG enzymes activities in its culture filtrates followed by the moderate isolate M15 and the weakly pathogenic isolate M22.

The same data indicated that, the culture filtrates of the three tested isolate M9, M15 and M22 showed different degrees of activities of Cx enzymes. The highest enzyme activity of Cx was observed in culture filtrates of the highly pathogenic isolate M9 (aver. 87.7%) followed by the moderately pathogenic isolate M15 (aver. 82.1%). However the least Cx enzymes activity was resulted in culture filtrates of the weakly pathogenic M22 (aver. 73.1%). Generally, the Cx enzymes activities increased by increasing culture filtrate age and time of reaction and was correlated with the virulence of the tested isolates. In all isolates, activity of cellulolytic Cx enzymes was higher in 30 day-old culture filtrates of M15 and M22 whereas, was higher in 15 and 21 day-old culture filtrates of M9 and decreased in 30 day-old culture.

B- Activities of pectulolytic and cellulolytic enzymes *in vivo*:

Activities of pectulolytic (PME & PG) and cellulolytic (Cx) enzymes were determined in extracts of healthy and artificially inoculated 30 days old sesame seedlings variety Giza 32. Determinations were carried out 15, 30, 45 and 60 days after inoculation with any of the three tested isolates of *M. phaseolina* i.e.,, M9, M15 and M22.

Data presented in **Table (11)** indicated that, both inoculated and non-inoculated sesame plants exhibited activity of both pectulolytic (PME "Pectin methylestrase" and PG "polygalacturonase) and cellulolytic (Cx) enzymes. Activities of these enzymes, however, were conspicuously higher in inoculated than non-inoculated sesame plants. In inoculated plants, the enzyme activities seemed to be correlated with the pathogenic virulence and time elapsed after inoculation. The highest enzymatic activities were induced in diseased sesame plants 60 days after inoculation with the more virulent *M. phaseolina* isolate M9. In all cases, *M. phaseolina* isolate M22 (weakly) shows the lowest PME, PG and Cx enzymatic activities. The same data showed also that, the activities of the polygalacturonase (PG) and cellulolytic (Cx) enzymes were gradually increased with increasing time of reaction from 5 to 60 minutes at 30 deg C.

Table (10): Determination of pectulolytic (PG and PME) and cellulolytic enzymes activities for the virulent, moderately and weakly pathogenic isolates of *M. phaseolina* (in vitro).

Culture age (days)	Pectulolytic enzymes							cellulolytic enzymes					
	PME activity 0.1% NaOH cc	% Loss in PG-substrate viscosity after incubation periods at different reaction time (R.T) by minutes						% Loss in Cx-substrate viscosity after incubation periods at different reaction time (R.T) by minutes					
		5	**10**	**15**	**30**	**60**	Mean	**5**	**10**	**15**	**30**	**60**	Mean
Virulent pathogenic M9													
7 d	4.0*	56.2	75.1	78.4	91:5	98.3	79.9	64.2	78.6	84.1	92.2	95.9	83.0
15 d	4.8	61.1	76.7	80.1	90.6	98.6	81.4	79.0	85.7	90.4	94.5	97.0	89.3
21 d	6.7	66.0	78.3	85.9	93.8	98.8	84.6	79.0	86.9	90.5	94.8	97.4	89.7
30 d	8.0	80.8	89.8	92.4	97.3	99.2	91.9	78.0	86.3	90.4	94.3	96.4	89.1
Mean	5.88	66.0	80.0	84.2	93.3	98.7	**84.5**	75.0	84.4	88.9	94.0	96.7	**87.7**
Moderately pathogenic M15													
7 d	2.7	25.9	37.1	50.8	80.1	94.8	57.7	44.2	60.5	72.6	88.5	93.7	71.9
15 d	4.1	51.1	71.4	76.3	85.7	93.4	75.6	65.5	78.5	85.3	93.7	96.4	83.9
21 d	4.4	49.9	64.1	76.4	90.8	97.5	75.7	64.7	80.7	86.0	94.3	96.9	84.5
30 d	5.5	56.7	69.8	78.9	93.4	98.7	79.5	74.4	84.5	89.8	95.0	96.0	87.9
Mean	4.18	45.9	60.6	70.6	87.5	96.1	**72.1**	62.2	76.1	83.4	92.9	95.8	**82.1**
Weakly pathogenic M22													
7 d	0.4	15.6	32.1	42.9	59.6	69.0	43.8	10.3	24.2	51.1	72.9	86.1	48.9
15 d	0.5	17.2	33.1	45.1	59.3	69.3	44.8	41.8	64.4	78.4	88.7	93.7	73.4
21 d	5.3	20.6	36.7	46.7	62.0	75.2	48.2	65.7	79.4	87.6	92.5	96.0	84.2
30 d	5.7	25.6	38.1	53.4	63.4	77.7	51.6	68.9	80.9	87.7	94.1	96.7	85.7
Mean	2.98	19.8	35.0	47.0	61.1	72.8	**47.1**	46.7	62.2	76.2	87.1	93.1	**73.1**
Grand Mean	-	43.9	58.5	67.3	80.6	89.2		61.3	74.2	82.8	91.3	95.2	

25.0 and 100.0 ppm. of Rizolex-T, and 400.0, 200.0 and 400.0 ppm. of Benlate, respectively **(Table 12)**.

Substantial mycelial growth of *M. phaseolina* isolate M9 was noticed but that of isolates M15 and M22 was completely stopped at 1600 ppm. of the fungicide Amconil. Sclerotial formation by all tested isolates was affected similarly with few exceptions.

The fungicides Maxim and Benlate caused complete inhibition of sclerotial formation of *M. phaseolina* isolate M15 at 1.0 and 100.0 ppm., respectively. However, the fungicide Amconil prevented sclerotial formation at 200.0, 800.0, and 1600.0 ppm. for the 3 isolates M9, M15, and M22, respectively **(Table 13)**.

Regarding averages of mycelial growth **(Table 12)**, *M. phaseolina* isolate M9 seems to be the most tolerant for fungicides (27.2 mm), followed by isolate M15 (25.0 mm), and isolate M22 (21.9 mm). It is worthy to state that the weakly isolate M22 produced the highest number of sclerotia in fungicide-free medium (control) followed by the more virulent isolate M9 and the moderate virulent isolate M15 **(Table13)**.

Table (12): Effect of different concentrations of some fungicides on the linear growth of virulent, moderate and weak pathogenic isolates of *M. phaseolina*.

Fungal isolate	Conc. ppm	Fungicides					Mean
		Benlate	Amconil	Rizolex-T	Maxim	Vitavax	
Virulent M9	0.0	85.0	85.0	85.0	85.0	85.0	85.0
	0.1	85.0	85.0	85.0	6.7	85.0	69.3
	0.5	48.7	85.0	85.0	1.7	85.0	61.
	1.0	26.7	85.0	31.0	0.0	85.0	45.5
	5.0	21.7	76.0	17.0	0.0	80.7	39.1
	10	9.7	47.3	8.7	0.0	40.7	21.3
	25	7.7	38.0	5.7	0.0	14.0	13.1
	50	7.3	24.0	3.3	0.0	10.7	9.1
	100	5.7	15.7	2.0	0.0	0.0	4.7
	200	1.3	11.0	0.0	0.0	0.0	2.5
	400	0.0	7.0	0.0	0.0	0.0	1.4
	800	0.0	4.0	0.0	0.0	0.0	0.8
	1600	0.0	1.7	0.0	0.0	0.0	0.3
	Mean	23.0	43.4	24.8	7.2	37.4	**27.20**
Moderate M15	0.0	85.0	85.0	85.0	85.0	85.0	85.0
	0.1	73.3	85.0	85.0	9.7	85.0	67.6
	0.5	21.3	81.3	78.0	4.7	85.0	54.1
	1.0	17.3	71.7	20.3	2.3	79.0	38.1
	5.0	13.3	62.3	13.3	0.0	61.3	30.0
	10	9.7	40.0	11.3	0.0	39.7	20.1
	25	7.3	33.7	5.3	0.0	15.3	12.3
	50	6.0	20.3	3.7	0.0	2.0	6.4
	100	1.7	17.3	0.0	0.0	0.0	3.8
	200	1.0	15.3	0.0	0.0	0.0	3.3
	400	0.0	11.7	0.0	0.0	0.0	2.3
	800	0.0	7.3	0.0	0.0	0.0	1.5
	1600	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	18.2	40.8	23.2	7.8	34.8	**25.00**
Weak M22	0.0	85.0	85.0	85.0	85.0	85.0	85.0
	0.1	41.3	85.0	85.0	6.3	85.0	60.5
	0.5	17.7	77.0	73.7	0.0	82.0	50.1
	1.0	13.7	56.3	19.3	0.0	65.7	31.0
	5.0	10.0	47.3	11.3	0.0	53.7	24.5
	10	7.3	38.3	8.7	0.0	33.3	17.5
	25	6.0	29.0	0.0	0.0	1.0	7.2
	50	4.0	19.0	0.0	0.0	0.0	4.6
	100	1.3	11.7	0.0	0.0	0.0	2.6
	200	0.0	6.3	0.0	0.0	0.0	1.3
	400	0.0	2.7	0.0	0.0	0.0	0.5
	800	0.0	1.0	0.0	0.0	0.0	0.2
	1600	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	14.3	35.3	21.8	7.0	31.2	**21.90**

Table (13): Effect of different concentrations of some fungicides on sclerotial formation of virulent, moderate and weak pathogenic isolates of *M. phaseolina*.

Fungal isolate	Conc. ppm	Fungicides					Mean
		Benlate	Amconil	Rizolex-T	Maxim	Vitavax	
Virulent M9	0.0	38.3	38.3	38.3	38.3	38.3	38.3
	0.1	33.7	9.0	36.3	17.7	34.3	26.2
	0.5	27.0	7.7	33.3	9.7	25.0	20.5
	1.0	24.7	7.0	40.3	0.0	23.0	19.0
	5.0	21.3	5.0	47.0	0.0	16.3	17.9
	10	16.0	3.7	56.3	0.0	15.7	18.3
	25	13.3	2.0	66.3	0.0	11.3	18.6
	50	10.0	1.7	87.0	0.0	6.7	21.1
	100	8.0	1.0	92.3	0.0	0.0	20.3
	200	6.0	0.0	0.0	0.0	0.0	1.2
	400	0.0	0.0	0.0	0.0	0.0	0.0
	800	0.0	0.0	0.0	0.0	0.0	0.0
	1600	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	15.3	5.8	38.3	5.1	13.1	15.5
Moderate M15	0.0	26.0	26.0	26.0	26.0	26.0	26.0
	0.1	25.0	25.7	20.3	0.0	9.3	16.1
	0.5	23.0	24.0	12.7	0.0	5.7	13.1
	1.0	18.3	23.0	6.0	0.0	4.7	10.4
	5.0	12.0	19.0	4.0	0.0	2.7	7.5
	10	8.3	17.0	1.3	0.0	2.3	5.8
	25	4.3	15.0	0.0	0.0	2.0	4.3
	50	1.7	8.7	0.0	0.0	0.0	2.1
	100	0.0	4.7	0.0	0.0	0.0	0.9
	200	0.0	2.7	0.0	0.0	0.0	0.5
	400	0.0	1.0	0.0	0.0	0.0	0.0
	800	0.0	0.0	0.0	0.0	0.0	0.0
	1600	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	9.1	12.8	5.4	2.0	4.1	6.7
Weak M22	0.0	77.7	77.7	77.7	77.7	77.7	77.7
	0.1	74.0	72.0	51.0	14.0	74.3	57.1
	0.5	65.3	66.0	48.3	11.0	64.0	50.9
	1.0	57.7	55.3	84.0	4.7	51.0	50.5
	5.0	53.3	51.0	87.0	0.0	44.7	47.2
	10	27.7	48.3	94.3	0.0	37.3	41.5
	25	13.0	35.0	128.0	0.0	20.3	39.3
	50	9.0	32.0	133.7	0.0	15.3	38.0
	100	5.7	26.3	0.0	0.0	0.0	6.4
	200	4.0	24.0	0.0	0.0	0.0	5.6
	400	0.0	19.0	0.0	0.0	0.0	3.8
	800	0.0	5.7	0.0	0.0	0.0	1.1
	1600	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	29.8	39.4	54.2	8.3	29.6	32.3

2- Effect of some selected fungal and bacterial isolates on the growth of the highly, moderately and weakly pathogenic isolates of *M. phaseolina* on PDA medium:

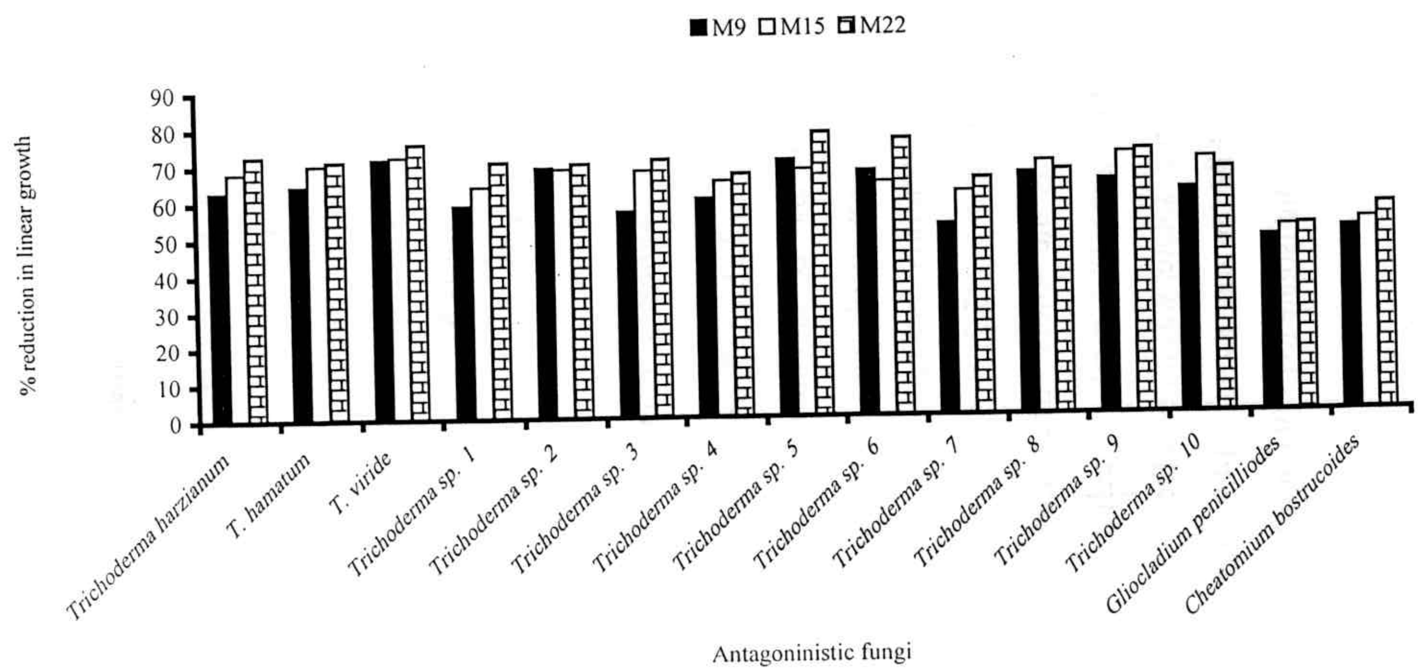
This study aimed to investigate the antagonistic effect of 15 fungi i.e., *Trichoderma harzianum, T. hamatum, T. virde*, 10 isolates of *Trichoderma* spp., *Gliocladium penicilloides* and *Chaetomium bostrycoides* as well as 5 antagonistic bacteria i.e., *Bacillus subtilis, B. megtla*, 3 isolates of *Bacillus* spp. on mycelial growth of *M. phaseolina* isolates M9, M15 and M22.

A- Effect of antagonistic fungi on growth of *M. phaseolina*:

Data in **Table (14)** and **Fig. (7)** indicated that, all tested antagonistic fungi caused significant reduction in mycelial growth of the three tested isolates of *M. phaseolina*. *G. penicilloides* and *C. bostrycoides* were the lowest effective in this regard. *Trichoderma viride* and *Trichoderma* sp. (No. 5) were the most antagonistic as they caused the highest reduction in growth of *M. phaseolina* isolates i.e., 73.3 and 72.4%, respectively. Followed by *Trichoderma* spp. No. 9, 6, 2, and *T. hamatum, T. harzianum* and *Trichoderma* sp. No. 8. The later 6 isolates of antagonisms reduced average growth of *M. phaseolina* isolates by 69.7%, 69.6%, 69.4%, 68.7%, 68.0% and 68.0%, respectively.

The same results also showed that the linear growth of *M. phaseolina* isolate M9 (the more pathogenic) was quite resist effects of the antagonistic fungi (growth reduced by 58.1%), followed by

Fig. (7): Effect of some antagonistic fungi on growth of *M. phaseolina* isolates M9, M15 and M22.



the moderately isolate M15 (61.7%) whereas, the weakly isolate M22 was more affected by different antagonistic fungi (64.8%).

As for the interaction between isolates of pathogen and the antagonistic fungi, the obtained results proved that, *Trichoderma viride*, *Trichoderma* spp. No. 5, 2, 6 were the best and significantly equal in suppressing mycelial growth of *M. phaseolina* isolate M9. *Trichoderma viride*, *Trichoderma* spp. No. 9, *T. hamatum*, *Trichoderma* spp. No 10, 8, 2, 5, *Trichoderma harzianum*, and *Trichoderma* sp. No. 3 exhibited similar best effect on *M. phaseolina* isolate **M15.** However *Trichoderma* spp. No. 5, 6 and *T. viride* were the best antagonistic for reducing growth of *M. phaseolina* isolate M22.

B- Effect of some antagonistic bacteria on growth of *M. phaseolina* tested isolates:

Data presented in **Table (15)** and **Figs. (8-A & -B)** show that, *Bacillus subtilis* and *B. megtla* were the best antagonistic bacteria for limiting growth of *Macrophomina* isolates as they caused the widest inhibition zone (averages 15.3 and 14.5 mm). *Bacillus* spp. No. 3 and 2 (12.2, 10.5 mm) came next whereas *Bacillus* sp No. 1 was the lowest effective one that caused the narrowest inhibition zone (8.7 mm). Mycelial growth of M22, the weakly pathogenic isolate, was more affected by antagonistic bacteria isolates (inhibition zone average 14.9 mm), followed by the moderately pathogenic isolate M15 (9.0 mm). However, the

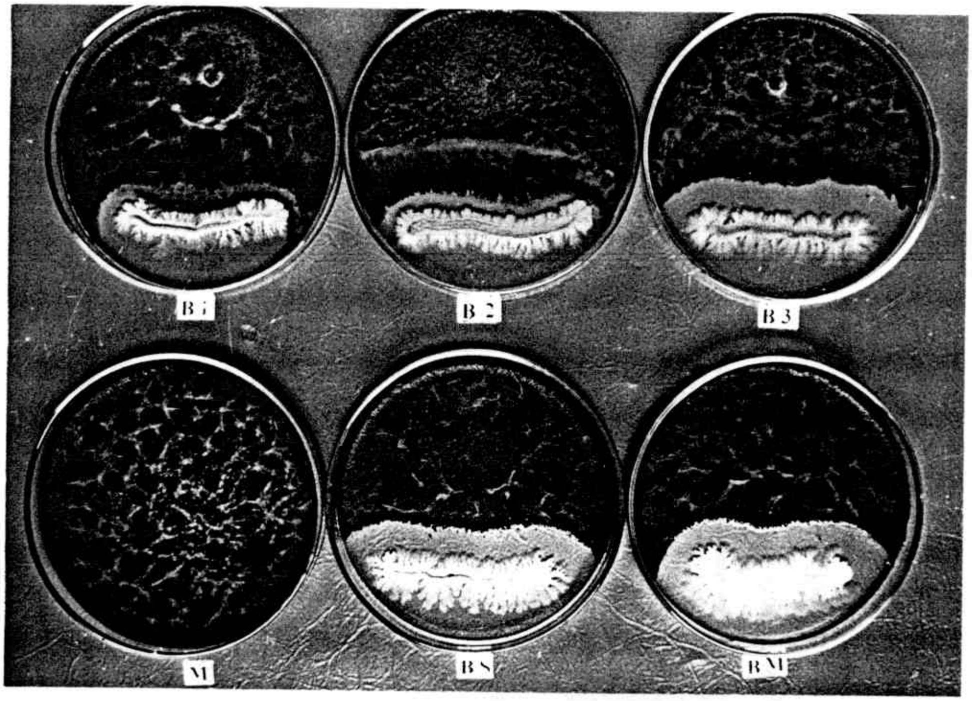
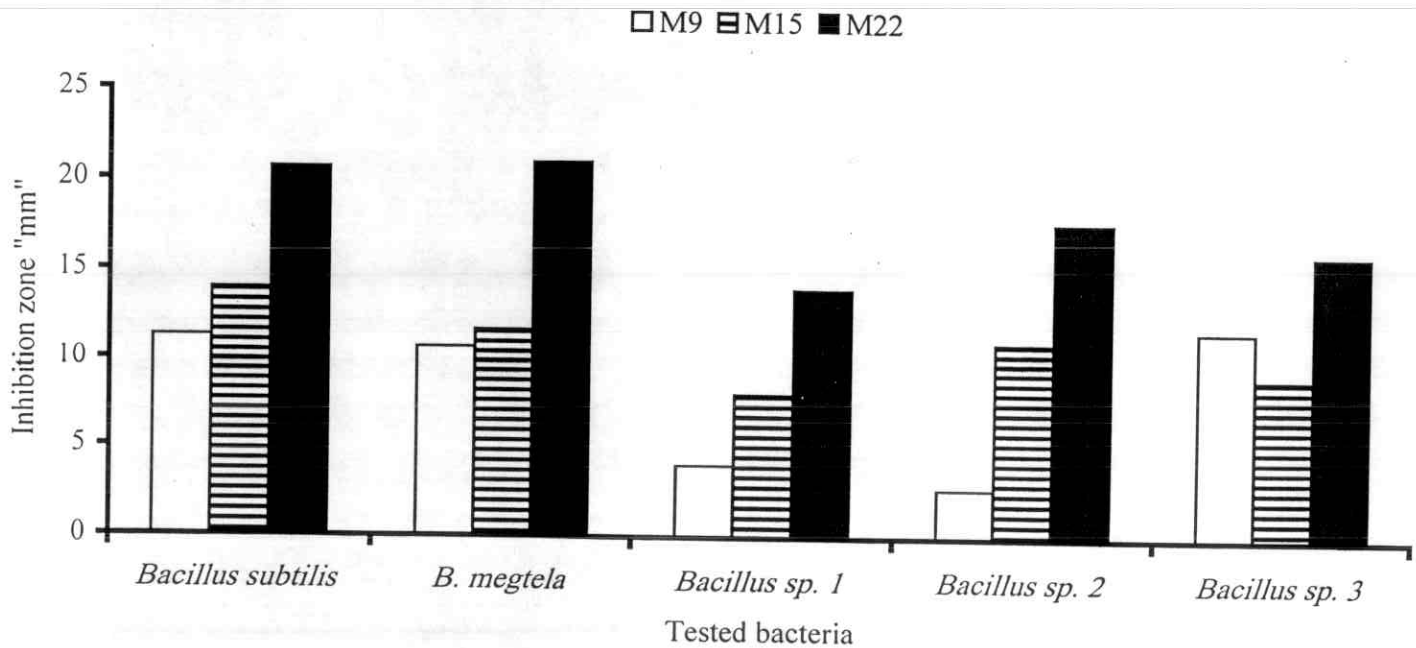


Fig (8-A): illustrated the antagonistic effect of some bacterial isolates (zone inhibition) against *M. phaseolina* isolate (M22) on PDA medium.

