

**THE INHERITANCE OF RESISTANCE TO LEAF BLIGHT CAUSED BY
Helminthosporium turcicum IN SUPERIOR GROUP OF INBRED LINES
 OF MAIZE
 BY**

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ABSTRACT

Eight new inbred lines of maize were crossed in diallel crosses system in 2002 season at Sakha Agriculture Research Station. In 2003 season, two experiments were conducted under artificial and natural infection to evaluate the parental lines and their resulted 28 single crosses for resistance to leaf blight disease (*Helminthosporium turcicum*), ear length and grain yield/plant.

Both general and specific combining ability (additive) and (non-additive) were important in inheritance of resistance to leaf blight disease, grain yield/plant and ear length. The inbred line SK-9203 exhibited highly resistance to leaf blight. Also, its GCA effects was positively significant for grain yield/plant and ear length under artificial and natural infection. The crosses B 73 x G-1002 and B 73 x SK N-8 exhibited positive and significant SCA for resistance to leaf blight disease. Also, nine crosses (L-121 x SK-9203), (B73 x SK-9121), (B-73 x SK-9203), (Gm-1002 x SK-9203), (SK-8118 x SK-9121), (SK-8118 x SK-N-8), (SK-9121 x SK-9203), (SK-9121 x SK-N8) and (SK-9203 x SK-N-8) were highly resistant to leaf blight over 97%. All these materials can be used to improve maize breeding program to resistance to leaf blight disease. The highest inbred lines for grain yield/plant under artificial and natural infestation were SK8118 and L121, respectively, while single crosses i.e SK 9203 x SK N-8 and SK 7266 /4 x SK 9121 were the highest under artificial and natural infestation, respectively.

INTRODUCTION

Southern leaf blight of maize (*Zea mays* L.) is caused by *Helminthosporium turcicum* was found in the north gavrnome in Egypt so that cause considerable damage in most maize growing in late season. This disease cause a serious reduction in plant yield and may cause death of adult plants Nooh *et al.*, (1988). Okori *et al.*, (1999). in diallel crosses, determined the gene action of resistance to leaf blight and found that resistance to this disease was due to non-additive genetic variance. Khalifa and Zein El-abdeen (2000) showed that resistance response of hybrids may be due to resistance of one parent only or due to complementary effects for resistance in both parents. Takamiya and Sendo (2000) found that GCA and SCA were significant indicated that both additive and

non-additive effects were importance in the inheritance of resistance to leaf blight disease. El-Kheshin (2002) found that both GCA and SCA were significant but GCA was more important than SCA variances in the inheritance of the resistant to *Helminthospor turcicum*. Bair *et al.*, (1990) and Tefferi *et al.*, (1996) found that leaf blight disease reduced yields of susceptible hybrids. Mosa (2003) found that the non additive gene effects controlled the inheritance of grain yield and ear length.

The aims of this investigation were to determined the behavior of the set inbred lines and their crosses tested under natural and artificial infection by *Helminthospor turcicum*. Also, to estimate the type of gene actions controlling of the inheritance this disease (combining ability effects)

MATERIALS AND METHODS

Eight inbred lines i.e. line 121, B-73, Gm-1002, SK-9203, SK-7266/4, SK-8118, SK-9203 and SKN-8 were highly resistance for *Helminthosporium turcicum* over 90% except Gm-1002 was moderate resistance over (70% resistant). These lines were crossed in diallel cross without reciprocal in 2002 season. The eight inbred lines and their resulted 28 single crosses were evaluated in two experiment in 2003 season, one experiment under natural infestation by *Helminthosporium turcicum* pathogen, Second experiment under artificial infection at Sakha Station. A Randomized Complete Block Design (RCBD) with two replications was used in both experiments. In each replication the genotypes were arrangement in two sets as follows eight inbred lines and 28 crosses respectively and randomly distributed in each set. The experiment unit was one row 6 m long 80 cm apart and 25 cm between hills, one plant left per hill.

Data recorded on leaf blight, ear length and grain yield per plant (g) after adjusting to 15% moisture content of infested and non infested experiments.

