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RESPONSE OF SOME COMMERCIAL MAIZE HYBRIDS AND THEIR PARENTS TO DOWNY MILDEW DISEASE AND YIELD LOSSES

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ABSTRACT

Thirty four white and yellow maize (*Zea mays* L.) inbred lines and hybrids were evaluated to downy mildew disease caused by *Peronosclerospora sorghi* (Weston and Uppal) C.G. Shaw. This study was performed in 2006 -20007 growing seasons at Gemmeiza Agricultural Research Station, El-Gharbea Governorate, Egypt. Out of the white maize genotypes, only the inbred lines Gm.22 and Gm.21were highly resistance(0 and 0.48% disease infection, respectively) . The other inbred lines showed infection types ranged from resistance (Gm.4 and Gm.30), moderate resistance (Gm.14, Gm.27 and Sd.7). Both of Gm.2 and Sd.63 showed moderate to susceptible infection types. The white hybrids (S.c.11, S.c.12, S.c.13, S.c.14 and S.c.26) were moderately resistant, while, hybrids S.c.21, S.c.22, S.c.27, T.w.c.321, T.w.c.325 and T.w.c326 were moderately susceptible then hybrids S.c.10, S.c.15, S.c.25, T.w.c.322 and T.w.c.327 were susceptible. It can be concluded that inbred lines Gm.4, Gm.21, Gm.30 and Sd.7 play a role in conferring resistance in their hybrids and could be considered as sources of resistance to downy mildew. All the tested yellow maize inbred lines and hybrids showed moderately susceptible, and susceptible infection types. Losses in grain yield were in a parallel line with disease infection. The yellow maize genotypes scored the highest percentage of yield reduction compared with the white genotypes . All of the white inbreds and hybrids showed losses in grain yield except the inbred line Gm.22. The highest % of grain yield losses were detected in the inbred lines Sd.63 and Gm.2 (31.19 and 21.22%, respectively) as well as the hybrids S.c.10 (34.48%), S.c.21 (31.61%) and S.c.26 (31.26%). Concerning with yellow maize genotypes, the highest losses % were noticed in the inbred lines 1021 and 1002 (66.11 and 64.85%, respectively) as well as the hybrids T.w.c. 352 (87.47%), S.c.52 (63.79%), S.c.155 (73.77%) then T.w.c351 (51.93%).

Keywords: *Zea mays* L., *Peronosclerospora sorghi* , Genotypes, Hybrids, Inbred lines , Resistance. Single crosses (S.c.), Three way crosses (T.w.c.).

INTRODUCTION

Downy mildew (*Peronosclerospora* sp.) is considered one of the most destructive diseases of maize. In Egypt, *Peronosclerospora sorghi* is the important species causing downy mildew in maize and named as sorghum downy mildew. Grain sorghum (*Sorghum vulgare* L.) causes epidemics of downy mildew and severe losses in grain yield up to 80 % depending on the growing genotypes (Krishnappa *et al*., 1995). In India, a survey performed by Krishnappa, *et al.,* 1995 in Karnataka revealed that incidence of downy mildew disease ranged from 10-90 % and yield loss from 30 - 40 % same results were obtained by Williams, 1984 ; Graig *et al*., 1989 ; Anahosur & Laxman, 1991 ; Sadoma, 2003 and El-Sherbeni *et al*., 2008.

Genetic resistance is the most efficient and has a sound way to control the disease (Kamala *et al*., 2002 and Barbose *et al*., 2005). Accordingly, breeding for resistance and using the resistant inbred lines, hybrids and cultivars are needed. Many sources for resistance have been identified and successfully used to control that disease (Yeh and Frederiksen, 1980 ; Frederiksen *et al*. 1986; Shivana and Anahosur, 1990 ; Olanya and Fejemisin, 1992 ; Krishnappa *et al*., 1995 ; Nazim *et al*., 1995 ; Narayana *et al*., 1997 ; Adipala *et al*., 1999; El-Moghazy, 2003 and Barbosa *et al*., 2005).

MATERIALS AND METHODS

This study was carried out in the disease nursery field of downy mildew at Gemmeiza Agricultural Research Station during 2006 and 2007 growing seasons.

