

VARIATION IN SENSITIVITY TO FUNGICIDES AMONG ISOLATES OF *Macrophomina phaseolina* FROM COTTON ROOTS

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ABSTRACT

Twenty isolates of *Macrophomina phaseolina* from cotton roots were evaluated *in vivo* for sensitivity to the seed-dressing fungicides Monceren, Monceren T, Rizolex T, Vitavax 200, and Maxim AP. Monceren and Rizolex T were the best performing fungicides in suppressing *M. phaseolina* under greenhouse conditions. This superiority was attributed to the following reasons: first, they were effective in increasing the percentage of surviving seedlings by 203.09 and 170.10%, respectively, regardless of the tested isolate. Second, they were also effective in increasing the height of surviving seedlings by 93.21 and 62.57%, respectively. Third, Monceren and Rizolex T were effective in increasing the dry weight of surviving seedlings in 50 and 40% of the tested isolates, respectively. A high significant positive correlation was observed between pathogenicity of isolates and their sensitivity to fungicides.

INTRODUCTION

Macrophomina phaseolina (Tassi) Goid., the causal agent of charcoal rot of cotton, is of widespread distribution in the Egyptian soil, and it is easily and frequently isolated from cotton roots particularly during the late period of the growing seasons (Aly *et al.*, 2000).

M. phaseolina is a non-specialized fungus, attacking more than 500 host species (Sinclair, 1982); therefore, rotation of cotton with other crops is a questionable practice for controlling this pathogen.

Resistance to *M. phaseolina* has not been found in cotton (Holliday and Punithalingam, 1970). Sources of resistance were considered completely lacking in Pakistan (Akhtar, 1977). Aly *et al.* (1998) reported variation in susceptibility of Egyptian cottons to *M. phaseolina*; however, none of the tested cultivars showed satisfactory level of resistance.

Thus, fungicides have become indispensable for controlling *M. phaseolina* on cotton. For instance, Dwivedi and Ghaube (1985) studied effect of fungicides on the emergence and infection of cotton seedlings by *M. phaseolina* in pot experiments. They found that emergence was maximized after treatment with a TMTD soil drench and the least seedling infection occurred in soils treated with benlate, TMTD, and PCNB (Quintozene).

Chauhan (1986a) reported that control of seedling disease of cotton due to *M. phaseolina* was best and germination maximized when seeds were treated with carbendazim, followed in effectiveness by quintozene.

Chauhan (1986b) evaluated seed treatments of 7 fungicides and selected pair-wise combinations. The percentage of root rot of cotton at harvest ranged from 14 to 22% in treated plots compared with 28% in the control. Benzimidazole-derived fungicides differed in their effects on isolates of *M. phaseolina*. Benlate and carbendazim were most inhibitory but a sesame

isolate was less sensitive to all fungicides.

Chauhan (1988) obtained good control of *M. phaseolina* on cotton by seed treatment with carbendazim followed by quintozene, while TMTD and catafox were less effective. A pre-sowing soil drench with quintozene and carbendazim gave very effective control.

Aly et al. (2001) evaluated the efficiency of Monceren, Monceren T, Vitavax 200, Rizolex T, and Maxim AP for controlling *M. phaseolina* on cotton, under greenhouse conditions. Monceren, Monceren T, and Rizolex T were equally effective in increasing the percentage of surviving seedlings and the plant height; however, Monceren was the only fungicide, which significantly increased dry weight of seedlings.

The objective of this investigation was to evaluate variation in sensitivity to five seed-dressing fungicides, commonly used for controlling cotton seedling damping-off, among 20 isolates of *M. phaseolina* isolated from cotton roots.

MATERIALS AND METHODS

Fungal Isolates

Isolates of *M. phaseolina* used in the current study (Table 1) were obtained from the fungal collection of Cotton Disease Research Section, Plant Pathology Research Institute, Agricultural Research Center, Giza, Egypt. The isolates were originally isolated from cotton roots.

Table 1. Geographic origins of *M. phaseolina* isolates used in this study.

