J. Agric. Sci. Mansoura Univ., 30 (2): 731 - 742, 2005

COMBINING ABILITY OF RESISTANCE TO LATE WILT DISEASE AND GRAIN YIELD AND THEIR RELATIONSHIPES UNDER ARTIFICIAL AND NATURAL INFECTIONS IN MAIZE

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ABSTRACT

Late wilt (*Cephalosporium maydis*) is one of the most serious diseases of maize in Egypt. It causes a noticeable reduction in plant yield. A half diallel crosses mating design among eight yellow inbred lines of maize were used in 2002 growing season. The eight parental inbred lines and their 28F_1's were evaluated in two trials at Sakha Agricultural Research Station. The first one was conducted in season 2003 under natural infection, while, the second trial was performed during two growing season 2003 and 2004 in a disease nursery under artificial infection. The genetic analysis of crosses was done according to Griffing (1956) method 4, model 1.

Mean squares of general combining ability (GCA) were significant for all studied traits under artificial and natural infections. While, the mean squares due to specific combining ability (SCA) were significant for resistance to late wilt disease, grain yield/ plant and ear length under artificial infection but for grain yield/plant only under natural infection. The ratios between GCA and SCA mean squares exceeded the unity for all studied traits. These results indicate that the additive gene effects played a major role than the non additive gene effects in the inheritance of all studied traits under artificial and natural infections.

The parental inbred line Sk9203 considered as a good combiner for percentage of resistance to late wilt disease, grain yield/ plant, ear length and number of kernels/ row under artificial infection and grain yield/ plant under natural infection. While, inbred line L121 showed significant desirable GCA effects for grain yield/plant and ear length under artificial infection and percentage of resistance to late wilt disease and grain yield/ plant under natural infection. In the same time SC Sk7266 x Sk9203 exhibited highly significant and desirable SCA effects for grain yield/ plant under artificial and natural infections.

Mean, over all the crosses, was higher compared to *per se* mean over all the inbred lines for percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections. Also, mean over all the inbred lines and mean over all the crosses were reduction under artificial infection compared to its under natural infection for resistance to late wilt disease and grain yield/ plant.

The correlation coefficient (r) , between *per se* means of the inbred lines and those of their averages from 7F_1's to other 7 inbred lines was significant for percentage of resistance to late wilt disease under artificial and natural infections, indicating that resistance to late wilt disease was transmitted from inbreds to hybrids. Correlation coefficient between percentage of resistance to late wilt disease under artificial and natural infections was insignificant. While, highly significant and positive correlation coefficient was observed between grain yield/ plant under artificial and natural infections with late wilt disease. Therefore, grain yield/ plant under artificial infection with late wilt disease could be used as an estimation of grain yield/ plant under natural infection.

INTRODUCTION

Maize crop is affected by many diseases, which reduce yield. The late wilt disease caused by *Cephalosporium maydis* is one of the major diseases affecting maize in Egypt One from tests to restriction hybrids in Egypt is evaluation of the promising hybrids for yield potentiality and resistance to late wilt disease under artificial infection. The information of the type of gene action is very important for the breeder in making decisions for the allocation of resources and expected response to selection for this disease. Samra *et al.*(1962) were the first isolated the pathogen from the roots and stems of wilting maize plants in 1960 and identified the late wilt pathogen as *Cephalosporium maydis*. Sabet *et al.* (1970) reported that *C. maydis* infected young plants easily but when the plants aged, few plants were infected and none after approximately 50 days from sowing .El-Shafey *et al.*(1988) tested a number of maize genetic materials against *C. maydis* under artificial soil inoculation. They classified them as highly resistant, resistant, moderately resistance and susceptible for infection percentages of 5,10, 10-15 and more than 15%, respectively. In the same time, Rao *et al.* (1990) and Bruder(1991) reported that the grain yield reduction largely depended on the susceptibility of the grown cultivars and the degree of soil infection. Shehata and Salem(1972), Shehata (1976) and El-Itriby *et al.*(1984) concluded that dominance and epistatic effects play a major part in conditioning resistance to late wilt disease.On the other hand, Nawar and Salem(1985), Sayed Ahmed(1987), Salem *et al.*(1992),El-Shenawy (1995), Mosa(2001) and Amer *et al.*(2002) found that the additive gene action played a major role in the expression of resistance to late wilt disease.While, Pajic(1986), Lima *et al.*(1995),Turgut *et al.*(1995), Abd El-Maksoud(1997), Geetha and Jayaraman(2000) and Singh *et al.*(2002) found that the non additive gene action controlled the inheritance of grain yield.While, Al-Naggar(1991), El-Shamarka(1995),Mosa(1996), Murariu(1998), Ogunbodede *et al.*(2000) and Rameeh *et al.*(2000) reported that additive gene effects were more important component in the expression of grain yield. The main objective of the present study were to: Estimate combining ability effects and type of gene action for resistance to late wilt disease and yield, identify superior inbred lines and crosses for resistance to late wilt disease and yielding ability to provide wide diversity of germplasm, which is necessary to promote the breeding program for disease resistance and estimate relationships between resistance to late wilt disease and yield under artificial and natural infection conditions.