M: control
BS: *Bacillus subtilis*
BM: *B. megtela*
B1: *Bacillus* sp1
B2: *Bacillus* sp2
B3: *Bacillus* sp3

Fig. (8-B): Inhibition zone " mm" caused by some antagonistic bacteria against *M. phaseolina* isolates M9, M15 and M22 on PDA medium.



more pathogenic isolate M9 was quite resistant to antagonistic bacterial isolates (inhibition zone average 6.7 mm).

Table (14): Effect of some antagonistic fungi on growth of virulent, moderate and weak pathogenic *M. phaseolina* isolates.

Antagonistic fungi	% reduction in linear growth of *M. phaseolina* isolates			
	M9	**M15**	**M22**	**Mean**
Trichoderma harzianum	63.1	68.2	72.8	68.0
T. hamatum	64.6	70.2	71.3	68.7
T. viride	71.8	72.3	75.9	73.3
Trichoderma sp. 1	59.0	64.1	70.8	64.6
Trichoderma sp. 2	69.2	68.7	70.2	69.4
Trichoderma sp. 3	57.0	68.2	71.3	65.5
Trichoderma sp. 4	60.5	65.2	67.2	64.3
Trichoderma sp. 5	70.8	68.2	78.2	72.4
Trichoderma sp. 6	67.7	64.6	76.4	69.6
Trichoderma sp. 7	52.9	61.8	65.5	60.1
Trichoderma sp. 8	66.7	69.8	67.5	68.0
Trichoderma sp. 9	64.6	71.8	72.8	69.7
Trichoderma sp. 10	62.0	70.2	67.5	66.6
Gliocladium penicilliodes	48.7	51.3	51.8	50.6
Cheatomium bostrucoides	50.8	52.9	57.0	53.6
Control	0.0	0.0	0.0	0.0
Mean	58.1	61.7	64.8	-

LSD. at 5% for:	Isolates (I)	Antagonistic fungi (A)	I x A
	1.25	2.88	4.98

3- Effect of some plant extracts on *M. phaseolina* linear growth and sclerotial productivity *in vitro*:

Twelve different aqueous plant extracts were used after sterilizing them by filtration or by autoclaving for evaluating their effect on linear growth and sclerotial formation of three isolates of *M. phaseolina* i.e., M9, M15 and M22.

Table (15): Effect of some bacterial isolates against virulent, moderate and weak pathogenic isolates of *M. phaseolina* on PDA medium.

Antagonistic fungi	Inhibition zone (mm) and *M. phaseolina* isolates			
	M9	M15	M22	Mean
Bacillus subtilis	11.3	14.0	20.7	15.3
B. megtela	10.7	11.7	21.0	14.5
Bacillus sp. 1	4.0	8.0	14.0	8.7
Bacillus sp. 2	2.7	11.0	17.7	10.5
Bacillus sp. 3	11.7	9.0	16.0	12.2
Control	0.0	0.0	0.0	0.0
Mean	6.7	9.0	14.9	-

LSD. at 5% for:	Isolates (I)	Antagonistic fungi (A)	I x A
	0.82	1.16	2.01

A- Effect of filtered and autoclaved watery plant extracts on the linear growth:

As for the aqueous filtered extracts, the data presented in **Table (16)** showed that, garlic, rhubarb and anise filtered extracts were the best of all tested extracts. The filtered garlic extracts caused complete inhibition of growth of all isolates of *M. phaseolina* at the lowest concentration (10%). While, filtered extract of rhubarb could prevent growth of *M. phaseolina* isolate M9 and caused the highest significant decreases in growth of isolates M15 and M22 at the highest concentration (50%). Anise filtered extract was more effective against isolate M15 than isolates M9 and M22 at the highest concentration. Average of linear growth as affected by the later 2 extracts were 2.3 and 19.0 mm (isolate M9), 10.1 and 18.1 mm (isolate M15), and 6.6 and 22.7 mm (isolate M22) for rhubarb and anise extracts, respectively.

Table (16): Effect of different concentrations (10, 25, and 25%) of filtered watery plant extracts on linear growth (mm) and sclerotial formation (Number/microscopic field 10X) of 3 isolates of *M. phaseolina in vitro*.

Fungal isolate	Plant extracts	Linear growth at			Mean	Number of sclerotia at			Mean
		10%	25%	50%		10%	25%	50%	
M9	Cumin	75.0	60.7	44.7	60.1	18.0	10.5	3.0	10.5
	Rhubarb	4.0	3.0	0.0	2.3	0.8	0.5	0.0	0.4
	Eucalyptus	81.3	65.3	48.0	64.9	44.5	21.0	3.0	22.8
	Anise	30.3	17.7	9.0	19.0	35.3	21.8	17.5	24.9
	Garlic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rosselle	80.7	52.7	16.3	49.9	41.3	29.0	1.3	23.9
	Ginger	84.0	71.0	57.7	70.9	42.8	28.2	23.8	31.6
	Clove	80.3	47.0	14.3	47.2	34.8	31.3	23.0	29.7
	Fennel	76.3	63.0	52.0	63.8	40.8	33.8	31.5	35.4
	Azedarach	85.0	74.7	59.0	72.9	9.8	2.3	2.0	4.7
	Thyme	81.0	47.3	24.7	51.0	33.0	13.8	0.5	15.8
	Marjoram	57.7	36.0	22.0	38.6	4.3	2.5	1.0	2.6
	Control	85.0	85.0	85.0	85.0	45.0	45.0	45.0	45.0
	Mean	**63.3**	**48.0**	**33.3**	**48.1**	**27.0**	**18.4**	**11.7**	**19.0**
M15	Cumin	66.7	39.0	26.7	44.1	6.3	5.3	4.5	5.4
	Rhubarb	14.3	12.0	4.0	10.1	3.0	2.3	0.0	1.8
	Eucalyptus	68.3	45.3	13.0	50.9	8.3	68.5	101.0	59.3
	Anise	29.0	16.3	9.0	18.1	19.5	50.8	147.0	72.4
	Garlic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rosselle	83.3	56.3	32.7	57.4	12.0	22.3	29.3	21.2
	Ginger	85.0	64.7	40.0	63.2	41.0	49.5	139.0	76.5
	Clove	84.0	59.7	15.3	53.0	67.5	70.3	98.3	78.7
	Fennel	67.3	56.7	41.3	55.1	44.5	45.8	47.5	45.9
	Azedarach	77.3	58.7	50.3	62.1	41.5	56.3	95.0	64.3
	Thyme	79.3	42.7	33.0	51.7	4.5	2.0	1.5	2.7
	Marjoram	52.3	46.3	40.3	46.3	6.0	5.5	1.3	4.3
	Control	85.0	85.0	85.0	85.0	18.0	18.0	18.0	18.0
	Mean	**60.9**	**44.8**	**32.1**	**45.9**	**20.9**	**30.5**	**52.5**	**34.6**
M22	Cumin	58.3	38.7	32.0	43.0	190.3	206.5	215.0	203.9
	Rhubarb	10.0	7.7	2.0	6.6	15.5	7.5	5.3	9.4
	Eucalyptus	49.7	44.7	40.0	44.8	133.8	125.3	90.0	116.4
	Anise	33.0	22.3	12.7	22.7	116.8	100.3	76.8	98.0
	Garlic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rosselle	54.7	49.7	9.3	37.9	147.5	133.0	122.0	134.2
	Ginger	72.0	53.0	36.0	53.7	133.5	126.0	106.3	121.9
	Clove	79.7	48.0	14.7	47.4	135.0	118.8	113.8	122.5
	Fennel	62.7	44.0	32.7	46.4	155.8	121.8	103.8	127.1
	Azedarach	67.0	51.7	19.7	46.1	125.3	112.3	102.5	113.4
	Thyme	65.3	52.0	36.3	51.2	102.3	96.0	78.0	92.1
	Marjoram	42.0	32.3	27.7	34.0	134.3	80.3	77.0	97.2
	Control	85.0	85.0	85.0	85.0	180.0	180.0	180.0	180.0
	Mean	**52.3**	**40.7**	**26.8**	**39.9**	**120.8**	**108.3**	**97.7**	**108.9**

LSD. at 5% for	Isolates (I)	extracts (E)	Conc. (C)	I x E	I x C	E x C	I x E x C
Linear growth	0.43	0.90	0.43	1.56	0.75	1.56	2.69
Sclerotial No.	0.98	2.03	0.98	3.52	1.69	3.52	6.09

On the other hand, extracts of ginger, azedarach, fennel and eucalyptus were the least effective against growth of all isolates of *M. phasiolena*. Whereas the rest of aqueous filtered plant extracts including marjoram, rosselle, cumin, clove and thyme induced intermediate suppressive effects. With regard to aqueous autoclaved plant extracts, the data in **Table (17)** showed that, extracts of rosselle, clove and rhubarb caused the highest suppressive effect on the linear growth of the 3 isolates of *M. phaseolina*, while those of fennel, thyme, marjoram, garlic and anise were the least effective ones. The aqueous autoclaved extracts of azedarach, ginger, cumin and eucalyptus induced intermediate effect when compared with control treatment. The weakly isolate M22 was the most sensitive isolate for autoclaved extracts (48.9 mm) meanwhile, the more virulent isolate M9 (69.2 mm) was the least affected with autoclaved extracts followed by moderately isolate M15 (61.0 mm). Linear growth of *Macrophomina phaseolina*, particularly isolate M22 was decreased with the increasing concentrations of most extracts from 10 to 50%. Whatever, the rosselle and clove aqueous autoclaved extracts (against all isolates) and azedarach (against isolate M22 only) caused complete inhibition of fungal growth of these isolates at the highest concentrations (50%).

2- Effect of filtered and autoclaved watery plant extracts on sclerotial formation *in vitro*:

Concerning with the filtered extracts, the results in **Table (16)** and **Fig. (9-A)** stated that the filtered garlic extracts even at its lowest concentration (10%) caused no mycelial growth for the 3 isolates of *M. phaseolina* consequently fungal sclerotia could not be produced. The same results indicated also that sclerotial formation was considerably reduced by filtered extracts of rhubarb (average 3.9 sclerotia). Intermediate effect was induced by marjoram (34.7), thyme (36.9), rosselle (60.0) and azedarach (60.8). While, clove (77.0), ginger (76.7), cumin (73.3), fennel (69.5), eucolytus (66.2) and anise (65.1) seemed to be less effective when compared with average of control treatments (81.0).

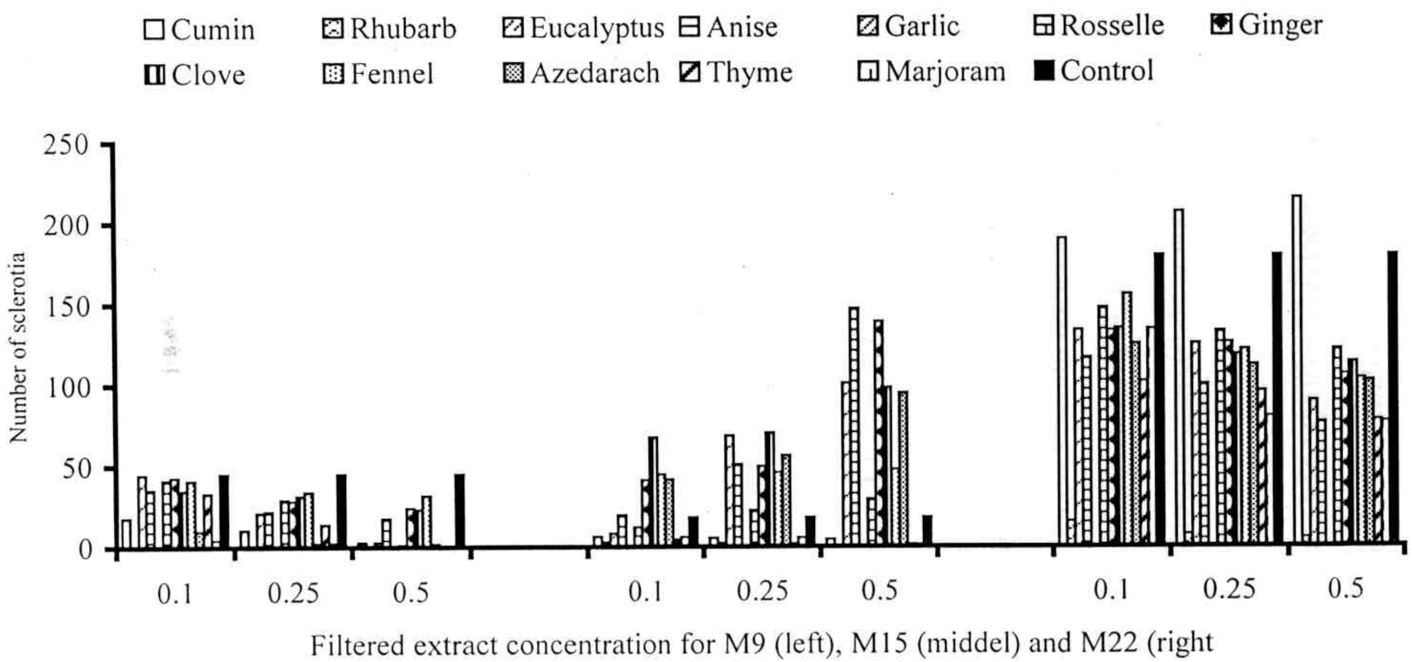
Sclerotial formation by *M. phaseolina* isolates M9 and M22 was mostly decreased with increasing concentrations of all extracts except aqueous extract of cumin which increasing sclerotial formation by isolate M22 with increasing concentration compared with control.

Table (17): Effect of different concentrations of autoclaved plant extracts on linear growth (mm) and sclerotial formation of 3 *M. phaseolina* isolates *in vitro*.

Fungal isolate	Plant extracts	Linear growth at 10%	25%	50%	Mean	Number of sclerotia at 10%	25%	50%	Mean
M9	Cumin	83.0	80.3	73.7	79.0	46.0	20.0	12.0	26.0
	Rhubarb	67.3	55.3	31.0	51.2	21.0	14.0	1.0	12.0
	Eucalyptus	82.3	79.3	62.3	74.7	69.3	55.0	43.0	55.8
	Anise	85.0	85.0	85.0	85.0	43.3	24.5	5.8	24.5
	Garlic	85.0	85.0	85.0	85.0	70.8	64.0	23.0	52.6
	Rosselle	51.7	42.3	0.0	31.3	63.5	46.5	0.0	36.7
	Ginger	66.7	61.0	54.3	60.7	56.3	23.3	16.8	32.1
	Clove	81.0	38.3	0.0	39.8	62.0	26.5	0.0	29.5
	Fennel	85.0	85.0	85.0	85.0	15.0	5.8	2.0	7.6
	Azedarach	85.0	85.0	9.0	59.7	38.5	31.8	19.8	30.0
	Thyme	85.0	85.0	85.0	85.0	44.0	35.0	18.8	32.6
	Marjoram	85.0	85.0	63.0	77.8	37.5	23.3	20.5	27.1
	Control	85.0	85.0	85.0	85.0	75.0	75.0	75.0	75.0
	Mean	79.0	73.2	55.3	**69.2**	**49.4**	**34.2**	**18.3**	**34.0**
M15	Cumin	79.3	65.0	43.7	62.7	22.5	14.8	8.8	15.4
	Rhubarb	55.7	39.3	17.3	37.4	11.0	7.0	2.0	6.7
	Eucalyptus	77.7	60.3	44.0	60.7	26.1	34.5	52.0	37.5
	Anise	85.0	64.3	55.3	68.2	30.5	45.8	82.0	52.8
	Garlic	85.0	85.0	85.0	85.0	23.8	15.5	10.8	16.7
	Rosselle	35.7	7.0	0.0	14.2	15.0	7.3	0.0	7.4
	Ginger	66.0	54.7	45.0	55.2	29.3	45.0	93.8	56.0
	Clove	65.3	15.0	0.0	26.8	16.5	10.0	0.0	8.8
	Fennel	85.0	85.0	78.3	80.6	15.5	11.0	7.0	11.2
	Azedarach	85.0	72.7	2.7	53.4	26.0	41.8	64.3	44.0
	Thyme	85.0	81.0	78.7	81.6	17.8	14.5	6.0	12.8
	Marjoram	85.0	79.7	73.3	79.3	16.3	12.8	3.5	10.9
	Control	85.0	85.0	85.0	85.0	25.0	25.0	25.0	25.0
	Mean	75.0	61.1	46.8	**61.0**	**21.2**	**21.9**	**27.3**	**23.5**
M22	Cumin	46.0	31.7	18.3	32.0	61.8	42.0	17.3	40.4
	Rhubarb	44.0	32.0	13.0	29.7	23.0	17.0	5.0	15.0
	Eucalyptus	58.0	41.7	19.3	39.7	115.3	92.0	67.8	91.7
	Anise	68.0	62.0	52.3	60.8	121.5	94.8	74.5	96.9
	Garlic	64.0	54.7	48.3	55.7	128.5	111.3	89.5	109.8
	Rosselle	13.3	0.0	0.0	4.4	100.8	70.8	0.0	57.2
	Ginger	53.3	48.3	43.0	48.2	97.0	69.3	53.5	73.3
	Clove	21.3	3.7	0.0	8.3	86.0	69.8	0.0	51.9
	Fennel	83.3	77.0	74.7	78.3	32.8	21.3	8.3	20.8
	Azedarach	69.0	61.3	0.0	43.4	127.8	88.5	0.0	72.1
	Thyme	85.0	80.0	68.3	77.8	110.3	75.8	48.3	78.1
	Marjoram	79.0	72.7	66.0	72.6	100.0	72.5	41.3	71.3
	Control	85.0	85.0	85.0	85.0	140.0	140.0	140.0	140.0
	Mean	59.2	50.0	37.6	48.9	**95.8**	**74.2**	**42.0**	**70.7**

LSD. at 5% for	Isolates (I)	extracts (E)	Conc. (C)	I x E	I x C	E x C	I x E x C
Linear growth	0.44	0.91	0.44	1.57	0.76	1.57	2.72
Sclerotial No.	0.77	1.60	0.77	2.78	1.33	2.78	4.81

Fig. (9-A): Effect of different concentrations of filtered watery plant extracts on sclerotial formation of isolates M9, M15 and M22 of *M. phaseolina* in vitro.

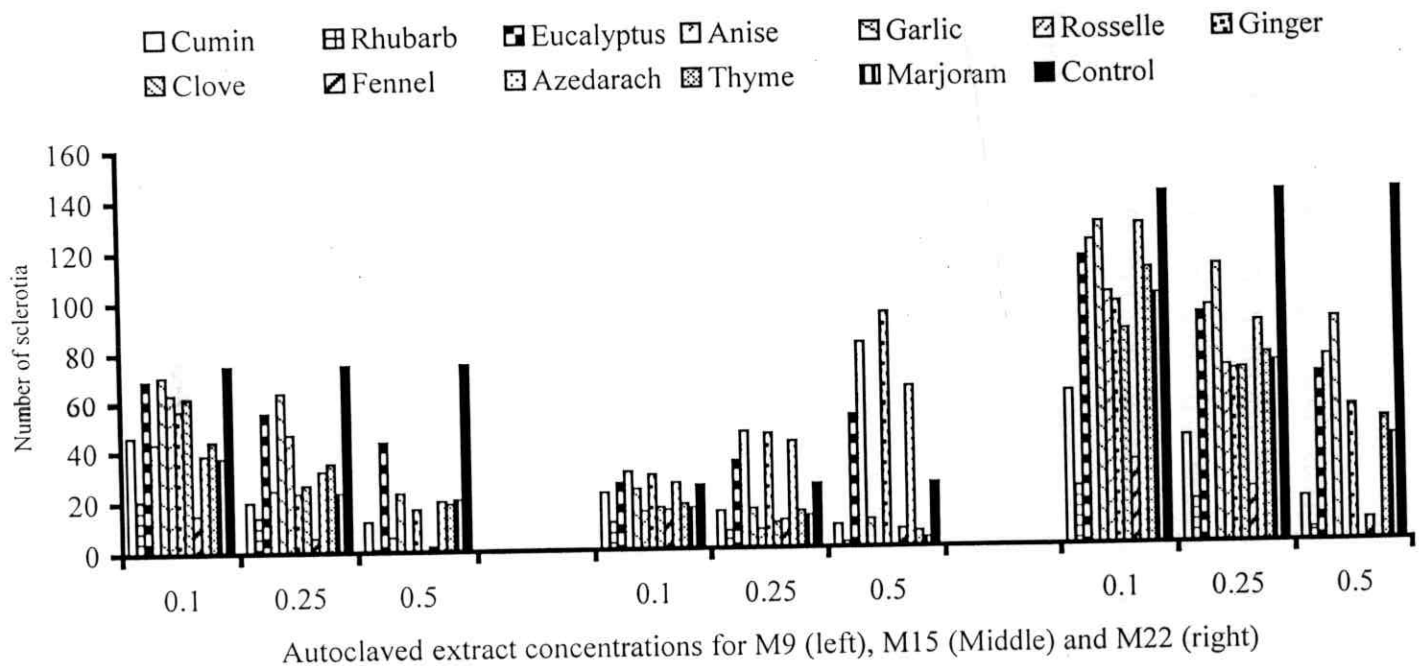


On contrast, most tested aqueous filtered extracts increased sclerotial formation of the moderately isolate M15 with increasing their concentrations compared with control treatment. Aqueous extracts of clove and ginger caused the highest increase, while, extract of garlic, rhubarb, thyme, marjoram and cumin in listed order decreased the sclerotial formation of this isolate.

As for the aqueous autoclaved extracts, the data presented in **Table (17)** and **Fig. (9-B)** showed that extract of rhubarb was the best for causing the highest decrease of sclerotial formation (average 11.2) followed by fennel (average 13.2). The autoclaved extracts of cumin, clove, rossella and marjorum were intermediate ones, whereas, those of eucalyptus, garlic, clove, ginger, azedarch and thyme were least effective in this respect. Increasing concentrations of all tested autoclaved extracts resulted in significant decrease in sclerotial formation by isolates M9 and M22. While, in isolate M15, increasing concentrations of some autoclaved extracts i.e., eucalytus, azedarach, anise and ginger from 10% to 50% inceased number of sclorotia from 26.1 to 52.0 (aver. 37.5), 26.0 to 64.3 (aver. 44.0), 30.5 to 82.0 (aver. 52.8), and 29.3 to 93.8 (aver. 56.0), respectively compared with control (25.0).