Isolate no.	Geographic origin
1	Manzala, Daqagliya
2	Sakha, Kafr El-Sheikh
3	Minouf, Minufiya
4	Santa, Gharbiya
5	Damanhoor, Beheira
6	El-Riyad, Kafr El-Sheikh
7	Giza, Giza
8	Faiyoum
9	Sohag, Sohag
10	Manfaloot, Assiute
11	Manfaloot, Assiute
12	Abou-Korkas, Minya
13	El-Minya, Minya
14	Sohag, Sohag
15	Sohag, Sohag
16	Shandaweel, Sohag
17	Meet Ghamr, Daqahilya
18	Abou-Kibeer, Sharqiya
19	Sirs El-Lian, Minufia
20	Damanhoor, Beheira

Production of *M. phaseolina* inoculum used in soil infestation

Substrate for growth of isolates was prepared in 500-ml glass bottles, each bottle contained 50 g of sorghum grains and 40 ml of tap water. Contents of each bottle were autoclaved for 30 minutes. Isolated inoculum,

taken from one-week-old culture on PDA, was aseptically introduced into the bottle and allowed to colonize sorghum for three weeks.

In vivo interaction between isolates of *M. phaseolina* and seed-dressing fungicides

Twenty batches of autoclaved soil were placed on greenhouse benches and individually infested with each *M. phaseolina* isolate (Table 1) at a rate of 40 g/kg soil. After thoroughly mixing, infested soil was dispensed into 15-cm-diameter clay pots. Seeds of cotton cultivar Giza 89 were treated with fungicides (Table 2). Flowable fungicides were added to dry seeds, while powdered ones were added to slightly moist seeds. The seeds were shaken thoroughly in plastic bags for five minutes and allowed to dry before being planted in the infested pots (10 seeds/pot). In the control treatment, no fungicide was added to seeds. The pots were randomly distributed on a greenhouse bench under temperature regime ranged from 22.5±3.5°C to 39±7°C. Preemergence damping-off was recorded 15 days after planting. Postemergence damping-off, survivals, plant height (cm), and dry weight (mg/plant) were recorded 45 days after planting.

Table 2. Fungicides used in the study and their active ingredients.

Fungicide ^a	Rate (per kg seed)	Active ingredient ^b	Formulation
Monceren	3 g	25 % Pencycuron	WP
Monceren T	3 g	15% Pencycuron + 32% Thiram	WP
Rizolex T	3 g	20% Tolclofos-methyl + 30% Thiram	WP
Vitavax 200	4 g	37% Carboxin + 37.5 Thiram	WP
Maxim AP	2 ml	3.5% ^c (Metalaxyl M + Fludioxanil)	FS

^a Trade name.

^b Common name.

^c Total active ingredient of the two compounds.

^d WP = Wettable powder and FS = Flowable formulation for seed treatment.

Statistical analysis of the data

The experimental design of the present study was a randomized complete block with five replicates. Analysis of variance (ANOVA) of the data was performed with the MSTAT-C Statistical Package. Least significant difference (LSD) was used to compare between means of fungicides within *M. phaseolina* isolates. Percentage data were transformed into arc sine angles before carrying out the ANOVA to produce approximately constant variance. Correlation analysis was performed with a computerized program.

RESULTS AND DISCUSSION

ANOVA (Table 3) showed that isolate was a nonsignificant source of variation (P = 0.10) in preemergence damping-off, while it was a significant source of variation in postemergence damping-off (P = 0.01), survival (P = 0.0000), plant height (P = 0.02), and dry weight (P = 0.0000). Fungicide was a very highly significant source of variation (P = 0.0000) in all the tested parameters except preemergence damping-off. Isolate x fungicide interaction was a significant source of variation only in preemergence damping-off (P = 0.003) and dry weight (0.0000). Isolate x fungicide interaction accounted for

78.38 and 61.08% of the explained (model) variation in preemergence damping-off and dry weight, respectively (Table 4). Fungicide was more important than isolate as a source of variation in postemergence damping-off, survival, and plant height, while isolate was slightly more important than fungicide as a source of variation in dry weight.

Table 3. Analysis of variance of the effects of isolate of *M. phaseolina*, seed-dressing fungicide and their interaction on cotton seedling disease variables (cultivar Giza 89) under greenhouse conditions.