Isolation and preparations of inoculum

Maize leaves infected by the pathogen were washed in top water and cur to small pieces and dipped in 0.2% mercuric chloride for half to one minute, allowed to pass through a series distilled water and dried after sterilized filter paper and transferred in to Petri-plates containing PDA medium and incubated at 27 to 30 °C for 7 to 10 days. The resulted fungal isolate, were microscopically examined and purified using single spore and hyphal tip techniques. Spor suspension was prepared from 2 to 4 weeks old pure cultures grown on PDA in Petri-plates at 28°C. Distilled sterile water was added to each plate fungal. Growth was scrapped with the aid of a sterile scraped to release the conidia and /or mycelial fragments of the tested fungus. Spore suspension was adjusted to the concentration of 10.000 conidia/ml and used for spray of maize genetic materials after 50 to 55 days of sowing as adopted by Gouda (1996). Data were recorded 35 days after inoculation (90 days after sowing). The modified scale of Elliott and Jenkins (1946) for estimating *Helminthosporium turcicum* infection on maize plants Table (1).

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Table (1): Scale for estimating *Heliminthosporium turcicum* infection on maize plants.

Rating Scale	% Leaf area infected	Resistance level
0.5	< 5	Highly resistant
1.0	6-10	Resistant
2.0	11-25	Moderately resistant
3.0	26-50	Moderately susceptible
4.0	51-75	Susceptible
5.0	>75	Highly susceptible

The analysis of variance was carried out by Steel and Torrie (1980). However combining ability analysis was computed according to Griffing 1956.

RESULTS AND DISSCION

Table (2) shows highly significant mean squares of genotypes for resistant to leaf blight, ear length and grain yield/plant in the two experiments (artificial and natural infection). Also, GCA and SCA mean squares were highly significant for all studied traits under artificial and natural infection except SCA was not significant for resistant to leaf blight trait under natural infection. This result indicated that the importance role of both additive and non-additive gene effects for inheritance of these traits and the genotypes must be testing under artificial infection conditions to appear their ability to resistant for leaf blight disease and it is considered of promising single crosses for highly resistance and yielding potent to used in maize program. These results were similar with what obtained by Takamiya and Sendo (2000) and El-Kheshin (2002). The ratio GCA/SCA for leaf blight resistance under the two conditions were higher than unity indicating the importance role of the additive gene effects than non-additive gene effects for inheritance of this trait. This result was agreed with those obtained by El-Keshin (2002).

For grain yield and ear length, the ratio of GCA and SCA were less than unity indicating the importance role of the non-additive gene effects than additive gene effects for inheritance of this traits except ear length under natural infestation. These results agreement with Kassem *et al.* (1979), Singh and Asnami (1979), Nawar and Khamis (1983), Sedhom (1992), Abd-Elsattar *et al.*, (1999) El-Shenawy *et al.*, (2002) and Mosa (2003).

Mean performances of parents and their crosses are presented in Table (3). The inbred line (SK-9203) was highly resistance to leaf blight disease while, the inbred line Gm 1002 was moderately resistant under artificial infection. On the other hand, under natural infection the inbred line (SK-8118) was highly resistant, while the inbred line Gm-1002 was moderately resistant. The results indicated that the behavior of inbred line Gm- 1002 was the same direction under two cases (artificial and natural infection).

Table (2): Mean squares from analysis of variance and combining ability for leaf blight, ear length and grain yield/plant.

S.O.V	d.f	Resistance to leaf blight (R.L.B%)	
		Artificial infestation	Natural infestation
Replications	1	0.0556	102.722
Genotypes	35	110.357**	25.842*
GCA	7	262.514**	51.900**
SCA	28	72.317*	19.32
Error	35	34.712	15.093
Ratio GCA/SCA		3.63	2.69
		Ear length (cm)	
Replications	1	0.1789	11.202*
Genotypes	35	17.667**	20.664**
GCA	7	14.158**	21.881**
SCA	28	18.544**	20.359**
Error	35	1.831	2.310
Ratio GCA/SCA		0.763	1.075
		Grain yield/plant (g)	
Replications	1	698.619	9.729
Genotypes	35	7013.099**	4795.644**
GCA	7	1872.354*	1665.492*
SCA	28	8298.286**	5578.182**
Error	35	958.284	595.261
Ratio GCA/SCA		0.226	0.299

*, ** significant at 0.05 and 0.01 level of probability, respectively.