MATERIALS AND METHODS

The present investigation was carried out at Sakha Research Station during the three successive growing seasons, 2002, 2003 and 2004. Eight diverse yellow maize inbred lines, L121, B-73, Gm1002, SkN8, Sk7266, Sk8118, Sk9121 and Sk9203 were chosen for this study. All segregating generations for Sk7266, Sk8118, Sk9121 and Sk9203 were under artificial infection with late wilt disease in a disease nursery at Sakha Research Station. Annually, different isolates of *C. maydis* were used to re-infect the disease nursery to increase the efficiency of selection. Infection technique was carried out according to El-Shafey *et al.*(1988). In 2002 growing season a half diallel crosses involving eight inbred lines was made to obtain 28 F1 hybrids. The eight inbred lines and their 28 F_1 crosses and two checks varieties (Sc Pioneer 3080 and SC155) were evaluated in two trials. The first conducted during 2003 growing season in field experiments under natural infection. Data, in the first trial, were recorded on percentage of resistance to late wilt disease (taken from each plot at the age of 35 days after 50% silking) and grain yield/ plant g (grain yield per plot adjusted to 15% moisture/ number of plants per plot). The second trial was performed during both 2003 and 2004 growing seasons in a disease nursery under artificial soil inoculation by the pathogen *Cephalosporium maydis*. Data, in the second trial, were recorded on several attributes, viz ; silking date (days), plant height (cm.), percentage of resistance to late wilt disease, grain yield/ plant (g.), ear length (cm.) and number of kernels/ row. The ordinary agricultural practices were done as usual in the production of maize during the growing season.

The randomized complete blocks design (RCBD) with four replications was used in the two trials. Plot was one row 6 m. long in the first trial and 2 m. long in the second trial , 80 cm. width, 25 cm. between hills and three seeds were sown per hill. The plants were thinned latter to one plant per hill before the first irrigation The ordinary analysis of variance for RCBD was firstly performed according to Snedecor and Cochran (1980) for every year and combined over years. Before calculating the combined analysis, test of homogeneity of error mean squares for two years was done. General and specific combining ability estimates were obtained by employing Griffing's (1956) diallel crosses analysis designated as method 4, model 1.

RESULTS AND DISCUSSIONS

Analysis of variance for six traits under artificial infection with late wilt disease over two years (2003 and 2004) and two traits under natural infection in 2003 season are presented in Table 1.A highly significant differences were shown among years for plant height trait only. Highly significant differences were also exhibited among genotypes (G) and their partitions; parents (P), crosses (C) and (P vs C) or heterosis for all studied traits except parents for grain yield / plant and number of kernels / row under artificial infection, indicting that the genotypes and their partitions involved herein differed significantly from each other in this study. The interactions between G x Y were significant for silking date, plant height and grain yield/ plant traits. Similarly P x Y interactions were significant for plant height and percentage of resistance to late wilt disease. The interactions C x Y were significant for plant height and grain yield / plant, while P vs C interactions were significant for silking date and plant height. These results indicated that genotypes and their partitions under artificial infection were affected by years change for those traits. Comstoc and Moll (1963) defined the genotype x environment interaction as the differential response of phenotypes to the change in environments.