Parameter and source of variation ^a	D.F.	M.S.	F. value	P > F
Preemergence damping-off				
Replication	4	135.580	1.670	0.1558
Isolate (S)	19	117.708	1.449	0.0990
Fungicide (F)	5	86.762	1.068	0.3771
S x F	95	122.574	1.509	0.0031
Error	476	81.209		
Postemergence damping-off				
Replication	4	3197.978	16.888	0.0000
Isolate (S)	19	365.696	1.931	0.0106
Fungicide (F)	5	2297.188	12.131	0.0000
S x F	95	206.372	1.090	0.2805
Error	476	189.360		
Survival				
Replication	4	4942.379	19.2649	0.0000
isolate (S)	19	610.877	2.3811	0.0009
Fungicide (F)	5	3084.311	12.0223	0.0000
S x F	95	240.607	0.9379	
Error	476	256.549		
Plant height				
Replication	4	3817.911	17.928	0.0000
isolate (S)	19	393.898	1.850	0.0160
Fungicide (F)	5	19888.751	9.339	0.0000
S x F	95	184.757	0.868	
Error	476	212.960		
Dry weight				
Replication	4	174001.936	10.0003	0.0000
Isolate (S)	19	72035.026	4.1400	0.0000
Fungicide (F)	5	236960.896	13.6137	0.0000
S x F	95	53672.566	3.0847	
Error	476	17399.650		

^a Replication is random, while each of fungicide and *M. phaseolina* isolate is fixed.

Table 4. Relative contribution of isolate of *M. phaseolina*, seed-dressing fungicide and their interaction to variation in cotton seedling disease variables (cultivar Giza 89) under greenhouse conditions.

Source of variation	Relative contribution ^a to variation in				
	Preemergence damping-off	Postemergence damping-off	Survival	Plant height	Dry weight
Isolate (S)	15.05	13.67	16.66	14.89	16.39
Fungicide (F)	2.92	22.60	22.14	19.79	14.19
S x F	78.38	38.57	32.82	34.93	61.08

^a Calculated as percentage of sum squares of the explained (model) variation.

Due to the high significance of isolate x fungicide interaction as a source of variation in preemergence damping-off, a LSD was calculated to compare between fungicide means within each isolate (Table 5). These comparisons showed that the differences in preemergence damping-off between fungicides and the control was not the same for each isolate- that is, *M. phaseolina* isolates responded differently to the application of fungicides. For example, Monceren significantly increased preemergence damping-off caused by isolate 6, while it significantly reduced preemergence damping-off caused by isolate 15. On the other hand, Monceren did not show any effect on the other isolates. Pathogenicity of isolate 6 was also increased by Maxim AP; however, this fungicide significantly suppressed pathogenicity of isolate 8.

The nonsignificance of isolate x fungicide interaction as a source of variation in postemergence damping-off indicated that isolate and fungicides under consideration acted independently of each other-that is, fungicidal efficiency was not affected by the tested isolate. Therefore, LSD was calculated to compare between the general means of fungicides (Table 6). These comparisons showed that all the tested fungicides were effective in reducing postemergence damping-off regardless of the tested isolate; however, they showed different levels of efficiency. Thus, Monceren and Monceren T were the best performing fungicides in reducing infection regardless of *M. phaseolina* isolate. They reduced infection by 38.17 and 27.42%, respectively. Rizolex T and Maxim AP were almost equally effective because they reduced infection by 23.89 and 22.94%, respectively. Vitavax 200 was the least effective fungicide because it reduced infection only by 17.38%. Monceren, Monceren T, Rizolex T, Vitavax 200, and Maxim AP were all effective in increasing the percentage of surviving seedlings by 203.09, 145.36, 170.10, 115.46, and 130.93%, respectively (Table 7). The fungicides were also effective in increasing the height of surviving seedlings by 93.21, 60.80, 62.57, 54.96, and 57.27%, respectively (Table 8). The comparisons between fungicides and the control within isolates revealed that the efficiency of the tested fungicides in increasing the dry weight of surviving seedlings varied from one isolate to another. Thus, Monceren, Monceren T, Rizolex T, Vitavax 200, and Maxim AP were effective against 10, 6, 8, 4, and 5 isolates, respectively (Table 8).