In general, the autoclaved extracts of fennel produces the lowest numbers of sclerotia of isolate M9 (7.6), followed by rhubrab (12.0), and cumin (26.0). In isolate M22, the autoclaved

Fig. (9-B): Effect of different concentrations of autoclaved watery plant extracts on sclerotial formation of isolates M9, M15 and M22 of *M. phaseolina* in vitro.



extracts of rhubrab was the best for reducing sclerotial formation (15.0), followed by Fennel (20.8), clove (51.9), and rosselle (57.2).

Sclerotial productivity of isolate M15 only was responded in different manners against tested extracts. It was increased significantly by increasing concentrations of some autoclaved extracts i.e., ginger (average 56.0), followed by anise (aver. 52.8), azedarach (aver. 44.0) and eucalyptus (aver. 37.5). Meanwhile it was decreased significantly by increasing concentrations of the autoclaved extracts of rhubrab (6.7), rosselle (7.4), clove (8.8), Marjoram (10.9), Fennel (11.2), and Thyme (12.8) compared with (25.0) in its untreated control. The autoclaved extracts of garlic, anise and thyme (isolate M9), fennel and garlic (isolate M15) never affected the mycelial growth when compared with control. It is worthy to state that the filtered extracts of these plants especially garlic and anise were the most toxic against growth of all isolates. Also, toxicity of rhubrab extracts (against all isolates), anise (against isolates M15 and M22) and garlic (against isolate M22) was partially decreased by autoclaving if compared with filtered same extracts.

The present results indicated, in general, that autoclaving some extracts such as rosselle and clove, azedarach and genger make them more toxic against fungal growth and sclerotial formation than same extracts that were sterilized by filtration. The opposite trend was noticed in garlic extract. Little or no variations were detected between toxicity of both autoclaved and filtered extracts of rhubarb.

4- Effect of different chemical inducers and concentrations on linear growth and sclerotial formation of three *M. phaseolina* isolates *in vitro*:

As for linear growth, the data in **Table (18)** illustrated that, the linear growth of the 3 tested *M. phaseolina* isolates was significantly decreased by most tested chemical inducers.

The linear growth of the virulent isolate M9 was the least affected by all tested inducers followed by the moderate isolate M15, whereas, the weakly isolate M22 was the most sensitive one. The highest decrease in linear growth was produced by the IBA (average 28.0 mm) and IAA (average 29.3 mm). Meanwhile, potassium chloride (82.4 mm) and H_2O_2 (79.2 mm) were the least effective. However, salicylic acid, Bion and tanic acid caused intermediate decrease in linear growth i.e., 59.9, 62.0 and 71.5 mm compared with control (85.0 mm). As for IAA and IBA, no linear growth was noticed at concentration of 800 ppm for isolates M9 and M15 and 400 ppm. for isolate M22. Meanwhile, salicylic acid caused no growth of the 3 tested isolates at 1600 ppm.

Table (18): Effect of different concentrations of some resistance inducing agents on linear growth of 3 *M. phaseolina* isolates *in vitro*.

Tested compound	Isolate No.	Concentration [p.p.m.]								Mean
		0	25	50	100	200	400	800	1600	
IAA	M9	85.0	67.7	59.0	49.0	38.7	15.3	0.0	0.0	39.3
	M15	85.0	43.7	31.7	25.3	20.7	5.7	0.0	0.0	26.5
	M22	85.0	41.0	21.3	15.7	13.0	0.0	0.0	0.0	22.0
IBA	M9	85.0	69.0	56.3	48.0	26.7	7.3	1.7	0.0	36.8
	M15	85.0	50.0	43.3	18.7	8.3	6.7	1.3	0.0	26.7
	M22	85.0	30.3	23.7	18.0	7.3	0.0	0.0	0.0	20.5
		Concentration [mM]								
		0	0.1	0.25	0.50	1.0	2.0	4.0	8.0	
Salysalic acid	M9	85.0	85.0	85.0	85.0	85.0	85.0	71.7	0.0	72.7
	M15	85.0	78.6	78.0	77.0	76.0	71.7	71.0	0.0	67.2
	M22	85.0	65.7	47.7	39.0	33.7	26.0	21.7	0.0	39.9
Tanic acid	M9	85.0	85.0	85.0	85.0	85.0	85.0	60.0	23.3	74.2
	M15	85.0	85.0	85.0	85.0	79.7	70.3	52.3	20.7	70.4
	M22	85.0	85.0	85.0	85.0	76.7	71.3	50.3	20.0	69.8
Bion	M9	85.0	85.0	85.0	85.0	85.0	46.3	26.0	11.0	63.5
	M15	85.0	85.0	85.0	76.0	69.3	51.3	33.3	21.3	63.3
	M22	85.0	85.0	81.0	71.0	61.0	37.7	31.0	23.0	59.3
		Concentration [%]								
		0	0.1	0.25	0.50	1.0	2.0	4.0	8.0	
KCl	M9	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
	M15	85.0	85.0	85.0	85.0	85.0	85.0	85.0	81.0	84.5
	M22	85.0	85.0	85.0	85.0	77.3	73.3	71.0	60.7	77.8
H_2O_2	M9	85.0	85.0	85.0	85.0	85.0	85.0	81.3	55.0	80.8
	M15	85.0	85.0	85.0	85.0	85.0	82.3	78.3	57.7	80.4
	M22	85.0	85.0	85.0	85.0	79.7	72.3	62.3	56.3	76.3

LSD. at 5% for

Isolates (Is)	Inducers (I)	Conc. (C)	Is x I	Is x C	I x C	Is x I x C
0.32	0.49	0.53	0.85	0.91	1.39	2.41

Regarding with sclerotial production, data in **Table (19)** showed that, IBA and IAA were the best chemical inducers for decreasing sclerotial formation followed by SA, Bion, tanic acid, whereas KCl and H_2O_2 were the least effective in this respect. The produced number of sclerotia was inversely correlated with concentrations of any chemical inducer. On the other hand, the weakly isolate M22 formed the highest number of sclerotia, whereas, M15 formed the least number of sclerotia. However, virulent isolate M9 formed intermediate number of sclerotia.

Table (19): Effect of different concentration of inducer chemical agents on sclerotial formation of virulent, moderate and weak pathogenic isolates of *M. phaseolina in vitro*.

Tested compound	Isolate No.	Concentration [p.p.m.]								**Mean**
		0	25	50	100	200	400	800	1600	
IAA	M9	*50.0	43.3	36.3	30.7	22.0	12.7	0.0	0.0	24.4
	M15	26.0	22.7	17.3	14.7	10.7	3.0	0.0	0.0	11.8
	M22	170.0	150.0	141.3	119.7	91.7	72.0	0.0	0.0	93.1
IBA	M9	50.0	41.0	33.3	27.0	20.3	11.0	0.7	0.0	22.9
	M15	26.0	15.3	12.3	9.3	6.0	1.7	0.7	0.0	8.9
	M22.	170.0	138.7	124.7	111.0	94.3	66.3	0.0	0.0	88.1
		Concentration [mM]								
		0	0.1	0.25	0.50	1.0	2.0	4.0	8.0	
Salysalic acid	M9	50.0	47.7	43.7	41.0	36.0	28.0	14.7	0.0	32.6
	M15	26.0	25.0	23.0	18.0	16.7	12.7	6.0	0.0	15.9
	M22	170.0	155.7	141.0	131.3	120.0	99.7	86.0	0.0	113.0
Tanic acid	M9	50.0	49.7	47.0	43.0	37.7	33.3	13.7	8.3	35.3
	M15	26.0	25.7	23.3	19.3	15.3	10.0	6.7	1.0	15.9
	M22	170.0	166.0	155.3	143.3	133.0	122.7	106.3	85.3	135.2
Bion	M9	50.0	49.3	45.3	41.7	34.7	31.3	23.7	13.0	36.1
	M15	26.0	24.7	22.0	20.3	18.3	16.3	8.7	2.3	17.3
	M22	170.0	167.7	150.0	138.3	129.3	115.0	92.7	70.3	129.2
		Concentration [%]								
		0	0.1	0.25	0.50	1.0	2.0	4.0	8.0	
KCl	M9	50.0	49.3	48.0	44.3	42.7	39.0	33.3	30.7	42.2
	M15	26.0	26.0	25.0	22.3	19.0	18.3	17.0	11.7	20.7
	M22	170.0	168.7	159.0	152.7	142.0	130.7	104.3	92.7	140.0
H_2O_2	M9	50.0	49.0	46.0	44.7	41.3	33.7	25.7	20.0	38.8
	M15	26.0	26.0	23.0	21.0	18.3	14.7	13.7	12.0	19.3
	M22	170.0	166.7	156.3	148.7	138.3	117.0	96.7	84.3	134.8

LSD. at 5% for Isolates (Is)	Inducers (I)	Conc. (C)	Is x I	Is x C	I x C	Is x I x C
0.50	0.76	0.81	1.31	1.40	2.14	3.70

* = Average number of sclerotia

Greenhouse experiments:

1- The residual effect of the preceding winter crops on charcoal rot disease incidence:

In this study, plants of some winter crops were grown for 5 months in potted soil infested with *M. phaseolina* isolate M9 then the same pots were planted in the next summer season with sesame to investigate the residual effect of these crops on the sesame charcoal rot disease.

The data presented in **Table (20)** and **Fig. (10)** showed that, all measured disease criteria i.e., pre- and post emergence damping off, survived seedlings, charcoal rotted and healthy standing plants were affected significantly by the residual effect of the tested previouly winter crops. In this regard, flax, onion, and garlic induced the best residual effect on controlling infection with *M. phaseolina* on sesame plants that planted in the following summer season. They produced the highest percentages of survived seedlings (85.0%) and healthy standing mature plants (70.0-72.5%). Also they caused the lowest percentages of pre- and post-emergence damping-off at seedling stage (5.0-10.0%) and charcoal rot (12.5-15.0%) at the maturity stage. In point, barley and clover came next followed by safflower, lupine and rapseed, respectively. Percentages of survived sesame seedlings as affected by the later five preceding winter crops were 82.5, 77.5, 65.0, 57.5, and 57.5% while percentages of healthy standing mature sesame plants were 62.5, 57.5, 40.0, 30.0 and 30.0%, respectively.

Table (20): Effect of the preceding winter crops on charcoal rot disease incidence at seedling and maturity stages.

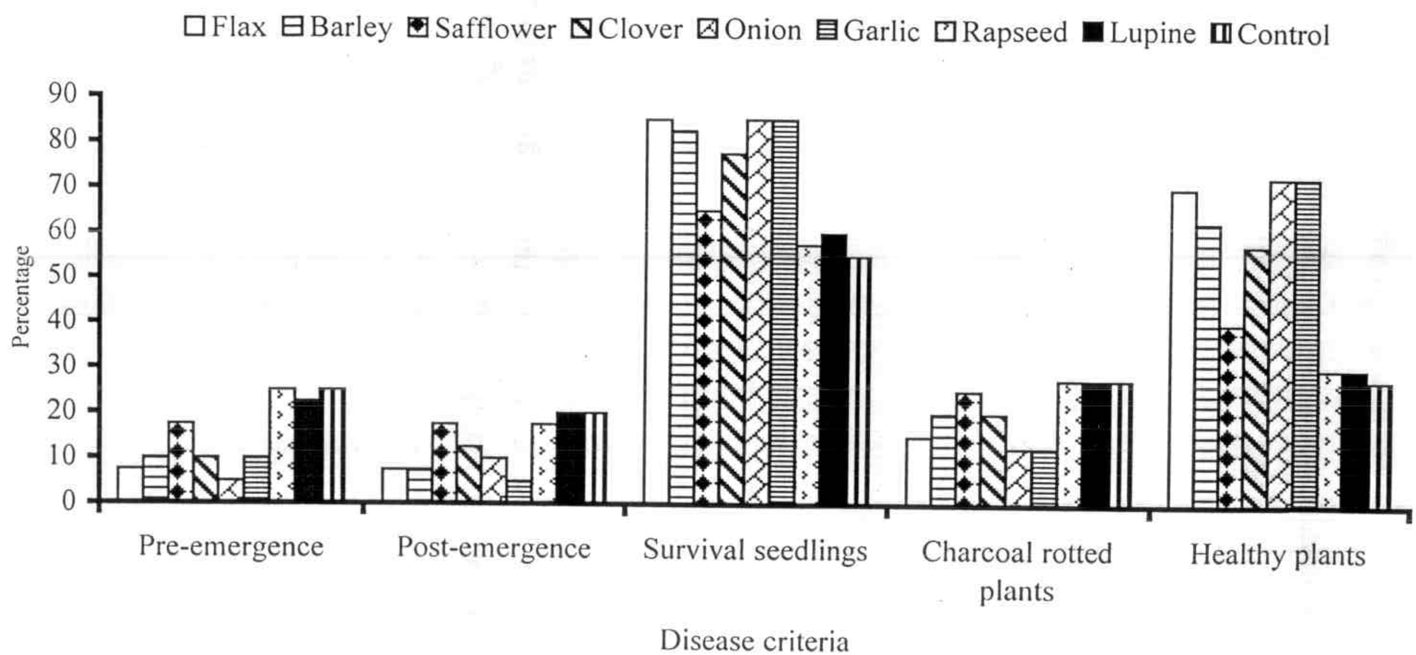
Infested soil	Seedling stage			Maturity stage	
	% Pre-emergence	% Post-emergence	% Survival seedlings	% Charcoal rotted plants	% Healthy plants
Flax	7.5	7.5	85.0	15.0	70.0
Barley	10.0	7.5	82.5	20.0	62.5
Safflower	17.5	17.5	65.0	25.0	40.0
Clover	10.0	12.5	77.5	20.0	57.5
Onion	5.0	10.0	85.0	12.5	72.5
Garlic	10.0	5.0	85.0	12.5	72.5
Rapseed	25.0	17.5	57.5	27.5	30.0
Lupine	22.5	20.0	57.5	27.5	30.0
Un-planted	25.0	20.0	55.0	27.5	27.5
LSD at 5%	9.02	n.s.	11.5	8.26	10.65

2- Effect of soil green amendment with leguminous winter crops and date of sowing on charcoal rot disease.

In this study, the 4 months old vegetative growth of five leguminous winter crops grown in potted soils infested with *M. phaseoilina* isolate M9 was turned in the same potted soils on the last day of April. Then pots were replanted with sesame seeds on the 10th, 20th and 30th of the next month (May). Efficacy of each of these treatments on disease criteria incited by the tested pathogen was estimated.

Results in **Table (21)** indicated that, the average of pre-emergence damping-off in soils amended with faba bean and clover vegetative growths, was decreased significantly to 20.0 & 21.67%, respectively meanwhile soils amended with lintel and chickpea increased it significantly to 39.17 & 37.5%, respectively compared with 27.5% in control treatment (un-amended). However, the average of post-emergence damping-off

Fig. (10): Effect of the preceding winter crops on the charcoal rot disease incidence caused by *M. phaseolina* isolate M9.



was not affected significantly in soils amended with faba bean, clover and lupine but it was increased significantly in soils amended with lintel (34.2%) and chickpea (37.5%) compared with control (27.5%). In soil amended with clover only slight significant increase was noticed in averages of survived seedlings (54.2%) and healthy standing plants (45.8%) compared with 45.0% and 36.7%, respectively in control treatment. The incidence of charcoal rot was not affected significantly by different soil amendments.

The same data proved that, delaying sowing time after soil amendment resulted in significant increase in % pre- and post-emergence damping-off and significant decrease in % survived seedlings and healthy standing mature plants. Sowing sesame seeds 10, 20 and 30 days after soil amendment resulted in 25.0, 27.5 and 34.6% pre-emergence damping-off; 23.3, 30.0 and 37.5% post- emergence damping-off; 51.7, 42.5 and 27.9% survived seedlings and 43.3, 34.2 and 21.7% healthy standing plants, respectively. The obtained results noticed also that the incidence of charcoal rot was not affected significantly by sowing date or the interaction between sowing date and soil amendment.

Table (21): Effect of leguminous winter crops as green amendments on the incidence of charcoal rot disease.

Sowing date	Green amendments	% Disease incidence				
		At seedling stage			At maturity stage	
		% Pre	% Post	% Survival	% Charcoal	% Healthy
10 May	Faba bean	17.5	22.5	60.0	7.5	52.5
	Clover	17.5	20.0	62.5	7.5	55.0
	Lentil	35.0	27.5	37.5	7.5	30.0
	Chickpea	30.0	25.0	45.0	12.5	32.5
	Lupine	25.0	22.5	52.5	7.5	45.0
	Un-planted	25.0	22.5	52.5	7.5	45.0
	Mean	**25.0**	**23.3**	**51.7**	**8.3**	**43.3**
20 May	Faba bean	15.0	30.0	55.0	10.0	45.0
	Clover	22.5	22.5	55.0	7.5	47.5
	Lentil	42.5	30.0	27.5	7.5	20.0
	Chickpea	37.5	42.5	20.0	5.0	15.0
	Lupine	20.0	27.5	52.5	10.0	42.5
	Un-planted	27.5	27.5	45.0	10.0	35.0
	Mean	**27.5**	**30.0**	**42.5**	**8.3**	**34.2**
30 May	Faba bean	27.5	35.0	37.5	7.5	30.0
	Clover	25.0	30.0	45.0	10.0	35.0
	Lentil	40.0	45.0	15.0	5.0	10.0
	Chickpea	45.0	45.0	10.0	2.5	7.5
	Lupine	40.0	37.5	22.5	5.0	17.5
	Un-planted	30.0	32.5	37.5	7.5	30.0
	Mean	**34.6**	**37.5**	**27.9**	**6.3**	**21.7**

LSD at 5% for:	Pre-	Post-	Survival	Rot	Healthy
Amendments	5.69	5.32	6.91	n.s	6.39
Dates	4.02	3.76	4.89	n.s	4.52
Interaction	n.s	n.s	n.s	n.s	n.s

3- Effect of method of application of some fungicides and commercial biocides on sesame charcoal rot disease.

This study was conducted to evaluate effect of treating soil or sesame seeds with some fungicides and/or biocides on controlling charcoal rot disease.

Data obtained in **Table (22)** and **Fig. (11)** indicated that, generally the fungicidal seed treatments controlled disease incidence better than the fungicidal soil treatments. Most if not all measured disease criteria at both seedling and mature stages were improved significantly by the tested fungicidal seed treatments. The best results in this regard was produced by the two fungicides benlate and rizolex-T followed by maxim, vitavax-T and plant gaurd, respectively. Treating sesame seeds with benlate and rizolex-T resulted in 0.0% and 3.3% pre-emergence; 3.3% and 6.7% post-emergence; 96.7% and 90.0% survived seedlings; 3.3% and 6.7% rotted plants and 93.3% and 83.3% healthy standing plants, respectively.

As for soil treatments, slight significant improvement in disease control was produced by amconil meanwhile the fungicides rizolex-T and vitavax-T had no significant effect on disease incidence at seedling stage and produced the lowest significant effect on controlling the disease incidence at maturity stage. Treating soil with the latter 2 fungicides decreased % rotted plants to 13.3% and 13.3% and increased healthy standing plants to 46.7% and 43.3% compared with 23.3% and 26.7%, respectively in control treatment.

4- Effect of treating sesame seeds with some antagonistic fungi and bacteria on incidence of charcoal rot disease:

In this study, some antagonistic fungi and bacteria were used singly as seed dressing to study their effect on pre and post-emergence damping-off as well as charcoal rot disease incidence under greenhouse conditions. The used fungi and bacteria including *Trichoderma harzianum, T. hamatum, T. viride,* *Trichoderma* spp. No.2, 3, 5, 6, 8, 9, 10, *Gilocladium penicilloides* and *Cheatomium bostrycoides*, *Bacillus subtilis*, *B. megtella* and *Bacillus* spp. No. 3)

Table (22): Effect of some fungicides and commercial biocides that applied as seed or soil treatments on the incidence of damping-off and charcoal rot diseases.

Fungicides and	Method of application	% Disease incidence				
		At seedling stage			At maturity stage	
		% Pre-	% Post-	% Survival	% Rotted plants	% Healthy plants
Rizolex-T	Seed	3.3	6.7	90.0	6.7	83.3
Rizolex-T	Soil	23.3	16.7	60.0	13.3	46.7
Vitavax-thiram	Seed	13.3	10.0	76.7	13.3	63.3
Vitavax-thiram	Soil	20.0	23.3	56.7	13.3	43.3
Plant guard	Seed	16.7	3.3	80.0	16.7	63.3
Benlate	Seed	0.0	3.3	96.7	3.3	93.3
Maxim	Seed	6.7	13.3	80.0	10.0	70.0
Rhizo-N	Seed	16.7	16.7	66.7	13.3	53.3
Amconil	Soil	13.3	16.7	70.0	20.0	50.0
Control		**26.7**	**23.3**	**50.0**	**23.3**	**26.7**

	Pre	Post	Survival	Rot	Healthy
L.S.D at 5% for:	8.61	9.53	11.5	9.29	11.77

The data in **Table (23)** and **Fig. (12)** showed that, most tested antagonistic fungi and bacteria were significantly effective in controlling disease incidence at seedling and/or maturity stages. The disease control at seedling stage in term of % survived seedlings, it could be noticed that the maximum percentage of survived seedlings was produced by *Trichoderma harzianum* (100.0%) followed by *Chaetomium bostrycoides* (96.7%) and *Trichoderma* sp. No. 5 (93.3%) without significant differences between them followed by *T. hamatum* (86.7%). However, the lowest significant increases in % survived seedlings were produced by *Trichoderma* sp 3 (60.0%) followed by *Trichoderma* sp 8 (63.3%) and *Gliocladium penicilloides* (63.3%). The latter 3 antagonist fungi had no significant effect on suppressing post-emergence damping-off (20.0-26.7%) compared with control (26.7%).

As for controlling disease at maturity stage, the same data proved that *Trichoderma harzianum*, *Chaetomium bostrycoides*, *T. hamatum*, *T. viride*, *Trichoderma sp 5* and *Trichoderma sp 6* were the best for causing significant reduction in incidence of charcoal rotted plants (3.3-10.0%) compared with control (26.7%). The incidence of charcoal rot was not significantly affected by *Bacillus subtillus*, *Trichoderma* sp 8, *Trichoderma* sp 10, *Bacillus* sp3, *B. megtella* and *Gliocladium penicilloides* (20.0-26:7%). Finally, *Trichoderma harzianum* and *Chaetomium bostrycoides* produced the highest % healthy standing plants i.e., 96.7 and 90.0%, respectively without significant differences followed by *Trichoderma* sp 5 (83.3%) and *T. hamatum* (80.0%). However, the lowest significant increase in healthy standing plants was induced by *Trichoderma* sp 3, *Trichoderma* sp 8, *B. megtella* (43.3%), *Gliocladium penicilloides* (36.7%) and *Trichoderma* sp 10 (30.0%) compared with control (16.7%).