For ear length trait, the means ranged from 7.0 cm for inbred line (SK-72266/4) to 11.6 cm for inbred line (SK-9203) under artificial infection but under natural infection the means ranged from 6.2 cm for line (SK-7266/4) to 14.9 cm for SK-9203 indicating that behavior the two lines was in similar direction under artificial and natural infection.

Values of means for grain yield/plant ranged from (13.25 g) for line (SK-7226/4) to (56.66 g) for line (SK-8118) under artificial infection but under natural infection, the means ranged from (13.81 g) for line (SK-7226/4) to (82.10 g) for line L121. These results indicated that the inbred line (SK-7266/4) exhibited the same means under different experimental conditions.

Regarding to mean performances of single crosses resulting for leaf blight resistance. The means for resistance under artificial infestation ranged from 65% for cross L121 x Gm-1002 (as low resistance) to 97% (high resistance) for nine crosses i.e. (L121 x SK-9203), (B73 x SK-9121), (B73 x SK-9203), (Gm1002 x SK-9203), (SK-8118 x SK-9121), (SK-8118 x SK N-8), (SK-9121 x SK-9203), (SK-9121 x SK N-8), and (SK-9203 x SK N-8). Meanwhile the resistance means under natural infection ranged from 87.5% (moderately resistant) for the single cross SK-7226/4 x SK-9203 to 100% (immune genotype) for eight single crosses i.e. B73 x SK9121, B73 x SK9203, Gm1002x SK8118, SK7266/4x SK8118, SK7266/4 x SK9121, SK 8118 x SK9121, SK8118 x SK 9203 and SK9121x SK 9203. Besides that sixteen crosses were highly resistant, where their mean percentage exceeded 95% for resistant to leaf blight disease. The previous promising crosses may be used in maize program for resistance to leaf blight disease.

Table (3): Mean performances of eight inbred lines and their 28 crosses for three studied traits.