The results of the present study demonstrated that Monceren and Rizolex T were the best performing fungicides in controlling *M. phaseolina* on cotton. This superiority was attributed to the following reasons: first, they were effective in increasing the percentage of surviving seedlings by 203.09 and 170.10%, respectively, regardless of the tested isolate. Second, they were also effective in increasing the height of surviving seedlings by 93.21 and 62.57%, respectively. Third, Monceren and Rizolex T were effective in increasing the dry weight of surviving seedlings in 50 and 40% of the tested isolates, respectively. In general, the results of the present study agree with those of some other workers. For example, El-Barougy (1990) found that Rizolex inhibited the linear growth of *M. phaseolina*. In seed-dressing trials, Anaso (1995) found that Vitavax 200 and Metalaxyl were ineffective against charcoal rot of sorghum. Aly *et al.* (2001) reported that Monceren and Rizolex T were effective against *M. phaseolina* on cotton.

Table 5. Effect of isolate of *M. phaseolina*, seed dressing fungicide, and their interaction on preemergence damping-off of cotton seedlings (Cultivar Giza 89) under greenhouse conditions.

<i>M. phaseolina</i> isolate	Fungicide													
	Monceren		Monceren T		Rizolex T		Vitavax 200		Maxim AP		Control		Mean	
	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
1	34.00 ^a	(34.85) ^b	46.00	(42.69)	28.00	(31.63)	40.00	(39.18)	40.00	(39.12)	36.00	(36.65)	37.33	(37.35)
2	32.00	(33.77)	36.00	(36.23)	36.00	(36.60)	32.00	(33.64)	30.00	(32.07)	26.00	(27.65)	32.00	(33.32)
3	38.00	(37.80)	36.00	(36.82)	40.00	(38.95)	28.00	(31.33)	30.00	(32.54)	34.00	(35.44)	34.33	(35.48)
4	36.00	(36.70)	40.00	(39.13)	30.00	(32.96)	36.00	(36.65)	32.00	(34.24)	30.00	(33.08)	34.00	(35.46)
5	38.00	(38.03)	28.00	(31.11)	38.00	(37.85)	14.00	(17.27)	30.00	(32.66)	28.00	(31.46)	29.33	(31.40)
6	56.00	(48.51)	26.00	(30.13)	36.00	(36.65)	28.00	(31.16)	42.00	(40.33)	28.00	(28.33)	36.00	(35.85)
7	36.00	(36.65)	44.00	(41.49)	32.00	(34.24)	32.00	(34.29)	38.00	(39.13)	34.00	(35.49)	36.00	(36.88)
8	40.00	(39.18)	18.00	(24.64)	30.00	(32.96)	36.00	(36.77)	26.00	(27.47)	42.00	(40.11)	32.00	(33.52)
9	38.00	(37.28)	28.00	(28.75)	44.00	(41.31)	32.00	(34.06)	42.00	(40.28)	28.00	(31.28)	35.33	(35.50)
10	38.00	(38.03)	48.00	(43.85)	36.00	(36.65)	36.00	(36.82)	30.00	(33.08)	40.00	(38.95)	38.00	(37.89)
11	34.00	(34.97)	44.00	(41.49)	22.00	(27.60)	38.00	(37.98)	34.00	(35.27)	20.00	(25.98)	32.00	(33.88)
12	46.00	(42.64)	38.00	(37.62)	16.00	(23.02)	38.00	(37.80)	28.00	(31.34)	42.00	(40.38)	34.67	(35.47)
13	30.00	(32.49)	32.00	(33.69)	20.00	(26.27)	38.00	(37.98)	30.00	(33.08)	30.00	(33.08)	30.00	(32.77)
14	28.00	(31.16)	30.00	(32.49)	36.00	(36.65)	34.00	(35.44)	26.00	(30.26)	38.00	(37.93)	32.00	(33.99)
15	22.00	(25.23)	28.00	(31.75)	28.00	(31.33)	24.00	(28.80)	30.00	(32.96)	48.00	(43.80)	30.00	(32.31)
16	28.00	(31.46)	36.00	(36.42)	22.00	(27.60)	32.00	(34.11)	36.00	(36.47)	32.00	(33.82)	31.00	(33.31)
17	34.00	(35.09)	38.00	(37.75)	30.00	(33.08)	30.00	(32.49)	38.00	(37.80)	24.00	(26.57)	32.33	(33.80)
18	30.00	(32.49)	38.00	(37.80)	32.00	(33.64)	38.00	(37.98)	36.00	(36.65)	52.00	(46.10)	37.67	(37.44)
19	32.00	(34.11)	40.00	(39.18)	30.00	(32.66)	44.00	(41.49)	38.00	(37.85)	24.00	(26.57)	34.67	(35.31)
20	38.00	(37.75)	40.00	(39.18)	44.00	(41.54)	30.00	(32.96)	46.00	(39.56)	42.00	(40.33)	45.00	(38.55)
Mean	35.40	(35.91)	35.70	(36.11)	31.50	(33.41)	33.00	(34.41)	34.10	(35.11)	33.90	(34.65)	34.15	(34.97)