Sources of maize materials:

Thirty four white and yellow maize (*Zea mays* L.) inbred lines and hybrids were obtained from the National Maize Programe, Field Crops Res. Instit. for evaluation against downy mildew disease (Table 1)**.**

Preparing the field nursery:

The field layout was prepared as follows: the highly susceptible variety of Sudan grass [Sordan79 (*Sorghum sudanens*)] was sown in every third row throughout the field at least three weeks prior to planting. Also , the field was surrounded by a border of three rows planted with the same Sudan grass as spreader of the asexual spores (conidia) to obtain equal distribution of the disease inoculums throughout the field. After establishment of the disease and the appearance of the abundant conidia on leaf surfaces (3-4 weeks), the rows in-between the spreader rows were planted with maize genotypes. Plants of sudan grass were cut monthly about 20-25 cm above soil level for increasing the spore production needed for infection (El-Mersawy, 2000).

Experimental design :

Maize genotypes were divided into two groups , the first was planted in the field disease nursery of downy mildew. While the second group was planted out of the field infection after treated the seeds by Metalaxyl {N-(2,6-dimethylpheny)-N-(methoxyacetyl)-DL-alanine methyl ester} at the rate of 3 gm/Kg seeds. Maize genotypes were planted in a Completely Randomized Block Design with three replicates**.**

Disease assessment :

Infection of downy mildew disease was carried out after 45 days of sowing as disease percentage. Downy mildew disease was estimated as percentage of infected plants. Disease infection was classified according to the scale adopted by Nazim *et al*.(1995), as follow: highly resistant (0 –5 %) , resistant (5.1 – 10 %), moderately resistant (10.1 – 20 %), moderately susceptible (20.1 – 30 %), susceptible (30.1 – 50 %) and highly susceptible (More than 50 %). Percentage of downy mildew infection (D.M.I. %) was calculated using the equation:

$$(\text{D.M.I.})\ \% = \frac{\text{No. of infected plants}}{\text{No. of total plants}} \times 100$$

Yield losses assessment :

Losses of yield grain was calculated according to Calpouzos *et al*., 1976.

$$\text{Losses \%} = \frac{Yh - Yd}{Yh} \times 100$$

Where :

Yh = Yield of healthy plants.
Yd = Yield of disease plants.

Table (1): List of thirty four maize genotypes tested against downy mildew disease during 2006 – 2007 growing seasons.

White		Yellow	
Maize genotypes	**Pedigree**	**Maize genotypes**	**Pedigree**
Inbred lines			
	Parent		Parent
Gm.2	"	1001	"
Gm.4	"	1002	"
Gm.14	"	1004	"
Gm.21	"	1021	"
Gm.2	"		
Gm.27	"		
Gm.30	"		
Sd. 7	"		
Sd.63	"		
Hybrids			
Single crosses (S.c.)			
S.c.10	Sd.7 X Sd. 63	S.c.51	1001 X 1004
S.c.11	Sd.7 X Gm. 4	S.c.52	1002 X 1004
S.c.12	Sd.7 X Gm.21	S.c.155	1002 X 1021
S.c.13	Gm.4XGm.30		
S.c.14	Sd. 7 XGm.30		
S.c.15	Sd.63XGm.30		
S.c.21	Gm.2 X Sd.63		
S.c.22	Gm.21X Sd.63		
S.c.25	Gm.14X Sd.63		
S.c.26	Gm.22X Sd.63		
S.c.27	Gm.27X Sd.63		
Three way crosses (T.w.c.)			
T.w.c.321	S.c.21 X Sd.7	T.w.c.351	S.c.51 X 1021
T.w.c.322	S.c.22 X Sd.7	T.w.c.352	S.c.52 X 1021
T.w.c.325	S.c.25 X Sd.7		
T.w.c.326	S.c.26 X Sd.7		
T.w.c.327	S.c.27 X Sd.7		

RESULTS AND DISSCUSION

Data in Table (2) reveal the response of 25 white genotypes to downy mildew disease. The genotypes showed different responses range between resistant to susceptible reactions. Out of the nine inbred lines , Sd-63 showed susceptible infection type (S) with mean disease severity 32.61%, while, the inbred line Gm.2 was moderately susceptible (22.08%).

The remained lines showed reactions ranged between infection types, HR(Gm.22 and Gm.21) ; R (Gm.4 and Gm.30**);** then MR (Gm.27 and Gm.14) .

Table (2) :Response of commercial white maize inbred lines and their hybrids to downy mildew disease during 2006 / 2007 growing seasons .