Genotype	Resistance to Leaf blight (R.L.B%)		Ear length (cm)		Grain yield/plant (g)	
	Artificial infestation	Natural infestation	Artificial infestation	Natural infestation	Artificial infestation	Natural infestation
Lines						
L-121	95.0	96.0	8.100	9.9	37.73	82.097
B 73	97.0	97.5	10.70	10.3	51.132	47.723
Gm 1002	78.0	84.0	9.4	9.5	32.85	35.77
SK-7266/4	96.0	97.0	7.0	6.2	13.254	13.807
SK-8118	93.0	100.0	10.0	11.2	56.663	47.968
SK-9121	97.5	98.5	10.9	13.0	44.578	40.066
SK-9203	98.5	97.5	11.60	14.9	53.321	63.621
SK N-8	95.0	98.5	7.50	10.5	26.32	50.787
Crosses						
L-121 x B 73	85.0	93.5	14.80	16.5	160.853	106.797
L-121 x Gm 1002	65.0	89.0	16.60	18.0	150.094	185.866
L-121 x SK-7266/4	96.0	97.0	12.90	17.1	76.653	126.975
L-121 x SK-8118	95.0	97.5	16.50	18.4	211.888	188.603
L-121 x SK-9121	86.5	95.0	15.40	15.9	160.293	111.315
L-121 x SK-9203	97.0	93.5	19.20	21.2	139.927	177.595
L-121 x SKN-8	96.0	97.0	13.90	14.9	161.212	160.0
B 73 x Gm 1002	96.0	96.0	14.40	16.3	144.973	139.468
B 73 x SK-7266/4	92.5	97.0	13.6	16.1	127.184	122.865
B 73 x SK-8118	93.5	98.5	15.0	16.9	155.556	165.68
B 73 x SK-9121	97.0	100.0	15.0	16.6	202.812	151.011
B 73 x SK-9203	97.0	100.0	15.9	19.1	119.815	148.638
B 73 x SKN-8	96.0	96.0	14.1	16.4	151.866	133.489
Gm 1002 x Sk-7266/4	80.0	98.5	14.0	17.0	163.867	112.754
Gm 1002 x SK-8118	96.5	100.0	16.2	16.1	158.357	165.018
Gm 1002 x SK-9121	90.0	97.0	14.6	14.6	142.845	149.338
Gm 1002 x SK-9203	97.0	97.5	19.3	17.8	195.996	184.02
Gm 1002 x SKN-8	75.0	98.5	13.8	14.1	184.061	152.454
SK-7266/4 x SK-8118	92.5	100.0	16.2	16.7	170.687	144.601
SK-7266/4 x SK-9121	87.5	100.0	16.3	17.7	161.977	192.786
SK-7266/4 x SK-9203	93.5	87.5	17.9	20.1	198.372	176.036
SK-7266/4 x SKN-8	86.0	97.0	13.4	13.6	90.775	86.153
SK-8118 x SK-9121	97.0	100.0	14.3	15.4	109.813	121.086
SK-8118 x SK-9203	93.5	100.0	15.6	19.2	215.303	149.832
SK-8118 x SKN-8	97.0	97.0	14.9	14.2	167.318	123.692
SK-9121 x SK-9203	97.0	100.0	16.6	16.5	132.822	120.214
SK-9121 x SKN-8	97.0	98.5	14.0	14.5	165.463	130.501
SK-9203 x SKN-8	97.0	98.5	14.8	17.2	216.393	164.778
L.S.D 0.05	11.96	7.8865	2.746	3.0853	62.841	49.527
0.01	15.9	10.5	3.693	4.149	84.51	66.606

For ear length the means of single crosses ranged from (13.4 cm) for the cross (SK-7266/4 x SKN-8) to (19.3 cm) for the cross (Gm 1002 x SK-9203) under artificial infection. But under natural infection the means ranged from (13.6 cm) for the cross (SK-7266/4 x SN-8) to (21.2 cm) for the cross (L121 x SK-9203).

For grain yield/plant the means ranged from (76.65 g) for the cross (L121 x SK-7226/4) to (216.39 g) for the cross (SK-9203 x SKN-8) under artificial infection. Meanwhile under natural infection, the means ranged from (86.15 g) for the cross (SK-7226/4 x SN-8) to (192.79 g) for the cross (SK-7266/4 x SK-9121). These results indicated the ability of some single crosses such as single cross (SK-9203 x SKN-8) gave the highest mean comparing to the other single crosses under artificial infection conditions. Generally, the inbred lines SK-9203 was superior for resistance to leaf blight, ear length and grain yield /plant under infestation and non infestation. Such as single cross SK9203 X SKN-8 was the highest crosses for resistance to leaf blight and grain yield /plant, additional to single crosses B-73 x SK-9121, SK-8118 x SK-9203 and SK-9203 x SK-N-8 were the highest for grain yield/plant under infestation as will as SK 7266/4 x SK9121 under non infestation.

Table (4) showed the GCA effects for the eight parents for different traits under this study. For resistant of leaf blight disease the inbred line (SK-9203) exhibited highly positive and significant GCA effects, in addition to four lines exhibited positive GCA effects under artificial infection. But under natural infection, the line (SK-8118) exhibited positive and significant GCA effects.

For ear length the inbred line (SK-9203) exhibited highly positive and significant GCA effects under artificial and natural infection. Also, the inbred line (SK-9203) exhibited positive and significant GCA effects for grain yield/plant under artificial and natural infection. These results indicated that the inbred line (SK-9203) considered as good combiner in this study for all traits.

Table (4): Estimates of general combining ability effects for eight inbred lines for the studied chraters.