Fig. (11): Effect of some fungicides and commercial biocides applied as seed or soil treatments on the incidence of charcoal rot disease.

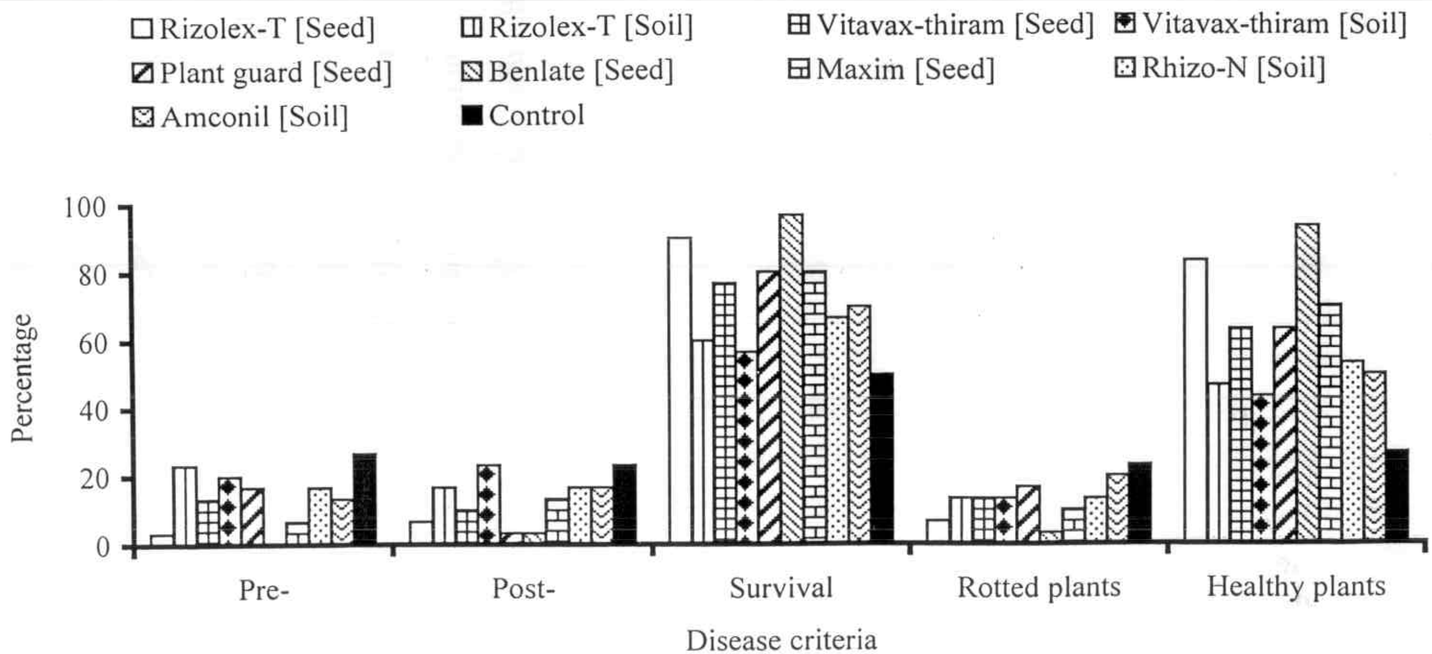


Fig. (12): Effect of some antagonistic fungi and bacteria on sesame charcoal rot disease.

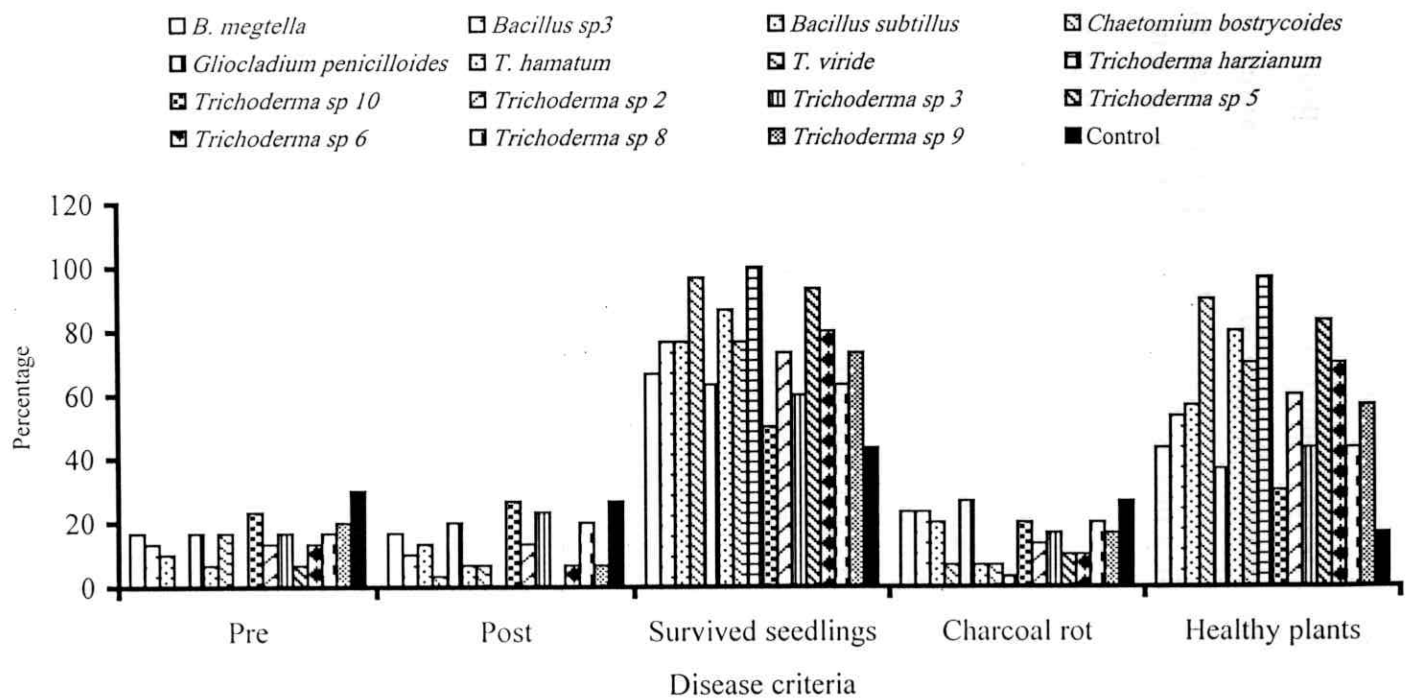


Table (23): Effect of some antagonistic fungi and bacteria on charcoal rot disease incidence on sesame plants.

Antagonistic fungi or bacteria	Disease incidence				
	At seedling stage			At maturity stage	
	% Pre	% Post	% Survival	% Rot	% Healthy
B. megtella	16.7	16.7	66.7	23.3	43.3
Bacillus sp3	13.3	10.0	76.7	23.3	53.3
Bacillus subtillus	10.0	13.3	76.7	20.0	56.7
Chaetomium bostrycoides	0.0	3.3	96.7	6.7	90.0
Gliocladium penicilloides	16.7	20.0	63.3	26.7	36.7
T. hamatum	6.7	6.7	86.7	6.7	80.0
T. viride	16.7	6.7	76.7	6.7	70.0
Trichoderma harzianum	0.0	0.0	100.0	3.3	96.7
Trichoderma sp 10	23.3	26.7	50.0	20.0	30.0
Trichoderma sp 2	13.3	13.3	73.3	13.3	60.0
Trichoderma sp 3	16.7	23.3	60.0	16.7	43.3
Trichoderma sp 5	6.7	0.0	93.3	10.0	83.3
Trichoderma sp 6	13.3	6.7	80.0	10.0	70.0
Trichoderma sp 8	16.7	20.0	63.3	20.0	43.3
Trichoderma sp 9	20.0	6.7	73.3	16.7	56.7
Control	30.0	26.7	43.3	26.7	16.7
LSD. at 5%	8.17	9.05	10.32	7.96	9.53

5- Effect of vesicular arbuscular-mycorrhizal (VAM) on sesame charcoal rot disease incidence.

In this experiment the potted soil infested with *M. phaseolina* was inoculated with soil preparations containing different VAM fungi at rate of 100 g/pot or with mixture of VAM axenic culture preparation at rates of 1, 2, 4, and 8 g/Kg soil just before sowing sesame seeds. Effect of these different VAM treatments on disease incidence was determined.

A- Effect of inoculation with some VAM- soil preparations on charcoal rot disease incidence:

Data in **Table (24)** and **Fig. (13-A)** showed that, the inoculation with soil preparations containing G1+G2+G3+G4 followed by G1 (*G. macrocarpum*) alone and G3+G4 were the best treatments for controlling disease incidence at the seedling stage without significant differences. These 3 VAM treatments decreased % pre-emergence damping-off to 0.0, 3.3 and 6.7% and increased survived seedlings to 93.3, 86.7 and 83.3%, respectively. However, the soil preparations containing G2 (*G. austerli*) or G3 (*Glomus* sp.) each alone, G1+G2 and G1+G3 showed no significant effect on pre-emergence damping-off (16.7-23.3%) and survived seedlings (60.0-66.7%) compared with the corresponding figures in control treatment i.e., 23.3% and 56.7%, respectively. The soil preparation containing G1+G4 has no significant effect on % pre-emergence damping-off but caused significant increase in survived seedling (70.0%).

Percentage of post-emergence damping-off (at seedling stage) and charcoal rotted plants (at mature stage) was not significantly affected by all tested soil VAM preparations but the lowest percentage (6.7%) was induced by preparation containing the 4 VAM fungi (G1+G2+G3+G4). The latter VAM treatment was best of all tested treatments for maximizing % healthy standing plants (86.7%) followed by G1 alone (76.7%), G3+G4 (70.0%), G2+G3 (63.3%), and G4 "mati VAM" (63.3%). The soil preparation containing G2 alone has no significant effect on healthy standing plants (43.3%) meanwhile, G2 alone, G3 alone and G1+G2 produced the lowest increases i.e., 43.3%, 53.3% and 46.7%, respectively compared with 36.7% in control treatment.

Table (24): Effect of VAM soil preparations on sesame charcoal rot disease.

VAM soil preparation	% Disease incidence				
	Seedling stage			Maturity stage	
	% Pre-emergence	% Post-emergence	% Survival seedlings	% Charcoal rot	% Healthy plants
G. macrocarpum [G1]	3.3	10.0	86.7	10.0	76.7
G. australe [G2]	23.3	16.7	60.0	16.7	43.3
Malti VAM [G4]	13.3	10.0	76.7	13.3	63.3
Glomus sp. [G3]	20.0	13.3	66.7	13.3	53.3
G1 + G2	20.0	16.7	63.6	16.7	46.7
G1 + G3	16.7	16.7	66.7	13.3	53.3
G1 + G4	16.7	13.3	70.0	10.0	60.0
G2 + G3	13.3	13.3	73.3	10.0	63.3
G2 + G4	10.0	16.7	73.3	13.3	60.0
G3 + G4	6.7	10.0	83.3	13.3	70.0
G1+G2 + G3 +G4	0.0	6.7	93.3	6.7	86.7
Control	23.3	20.0	56.7	20.0	36.7
LSD. at 5%	9.63	n.s.	11.70	n.s.	8.55

B- Effect of inoculation with mixture of axenic culture preparation contained 4 VAM fungal isolates on charcoal rot disease incidence:

In this study, 4 isolates of VAM fungi isolated from roots of onion, broad bean, Swiss cheese and maize plants and grown axenically on modified barley-sand medium were kindly provided by Prof. Dr. El-Fiki. The 4 isolates were mixed together and added to the potted sterilized soil at four levels i.e., 1, 2, 4 and 8 g/kg soil at the same time of soil infestation with the tested pathogen. The effect of these VAM treatments on disease incidence was determined.

Data in **Table (25)** and **Fig. (13-B)** show that, adding the different levels of VAM preparation containing mixture of axenic cultures of 4 isolates of VAM fungi to soils infested with

Fig. (13-A): Effect of VAM soil preparations on sesame charcoal rot disease incidence.

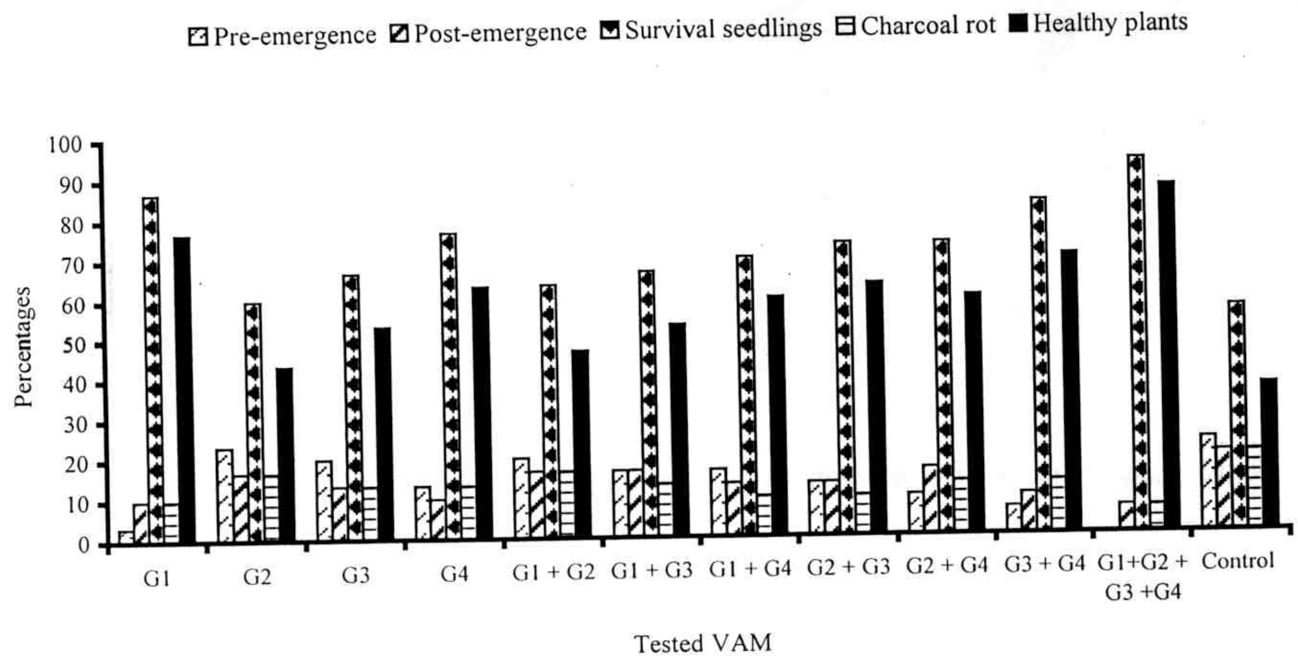
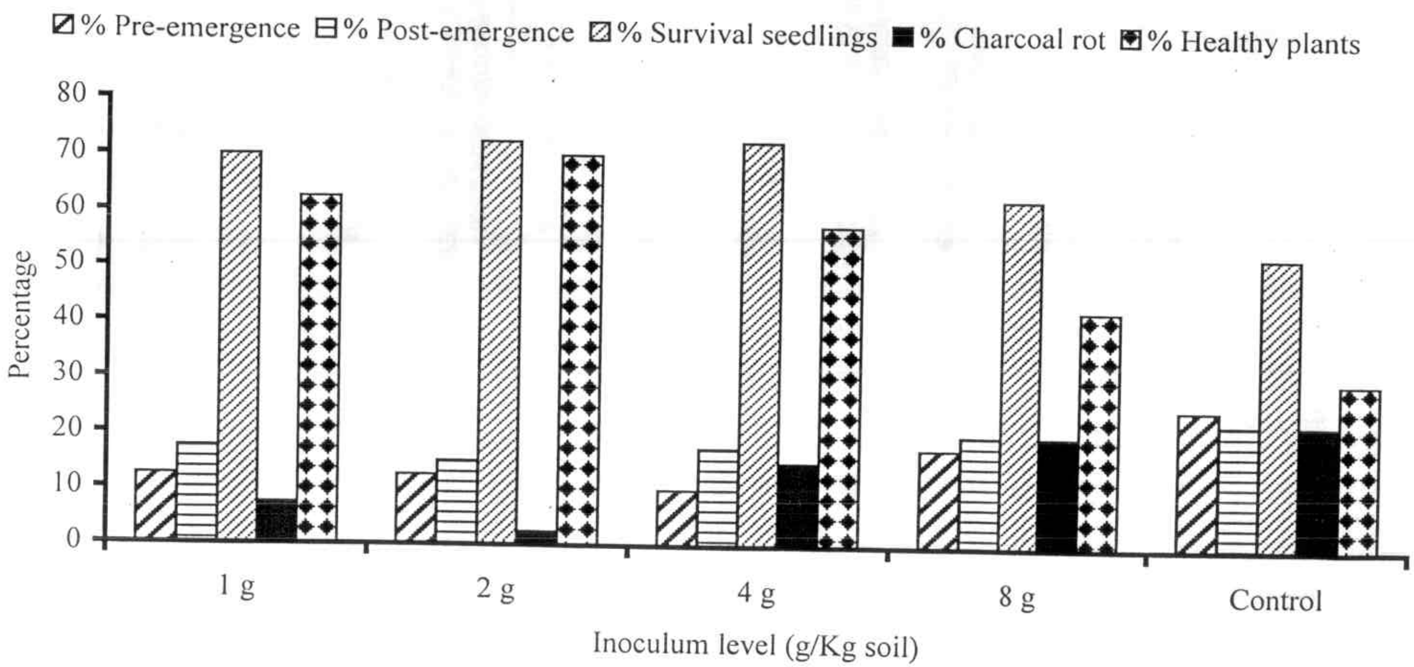


Fig. (13-B): Effect of different levels of axenic cultures of VAM fungi on charcoal rot disease incidence.



M. phaseolina resulted in significant improvement in disease control at seedling (pre-emergence damping-off and survived seedlings) and maturity stages (healthy standing plants). Applying this preparation at rates of 1, 2, 4 and 8 g/Kg potted soil reduced % pre-emergence damping-off to 12.5, 12.5, 10, and 17.5% and increased % survived seedlings to 70.0, 72.5, 72.5 and 62.5% and healthy standing plants to 62.5, 70.0, 57.5 and 42.5%, respectively. The incidence of post-emergence damping-off was not significantly decreased by all tested levels (15.0-20.0%) compared with control (22.5%). However, the lowest incidence of charcoal rotted plants were induced by the inoculum rates 1 and 2 g/Kg soil, respectively. The highest 2 levels i.e., 4 and 8 g/Kg soil showed no significant difference in the incidence of charcoal rot when compared with control treatment.

Table (25): Effect of different levels of axenic cultures of vesicular arbuscular mycorrhizal [VAM] fungi on charcoal rot disease incidence on sesame plants.

Tested VAM fungi	% Disease incidence				
	Seedling stage			Maturity stage	
	% Pre-emergence	% Post-emergence	% Survival seedlings	% Charcoal rot	% Healthy plants
1 g/kg soil	12.5	17.5	70.0	7.5	62.5
2 g/kg soil	12.5	15.0	72.5	2.5	70.0
4 g/kg soil	10.0	17.5	72.5	15.0	57.5
8 g/kg soil	17.5	20.0	62.5	20.0	42.5
Control	25.0	22.5	52.5	22.5	30.0
LSD. at 5%	**7.31**	**n.s.**	**7.17**	**7.83**	**9.01**

C- Microscopic examination of roots of sesame plants inoculated with VAM- soil preparations or with mixture 4 VAM fungal isolates produced in axenic cultures:

The microscopic examination of macerated roots of sesame plants grown in sterilized potted soil infested with the charcoal rot pathogen (*M. phaseolina*) only showed extensive numbers of *M. phaseolina*-sclerotia in addition few numbers of some structures characterizing the VAM fungi i.e., vesicles **(Fig. 14-A & -B)**. The later VAM structures were detected also in roots of sesame plants grown in the sterilized potted soil without pathogen "non-infested" **(Fig. 14-C)** or inoculated with any of the tested soil VAM preparations **(Fig. 14-D)**. The formation of the pathogen sclerotia was nearly absent while extensive VAM structures were noticed in roots of sesame plants grown in potted soils containing both charcoal rot pathogen and any of the tested VAM soil or axenic culture preparations **(Fig. 14-E, -F, and -G)**.

6- Effect of filtered and autoclaved watery plant extracts on controlling the incidence of charcoal rot disease on sesame plants.

This study aimed to evaluate effect of soaking sesame seeds in the solutions of the above mentioned filtered or autoclaved aqueous plant extracts on suppressing the incidence of sesame pre- and post emergence damping-off and charcoal rot under greenhouse conditions.

Data presented in **Table (26)** and **Figs. (15 and 16)** indicated that, all determined disease criteria were significantly affected by tested plant extracts compared with control treatment. No significant variations were detected between averages of both filtered and autoclaved extracts. As for source of extract, the same data revealed that extracts of rhubarb, cumin, anise, rosselle, azedarach and clove

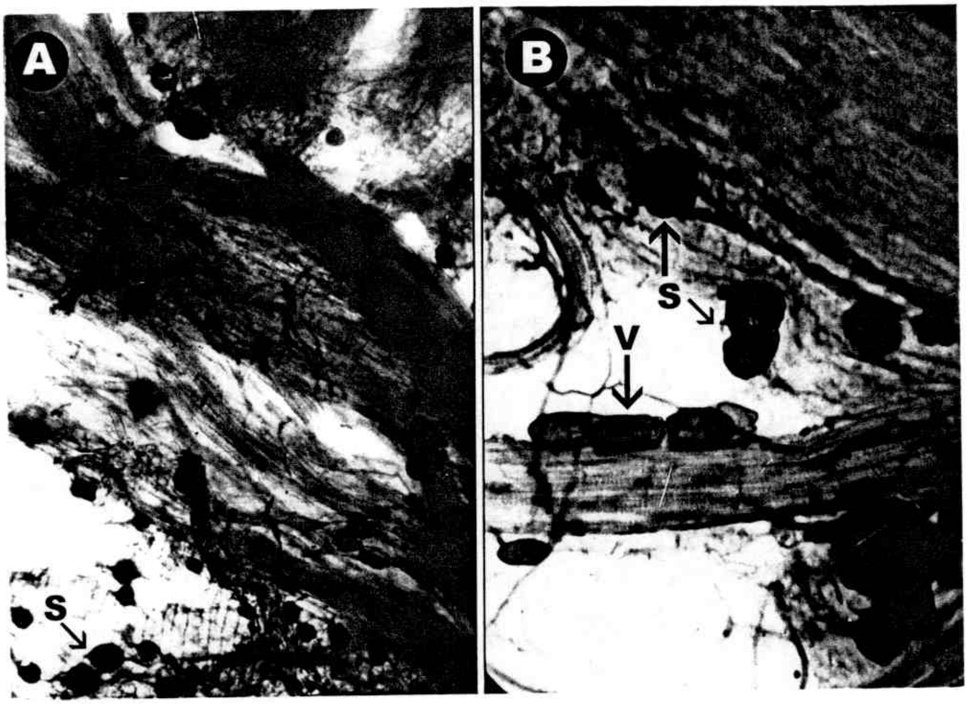


Fig (14 A&B): illustrated the extensive numbers of sclerotia (s) in adding a few numbers of some vesicles of VAM fungi.