^a Mean of five replicates.^b Percentage data were transformed into arc sine angles before carrying out the analysis of variance to produce approximately constant variance.LSD (transformed data) for isolates x fungicide interaction = 11.20 ($P \leq 0.05$) or 14.74 ($P \leq 0.01$).

Table 6. Effect of isolate of *M. phaseolina*, seed dressing fungicide, and their interaction on postemergence damping-off of cotton seedlings (Cultivar Giza 89) under greenhouse conditions.

<i>M. phaseolina</i> isolate	Fungicide												Mean	
	Monceren		Monceren T		Rizolex T		Vitavax 200		Maxim AP		Control		%	Trans-formed
	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed		
1	46.00 ^a	(42.52) ^b	32.00	(31.38)	48.00	(43.80)	42.00	(40.16)	44.00	(41.14)	58.00	(49.67)	45.00	(41.44)
2	44.00	(40.72)	38.00	(37.57)	50.00	(45.05)	58.00	(49.67)	58.00	(50.31)	50.00	(44.95)	49.67	(44.71)
3	42.00	(39.98)	48.00	(43.85)	48.00	(43.85)	54.00	(47.36)	54.00	(47.78)	54.00	(47.53)	50.00	(45.06)
4	38.00	(37.38)	42.00	(40.16)	46.00	(42.22)	38.00	(37.62)	36.00	(36.18)	56.00	(48.55)	42.67	(40.35)
5	30.00	(32.96)	34.00	(35.56)	36.00	(36.29)	40.00	(39.13)	36.00	(36.18)	64.00	(53.23)	40.00	(38.89)
6	28.00	(31.88)	54.00	(47.36)	40.00	(38.53)	54.00	(47.31)	46.00	(41.99)	72.00	(61.67)	49.00	(44.79)
7	34.00	(35.27)	26.00	(27.00)	22.00	(24.05)	54.00	(47.48)	32.00	(33.64)	62.00	(52.20)	38.33	(36.61)
8	28.00	(30.22)	42.00	(40.11)	46.00	(42.64)	26.00	(30.13)	44.00	(44.27)	42.00	(39.69)	38.00	(37.84)
9	22.00	(27.47)	36.00	(36.89)	28.00	(28.15)	46.00	(42.05)	44.00	(41.31)	64.00	(53.82)	40.00	(38.28)
10	38.00	(37.38)	44.00	(41.31)	52.00	(46.15)	52.00	(46.03)	46.00	(42.65)	54.00	(47.07)	47.67	(43.52)
11	26.00	(27.00)	40.00	(39.00)	42.00	(40.21)	48.00	(43.80)	36.00	(33.05)	76.00	(61.07)	44.67	(40.69)
12	8.00	(12.69)	44.00	(41.49)	56.00	(49.28)	40.00	(38.95)	24.00	(28.15)	44.00	(41.44)	36.00	(35.33)
13	14.00	(13.84)	36.00	(33.17)	48.00	(42.78)	40.00	(38.53)	38.00	(34.85)	58.00	(49.66)	39.00	(35.47)
14	30.00	(32.49)	50.00	(45.23)	32.00	(33.47)	50.00	(45.05)	48.00	(43.85)	46.00	(42.64)	42.67	(40.45)
15	40.00	(38.65)	36.00	(35.99)	32.00	(31.28)	56.00	(49.11)	56.00	(48.46)	46.00	(42.64)	44.33	(41.02)
16	44.00	(41.36)	40.00	(38.53)	42.00	(40.23)	48.00	(43.97)	46.00	(41.99)	62.00	(52.67)	47.00	(43.13)
17	36.00	(35.53)	50.00	(44.87)	38.00	(37.34)	56.00	(48.69)	50.00	(44.82)	68.00	(58.72)	49.67	(44.99)
18	58.00	(50.07)	44.00	(41.31)	52.00	(46.15)	52.00	(46.15)	40.00	(38.95)	38.00	(37.67)	47.33	(43.39)
19	46.00	(42.17)	48.00	(43.62)	44.00	(41.49)	34.00	(34.80)	54.00	(47.53)	66.00	(55.03)	48.67	(44.11)
20	38.00	(37.80)	26.00	(29.48)	48.00	(40.67)	34.00	(34.85)	28.00	(28.33)	36.00	(36.23)	35.00	(34.56)
Mean	34.50	(34.37)	40.50	(38.70)	42.50	(39.68)	46.10	(42.54)	43.00	(40.27)	55.80	(48.83)	43.73	(40.73)