Inbred lines	Resistance to leaf blight (R.L.B%)		Ear length (cm)		Grain yield/plant (g)	
	Artificial infestation	Natural infestation	Artificial infestation	Natural infestation	Artificial infestation	Natural infestation
L-121	-1.825	-1.775*	-0.060	0.340	-5.190	10.299
B 73	2.225	0.375	-0.190	0.010	-2.295	-5.496
Gm 1002	-7.725	-2.775**	0.160	-0.550	1.762	4.211
SK-7266/4	-0.875	-0.125	-0.780	-0.770*	-17.225*	-12.857*
SK-8118	1.925	2.075	0.260	0.090	11.405	3.610
SK-9121	1.725	1.525	0.190	-0.120	-2.309	-6.197
SK-9203	4.025**	-0.025	1640*	2.250**	13.707*	13.00*
SKN-8	0.525	0.725	-1.220	-1.250**	0.145	-6.571
L.S.D _{g10.05}	2.48	1.6496	0.5745	0.6455	13.1434	10.3595
0.01	3.330	2.20	0.7726	0.8680	17.6756	13.9317

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Table (5) showed the SCA effects for the studied traits. The crosses (B73 x Gm 1002) and (B73 x SKN-8) were the most desirable crosses for resistance to this disease where they had positive and significant SCA effects under artificial infection, Also twelve under artificial infection single crosses exhibited positive SCA effects under artificial infection for leaf blight resistance. Meanwhile under natural infection there were sixteen crosses had positive for SCA effects.

Table (5): Estimates of specific combining ability effects of 28 crosses for three traits.

Crosses	Resistance to leaf blight (R.L.B%)		Ear length (cm)		Grain yield/plant (g)	
	Artificial Infection	Natural Infection	Artificial Infection	Natural Infection	Artificial Infection	Natural Infection
L-121 x B 73	-7.483	-2.017	1.039	0.772	36.307	-22.268
L-121 x Gm 1002	-17.533**	-3.367	2.489**	2.832**	21.492	47.095**
L-121 x SK-7266/4	6.617	1.983	-0.271	2.152*	-32.963	5.271
L-121 x SK-8118	2.817	0.283	2.289*	2.592**	73.642**	50.431**
L-121 x SK-9121	-5.483	-1.667	1.259	0.302	35.762	-17.049
L-121 x SK-9203	2.717	-1.617	3.609**	3.232**	-0.622	30.034
L-121 x SKN-8	5.217	1.133	1.169	0.432	34.226	32.010
B 73 x Gm 1002	9.417*	1.483	0.419	1.462	13.476	16.491
B 73 x SK-7266/4	-0.933	-0.167	0.559	1.482	14.674	16.956
B 73 x SK-8118	-2.733	-0.867	0.919	1.422	14.415	43.305*
B 73 x SK-9121	0.967	1.183	0.989	1.332	75.386**	38.442*
B 73 x SK-9203	-1.333	2.733	0.439	1.462	-23.628	16.872
B 73 x SKN-8	1.167	-2.017	1.499	2.262**	21.986	21.292
Gm 1002 x SK-7266/4	-3.483	4.483	0.609	2.942**	47.300*	-2.861
Gm 1002 x SK-8118	6.217	3.783	1.769*	1.182	13.159	32.936
Gm 1002 x SK-9121	3.917	1.333	0.239	-0.108	1.362	27.063
Gm 1002 x SK-9203	8.617*	3.383	3.489**	0.722	48.496*	42.547*
Gm 1002 x SKN-8	-9.883*	3.633	0.849	0.522	50.123*	30.553
SK-7266/4 x SK-8118	-0.633	1.133	2.709**	2.002*	44.476*	29.587
SK-7266/4 x SK-9121	-5.433	1.683	2.879**	3.212**	49.481*	87.579**
SK-7266/4 x SK-9203	-1.733	-9.267**	3.029**	3.246**	69.860**	51.631**
SK-7266/4 x SKN-8	-5.733	-0.517	1.389	0.242	-24.176	-18.680
SK-8118 x SK-9121	1.261	-0.517	-0.161	0.052	-31.313	-0.588
SK-8118 x SK-9203	-4.533	1.033	-0.311	1.482	58.240**	8.961
SK-8118 x SKN-8	2.467	-2.717	1.849*	-0.018	23.737	2.392
SK-9121 x SK-9203	-0.833	1.583	0.759	-1.008	-10.607	-10.851
SK-9121 x SKN-8	2.667	-0.667	1.019	0.492	35.596	19.007
SK-9203 x SKN-8	0.367	0.883	0.369	0.822	70.510**	34.088**
LSD α 0.05	7.66	5.03	1.76	1.98	40.29	33.83
0.01	10.18	6.70	2.36	2.22	54.19	45.50