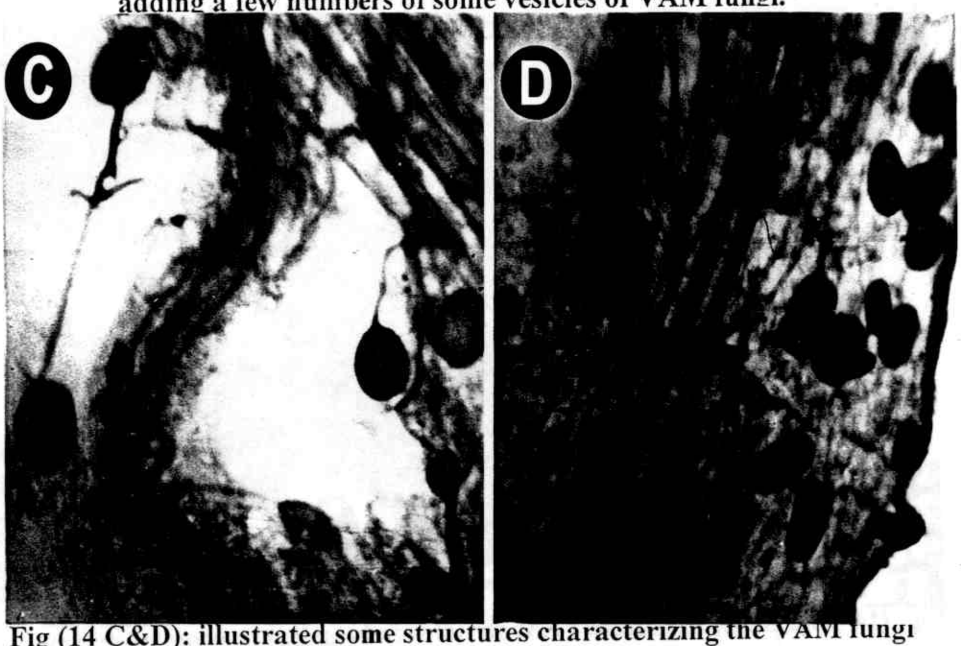


Fig (14 C&D): illustrated some structures characterizing the VAM fungi i.e., vesicles in macerated roots of sesame plants that grown in sterilized soil without pathogen (control "C") or inoculated with VAM fungi preparations "D".

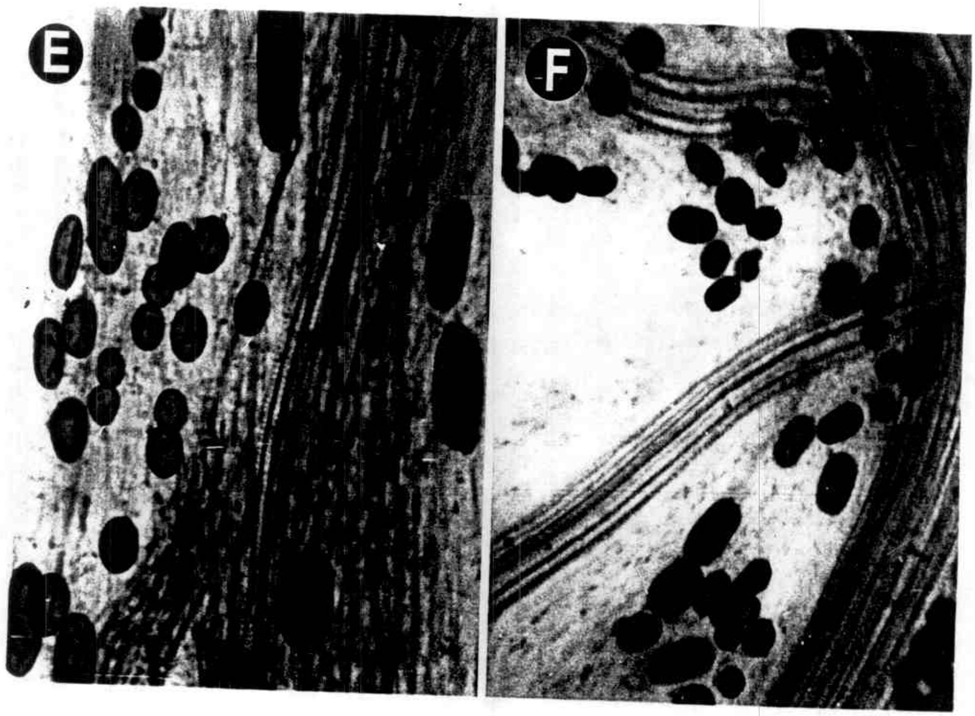


Fig (14 E&F): Show extensive VAM structures in roots of sesame plants grown in soil inoculated with Malt-Vam mycorrhiza "E" and

Fig (14 G): Show extensive VAM structures (vescles) in roots of sesame plants which grown in soil inoculated with 0.4% inoculum.

Fig. (15): Effect of filtered watery plant extracts on the incidence of charcoal rot disease.

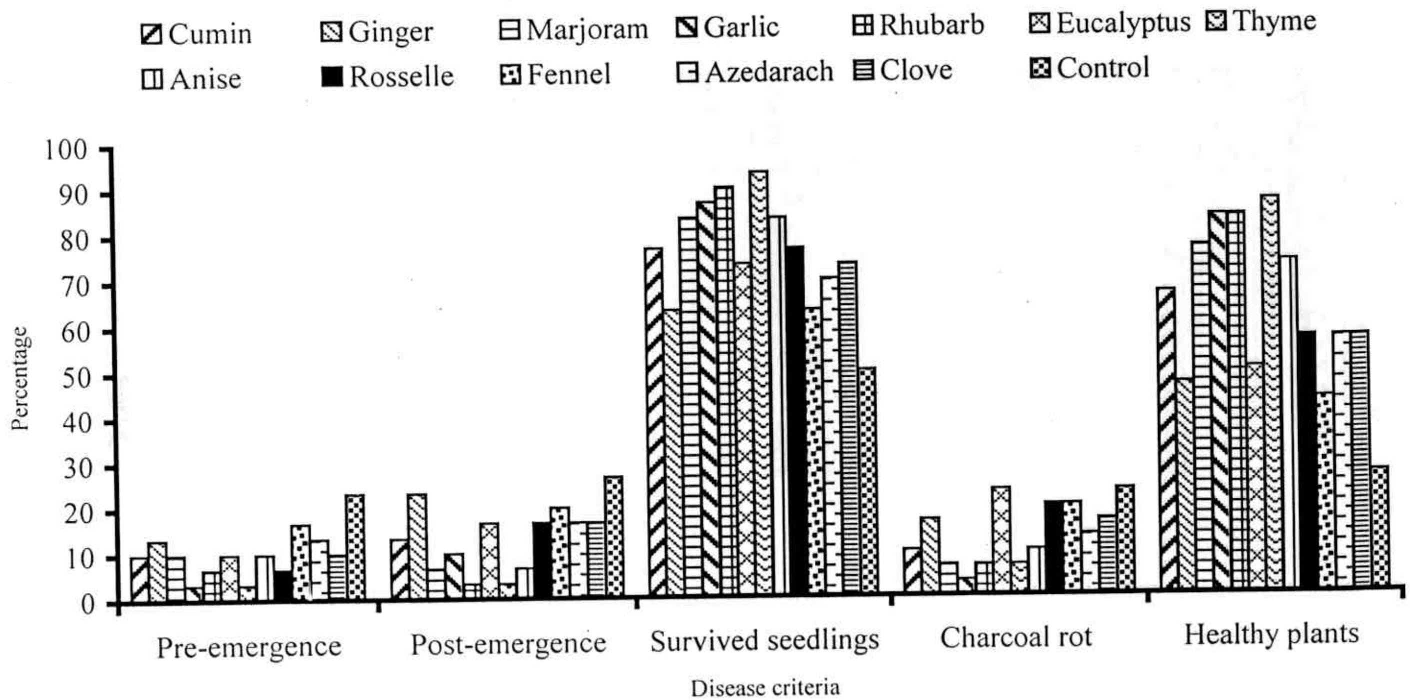
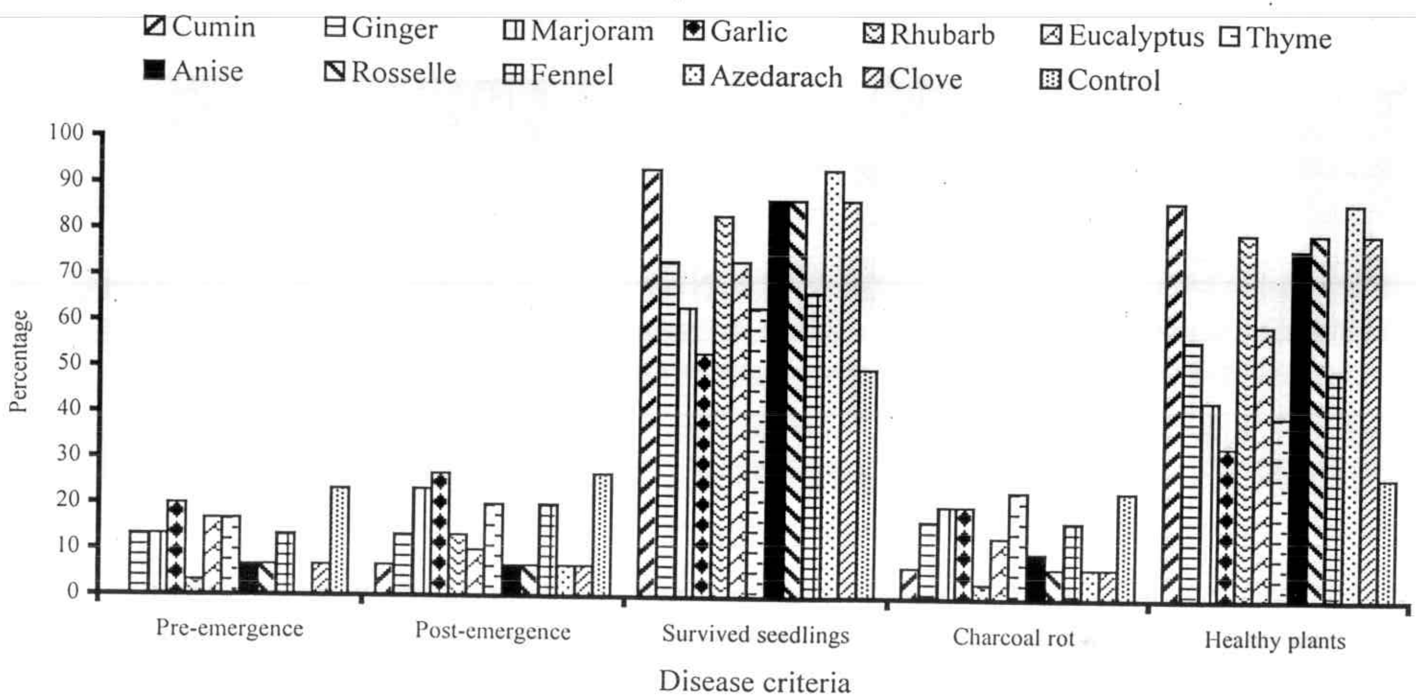


Fig. (16): Effect of autoclaved watery plant extracts on the incidence of charcoal rot disease.



in the listed order followed by thyme and marjoram were the best for minimizing percentages of both pre- and post-emergence damping-off and maximizing percentage of survived seedlings. At these disease stages, the extracts of ginger, eucalyptus and fennel were the least effective without significant differences in between. On the other hand, the extracts of rhubarb, cumin, and anise were the best for controlling incidence of charcoal rot and increasing percentages of healthy plants.

Table (26): Effect of filtered and autoclaved watery plant extracts on charcoal rot disease incidence.

Source of plant extract	Extracts									
	Filtered extracts					Autoclaved extracts				
	Pre-emergence	Post-emergence	% Survived seedlings	% Charcoal rot	% Healthy plants	Pre-emergence	Post-emergence	% Survived seedlings	% Charcoal rot	% Healthy plants
Cumin	10.0	13.3	**76.7**	10.0	66.7	0.0	6.7	93.3	6.7	86.7
Ginger	13.3	23.3	**63.3**	16.7	46.7	13.3	13.3	73.3	16.7	56.7
Marjoram	10.0	6.7	**83.3**	6.7	76.7	13.3	23.3	63.3	20.0	43.3
Garlic	3.3	10.0	**86.7**	3.3	83.3	20.0	26.7	53.3	20.0	33.3
Rhubarb	6.7	3.3	**90.0**	6.7	83.3	3.3	13.3	83.3	3.3	80.0
Eucalyptus	10.0	16.7	**73.3**	23.3	50.0	16.7	10.0	73.3	13.3	60.0
Thyme	3.3	3.3	**93.3**	6.7	86.7	16.7	20.0	63.3	23.3	40.0
Anise	10.0	6.7	**83.3**	10.0	73.3	6.7	6.7	86.7	10.0	76.7
Rosselle	6.7	16.7	**76.7**	20.0	56.7	6.7	6.7	86.7	6.7	80.0
Fennel	16.7	20.0	**63.3**	20.0	43.3	13.3	20.0	66.7	16.7	50.0
Azedarach	13.3	16.7	**70.0**	13.3	56.7	0.0	6.7	93.3	6.7	86.7
Clove	10.0	16.7	73.3	16.7	56.7	6.7	6.7	86.7	6.7	80.0
Control	23.3	26.7	50.0	23.3	26.7	23.3	26.7	50.0	23.3	26.7
Mean	**10.5**	**13.9**	**75.6**	**13.6**	**62.1**	**10.8**	**14.4**	**74.9**	**13.3**	**61.6**

L.S.D. at 5% for:	Pre-	Post-	Survival	Rot	Healthy
Kind of extract	n.s.	n.s.	n.s.	n.s.	n.s.
Source of extract	6.92	6.47	8.06	5.82	6.61
Interaction	9.79	9.16	11.40	8.23	9.35

The same data proved that the different disease criteria were affected differently by both filtered (F) and autoclaved (A) plant extracts. The lowest percentage of pre-emergence damping-off was induced by extracts of cumin (A) followed by azederach (A), garlic (F), thyme (F), rhubarb (A), rhubarb (F), roselle (F), Anise (A), roselle (A) and clove (A). With regard to controlling post-emergence damping off, extract of rhubarb (F) was the best followed by thyme (F), marjoram (F), anise (F), cumin (A), anise (A), roselle (A) and clove (A). Whatever, the highest percentages of survived seedlings were produced by extract of thyme (F), followed by cumin (A), azederach (A), rhubarb (F), garlic (F), anise (A), roselle (A), clove (A, marjoram (F), anise (F), and rhubarb (A).

Regarding charcoal rot and healthy plants, the same results indicated that, the filtered extracts were more effective than autoclaved extracts of thyme, garlic and marjoram in reducing charcoal rot infection and increasing healthy standing plants. The filtered extracts of these 3 plants reduced charcoal rot to 6.7, 3.3 and 6.7% compared with 23.3, 20.0 and 20.0% in case of their autoclaved extracts, respectively. Similarly, the healthy standing plants were 86.7, 83.3 and 76.7% in case of filtered extracts and 40.0, 33.3 and 43.3% in case of autoclaved extracts of the same 3 plants, respectively. On contrast, the autoclaved extracts were more effective than fltered extracts of cumin, azedarach, roselle and clove for controlling charcoal rot and increasing healthy standing plants. The autoclaved extracts of these 4 plants decreased charcoal rot infection to 6.7, 6.7, 6.7 and 6.7% compared with 10.0, 13.3, 20.0 and 16.7% in case of their filtered extracts, respectively. Also, % healthy standing plants was higher in case of the autoclaved extracts of the latter 4 plants i.e., 86.7, 86.7, 80.0 and 80.0% than their filtered extracts i.e., 66.7, 56.7, 56.7 and 56.7%, respectively. It is interest to state that both filtered and autoclaved extracts of ginger and anise were approximately equal in controlling disease incidence and increasing healthy standing plants.

The above results concluded that the best control of charcoal rot disease on sesame plants could be obtained by soaking sesame seeds in filtered extracts of thyme, rhubrab or garlic (healthy standing plants 83.3-86.7%) or autoclaved extracts of cumin or azedarach (healthy standing plants 86.7%)

7- Efficiency of soaking sesame seeds in different concentrations of some chemicals inducing systemic resistance against infection with charcoal rot disease:

In this study, 7 chemical compounds each at four concentrations were used for soaking sesame seeds. Salicylic acid (SA), tanic acid (Tan) and Bion were used at 1, 2, 4 and 8 mM. Indol acetic acid (IAA) and indol butyric acid (IBA) were used at 50, 100, 200 and 400 ppm. Hydrogen peroxide (H_2O_2) and potassium chloride (KCl) were used at 0.5, 1, 2 and 4%. Effect of different treatments on disease incidence, activities of oxidative enzymes, phenols content and sugars content was determined.

7A - Effect on disease incidence:

Data presented in **Table (27-A)** showed that, indol butyric acid (IBA) and salicylic acid (SA) were the most effective for decreasing pre-emergence damping-off (averages 4.2 and 6.7%, respectively), followed by indol acetic acid (IAA), potassium chloride (KCl), tanic acid and Bion (13.4, 14.2, 16.7 and 20.8%, respectively). However, hydrogen peroxide (H_2O_2) shows no significant effect on pre-emergence damping-off (24.2%).

In general, IBA prevent incidence of pre-emergence damping-off at 100 ppm (0.0%) and minimizes it to 3.3% and 3.3% at 200 ppm and 400 ppm, respectively. SA also caused complete suppression of pre-emergence (0.0%) at 2 mM and causes 3.3% only at 4 mM. IAA induces 6.7% pre-emergence at 100 ppm. It is worthy to state that the above-mentioned concentrations of IBA, SA and IAA were significantly equal against incidence of pre-emergence damping-off stage.

Concerning the post-emergence damping off, the same data indicated that, salicylic acid followed by IBA, IAA and tanic acid caused the highest significant decreases in post emergence damping-off (averages 2.5, 5.0, 5.8 and 5.8%, respectively). While, Bion, KCl and H_2O_2 caused the least significant decreases (averages 11.7, 13.3 and 17.5%, respectively). The highest decreases in post-emergence damping-off (0.0-6.7%) were caused by IBA at 100, 200, and 400 ppm; SA at 1, 2, 4, and 8 mM; IAA at 50, 100, and 200 ppm; and Tanic acid at 1, 2, and 4 mM. IBA at 100 and 200 ppm and SA at 8 mM were the most superior treatments in this respect. While, H_2O_2 at 8% was the least effective in reduction of post-emergence.

Regarding with the survived seedlings, the same results showed that, IBA and SA caused the highest increase in average of survived seedlings (90.8%) followed by IAA and tanic acid (80.8 and 77.5%), while, KCl and Bion were intermediate. However, H_2O_2 was the least effective one in this respect when compared with control treatment. IAA at 100 ppm; IBA at 100, 200, and 400 ppm; SA at 2, 4, and 8 mM were significantly equal in improving survived seedlings (90.0-100.0%) but the superior treatments were IBA at 100 ppm (100.0%) and 200 ppm (96.7%) and SA at 4 mM (96.7%).

Concerning the charcoal rot disease and healthy plants, data in **Table (27-B)** indicated that all tested treatments were significantly effective when compared with control treatment. However, SA and IBA were the best treatments for controlling the disease incidence as they minimized averages % charcoal rot disease to 1.7% and 6.7% and increased averages % healthy standing plants to 89.2% and 84.2%, respectively. While, H_2O_2 and KCl were the least effective as they decreased charcoal rot to 13.3% and 17.5% compared with 23.3% in control treatment. The later treatments increased healthy standing plants to 55.0%

and 45.0% compared with 26.7% in control treatment. As for Tanic acid, IAA, and Bion, they decreased charcoal rot to 8.3%, 9.2%, and 10.8% and increased healthy standing plants to 69.2%, 71.7%, and 56.7%, respectively. Whatever, IBA at 100 ppm and SA at 4 mM were the superior treatments as they completely suppressed incidence of charcoal rot (0.0%) and produces the maximum healthy standing plants i.e., 100.0% and 96.7% healthy standing plants without significant differences between them. IAA at 100 ppm and Tanic acid at 2 mM came next. The latter treatments produced 3.3% charcoal rot and 86.7% and 80.0% healthy standing plants, respectively.

7B - Effect on the oxidative enzymes:

Data in **Table (28)** showed that all tested chemical inducers increased the activity level of any of the three oxidative enzymes i.e., peroxidase, polyphenol oxidase and catalase measured as optical density/minute/g fresh weight in tissues of sesame plants that were grown from treated seeds compared with those grown from untreated seeds (control).

Table (27-A): Effect of different concentrations of chemical inducers as seed soaking on the induction of resistance against incidence of damping-off that caused by *M. phaseolina* on sesame plants.

Disease Incidence	Inducers	Concentrations *				
		I	II	III	IV	Mean
% Pre-emergence	H_2O_2	26.7	23.3	20.0	26.7	24.2
	KCl	13.3	16.7	16.7	10.0	14.2
	IAA	16.7	6.7	13.3	16.7	13.4
	IBA	10.0	0.0	3.3	3.3	4.2
	SA	13.3	3.3	0.0	10.0	6.7
	Tanic acid	20.0	13.3	16.7	16.7	16.7
	Bion	13.3	23.3	20.0	26.7	20.8
	Control	26.7	26.7	26.7	26.7	26.7
	Mean	17.5	14.2	14.6	17.1	
% Post-emergence	H_2O_2	16.7	16.7	13.3	23.3	17.5
	KCl	16.7	20.0	13.3	3.3	13.3
	IAA	6.7	3.3	3.3	10.0	5.8
	IBA	13.3	0.0	0.0	6.7	5.0
	SA	3.3	3.3	3.3	0.0	2.5
	Tanic acid	6.7	3.3	3.3	10.0	5.8
	Bion	6.7	13.3	10.0	16.7	11.7
	Control	23.3	23.3	23.3	23.3	23.3
	Mean	11.7	10.4	8.7	11.7	
% Survived seedlings	H_2O_2	56.7	60.0	66.7	50.0	58.4
	KCl	70.0	63.3	70.0	86.7	72.5
	IAA	76.7	90.0	83.3	73.3	80.8
	IBA	76.7	100	96.7	90.0	90.8
	SA	83.3	93.3	96.7	90.0	90.8
	Tanic acid	73.3	83.3	80.0	73.3	77.5
	Bion	80.0	63.3	70.0	56.7	67.5
	Control	50.0	50.0	50.0	50.0	50.0
	Mean	70.8	75.4	76.7	71.3	

* H_2O_2 and KCl used at conc. 0.5, 1, 2 and 4%, IAA and IBA used at rate 50, 100, 200 and 400 ppm, while, SA, Tanic acid and Bion used at conc. 1, 2, 4 and 8 mM.