No	Genotype	Pedigree	Downy mildew infection %			Infection type
			2006	2007	Mean	
Inbred line						
1	Gm. 2	parents	22.41	21.75	22.08	M s
2	Gm. 4	"	7.55	6.15	6.85	R
3	Gm. 14	"	17.07	17.18	17.13	M r
4	Gm. 21	"	0.96	0.00	0.48	H r
5	Gm. 22	"	0.00	0.00	0.00	H r
6	Gm. 27	"	12.47	16.37	14.42	M r
7	Gm. 30	"	9.31	7.87	8.59	R
8	Sd. 7	"	11.40	11.96	11.68	M r
9	Sd. 63		32.79	32.43	32.61	S
Hybrids						
10	S.c. 10	Sd.7 X Sd.63	36.63	34.47	35.55	S
11	S.c. 11	Sd.7 X Gm.4	12.78	16.49	14.63	M r
12	S.c. 12	Sd.7 X Gm.21	16.60	19.68	18.14	M r
13	S.c. 13	Gm.4XGm.30	13.63	11.66	12.64	M r
14	S.c. 14	Sd.7 X Gm.30	16.39	19.21	17.80	M r
15	S.c. 15	Sd.63XGm.30	30.42	31.52	30.97	S
16	S.c. 21	Gm.2 X Sd.63	29.08	28.78	28.93	M s
17	S.c. 22	Gm.21X Sd.63	25.08	24.82	24.95	M s
18	S.c. 25	Gm.14X Sd.63	30.82	31.79	31.31	S
19	S.c. 26	Gm.22X Sd.63	19.43	19.64	19.53	M r
20	S.c. 27	Gm.27X Sd.63	25.69	24.28	24.99	M s
21	T.w.c. 321	S.c. 21 X Sd.7	30.11	29.64	29.87	M s
22	T.w.c. 322	S.c. 22 X Sd.7	30.91	29.73	30.32	S
23	T.w.c. 325	S.c. 25 X Sd.7	29.11	27.78	28.45	M s
24	T.w.c. 326	S.c. 26 X Sd.7	23.60	24.48	24.04	M s
25	T.w.c. 327	S.c. 27 X Sd.7	32.34	32.64	32.49	S
L.S.D. at 0.05			3.11	3.27	3.15	

S.c. = Single crosses . T.w.c. = Three way crosses.

Concerning with the white hybrids, it exhibited reactions ranged between MR to S infection types. Single crosses no·s 11, 12,13,14, 26 showed moderate resistant reaction (14.63, 18.14, 12.64, 17.80 and 19.53% disease severity, respectively). Single crosses no·s 21, 22, 27 and Twc. no·s , 321,325, and 326 were moderate susceptible (28.93, 24.95, 24.93, 29.87, 28.87, 28.45 and 24.04 % disease severity, respectively). However, the hybrids,Sc.10, Sc.15, Sc.25, Twc.322 and Twc.327 were susceptible.

Experience has shown that the most efficient control of downy mildew on maize is through-out incorporating genetic resistance available from desirable downy mildew resistant donors. Therefore, a great attention paid the breeders to find out resistant sources to commercial varieties and hybrids (Borges, 1987; Shivanna & Anahosur, 1990; Reedy *et al*., 1992 and Sadoma, 2003). The obtained results show that the white inbred lines Gm.4, Gm.30 and Sd.7 shared in conferring resistance in some hybrids i.e. Sc.11, Sc.12, Sc.13 and Sc.14. So, these lines could be considered as important sources of resistance to that disease. Similar results were obtained by Gowda *et al.,*1991; Nazim *et al*.,1995 and Adipala *et al*.,1999.

Screening of local yellow maize genotypes reveal that no one of them showed resistance to downy mildew disease . It could be said that all of yellow inbred lines and hybrids maize has not any genes of resistance or susceptibility is dominance over resistance in these genotypes. Similar results were obtained by Olanya and Fejemisin (1992) they stated that 5 genotypes of maize recorded mean percentage of infection ranged from 70 – 100 %.

Table (3) : Response of 4 inbred lines and 5 commercial yellow maize hybrids to downy mildew disease during 2006 and 2007 growing seasons .