Mean performance of 28 F_1 crosses for six studied traits under artificial infection with late wilt disease and two studied traits under natural infection are shown in Table 2.The mean values under artificial infection for silking date ranged from 58.35 days for the cross Sk7266 x Sk8118 to 63.62 days for the cross L121 x Sk 9121, plant height ranged from 217.5 cm. for the cross Sk7266 x Sk8118 to 257.25 cm. for the cross Gm1002 x Sk9203, percentage of resistance to late wilt disease varied from 67.62% for the cross

L121 x Sk N8 to100% for the cross Sk7266 x Sk9121and Sk7266 x Sk9203, grain yield/ plant varied from 151.27 g. for the cross Sk8118 x Sk9121 to 230.43 g. for the cross Sk7266 X Sk9203. Moreover, four crosses i.e L121 x Sk7266 207.87 g., L121 x SkN8 205.09 g., Gm1002 x Sk9203 224.23 g. and Sk8118 x SkN8 206.50 g. were insignificantly out-yielded compared to the best check SC3080 204.48 g Meanwhile, Sk7266 x Sk9203 was significantly increased compared to SC3080. Ear length ranged from 15.87 cm. for the cross Gm1002 x Sk9121 to 21.15 cm. for the cross L121 x Sk9203. Number of kernels/ row ranged from 32.75 for the cross Gm1002 x Sk9121 to 41.5 for the cross Sk7266 x Sk9203. On the other hand, the mean values under natural infection for percentage of resistance to late wilt disease ranged from 90.17% for the cross Sk7266 x SkN8 to 100% for 17 crosses. With respect to, grain yield / plant, it ranged from 127.15 g. for the cross Sk8118 x Sk9121 to 262.56 g. for the cross L121 x SkN8. Moreover, two crosses L121 x SkN8 and Sk7266 x Sk9203 were significantly higher than the best check SC3080. Generally, the cross Sk7266 x Sk9203 showed 100% resistance to late wilt disease under artificial and natural infections. It showed also significant increase for grain yield/ plant under artificial and natural infections compared to two commercial check SC3080 andSC155. Besides, it had suitable plant height and earliness. Therefore it will be evaluate in the advanced level of testing in the maize breeding program.

Table 1: Analysis of variance for six traits under artificial infection with late wilt disease over two seasons (2002 and 2003) and two traits under natural infection in 2003 season.

S o v	d.f	Artificial infection with late wilt disease						Natural infection	
		Silking date (days)	Plant height (cm)	Resistance to late wilt disease %	Grain yield / plant (g)	Ear length (cm)	Number of kernels /row	Resistance to late wilt disease %	Grain yield /plant(g)
Years (Y)	1	6.12	31899 17**	23.67	290.85	1.02	1.21	-	-
Error	6	11 82	920.32	164.95	1855.35	7 92	41.17	-	-
Genotypes(G)	35	101.38**	9780.07**	687.36**	25130 92**	59.25**	380.36**	63 86**	14562 34**
Parents(P)	7	32.74**	5095.26**	420.19**	456.75	15.30**	15 43	139 94**	2756.59**
Crosses(C)	27	16.67**	699 99**	761.87**	3539 60**	14.17**	44 89**	30 49**	3547 21**
P vs C	1	2869.03**	287735 9**	545.78**	780815 7**	1584.06**	11992 56**	432 28**	394611 1**
G X Y	35	6 19*	500 82**	84.48	1592.44**	1 69	9.38	-	-
P X Y	7	3.89	546 06*	186 46*	354 89	2.40	13 98	-	-
C X Y	27	3 61	467 09**	59.95	1966.7**	1.47	8 53	-	-
P vs C X Y	1	91 95**	1094 85*	32 93	150.27	2.66	0 13	-	-
Error	210	3.75	235 60	69 13	482 37	1 18	8 21	14 66	473 39
Cv %		3 12	6 84	9.78	14 34	6 48	8 75	3 93	12 54