LSD. at 0.05 for:	Pre	Post	Surv.
Chemical Inducer (I):	4.10	4.23	5.79
Concentrations (C):	2.90	N.S.	4.10
I x C	8.19	8.45	11.58

Table (27-B): Effect of different concentrations of chemical inducers as seed soaking for the induction of resistance of sesame plants against incidence of charcoal rot that caused by *M. phaseolina*.

Disease Incidence	Inducers	Concentrations *				
		I	II	III	IV	Mean
Charcoal rot	H_2O_2	10.0	13.3	16.7	13.3	13.33
	KCl	20.0	20.0	13.3	16.7	17.50
	IAA	10.0	3.3	10.0	13.3	9.15
	IBA	13.3	0.0	6.7	6.7	6.68
	SA	3.3	3.3	0.0	0.0	1.65
	Tanic acid	10.0	3.3	6.7	13.3	8.33
	Bion	3.3	10.0	13.3	16.7	10.83
	Control	23.3	23.3	23.3	23.3	23.30
	Mean	11.65	9.56	11.25	12.91	
Healthy plants	H_2O_2	46.7	46.7	50.0	36.7	45.03
	KCl	50.0	43.3	56.7	70.0	55.00
	IAA	66.7	86.7	73.3	60.0	71.68
	IBA	63.3	100.0	90.0	83.3	84.15
	SA	80.0	90.0	96.7	90.0	89.18
	Tanic acid	63.3	80.0	73.3	60.0	69.15
	Bion	76.7	53.3	56.7	40.0	56.68
	Control	26.7	26.7	26.7	26.7	26.70
	Mean	59.18	65.84	65.43	58.34	

* H_2O_2 and KCl used at conc. 0.5, 1, 2 and 4%, IAA and IBA used at rate 50, 100, 200 and 400 ppm, while, SA, Tanic acid and Bion used at conc. 1, 2, 4 and 8 mM.

LSD. at 0.05 for:	Charcoal	Healthy
Chemical Inducer (I):	3.95	5.94
Concentrations (C):	n.s.	4.20
I x C	7.90	11.87

The activity level of any of these oxidative enzymes as affected by the tested chemicals and their concentrations was conspicuously varied. In this respect, the level activity of peroxidase enzyme was higher in IBA treatment followed by SA, H_2O_2, Bion and IAA treatments, which recorded 1.45, 1.44, 1.44, 1.41 and 1.38, respectively. Meanwhile, Tanic acid and KCl recorded the lowest increases in levels of this enzyme i.e., 1.21 and 1.20, respectively compared with 0.63 in control treatment. In general, SA at 2 mM shows the highest level of peroxidase activity (1.97) followed by IBA at 100 ppm (1.87), Bion at 1 mM (1.78) and H_2O_2 at 0.5% (1.77), IAA at 200 ppm (1.53), Tanic acid at 2mM (1.35) and KCl at 2.0% (1.29).

As for polyphenoloxidase (PPO) activity, IBA recorded the highest level of PPO activity (average 1.43) followed by IAA (1.37), SA (1.33), H_2O_2 (1.30), Tanic acid (1.28), KCl (1.18), and Bion (1.18). Whatever, IBA at 200 ppm induced the highest PPO activity (1.70) followed by Tanic acid at 1 mM (1.52), SA at 2 mM (1.51), IAA at 50 ppm (1.48), H_2O_2 at 0.5% (1.39), KCl at 2.0% (1.29) and bion at 1 mM (1.26).

Concerning with catalase activity, the same results showed that, IBA recorded the highest increase in level of catalase activity (average 2.63), followed by Bion (2.60), IAA (2.55), KCl (2.54), SA (2.48), H_2O_2 (2.28) and Tanic acid (2.22), respectively. As for interaction, the highest level of catalase activity was recorded by KCL at 4% (2.89), followed by H_2O_2 at 0.5% (2.88), Bion at 1 mM (2.78), IAA at 50 ppm (2.77), IBA at 400 ppm (2.71), SA at 2mM (2.70), and Tanic acid at 2 mM (2.66), respectively.

Table (28): Activities of peroxidase, polyphenoloxidase and catalase enzymes (as optical density/minute/g fresh weight) in leaves of sesame plants that grown from seeds treated with different concentrations of different chemical inducers.

Enzyme	Inducers	Concentrations *				
		I	II	III	IV	Mean
Peroxidase activity	H_2O_2	1.77	1.50	1.35	1.14	1.44
	KCl	1.23	1.07	1.29	1.22	1.20
	IAA	1.39	1.43	1.53	1.17	1.38
	IBA	1.24	1.87	1.36	1.33	1.45
	SA	1.18	1.97	1.44	1.18	1.44
	Tanic acid	1.20	1.35	1.12	1.17	1.21
	Bion	1.78	1.57	1.29	1.02	1.42
	Control	0.63	0.63	0.63	0.63	0.63
	Mean	1.30	1.42	1.25	1.11	
Polyphenoloxidase activity	H_2O_2	1.39	1.30	1.23	1.29	1.30
	KCl	1.07	1.09	1.29	1.27	1.18
	IAA	1.48	1.39	1.36	1.23	1.37
	IBA	1.24	1.47	1.70	1.32	1.43
	SA	1.17	1.51	1.36	1.26	1.33
	Tanic acid	1.52	1.23	1.21	1.16	1.28
	Bion	1.26	1.17	1.24	1.05	1.18
	Control	0.62	0.62	0.62	0.62	0.62
	Mean	1.22	1.22	1.25	1.15	
Catalase activity	H_2O_2	2.88	2.35	1.95	1.93	2.28
	KCl	2.00	2.44	2.84	2.89	2.54
	IAA	2.31	2.77	2.52	2.60	2.55
	IBA	2.55	2.66	2.60	2.71	2.63
	SA	2.16	2.70	2.60	2.46	2.48
	Tanic acid	1.57	2.66	2.44	2.22	2.22
	Bion	2.78	2.66	2.51	2.45	2.60
	Control	1.83	1.83	1.83	1.83	1.83
	Mean	2.26	2.51	2.41	2.39	

* H_2O_2 and KCl used at conc. 0.5, 1, 2 and 4%, IAA and IBA used at rate 50, 100, 200 and 400 ppm, while, SA, Tanic acid and Bion used at conc. 1, 2, 4 and 8 mM.

7C - Effect on phenolic contents:

The data in **Table (29)** showed that, the amounts of phenol contents including the free (6.26-10.68 mg), conjugated (0.57-2.62 mg) and total phenols (6.83-12.02 mg) were obviously higher in sesame plants which grown from seeds treated with any of the tested chemical inducers than those grown from untreated seeds

(0.30 mg); and H_2O_2 (0.08 mg). As for total sugars, KCl produced the highest amount (3.10 mg) followed by IBA (2.98 mg); SA (2.93 mg); Tanic acid (2.41 mg); Bion (1.80 mg); IAA (1.50 mg); H_2O_2 (1.02 mg) compared with control (0.94 mg).

Table (30): Determination of sugars content in the induced sesame plants that treated with different chemical inducers (mg/5g fresh weight).

Enzyme	Inducers	Concentrations *				
		I	II	III	IV	Mean
Reducing sugars	H_2O_2	1.26	0.79	0.88	0.83	0.94
	KCl	2.12	1.58	1.64	0.89	1.56
	IAA	1.26	1.02	0.94	1.10	1.08
	IBA	2.71	2.79	2.13	3.13	2.69
	SA	2.06	2.32	2.13	1.86	2.09
	Tanic acid	1.59	1.48	1.87	1.95	1.72
	Bion	0.88	1.96	0.79	1.06	1.17
	Control	0.84	0.84	0.84	0.84	0.84
	Mean	1.59	1.60	1.40	1.46	
Non-reducing	H_2O_2	0.10	0.05	0.06	0.10	0.08
	KCl	0.98	1.73	1.25	2.20	1.54
	IAA	0.47	0.15	1.02	0.03	0.42
	IBA	0.14	0.25	0.35	0.44	0.30
	SA	0.67	0.07	1.55	1.06	0.84
	Tanic acid	0.44	1.17	1.10	0.06	0.69
	Bion	0.37	0.77	1.14	0.13	0.60
	Control	0.10	0.10	0.10	0.10	0.10
	Mean	0.41	0.54	0.82	0.52	
Total sugars	H_2O_2	1.37	0.84	0.94	0.92	1.02
	KCl	3.10	3.31	2.89	3.09	3.10
	IAA	1.73	1.17	1.96	1.13	1.50
	IBA	2.84	3.03	2.48	3.56	2.98
	SA	2.73	2.39	3.68	2.92	2.93
	Tanic acid	2.02	2.64	2.96	2.02	2.41
	Bion	1.25	2.73	1.92	1.20	1.80
	Control	0.94	0.94	0.94	0.94	0.94
	Mean	2.00	2.13	2.22	1.97	

* H_2O_2 and KCl used at conc. 0.5, 1, 2 and 4%, IAA and IBA used at rate 50, 100, 200 and 400 ppm, while, SA, Tanic acid and Bion used at conc. 1, 2, 4 and 8 mM.

The rate of accumulation of different kinds of sugars in leaves of sesame plants seems to be affected by the 4 tested concentrations of known chemical inducer. The highest amounts of reducing sugars were induced at the lower concentration of some treatments as in H_2O_2 (1.26 mg), KCl (2.12 mg) and IAA (1.26 mg) and at the second concentration of another treatments as in IBA (2.79 mg), SA (2.32 mg) and Bion (1.96 mg). While, Tanic acid (1.95 mg) does this at its higher concentration. This trend was quietly varied in case of non-reducing and total sugars contents.

8- Varietal resistance:

This experiment was conducted to investigate the reaction of certain cultivars and strains of sesame against infection with charcoal rot caused by *M. phaseolina* isolate M9 under stress of artificial infestation. The obtained results are presented in **Table (31)**.

The obtained results **(Table 31)** and **Fig. (17)** indicated that, the tested cultivars and strains of sesame reacted differently throughout the different stages of disease development. Percentages of Pre-, post-emergence damping off, survived seedlings, charcoal rotted, and healthy standing plants were ranged 0.0-33.3%, 0.0-26.7%, 43.3-96.7%, 0.0-40.0%, and 3.3-83.3%, respectively. Based on percentage of healthy plants, the screened sesame entries (cultivars and strains) could be classified as follow:

1 – Highly susceptible entries including 8 entries i.e., strain 806, strain 792, strain 779, strain 799, B11, strain 772, Giza 32, and Toushka 2. Out of all these entries, strain 806 exhibited the highest damage at mature stage as % charcoal rot was maximized

to 40.0% and % healthy standing plants was minimized to 3.3%. Percentages of charcoal rot and healthy standing plants in the rest of entries were ranged between 16.7-23.3% and 30.0-40.0%, respectively. Also, these entries exhibited the highest % pre-emergence damping off (23.3-33.3%), post-emergence damping-off (16.7-26.7%), and lowest % survived seedlings (43.3-56.7%).

2 - Susceptible entries including 7 entries i.e., strain 773, strain 786, Toushka 1, strain 796, strain 774, strain 775, and strain 797. Percentages of healthy standing plants in these entries were ranged from 50.0-56.7%. Based on % survived seedlings, the first 4 entries were classified as moderate resistant (60-66.7%) while the later 3 were classified as resistant entries (73.3%). Among these entries, the first 3 exhibited the highest incidence of pre-emergence damping-off (23.3%) and lowest % healthy standing plants (50.0%) while the later 3 exhibited the highest percentages of both survived seedling (73.3%) and healthy plants (56.7%).

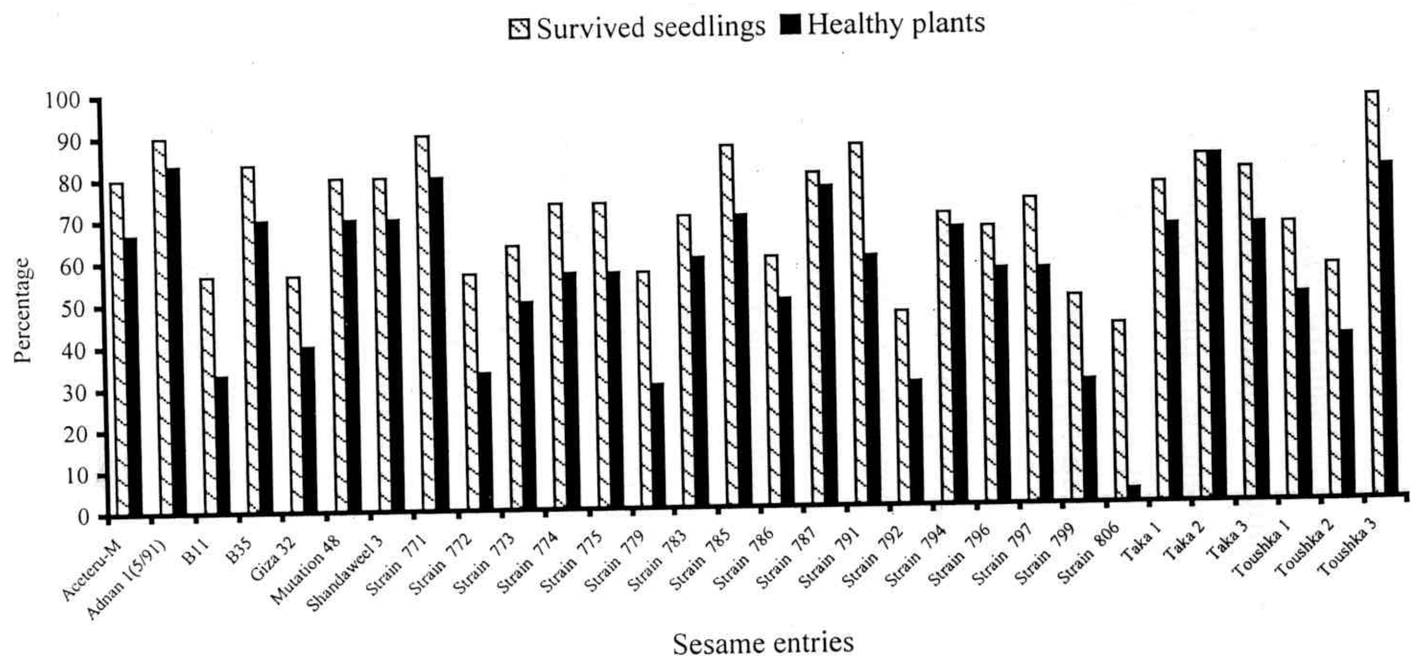
3 – Moderate susceptible entries including 6 entries i.e., strain 783, strain 791, strain 794, Taka 1, Aceteru-M, and Taka 3. Percentages of healthy standing plants in these entries were ranged 60.0-66.7%. Based on % survived seedlings, strain 783, strain 794 and Taka 1 were classified as moderate resistant (70.0-76.7%) while strain 791, Aceteru-M, and Taka 3 were classified as resistant entries (80.0-86,7%). Strain 791 exhibited the lowest % pre- and post-emergence damping-off (6.7%) but exhibited also the highest % charcoal rot (26.7%). Among all these entries, strain 794 exhibited the lowest incidence of charcoal rot (3.3%).

Table (31-A): Evaluation of sesame entries for pre-and post-emergence damping-off and charcoal rot disease under greenhouse conditions.

Cultivar or strain	Seedling stage			* Reaction	Mature stage		* Reaction
	% Pre-	% Post-	% Survival		% Rot	% Healthy	
Aceteru-M	10.0	10.0	80.0	R	13.3	66.7	MS
Adnan 1(5/91)	10.0	0.0	90.0	HR	6.7	83.3	R
B11	26.7	16.7	56.7	S	23.3	33.3	HS
B35	10.0	6.7	83.3	R	13.3	70.0	MR
Giza 32	23.3	20.0	56.7	S	16.7	40.0	HS
Mutation 48	10.0	10.0	80.0	R	10.0	70.0	MR
Shandaweel 3	13.3	6.7	80.0	R	10.0	70.0	MR
Strain 771	6.7	3.3	90.0	HR	10.0	80.0	R
Strain 772	23.3	20.0	56.7	S	23.3	33.3	HS
Strain 773	23.3	13.3	63.3	MS	13.3	50.0	S
Strain 774	16.7	10.0	73.3	MR	16.7	56.7	S
Strain 775	13.3	13.3	73.3	MR	16.7	56.7	S
Strain 779	23.3	20.0	56.7	S	26.7	30.0	HS
Strain 783	16.7	13.3	70.0	MR	10.0	60.0	MS
Strain 785	6.7	6.7	86.7	R	16.7	70.0	MR
Strain 786	23.3	16.7	60.0	MS	10.0	50.0	S
Strain 787	13.3	6.7	80.0	R	3.3	76.7	MR
Strain 791	6.7	6.7	86.7	R	26.7	60.0	MS
Strain 792	33.3	20.0	46.7	HS	16.7	30.0	HS
Strain 794	16.7	13.3	70.0	MR	3.3	66.7	MS
Strain 796	20.0	13.3	66.7	MS	10.0	56.7	S
Strain 797	16.7	10.0	73.3	MR	16.7	56.7	S
Strain 799	26.7	23.3	50.0	S	20.0	30.0	HS
Strain 806	30.0	26.7	43.3	HS	40.0	3.3	HS
Taka 1	13.3	10.0	76.7	MR	10.0	66.7	MS
Taka 2	10.0	6.7	83.3	R	0.0	83.3	R
Taka 3	10.0	10.0	80.0	R	13.3	66.7	MS
Toushka 1	23.3	10.0	66.7	MS	16.7	50.0	S
Toushka 2	26.7	16.7	56.7	S	16.7	40.0	HS
Toushka 3	0.0	3.3	96.7	HR	16.7	80.0	R
L.S.D. 5%	7.84	7.34	7.58		7.80	6.41	

* Variety reaction	Rang of survived seedlings or healthy plants
Highly resistant (HR)	Up to 90.0%
Resistant (R)	< 90.0 to 80.0%
Moderate resistant (MR)	< 80.0 to 70.0%
Moderate susceptible (MS)	< 70.0 to 60.0%
Susceptible (S)	< 60.0 % 50.0%
Highly susceptible (HS)	< 50.0%

Fig. (17): Evaluation of sesame entries against infection with *M. phaseolina* expressed as % survived seedlings and healthy standing plants under greenhouse conditions.



4 – Moderate resistant entries including 5 entries i.e., B35, Mutation 48, Shandaweel 3, strain 785, and strain 787 which produced 70.0-76.7% healthy standing plants. These entries described as resistant at seedling stage as they produced 80.0-86.7% survived seedlings. All these entries were affected equally at stages of pre- and post-emergence damping off. While, strain 785 and strain 787 showed the highest (16.7%) and lowest (3.3%) incidence of charcoal rot, respectively.

5 –Resistant entries including 4 entries i.e., strain 771, Toushka 3, Adnan 1(5/91), and Taka 2. This group of sesame entries produced the highest % healthy standing plants (80.0-83.3%). As for survived seedlings, the first 3 entries classified as high resistant (90.0%) while the later one was classified as resistant (83.3%). All these entries were not affected significantly at post-emergence stage (0.0-3.3%) and the first 2 entries only at the pre-emergence stage (0.0-6.7%). Among all entries, Taka 2 exhibited no infection with charcoal rot at maturity stage (0.0%), followed by Adnan 1(5/91) (6.7%) without significant differences in between.

The above classification of descriptive resistance could be confirmed and completely supported by the newly suggested accumulative resistance which calculated in similar way as previously described in accumulative virulence of the tested isolates of *M. phaseolina*. Arrangement of the tested sesame entries according to degree of their resistance to the charcoal rot disease incidence was shown in **Table (31-B)**.

Table (31-B): Accumulative resistance for the different tested sesame enteries against infection with *M. phaseolina* "based on specific disease ranks in the five examined disease criteria" (The present data were derived from **Table 33-A** #).

Cultivar or strain	Rank of resistance for					Total ranks	Descriptive rection at stage	
	Pre-	Post-	Survival	Rot	Healthy		Seedling	Mature
Strain 806	2	1	1	1	1	6	HS	HS
Strain 792	1	3	2	5	2	13	HS	HS
Strain 799	3	2	3	4	2	14	S	HS
Strain 779	4	3	4	2	2	15	S	HS
B11	3	4	4	3	3	17	S	HS
Strain 772	4	3	4	3	3	17	S	HS
Giza 32	4	3	4	5	4	20	S	HS
Toushka 2	3	4	4	5	4	20	S	HS
Strain 786	4	4	5	7	5	25	MS	S
Strain 773	4	5	6	6	5	26	MS	S
Toushka 1	4	6	7	5	5	27	MS	S
Strain 796	5	5	7	7	6	30	MS	S
Strain 774	6	6	9	5	6	32	MR	S
Strain 775	7	5	9	5	6	32	MR	S
Strain 797	6	6	9	5	6	32	MR	S
Strain 783	6	5	8	7	7	33	MR	MS
Strain 794	6	5	8	9	8	36	MR	MS
Taka 1	7	6	10	7	8	38	MR	MS
Strain 791	9	7	13	2	7	38	R	MS
Aceteru-M	8	6	11	6	8	39	R	MS
Taka 3	8	6	11	6	8	39	R	MS
Mutation 48	8	6	11	7	9	41	R	MR
Shandaweel 3	7	7	11	7	9	41	R	MR
B35	8	7	12	6	9	42	R	MR
Strain 785	9	7	13	5	9	43	R	MR
Strain 787	7	7	11	9	10	44	R	MR
Taka 2	8	7	12	10	12	49	R	R
Strain 771	9	8	14	7	11	49	HR	R
Toushka 3	10	8	15	5	11	49	HR	R
Adnan 1(5/91)	8	9	14	8	12	51	HR	R
L.S.D. 5%	7.84	7.34	7.58	7.80	6.41			

The data in Table (33-A) were arranged in descending order for pre- and post-emergence and charcoal rot and in ascending order for survival and healthy standing plants.

10- Biochemical changes associated with sesame entries varied in their reaction against artificial infection with charcoal rot disease:

Phenols (free, conjugated and total phenols) as well as sugars content (reduced, non-reduced and total sugars) were determined in fresh leaves of healthy plants of the 30 tested sesame entries (as mg/5g f.w.). The obtained data are illustrated in **Table (32)**.

The obtained results indicated that, with few exceptions, the amounts of free phenols, total phenols, reducing and total sugars were obviously higher, in general, in the sesame entries that were classified as high resistant "HR" and resistant "R" than those classified as susceptible "S" and high susceptible "HS" sesame entries.