^a Mean of five replicates.

^b Percentage data were transformed into arc sine angles before carrying out the analysis of variance to produce approximately constant variance.

LSD (transformed data) for isolates = 6.98 ($P < 0.05$) or 9.19 ($P < 0.01$).

LSD (transformed data) for fungicides = 3.82 ($P < 0.05$) or 5.03 ($P < 0.01$).

Table 7. Effect of isolate of *M. phaseolina*, seed dressing fungicide, and their interaction on survival of cotton seedlings (Cultivar Giza 89) under greenhouse conditions.

M. <i>phaseolina</i> isolate	Fungicide													
	Monceren		Monceren T		Rizolex T		Vitavax 200		Maxim AP		Control		Mean	
	%	Trans- formed	%	Trans- formed	%	Trans- formed	%	Trans- formed	%	Trans- formed	%	Trans- formed	%	Trans- formed
1	20.00 ^a	(26.27) ^b	22.00	(27.47)	24.00	(23.49)	18.00	(21.69)	16.00	(18.18)	8.00	(14.75)	18.00	(21.97)
2	24.00	(23.49)	26.00	(27.77)	14.00	(14.49)	10.00	(14.31)	12.00	(12.69)	16.00	(18.18)	17.00	(18.48)
3	20.00	(21.00)	16.00	(18.60)	12.00	(13.28)	18.00	(19.38)	16.00	(20.53)	12.00	(17.71)	15.67	(18.42)
4	26.00	(27.47)	18.00	(19.93)	24.00	(23.31)	26.00	(24.64)	28.00	(28.38)	14.00	(19.33)	22.67	(23.84)
5	32.00	(34.16)	38.00	(34.62)	30.00	(27.23)	46.00	(42.69)	34.00	(34.97)	8.00	(10.33)	31.33	(30.68)
6	16.00	(20.95)	20.00	(23.02)	24.00	(23.46)	18.00	(19.80)	12.00	(12.69)	2.00	(03.69)	15.33	(17.27)
7	30.00	(30.13)	30.00	(30.13)	46.00	(39.49)	14.00	(14.49)	28.00	(28.33)	4.00	(05.31)	25.33	(24.64)
8	32.00	(30.69)	40.00	(35.82)	24.00	(23.49)	38.00	(37.98)	28.00	(28.80)	14.00	(17.27)	29.33	(29.01)
9	40.00	(38.95)	36.00	(36.00)	28.00	(28.80)	22.00	(22.11)	14.00	(16.97)	6.00	(11.06)	24.33	(25.65)
10	24.00	(26.09)	8.00	(07.85)	12.00	(13.28)	12.00	(13.16)	24.00	(23.49)	6.00	(09.00)	14.33	(15.48)
11	26.00	(27.65)	16.00	(18.18)	36.00	(33.64)	14.00	(17.27)	30.00	(26.95)	4.00	(05.31)	21.00	(21.50)
12	46.00	(42.69)	18.00	(19.80)	28.00	(25.85)	22.00	(24.64)	48.00	(40.89)	12.00	(15.64)	29.00	(28.25)
13	56.00	(48.64)	32.00	(28.33)	32.00	(30.22)	22.00	(24.47)	32.00	(31.16)	10.00	(18.44)	30.67	(30.21)
14	42.00	(40.33)	20.00	(20.95)	32.00	(33.64)	16.00	(20.66)	26.00	(24.64)	16.00	(20.95)	25.33	(26.86)
15	38.00	(34.38)	36.00	(32.99)	40.00	(39.13)	20.00	(18.00)	14.00	(16.45)	6.00	(09.00)	25.67	(25.06)
16	28.00	(28.62)	24.00	(26.44)	36.00	(36.00)	20.00	(23.31)	18.00	(16.80)	6.00	(06.64)	22.00	(22.97)
17	30.00	(29.83)	12.00	(15.64)	32.00	(31.11)	14.00	(14.49)	12.00	(13.16)	8.00	(10.62)	18.00	(19.14)
18	12.00	(17.71)	18.00	(21.69)	16.00	(18.00)	10.00	(14.02)	24.00	(25.80)	10.00	(14.31)	15.00	(18.59)
19	22.00	(25.11)	12.00	(17.71)	26.00	(30.00)	22.00	(27.30)	8.00	(12.69)	10.00	(14.02)	16.67	(21.14)
20	24.00	(26.44)	34.00	(32.44)	8.00	(10.33)	36.00	(36.19)	24.00	(28.80)	22.00	(25.11)	24.67	(26.55)
Mean	29.40	(30.03)	23.80	(24.77)	26.20	(25.91)	20.90	(22.53)	22.40	(23.14)	9.70	(13.33)	22.07	(23.29)