For ear length there were nine crosses had positive and significant SCA effects under artificial infection the highest cross L121 x SK9203, while under natural infection, nine crosses gave positive and significant SCA effects the highest cross was SK7266/4 x SK N-8.

For grain yield/plant under artificial infection there were five crosses exhibited highly positive and significant SCA effects single cross B73 x SK9121 was best cross, while under natural infection eight crosses exhibited positive and significant SCA effects single cross SK7266/4 x SK9121 was best cross. General, single cross SK1002 X SK9203 had desirable SCA effects for all studied traits.

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**وراثة المقاومة لمرض لفحة الأوراق (*Helminthosporium turcicum*)
لمجموعة من سلالات الذرة الشامية**

- عباس عبد الحى الشناوى * ، صبحى عبد العزيز طلبية **
- * - محطة البحوث الزراعية بسخا - معهد بحوث المحاصيل الحقلية - قسم بحوث الذرة الشامية
- ** - محطة البحوث الزراعية بسخا - معهد بحوث أمراض النبات

تم التهجين بين ثمانية سلالات جديدة من الذرة الشامية بنظام التزاوج الدورى لتكوين ٢٨ هجين فردى فى موسم ٢٠٠٢ بمحطة البحوث الزراعية بسخا وفى موسم ٢٠٠٣ تم تقييم هذه السلالات والهجن الناتجة منها فى تجربتين احدهما تحت العدوى الصناعى بفطر لفحة الاوراق (*Helminthosporium turcicum*) والاخرى تحت العدوى الطبيعية. وكانت الصفات المدروسة صفة المقاومة لمرض تبقع الاوراق (*Helminthosporium turcicum*) وطول الكوز ومحصول النبات بالجرام. اظهرت النتائج مايلى:-

- كان فعل الجين الاضافى والغير اضافى له أهمية فى وراثه صفة المقاومة لمرض لفحة الاوراق ومحصول النبات وطول الكوز. كانت السلالة SK-9203 ذات قدرة انتلافية عالية المعنوية وموجبة للمقاومة لمرض لفحة الاوراق ومحصول النبات وطول الكوز تحت العدوى الصناعى والطبيعى كذلك اظهر الهجين B-73 x SK-1002 قدرة خاصة عالية المعنوية موجبة للمقاومة لمرض اللفحة يوجد ٩ هجن فردية عالية المقاومة للفة الاوراق اكثر من ٩٧% وهم (L-121 x SK-9230), (B73 x SK-9121), (B-73 x SK-9203), (Gm-1002 x SK-9203), (SK-8118 x SK-9121), (SK-8118 x SK-N-8), (SK-9121 x SK-9203), (SK-9121 x SK-N-8) and (SK-9203 x SK-N-8) ولذلك يمكن استخدام هذه السلالات والهجن الناتجة منها كمواد وراثية فى برنامج التربية للمقاومة لمرض لفحة الاوراق (*Helminthosporium turcicum*) - اعطت السلالة SK-9203 اعلى محصول تحت ظروف العدوى الصناعية بينما السلالة L-121 كانت الاعلى فى المحصول تحت ظروف العدوى الطبيعية كذلك اعطى الهجين SK-9203 x SK-N-8 اعلى محصول تحت ظروف العدوى الصناعية والهجين SK-7266/4 x SK-9121 اعطى اعلى محصول تحت ظروف العدوى الطبيعية.