The highest amounts of total phenols were detected in Toushka 3 "HR", Aceteru-M "R", strain 771 "HR", B35 "R", Adnan 1 (5/91) "HR", strain 794 "MR", Taka 2 "R", Shandaweel 3 "R", strain 791 "R", Mutation 48 "R", strain 785 "R", Taka 3 "R", and strain 787 "R", respectively.

Regarding with sugars content, the sesame entries B 35 "R" and Mutation 48 "R" contained the highest amounts of reducing and total sugars followed by Toushka 3 "HR", Adnan 1 (5/91) "HR", Strain 791 "R", Shandaweel 3 "R", Taka 2 "R" and Strain 771 "HR", respectively. Among this group, the resistant sesame entries Taka 3, strain 787, Aceteru-M and strain 785, respectively showed the lowest amounts of reducing and total sugars.

Table (32): Determination of phenolic compounds and sugars content (mg/5g fresh weight) in certain sesame entries.

Cultivar or strain	* Reaction at Seedling stage	Phenolic content			Sugars content		
		Free	Conjugated	Total	Reducing	Non-Reducing	Total
Aceteru-M	R	18.78	0.84	19.61	2.63	0.59	3.22
Adnan 1 (5/91)	HR	14.26	0.29	14.54	5.06	1.76	6.83
B11	S	3.99	4.42	8.41	2.21	0.11	2.33
B35	R	14.26	0.65	14.90	7.81	4.07	11.88
Giza 32	S	4.80	1.70	6.51	1.06	0.11	1.18
Mutation 48	R	11.52	1.42	12.94	8.01	3.79	11.79
Shandaweel 3	R	11.21	2.65	13.86	4.28	2.16	6.44
Strain 771	HR	8.99	6.18	15.18	5.32	0.96	6.28
Strain 772	S	4.22	3.13	7.35	3.21	0.17	3.38
Strain 773	MS	7.07	0.85	7.92	1.04	0.10	1.14
Strain 774	MR	6.88	2.22	9.10	2.89	1.69	4.58
Strain 775	MR	3.82	4.22	8.04	4.29	0.33	4.61
Strain 779	S	4.21	1.99	6.20	2.80	0.22	3.02
Strain 783	MR	6.79	1.12	7.92	1.52	0.32	1.83
Strain 785	R	7.06	4.36	11.42	2.22	0.64	2.86
Strain 786	MS	6.86	0.27	7.13	1.25	0.28	1.53
Strain 787	R	6.86	0.98	7.85	3.32	0.10	3.42
Strain 791	R	12.46	0.97	13.44	5.10	1.66	6.76
Strain 792	HS	3.05	1.99	5.05	3.52	0.14	3.67
Strain 794	MR	13.21	1.30	14.52	3.14	0.28	3.42
Strain 796	MS	8.27	1.95	10.22	1.75	1.52	3.27
Strain 797	MR	3.98	2.72	6.70	2.73	0.12	2.85
Strain 799	S	3.64	2.71	6.35	2.52	0.25	2.77
Strain 806	HS	2.42	2.93	5.35	0.94	0.04	0.98
Taka 1	MR	6.78	1.38	8.16	1.25	0.22	1.48
Taka 2	R	9.08	4.92	14.00	4.39	2.03	6.43
Taka 3	R	7.71	3.02	10.73	2.61	1.23	3.84
Toushka 1	MS	2.83	2.30	5.13	2.39	0.24	2.63
Toushka 2	S	6.19	1.24	7.44	3.46	0.51	3.97
Toushka 3	HR	21.33	0.99	22.32	7.18	1.19	8.38

As for the other sesame entries that were classified as moderate resistant "MR", moderate susceptible "MS", susceptible "S" and high susceptible "HS", the lowest amounts of free and total phenols were detected in strain 806 "HS" followed by Toushka 1 "MS" and strain 792 "HS" entries. While the lowest amounts of reducing and total sugars were found in strain 806 "HS", strain 773 "MS" and Giza 32 "S", respectively.

C - Electrophoretic detection of protein by sodium dodecyle sulphate, polyacrylamide gel electrophoresis (SDS-PAGE):

Polyacrylamide gel electrophoresis (SDS-PAGE) technique was used to determine the quantitative changes that occur in the soluble proteins of some selected sesame entries varied in their reaction against infection with charcoal rot under greenhouse conditions. The selected sesame entries including: 3 high resistant entries i.e., Adnan 1 (5/91), Toushka 3 and Strain 771; 5 resistant entries i.e., Aceteru-M, B 35, Mutation 48, Taka 2, Shandaweel 3, and Strain 787; 1 moderate susceptible entry i.e., Toushka 1; 4 susceptible entries i.e., B11, Giza 32, Strain 779 and Toushka 2 and 1 high susceptible entry i.e., strain 806.

Protein bands derived from the gel electrophoretic pattern of soluble proteins extracted from fresh healthy leaves of the selected sesame entries as well as similarity between them are illustrated by **Fig. (18-A & 25-B)**. The 15 tested entries were belonged to 2 main separate clusters with similarity 57.01%.

The first cluster consists of 3-sub clusters. The first sub cluster includes strain 806 "HS" alone. The second sub cluster included 2 sub-sub cluster with similarity 87.0%. The first sub-sub cluster includes Giza 32 "S" and strain 779 "S" with similarity 91.73% while the second sub-sub cluster includes B11

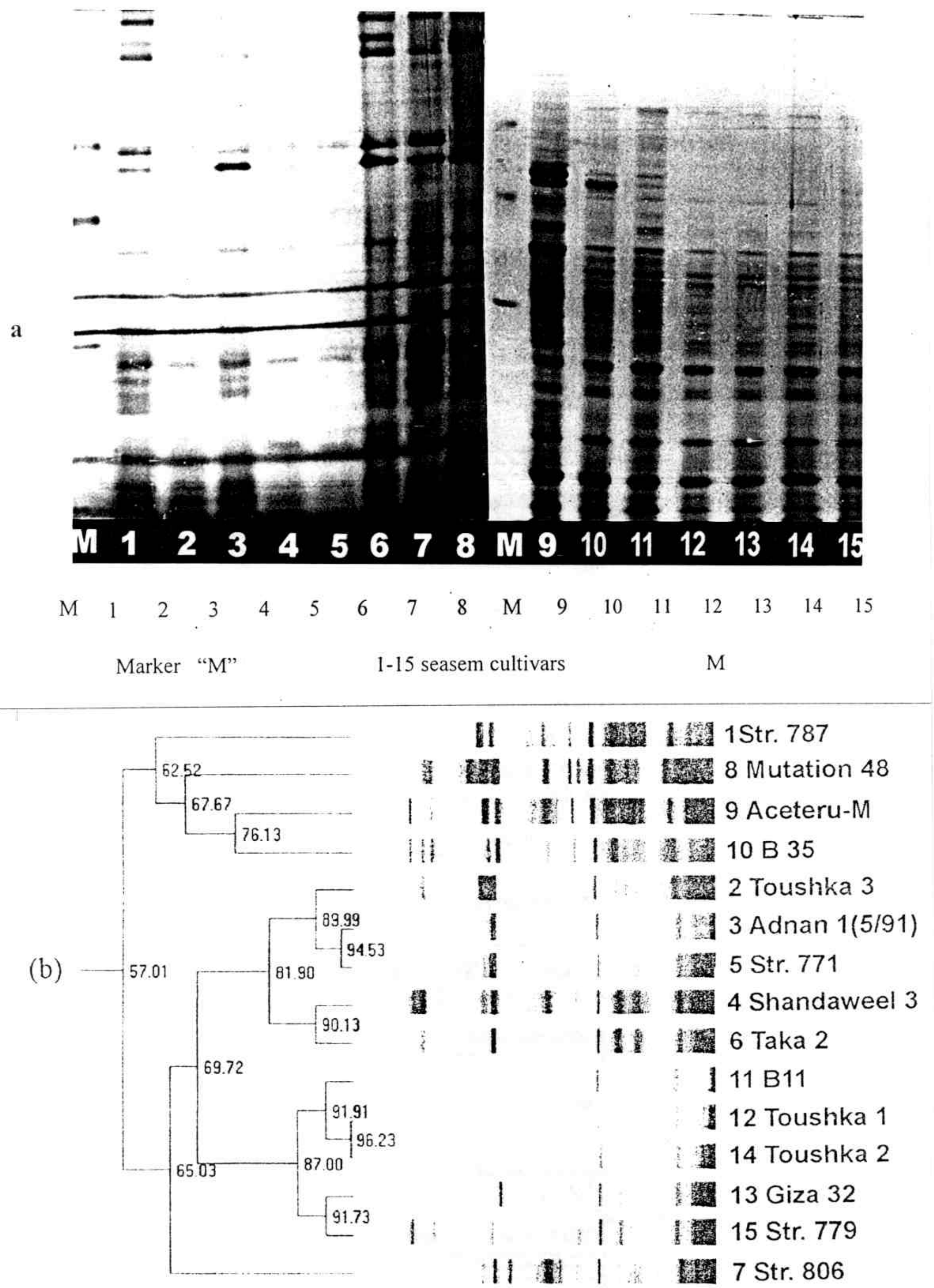
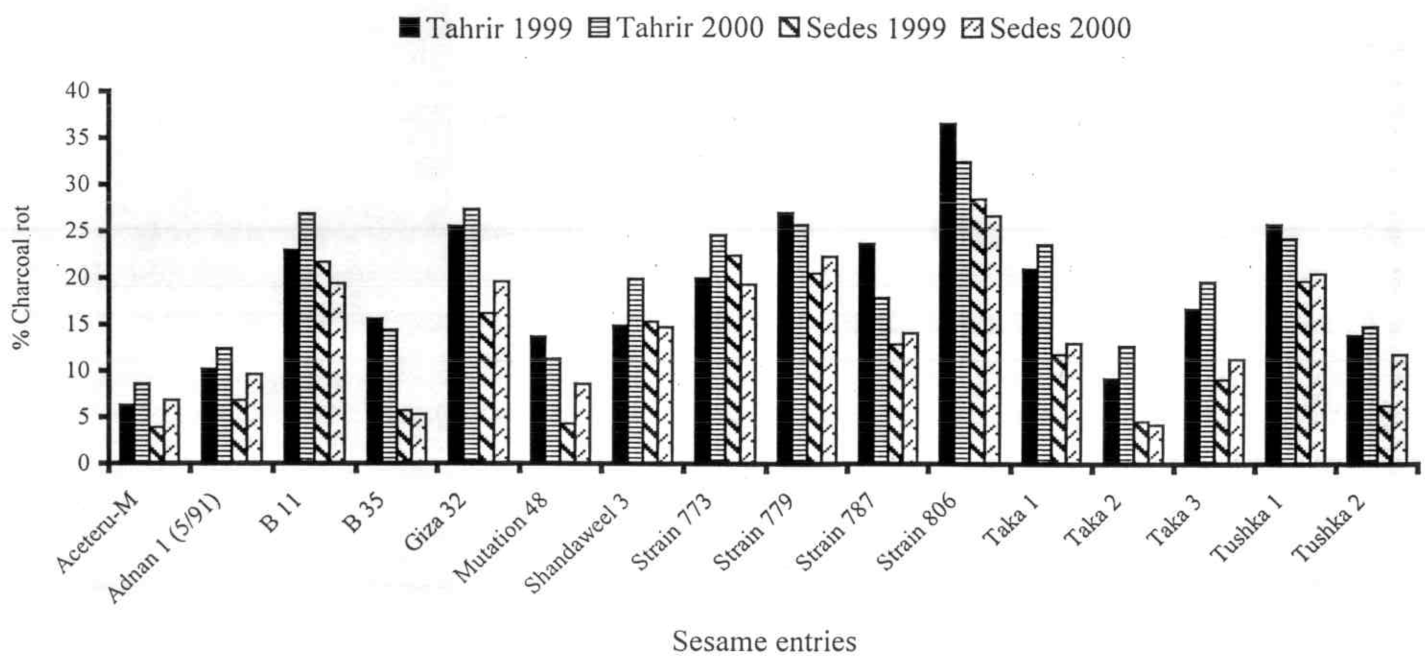


Fig. (18): SDS-PAGE protein patterns of 15 tested cultivars (a).

(b): phenograme showing similarity between any pair of tested cultivars and strains.

Fig. (19): Susceptibility of different sesame entries against the natural infection with charcoal rot disease under field conditions at Tahrir and Sedes locations.

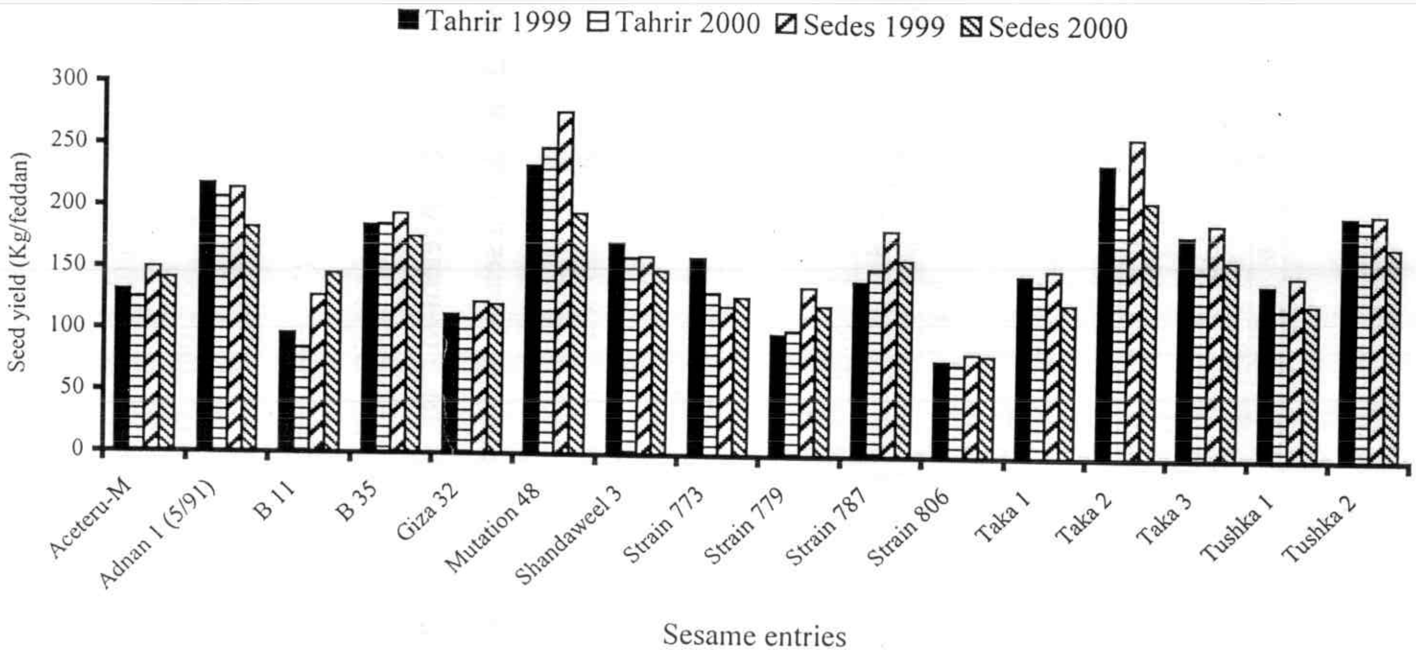


locations followed by the entry Giza 32 "S" during season 2000 at Tahrir location. It is interest to state that, most sesame entries that were reacted as high susceptible "HS" and susceptible "S" in greenhouse screening test, exhibited the highest increase in percentage of infection with charcoal rot under field conditions. Out of these, Tushka 2 "S" only could resist the natural infection significantly better than Taka 1 "MR" during both seasons and strain 787 "R" during season 1999 at Tahrir location. Tushka 2 "S" was significantly comparable also to Adnan 1 (5/91) "HR", Aceteru-M "R", B35 "R", Mutation 48 "R", and Taka 2 "R" during season 1999 at Sedes location.

Table (33): Susceptibility of different sesame entries and their seed yield as affected by the natural infection with charcoal rot disease under field conditions at Tahrir and Sedes locations.

Sesame entry and reaction at seedling stage		% Charcoal rot at location				Seed yield (Kg/fed.) at location			
		Tahrir		Sedes		Tahrir		Sedes	
		1999	2000	1999	2000	1999	2000	1999	2000
Aceteru-M	R	6.3	8.6	3.9	6.8	131.4	125.4	150.0	141.3
Adnan 1 (5/91)	HR	10.2	12.4	6.8	9.6	218.1	207.0	214.2	182.7
B 11	S	23.0	26.9	21.7	19.4	96.9	85.2	127.5	145.8
B 35	R	15.6	14.4	5.7	5.3	185.4	186.0	194.4	176.1
Giza 32	S	25.6	27.4	16.2	19.6	113.1	109.8	123.3	121.5
Mutation 48	R	13.7	11.3	4.3	8.6	234.3	248.4	277.5	195.6
Shandaweel 3	R	14.9	19.9	15.3	14.7	171.6	160.2	160.8	149.4
Strain 773	MS	20.0	24.6	22.4	19.3	160.2	132.0	120.9	128.4
Strain 779	S	27.0	25.7	20.5	22.3	98.7	102.0	137.1	121.8
Strain 787	R	23.7	17.9	12.9	14.1	142.2	152.1	183.5	159.6
Strain 806	HS	36.6	32.5	28.5	26.7	78.0	75.0	84.0	82.4
Taka 1	MR	21.0	23.6	11.8	13.0	147.6	140.7	152.1	124.8
Taka 2	R	9.2	12.7	4.6	4.2	237.9	205.8	259.2	208.5
Taka 3	R	16.7	19.6	9.1	11.3	181.2	153.0	190.8	161.2
Tushka 1	MS	25.8	24.3	19.7	20.5	141.9	122.4	148.8	126.3
Tushka 2	S	13.9	14.8	6.3	11.8	198.0	195.2	199.8	173.4
LSD at 5%		4.71	5.19	3.34	3.18	9.99	10.53	10.01	10.29

Fig. (20): Total seed yield productivity of different sesame entries as affected by the natural infection with charcoal rot disease under field conditions at Tahrir and Sedes locations.



As for seed yield, data in **Table (33)** and **Fig. (20)** indicated that the tested sesame entries were significantly varied in their seed yields. At Tahrir location, the highest total seed yield was produced by the sesame entries Taka 2 "R" (237.9 Kg) and Mutation 48 "R" (234.3 Kg) in season 1999 without significant variation in between followed by Adnan 1 (5/91) "HR" (218.1 Kg). While Mutation 48 "R" (248.4 Kg) was best of all in season 2000 at the same location followed by Adnan 1 (5/91) "HR" (207.0 Kg) and Taka 2 "R" (205.8 Kg). At Sedes location, the highest seed yield was produced by Mutation 48 followed by Taka 2 with significant differences only in season 1999. On the other hand, the highly susceptible entry strain 806 "HS" produces the lowest seed yield followed by B 11 "S", strain 779 "S", Giza 32 "S", Tuska 1 "MS" and Aceteru-M "R", respectively during both seasons at Tahrir location. At Sedes location, the lowest seed yield was produced also by strain 806 "HS" followed by strain 773 "MS", Giza 2 "S", B 11 "S" and strain 779 "S" during season 1999 and Giza 32 "S", strain 779 "S", Taka 1 "MR", and strain 773 "MS" durin season 2000. It could noticed also that, the seed yield that produced by the susceptible sesame entry Tushka 2 was significantly higher during both seasons at both locations than that produced by some resistant entries such as Shandaweel 3, Strain 787 and Aceteru-M.

Regarding with oil content, the data in **Tables (34-A and 34-B)** showed that, the percentages of oil content was considerably varied between the tested sesame entries either in seeds of healthy (52.9-62.9%) or diseased (48.2-59.4%) plants. In all entries, the oil content in seeds of infected plants was significantly lower than those of healthy plants. At Tahrir location, the highest percentage of oil content was produced by seeds of healthy plants of Adnan 1 (5/91) followed by strain 806 and B 35 in season 1999 and Adnan 1 (5/91) followed by strain 806, Tushka 2 and B 35 in season 2000. While, seeds of Giza 32 during both seasons and Shandaweel 3 in season 2000 produced the lowest % oil content at same location. The lowest % oil content during both seasons was detected in general, in seeds of diseased plants Giza 32, strain 787 and Shandaweel 3.

Table (34-A): Oil content of different sesame entries of healthy "H" and diseased "D" sesame plants as affected by the natural infection with charcoal rot disease under field conditions at Tahrir and Sedes locations.

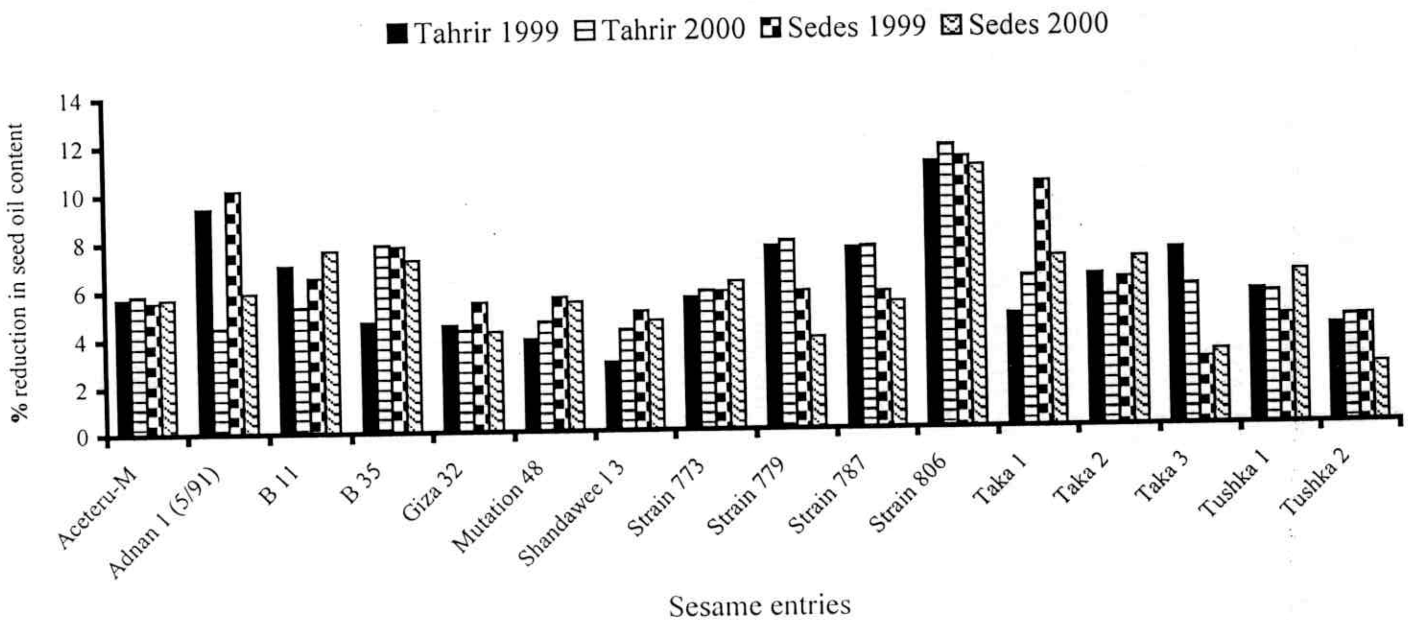
Sesame entry and reaction at seedling stage		% Seed oil content							
		Tahrir location				Sedes location			
		1999		2000		1999		2000	
		H	D	H	D	H	D	H	D
Aceteru-M	R	56.0	52.8	56.5	53.2	54.0	51.0	54.6	51.5
Adnan 1 (5/91)	HR	62.5	56.6	62.2	59.4	62.9	56.5	59.2	55.7
B 11	S	58.1	54.0	60.0	56.8	59.6	55.7	58.8	54.3
B 35	R	59.6	56.3	60.9	56.1	57.7	53.2	56.6	52.5
Giza 32	S	52.9	50.5	53.3	51.0	54.8	51.8	54.0	51.7
Mutation 48	R	58.5	56.2	60.1	57.3	58.4	55.1	58.6	55.4
Shandaweel 3	R	54.2	52.6	53.5	51.2	53.6	50.9	53.7	51.2
Strain 773	MS	59.0	55.7	59.8	56.3	60.0	56.5	61.0	57.2
Strain 779	S	57.3	52.9	56.9	52.4	53.4	50.3	53.9	51.8
Strain 787	R	55.3	51.1	55.0	50.8	55.6	52.4	56.3	53.3
Strain 806	HS	60.4	53.7	60.2	53.1	61.1	54.2	61.3	54.6
Taka 1	MR	58.4	55.6	58.3	54.6	53.7	48.2	54.5	50.6
Taka 2	R	58.1	54.4	58.4	55.2	56.4	52.9	55.2	51.3
Taka 3	R	59.3	54.9	59.3	55.8	56.0	54.4	56.8	55.0
Tushka 1	MS	56.5	53.2	55.8	52.7	54.1	51.6	54.4	50.9
Tushka 2	S	59.7	57.2	59.5	56.8	57.1	54.5	59.2	57.7
LSD at 5%		1.07		0.95		1.05		1.19	

Table (34-B): Percentage of *reduction in seed oil content of different tested sesame entries as affected by the natural infection with charcoal rot disease under field conditions at Tahrir and Sedes locations.