^a Mean of five replicates.

^b Percentage data were transformed into arc sine angles before carrying out the analysis of variance to produce approximately constant variance.

LSD (transformed data) for isolates = 8.13 ($P < 0.05$) or 10.70 ($P < 0.01$).

LSD (transformed data) for fungicides = 4.45 ($P < 0.05$) or 5.86 ($P < 0.01$).

Table 8. Effect of isolate of *M. phaseolina*, seed dressing fungicide, and their interaction on plant height and dry weight of cotton seedlings (Cultivar Giza 89) under greenhouse conditions.

<i>M. phaseolina</i> isolate	Plant height (cm)							Dry weight (mg/plant)						
	Monceren	Monceren T	Rizolex T	Vitavax 200	Maxim AP	Control	Mean	Monceren	Monceren T	Rizolex T	Vitavax 200	Maxim AP	Control	Mean
1	36.13	37.05	21.00	30.12	20.05	22.20	27.76	225.80	472.20	127.80	238.80	127.00	264.20	242.63
2	19.73	26.50	14.15	19.90	14.24	18.17	18.78	51.80	283.80	108.20	170.60	76.60	173.60	144.10
3	18.40	21.50	11.53	16.80	31.15	20.53	19.99	169.00	260.20	164.00	146.40	256.80	200.00	199.40
4	25.75	15.53	19.49	18.78	28.77	19.85	21.36	193.40	110.60	221.80	244.60	185.00	222.00	196.23
5	36.40	22.89	29.60	30.09	36.21	11.16	27.73	246.40	204.40	386.40	387.80	411.00	76.40	285.40
6	26.09	27.97	17.75	21.18	13.64	5.07	18.62	90.40	140.60	130.40	106.00	29.60	21.00	86.33
7	27.86	27.73	26.08	12.42	29.32	6.68	21.68	335.20	161.20	206.00	48.60	266.20	23.60	173.47
8	25.57	25.33	18.69	30.71	27.16	14.85	23.72	253.40	422.40	285.60	285.00	286.20	70.40	267.17
9	36.80	28.85	28.73	20.40	21.80	15.49	25.34	412.00	168.40	132.00	100.00	93.00	84.40	164.97
10	28.33	4.95	14.27	11.25	19.19	10.05	14.67	305.40	42.80	97.60	88.60	125.20	91.20	125.13
11	25.87	23.13	29.15	23.43	19.87	5.20	21.11	190.40	134.20	251.40	277.00	322.60	31.60	201.20
12	33.62	22.73	20.40	29.46	25.43	14.83	24.41	437.60	136.20	165.20	136.80	416.60	59.60	225.33
13	34.11	20.54	30.46	27.07	25.85	25.72	27.29	288.20	157.00	163.00	138.80	303.60	224.20	212.47
14	33.15	18.34	30.94	30.60	19.68	19.97	25.45	490.20	191.60	332.80	199.40	107.70	232.80	259.07
15	28.90	24.59	34.12	12.52	19.35	10.00	21.58	395.60	248.20	378.40	154.00	114.80	36.20	222.87
16	28.58	24.47	32.17	25.48	10.47	5.47	21.27	343.40	342.20	302.60	265.00	76.00	39.80	228.17
17	27.31	21.60	26.71	12.23	13.80	16.36	19.67	287.60	249.20	344.80	103.89	80.60	88.40	192.40
18	23.67	24.46	22.10	20.53	26.07	14.90	21.95	271.80	363.00	105.40	207.00	229.20	142.80	219.87
19	21.95	28.33	33.40	27.53	22.70	15.63	24.93	159.20	223.40	418.00	178.80	148.40	201.20	221.63
20	30.50	26.81	17.80	35.76	38.28	20.98	28.36	344.60	115.60	48.00	260.00	412.80	228.00	234.90
Mean	28.44	23.67	23.93	22.81	23.15	14.72	22.79	274.57	221.36	218.53	187.35	203.44	125.57	205.14