No	Genotype	Pedigree	Downy mildew infection %			Infection type
			2006	2007	Mean	
Inbred line						
1	**1001**	**parents**	42.21	42.89	42.55	S
2	**1002**	"	68.58	59.44	64.01	H s
3	**1004**	"	22.69	21.40	22.05	M s
4	**1021**	"	60.08	63.86	61.97	H s
Hybrids						
5	**S.c. 51**	**1001 X 1004**	41.42	46.60	44.01	S
6	**S.c. 52**	**1002 X 1004**	65.29	67.16	66.23	H s
7	**S.c. 155**	**1002 X 1021**	77.84	70.10	73.97	H s
8	**T.w.c. 351**	**S.c. 51X1021**	54.02	55.00	54.51	H s
9	**T.w.c. 352**	**S.c. 52X 1021**	82.85	80.93	81.89	H s
L.S.D. at 0.05			6.79	7.87	7.08	

M s = Moderately susceptible (20.1 – 30 % infection).
S = Susceptible (30.1 – 50 % infection).
H s = Highly susceptible (More than 50 % infection).
S.c. = Single crosses .
T.w.c. = Three way crosses

Data in table (4) clear that, differences between protected and infected white maize inbred lines and hybrids for grain yield / plot were due to differences in disease severity level which ranged from 0.48 – 32.61% in the inbred lines and from 12.64 -35.55 % in the hybrids. All of the white inbred and hybrids scored losses in grain yield except the inbred line Gm. 22, which was free from disease infection.

The highest % of losses were detected in The inbred lines Sd.63 and Gm.2 (31.19 and 21.22%, respectively) as well as the hybrids S.c.10 (34.48 %), S.c.21 (31.61 %) and S.c.26 (31.26 %). Whereas, The lowest percentages of losses were detected in the line Gm.4 (5.52 %) and the hybrids S.c.11 and S.c.12 (15.43 %). Concerning with, yellow maize genotypes, the highest losses % were noticed in the inbred lines 1021 and 1002 (66.11 and 64.85 %, respectively) as well as the hybrids T.w.c 352 (87.47 %), S.c.52 (63.79 %), S.c.155 (73.77 %) then T.w.c351 (51.93 %). The lowest loss % was 40.29 % in S c.51. In general, the loss % in grain yield was run in a parallel line with infection % of downy mildew either in white or yellow maize genotypes.

Table (4): Combined data of yield losses of 34 white and yellow maize genotypes due to the infection with downy mildew disease in 2006 and 2007 growing seasons.

White maize genotypes					Yellow maize genotypes				
		Yield Kg / plot					Yield Kg / plot		
Genotypes	Infection %	Protected	Infected	Loss %	Genotypes	Infection %	Protected	Infected	Loss %
Inbred line					**Inbred line**				
Gm. 2	22.08	3.110	2.50	21.22	**1001**	42.55	4560	2.650	41.89
Gm. 4	6.85	3.170	2.990	5.52	**1002**	64.01	4.780	1.680	64.85
Gm. 14	17.13	3.970	3.270	17.93	**1004**	22.05	5.520	4.250	23.01
Gm. 21	0.48	3.480	3.34	4.17	**1021**	61.97	4.190	1.420	66.11
Gm. 22	0.00	3.200	3.200	0.00					
Gm. 27	14.42	3.700	3.170	14.46					
Gm. 30	8.59	3.330	3.080	7.80					
Sd. 7	11.68	2.550	2.250	11.77					
Sd. 63	32.61	3.950	2.830	31.19					
Hybrids					**Hybrids**				
S.c. 10	35.55	11.580	7.550	4.48	**S.c. 51**	44.01	12.320	7.300	40.75
S.c. 11	14.63	10.420	8.790	15.43	**S.c. 52**	66.23	12.870	4.660	63.79
S.c. 12	14.63	10.420	8.790	15.43	**S.c. 155**	74.05	15.530	4.080	73.77
S.c. 13	18.14	12.420	10.200	17.87	**T.w.c. 351**	54.51	12.670	6.090	51.93
S.c. 14	12.64	11.930	10.230	12.99	**T.w.c. 352**	81.95	12.210	1.530	87.47
S.c. 15	17.80	13.540	11.50	16.93					
S.c. 21	30.97	13.150	8.830	31.16					
S.c. 22	28.93	12.670	9.000	28.94					
S.c. 25	24.95	11.210	8.480	24.40					
S.c. 26	31.31	13.170	9.020	31.52					
S.c. 27	19.53	11.800	9.480	19.66					
T.w.c. 321	24.99	12.130	9.080	25.07					
T.w.c. 322	29.87	16.040	11.180	28.84					
T.w.c. 325	30.32	15.080	10.580	29.83					
T.w.c. 326	28.45	13.750	9.820	28.45					
T.w.c. 327	24.04	11.150	8.530	23.45					
LSD at 0.05	3.15	0.54	0.42	-		7.08	0.64	0.53	-