Sesame entry and reaction at seedling stage		Tahrir		Sedes		
		1999	2000	1999	2000	Mean
Aceteru-M	R	5.71	5.84	5.56	5.68	5.698
Adnan 1 (5/91)	HR	9.44	4.50	10.17	5.91	7.505
B 11	S	7.06	5.33	6.54	7.65	6.645
B 35	R	4.70	7.88	7.80	7.24	6.905
Giza 32	S	4.54	4.32	5.47	4.26	4.648
Mutation 48	R	3.93	4.66	5.65	5.46	4.925
Shandawee l 3	R	2.95	4.30	5.04	4.66	4.238
Strain 773	MS	5.59	5.85	5.83	6.23	5.875
Strain 779	S	7.68	7.91	5.81	3.90	6.325
Strain 787	R	7.59	7.64	5.76	5.33	6.580
Strain 806	HS	11.09	11.79	11.29	10.93	11.275
Taka 1	MR	4.79	6.35	10.24	7.16	7.135
Taka 2	R	6.37	5.48	6.21	7.07	6.283
Taka 3	R	7.42	5.90	2.86	3.17	4.838
Tushka 1	MS	5.66	5.56	4.62	6.43	5.568
Tushka 2	S	4.19	4.54	4.55	2.53	3.953
Mean		6.169	6.116	6.463	5.851	

At Sedes location, the same data in **Table (34 a)** showed that, the seeds of healthy plants of Adnan 1 (5/91), strain 806 and strain 773 during both seasons produced the highest % oil. Meanwhile, the lowest % oil content was detected during both seasons in those of Shandaweel 3, Strain 779, Taka 1, Tushka 1 and Aceteru-M without significant differences in between. The seeds of diseased plants of Taka 1, Strain 779, Shandaweel 3, Aceteru-M, Tushka 1, Giza 32 and Taka 2 produced the lowest % oil content during both seasons without significant differences especially in season 2000.

Dealing with seed oil content as affected by charcoal rot infection, the data in **Table (34-B)** and **Fig. (21)** proved that, the average reduction in oil content in seeds of diseased plants was ranged between 3.95% in Tushka 2 "S" to 11.28% in strain 806 "HS". Percentages of reduction were considerably varied according to season, location and sesame entry. The lowest reduction in oil content during both seasons was associated with the sesame entries Shandaweel 3 (2.95-4.30%), Mutation 48 (3.93-4.66%) and Giza 32 4.32-4.54%) at Tahrir location and Taka 3 (2.86-3.17%) and Tushka 2 (2.53-4.55%) at Sedes location. On contrast, the highest reduction in oil content at both locations was associated with strain 806 "HS" (10.93-11.79%) during both seasons, Adnan 1 (5/91) "HR" (9.44-10.17%) during season 1999 and Taka 1 "MR" during both seasons (7.16-10.24%) at Sedes location, Fig. (21): Percentage of reduction in seed oil content of different sesame entries as affected by the natural infection with charcoal rot under field conditions of Tahrir and Sedes locations.



2- Effect of some commercial seed dressing fungicides and soil treatments on the incidence of charcoal rot disease and total seed yield of two sesame cultivars in two different localities under field conditions:

In this study different seed and or soil treatments to reveal the most superior treatment for controlling charcoal rot disease and increasing seed yield production of Giza 32 and Mutation 48 sesame cvs. The experiments were carried out during two successive seasons 1999 & 2000 at two different localities i.e.,, Tahrir locality, (Behira Province) and Sedes locality (Beni-Suef Province). Four fungicides and two biocides namely Rizolex-T, Vitavax-T, Benlate, Maxim, Rizo-N and Plant guard, were used for treating seeds while the 3 fungicides Rizolex-T, Vitavax-T and Amconil were used for treating soil.

The obtained results illustrated in **Tables 35, 36, 37** and **38** revealed that, all tested seed and soil treatments as well as their combinations were significantly effective in reducing charcoal rot disease incidence and increasing sesame seed yield production. The improvement in disease control and seed yield production was more obvious and significantly better when seed and soil treatments were combined together.

Effect of seed and/or soil treatments on charcoal rot disease incidence:

Regardless the interaction between seed and soil treatments, the efficiency of the tested seed treatments was slightly varied according to the sesame cultivar and/or location of the experiment. In this respect, rizolex-T and benlate, in general, were significantly equal and were the most effective as seed treatments for decreasing the incidence of charcoal rot disease on both sesame cvs. during both seasons particularly at Tahrir location **(Tables 35** and **37)** followed by maxim, vitavax-T, and the commercial biocides Rizo-N and Plant guard, respectively. At Sedes location, benlate in 1999 season and rizolex-T in both season produced the highest significant decreases in incidence of charcoal rot on Giza 32 **(Table 36)** and Mutation 48 cvs., **(Table 38)** respectively compared with control treatments.

Dealing with soil treatments, the obtained results indicated that the three tested fungicidal soil treatments i.e., rizolex-T, vitavax-T, and amconil were significantly equal in controlling disease incidence on Mutaion 48 cv. at Tahrir location during both seasons **(Tables 37)** and Sedes location during 1999 season **(Table 38).** Similar trend was noticed also during 1999 season on Giza 32 cv. at Tahrir location **(Table 35)**. However, during 1999 season, the best disease control on Mutation 48 cv. was obtained by rizolex-T and amocnil followed by vitavax-T. While, the latter soil treatment i.e., vitavax-T was the best for controlling the disease on Giza 32 cv. at both locations during 2000 season followed by amconil and rizolex-T. The sesame seed yield was significantly improved by any of the tested soil treatments compared with control treatment.

Regarding with interaction between seed/soil treatments, the obtained results proved that, the best disease control on Giza 32 cv. at Tahrir location **(Table 35)**, was produced by the following combined seed/soil fungicide treatments: rizolex-T/rizolex-T (8.3%), benlate/amconil (8.9%), rizolex-T/vitacax-T (10.2), and benlate/rizolex-T (10.5%) in 1999 season. While rizolex-T/vitacax -T (5.8%), benlate/amocnil (6.6%) and benlate/vitavax-T (6.8%) were the best combined treatments in 2000 season without significant difference. While at Sedes location **(Table 36)**, the lowest disease incidence was induced by rizolex-T/rizolex-T (7.3%), benlate/vitavax-T (8.7%), maxim/vitavax-T (9.1%) and rizolex-T/vitavax-T (9.4%) in 1999 season. But benlate/vitavax-T (7.5%), maxim/vitavax-T (8.3%) and benlate/amocnil (8.9%) were the best and significantly equal in controlling the disease in 2000 season.

As for Mutation 48 cv. the best disease control at Tahrir location **(Table 37)** was produced by the combined treatments: benlate/vitavax-T (4.0%), rizolex-T/amocnil (5.4%), rizolex-T/vitavax-T (7.4%) in 1999 season. In 2000 season, the disease incidence was not affected significantly by this interaction but the mentioned combined treatments produced the best results. At Sedes location **(Table 38)**, disease incidence was not affected significantly by seed/soil fungicide interaction in 1999 season. Meanwhile, in 2000 season rizolex-T/amocnile (4.8%), rizolex-

T/vitavax-T (5.1%), vitavax-t/amocnil (5.9%), rizolex-T/rizolex-T (6.0%) and benlate/vitavax-T (7.7%) were the best.

Table (35): Effect of seed treatment and/or soil with fungicides or biocides on the percentages of charcoal rot disease and seed yield (kg/fed.) of Giza 32 sesame cv (Tahrir locality, Behira Province).

Seed treatment	Soil treatment and Season								Mean	
	Rizolex-T		Vitavax-T		Amconil		Control			
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
% Charcoal rot										
Rizolex-T	8.3	12.9	10.2	5.8	16.4	13.7	22.0	22.7	14.2	13.8
Vitavax-T	18.1	11.6	14.5	13.2	15.3	15.4	25.6	26.3	18.4	16.6
Benlate	10.5	11.6	12.5	6.8	8.9	6.6	21.7	25.3	13.4	12.6
Maxim	15.0	18.7	14.5	13.0	11.8	15.3	24.7	23.8	16.5	17.7
Rizo-N	20.7	19.3	17.9	17.9	17.2	18.3	31.6	29.5	21.9	21.3
Plant guard	19.6	17.9	18.4	14.0	18.8	14.8	29.0	28.5	21.5	18.8
Control	34.9	29.2	33.8	31.2	31.6	35.0	43.6	40.8	36.0	34.1
Mean	18.2	17.3	17.4	14.6	17.1	17.0	28.3	28.1		
Seed yieldkg/feddan										
Rizolex-T	321.0	279.6	298.5	331.7	223.4	263.9	156.3	154.4	249.8	257.4
Vitavax-T	189.2	291.1	241.8	266.3	234.2	231.2	139.0	136.1	201.1	231.2
Benlate	295.2	294.0	268.6	322.7	314.4	326.5	159.6	142.2	259.5	271.4
Maxim	239.6	186.3	244.6	273.8	284.3	236.6	141.7	150.7	227.6	211.9
Rizo-N	163.2	169.1	190.5	193.7	198.3	184.5	118.3	123.7	167.6	167.8
Plant guard	170.2	197.5	183.6	259.4	180.3	247.0	126.0	128.7	165.0	208.2
Control	108.9	124.3	110.2	118.6	115.7	103.2	90.9	96.3	106.4	110.6
Mean	212.5	220.3	219.7	252.3	221.5	227.6	133.1	133.2		

LSD at 5% for	% Charcoal rotted plants		Total seed yield kg/feddan	
	1999	2000	1999	2000
Seed treatment	1.49	0.94	6.0.6	4.95
Soil treatment	1.13	0.71	4.58	3.74
Interaction	2.98	1.89	12.13	9.90

Effect of seed and/or soil treatments on seed yield:

The obtained results indicated also that benlate and rizolex applied as seed treatments were significantly equal and produced the highest increase in averages of seed yield of sesame cvs. Giza 32 **(Tables 35** and **36)** and Mutation 48 **(Tables 37** and **38)**. On the other side, the lowest increase in seed yield of both sesame cvs. was produced by the commercial biocide Plant guard and Rizo-N, respectively compared with control.

Concerning with soil treatments and their effect on seed. yield production, the obtained data showed that vitavax-T and amconil were significantly equal on Giza 32 cv. and produced higher seed yield than rizolex-T at Tahrir location **(Table 35)** in 1999 season. But vitavax-T was the best at Sedes location **(Table 36)**. The seed yield in Mutation 48 cv. during 1999 season was affected equally by the 3 tested soil treatments at Tahrir location **(Table 37)** but rizolex-T was best at Sedes location **(Table 38)**. In 2000 season, the soil treated with vitavax-T produced the highest seed yield of Giza 32 cv. at both Tahrir and Sedes locations. However, the highest significant increase in seed yield of Mutation 48 cv. during this season was produced by amocnil and rizolex-T at Tahrir location **(Table 37)** and amocnil and vitavax-T at sedes location **(Table 38)**.

With regard to interaction between seed/soil treatments, the rizolex-T/rizolex-T and benlat/amocnil treatments produced the highest significant increase in seed yield of Giza 32 cv in season 1999 at Tahrir location **(Table 35)** i.e., 321.0 and 314.4 Kg/fed., respectively, followed by rizolex-T/vitavax-T (298.5 Kg/fed.), benlate/rizolex-T (295.2 Kg/fed.) and maxim/amocnil (284.3 Kg/fed.). While, rizolex-T/vitavax-T (331.7 Kg/fed.), benlate/amocnil (326.5 Kg/fed.), and benlate/vitavax-T (322.7 Kg/fed.) were best of all treatments in 2000 season without significant differences. However, at Sedes location **(Table 36),** the highest seed yield of this cultivar was produced by rizolex-T/rizolex-T (366.7 Kg/fed.) and benlate/vitavax-T (358.1 Kg/fed.) in 1999 season. While rizolex-T/rizolex-T (390.3 Kg/fed.) and benlate/vitavax-T (385.2 Kg/fed.) were the best treatments for producing the highest sesame seed yield in 2000 season.

As for Mutation cv., benlate/vitavax-T and rizolex-T/amocnil were the best seed/soil treatments in 1999 season as they produced the highest seed yield i.e., 387.8 and 379.2 Kg/fed., respectively at Tahrir location **(Table 37)**. Meanwhile, rizolex-T/rizolex-T (366.9 Kg/fed.) was best of all treatments in 2000 season followed by benlate/vitavax-T (348.4 Kg/fed.), rizolex-T/vitavax-T (346.6 Kg/fed.), and benlate/rizolex-T (344.4 Kg/fed.).

At Sedes location **(Table 38)** the best treatments were rizolex-T/rizolex-T (449.3 Kg/fed.) and rizolex-T/amocnil (438.9 Kg/fed.) in 1999 season and rizolex-T/amocnil (446.0 Kg/fed.) and rizolex-T/vitavax-T (435.8 Kg/fed.) in 2000 season.

From the above mentioned results, it could be concluded that the fungicides rizolex-T and vitavax-T were more effective in controlling sesame charcoal rot and increasing sesame seed yield when used as seed treatment than as soil treatments. However, the best results were obtained when they used in dual combination. The combined seed/soil treatments rizolex-

T/amconil, rizolex-T/rizolex-T, benlate/vitavax-T and benlate/amconil could be recommended for controlling the incidence of charcoal rot disease and increasing seed yield in sesame plantation at both Tahrir and Sedes locations.

Table (36): Effect of seed and/or soil treatment with fungicides or biocides on the percentages of charcoal rot disease and total seed yield (kg/fed) of Giza 32 sesame cv at Sedes locality, Beni-Suef Province.

Seed treatment	Soil treatment and Season								Mean	
	Rizolex-T		Vitavax-T		Amconil		Control			
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
% Charcoal rot										
Rizolex-T	7.3	6.4	9.4	12.7	15.1	14.8	21.0	22.7	13.2	14.2
Vitavax-T	17.2	20.8	13.1	21.3	12.9	18.3	23.1	27.3	16.6	21.9
Benlate	10.4	13.6	8.7	7.5	11.7	8.9	21.9	16.2	13.2	11.6
Maxim	12.7	16.4	9.1	8.3	14.0	19.1	23.9	29.7	14.9	18.4
Rizo-N	23.0	26.5	16.9	14.7	21.8	28.2	31.4	33.3	23.3	25.7
Plant guard	16.3	18.2	19.0	21.7	20.3	21.1	26.5	28.5	20.5	22.4
Control	34.2	37.0	31.6	38.5	36.0	40.6	37.6	41.9	34.9	39.5
Mean	17.3	19.8	15.4	17.8	18.8	21.6	26.5	28.5		
Seed yieldkg/feddan										
Rizolex-T	366.7	390.3	346.0	319.7	253.4	282.3	215.9	186.2	295.5	294.6
Vitavax-T	229.7	206.8	277.1	198.8	286.6	223.9	195.4	174.3	247.2	201.0
Benlate	339.9	292.7	358.1	385.2	320.7	368.1	209.8	253.8	307.1	325.0
Maxim	294.4	261.7	351.7	377.5	263.5	217.0	190.4	159.4	275.0	253.9
Rizo-N	202.3	178.6	231.5	280.3	211.0	168.1	147.3	130.5	198.0	189.4
Plant guard	238.6	229.0	221.6	193.2	216.5	200.4	177.3	162.8	213.5	196.4
Control	134.3	125.6	149.8	116.5	127.0	111.8	118.8	106.7	132.5	115.2
Mean	258.0	240.7	276.5	267.3	239.8	224.5	179.3	167.7		

LSD at 5% for	% Charcoal rotted plants		Total seed yield kg/feddan	
	1999	2000	1999	2000
Seed treatment	1.33	1.98	4.28	5.33
Soil treatment	1.01	1.49	3.23	4.03
Interaction	2.67	3.95	8.55	10.66

Table (37): Effect of seed and/or soil treatment with fungicides or biocides on the percentages of charcoal rot disease and total seed yield (kg/fed) of Mutation 48 sesame cv at Tahrir locality, Behira Province.

Seed treatment	Soil treatment and Season								Mean	
	Rizolex-T		Vitavax-T		Amconil		Control			
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
% Charcoal rot										
Rizolex-T	9.8	6.6	7.4	8.1	5.4	7.9	16.6	15.3	9.8	9.5
Vitavax-T	12.5	12.9	14.7	12.0	11.3	10.9	21.3	18.6	15.0	13.6
Benlate	8.9	8.6	4.0	8.0	9.7	7.4	15.0	19.0	9.4	10.8
Maxim	14.1	12.2	13.5	12.8	11.0	11.0	16.1	19.3	13.7	13.8
Rizo-N	15.1	16.1	14.4	14.5	19.6	13.9	26.1	23.7	18.8	17.1
Plant guard	16.0	15.1	18.1	17.2	17.7	16.4	24.7	21.6	19.1	17.6
Control	29.3	19.4	31.3	22.8	29.1	20.8	33.3	28.4	30.8	22.9
Mean	15.1	13.0	14.8	13.6	14.8	12.6	21.9	20.8		
Seed yieldkg/feddan										
Rizolex-T	344.7	366.9	369.1	346.6	379.2	350.0	247.0	282.8	335.0	336.6
Vitavax-T	295.3	305.7	263.6	316.5	309.8	327.7	165.7	233.7	258.6	295.9
Benlate	359.7	344.4	387.8	348.4	346.5	353.7	239.7	231.2	333.4	319.4
Maxim	276.6	316.5	280.0	310.3	321.1	326.8	248.8	229.7	281.6	295.8
Rizo-N	258.7	261.9	262.9	288.5	176.3	294.6	140.4	153.8	209.6	249.7
Plant guard	248.4	284.1	196.4	245.1	213.9	258.5	150.9	174.4	202.4	240.5
Control	128.2	213.3	124.3	168.8	129.1	190.4	120.0	131.1	125.4	175.9
Mean	273.1	299.0	269.2	289.2	268.0	300.2	187.5	205.2		

LSD at 5% for	% Charcoal rotted plants		Total seed yield kg/feddan	
	1999	2000	1999	2000
Seed treatment	2.41	1.43	6.73	7.23
Soil treatment	1.82	1.08	5.08	5.47
Interaction	4.82	n.s.	13.45	14.46

Table (38): Effect of seed and/or soil treatment with fungicides or biocides on the percentages of charcoal rot disease and total seed yield (kg/fed) of Mutation 48 sesame cv at Sedes locality, Beni-Suef Province.

Seed treatment	Soil treatment and Season								Mean	
	Rizolex-T		Vitavax-T		Amconil		Control			
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
% Charcoal rot										
Rizolex-T	4.7	6.0	7.6	5.1	6.7	4.8	13.1	14.7	8.0	7.7
Vitavax-T	8.0	13.3	13.4	11.8	11.3	5.9	19.4	18.3	13.0	12.3
Benlate	7.9	9.8	11.2	7.7	8.9	10.7	15.5	14.2	10.9	10.6
Maxim	10.5	11.1	11.0	9.4	12.8	14.4	18.9	17.6	13.3	13.1
Rizo-N	15.3	12.5	15.3	13.0	12.5	12.0	22.1	21.0	16.3	14.6
Plant guard	13.4	13.0	15.8	11.4	11.8	12.5	20.9	20.0	15.5	14.2
Control	20.8	21.7	23.2	25.0	22.3	20.0	27.1	26.7	23.4	23.4
Mean	11.5	12.5	13.9	11.9	12.3	11.5	19.6	18.9		
Seed yieldkg/feddan										
Rizolex-T	449.3	429.4	433.7	435.8	438.9	446.0	326.9	293.9	412.2	401.3
Vitavax-T	426.5	317.7	346.7	361.1	372.7	430.3	225.8	255.4	342.9	341.1
Benlate	432.6	403.6	396.2	420.5	414.7	396.5	278.2	303.7	380.4	381.1
Maxim	399.3	379.0	391.0	406.0	336.2	298.1	238.2	269.4	341.2	338.1
Rizo-N	290.3	345.2	289.7	321.1	345.1	350.5	177.1	211.5	275.6	307.1
Plant guard	321.7	322.3	266.7	369.2	337.5	338.2	189.8	234.3	278.9	316.0
Control	190.6	205.7	163.5	179.2	176.6	239.9	153.3	168.6	171.0	198.4
Mean	358.6	343.3	326.8	356.1	346.0	357.1	227.0	248.1		

LSD at 5% for	% Charcoal rotted plants		Total seed yield kg/feddan	
	1999	2000	1999	2000
Seed treatment	1.54	1.65	7.63	7.74
Soil treatment	1.17	1.25	5.77	5.85
Interaction	n.s.	3.30	15.27	15.47