^a Mean of five replicates.

LSD for isolates = 7.40 ($P < 0.05$) or 9.19 ($P < 0.01$).

LSD for fungicides = 4.06 ($P \leq 0.05$) or 5.31 ($P \leq 0.01$).

LSD for isolate x fungicide interaction =

163.9 ($P \leq 0.05$) or 215.8 ($P \leq 0.01$).

Table 9. Correlation between pathogenicity of *M. phaseolina* isolates and their *in vivo* sensitivity to seed-dressing fungicides.

Pathogenicity variable	Sensitivity ^a of isolates to				
	Monceren	Monceren T	Rizolex T	Vitavax 200	Maxim AP
Precmergence damping-off	0.765 ^{b **}	0.747 ^{**}	0.714 ^{**}	0.687 ^{**}	0.832 ^{**}
Postmergence damping-off	0.586 ^{**}	0.625 ^{**}	0.825 ^{**}	0.629 ^{**}	0.605 ^{**}

^a Sensitivity of isolates was calculated according to the following formula $\frac{C-F}{C} \times 100$ where C is pathogenicity of isolate in the control treatment, while F is pathogenicity of isolate when seeds were treated with fungicide.

^b Linear correlation coefficient is significant at $p < 0.01$ (**).

A highly significant positive correlation was observed between pathogenicity of isolates and their *in vivo* sensitivity to fungicides (Table 9). This correlation indicates that the highly pathogenic isolates had the highest sensitivity to fungicides, while the weakly pathogenic ones had the lowest sensitivity.

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التباين فى الحساسية للمبيدات الفطرية بين عزلات فطر ماكروفومينا فاسيولينا المعزولة من جذور القطن

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أختبرت عشرون عزلة من فطر ماكروفومينا فاسيولينا - المعزولة من جذور القطن - تحت ظروف الصوبة لتقييم التباين فى حساسيتها للمبيدات الفطرية الكاسية للبذرة مونسرين ومونسرين تى وريزولكس تى وفيتافاكس ٢٠٠ وماكسيم إيه بى. كان المبيدان مونسرين وريزولكس تى هما الأكثر فاعلية فى مقاومة الإصابة بالفطر، ويعزى تفوق هذين المبيدين إلى الأسباب التالية: أولاً ، أظهرت فاعلية فى زيادة النسبة المئوية للبادرات الباقية على قيد الحياة بمقدار ٢٠٣,٩ و ١٧٠,١٠% ، على الترتيب ، وذلك بغض النظر عن العزلة المختبرة. ثانياً ، أظهرت فاعلية فى زيادة أطوال البادرات الباقية على قيد الحياة بمقدار ٩٣,٢١ و ٦٢,٥٧% ، على الترتيب. ثالثاً ، أظهرت فاعلية فى زيادة الوزن الجاف للبادرات الباقية على قيد الحياة فى ٥٠ و ٤٠% من العزلات المختبرة ، على الترتيب. لوحظ ارتباط موجب عالى المعنوية بين القدرة المرضية للعزلات وحساسيتها للمبيدات.