Anahosur and Laxman (1991) stated that the greatest loss in grain yield was recorded in genotype DMS-652 (78.5%), while the lowest loss was in genotype CSV-4 (9.6%). Also, Mendez *et al.*, (1990) found that the genotype FS-25A recorded grain yield 3.51 t./ha. as a result to high infection (16.1%) and was less than the genotype ATx-623 who scored disease infection 14.9 % and grain yield 3.84 t./ha. In India, a survey performed by Krishnappa *et al*., (1995) in Karnataka revealed that incidence of downy mildew disease ranged from 10 -90% and yiel loss from 30-40 %. Similar results were obtained by (Williams, 1984 ; Graig *et al*., 1989 ; Anahosur & Laxman, 1991 ; Sadoma, 2002 and El-Sherbeni *et al*., 2008) .

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استجابة بعض هجن الذرة الشامية وآبائها لمرض البياض الزغبى والخسارة في المحصول الناتجة عن الإصابة

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٢ قسم الذرة معهد بحوث المحاصيل الحقلية– مركز البحوث الزراعية

أجريت هذه الدراسة بمحطة البحوث الزراعية بالجميزة-مركز البحوث الزراعية خلال موسمي ٢٠٠٦و ٢٠٠٧ م حيث تم تقييم ٣٤ سلالة وهجين من الذرة الشامية البيضاء والصفراء لمرض البياض الزغبى المتسبب عن الفطر *Peronosclerospora sorghi*

كانت السلالتين جميزة ٢٢ وجميزة٢١ عالية المقاومة للمرض من بين طرز الذرة البيضاء المختبرة. هذا وقد أظهرت باقي السلالات ردود أفعال تتراوح ما بين المقاومة (جميزة ٤ و جميزة٣٠) ومتوسطة المقاومة (جميزة ١٤، جميزة ٢٧ و سدس ٧) ومتوسطة الإصابة (جميزة ٢) بينما كانت السلالة سدس ٦٣ حساسة للإصابة بالمرض . أظهرت الهجن الفردية البيضاء ثلاثة ردود أفعال وهى متوسطة المقاومة مثل الهجن الفردية (١١، ١٢ ،١٣ ، ١٤ و ٢٦) بينما كانت الهجن الفردية (٢١ ،٢٢ و٢٧) و الهجن الثلاثية (٣٢١ ، ٣٢٥ و ٣٢٦) متوسطة الإصابة . وكانت الهجن الفردية (١٠ ، ١٥ و ٢٥) و الثلاثية (٣٢٢ و ٣٢٧) حساسة للإصابة بالمرض . ويتضح من النتائج المتحصل عليها دور كل من السلالات جميزة٤ ، جميزة ٢١ ، جميزة ٢٢ ، جميزة٣٠ و سدس٧ في المساهمة في مقاومة مرض البياض الزغبى للهجن التي نتجت عن تهجين تلك السلالات حيث يمكن اعتبارها مصادر لمقاومة هذا المرض. هذا وقد أظهرت جميع سلالات وهجن الذرة الصفراء طرز إصابة مختلفة تراوحت من المتوسطة إلى حساسة للإصابة .وقد أوضحت الدراسة أن الخسارة في محصول الحبوب كانت موازية لشدة الإصابة بالمرض. هذا وسجلت السلالات والهجن الصفراء خسارة أعلى من مثيلتها البيضاء. ولقد سجلت جميع السلالات والهجن البيضاء خسارة في المحصول عدا السلالة جميزة ٢٢ عالية المقاومة للمرض. وكانت أعلى خسارة في المحصول في السلالات سدس ٦٣ وجميزة ٢ (٣١,١٩ و ٢١,٢٢ %) وكذلك في الهجين الفردي ١٠ (٣٤,٤٨ %) ، الهجين الفردي ٢١ (٣١,٦١ %) و الهجين الفردي ٢٦(٣١,٥٢ %) . بينما كانت أعلى خسارة في المحصول في السلالات الصفراء السلالتين ١٠٢١ و ١٠٠٢ (٦٦,١١ و ٦٤,٨٥ %) وكذلك الهجين الثلاثي ٣٥٢ (٨٧,٤٧ %) و الهجين الفردي ٥٢ (٦٣,٧٩ %) ثم الهجين الثلاثي ٣٥١ (٥١,٩٣%).