***,**significant at the 0.05 and 0.01 levels of probability ,respectively.**

Mean performance of eight inbred lines *per se* and their means from 7 F_1's to other 7 inbred lines for percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections with late wilt disease are presented in Table 3.The results cleared that the inbred lines Sk8118 ,Sk9121and Sk9203 showed the highest mean *per se* and mean from 7 F_1's to other 7 inbreds for percentage of resistance to late wilt disease under artificial and natural infections. Similarly, the inbred line L121 showed the highest mean *per se* and mean from 7 F_1's to the other 7 inbreds for grain yield/ plant under artificial and natural infections. The mean over all crosses was higher when compared with the mean over all inbred lines for percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections, meaning that the heterosis lead to increase these two traits. El-Itriby *et al.* (1984) and Amer *et al.* (1999) reached to a similar conclusion. Meanwhile, mean over all the inbred lines and mean over all the crosses were reduction under artificial infection compared to its under natural infection for resistance to late wilt disease and grain yield/ plant.

Table2: Mean performance of 28 crosses for six traits under artificial infection with late wilt disease and two traits under natural infection.

Cross	Artificial infection with late wilt disease						Natural infection	
	Silking date (days)	Plant height (cm)	Resistance to late wilt disease%	Grain yield / plant (g)	Ear length (cm)	No. of kernels /row	Resistance to late wilt disease%	Grain yield / plant (g)
L121 X B73	61.12	241.62	76.59	185.05	18.42	35.92	100.00	231.21
L121 X Gm1002	60.50	256.50	90.20	168.83	17.37	34.20	100.00	210.96
L121 X Sk7266	58.87	251.50	77.37	207.87	19.05	37.27	96.68	222.25
L121 X Sk8118	59.37	251.0	88.63	197.65	19.20	36.17	100.00	213.76
L121 X Sk9121	63.62	244.62	88.63	195.78	17.52	34.70	100.00	171.71
L121 X Sk9203	63.25	251.37	98.86	174.90	21.15	39.3	100.00	235 33
L121 X SkN8	61.75	246.62	67.62	205.09	17.30	34.15	100.00	262 56
B73 X Gm1002	58.75	241.75	76 36	176.85	17.45	36.35	99.00	212.76
B73 X Sk7266	60.12	250.00	73.05	168.50	17.02	34.97	98.00	188.97
B73 X Sk8118	58.87	233.62	92.95	194.19	17.6	37.15	96.50	196.07
B73 X Sk9121	60.25	238.00	72.50	167.33	17.57	36.10	100.00	166.75
B73 X Sk9203	60.00	245.37	84.09	179.17	20.25	39.65	96.00	203.20
B73 X SkN8	59.50	233.50	72.95	156.75	16.62	33.17	97.00	196 81
Gm1002 X Sk7266	59.00	250.25	86.81	170.40	16.50	33.37	90.45	188 58
Gm1002 X Sk8118	58.87	230.12	90.73	175.33	17.22	34.50	94.00	190.02
Gm1002 X Sk9121	60.25	245.50	86.36	157.11	15.87	32.75	100 00	180.70
Gm1002 X Sk9203	61.00	257.25	85.71	224.23	18.40	37.95	98.00	235.76
Gm1002 X SkN8	58.50	240.50	82.95	192.21	16.30	33.42	97.72	224.09
Sk7266 X Sk8118	58.35	217.50	90.56	157.59	17.57	36.12	99.00	177.95
Sk7266 X Sk9121	60.87	238.62	100.00	169.99	18.80	39 15	100.00	188.43
Sk7266 X Sk9203	60.00	241.37	100.00	230.43	20.27	41.50	100.00	248.49
Sk7266 X SkN8	59.62	233.87	72.14	170.58	17.55	35.87	90.17	218.20
Sk8118 X Sk9121	60.75	228.50	94.09	151.27	17.27	34.60	100.00	127.15
Sk8118 X Sk9203	61.5	248.87	97.61	169.41	20.42	39.70	100.00	230 81
Sk8118 X SkN8	59.0	231.87	84.09	206.50	17 22	33.77	100.00	191 25
Sk9121 X Sk9203	62.62	241 37	96.36	162.66	18.80	38.25	100.00	176 38
Sk9121 X SkN8	61.87	232.62	71.16	155.21	17.05	34 65	100 00	152.88
Sk9203 X SkN8	61.87	232.50	95.45	195.84	18.62	39 17	98.86	198 83
SC3080	60 25	249.38	98.86	204.48	17.50	39.30	100.00	205.34
SC155	61 50	254.75	100.00	191.52	18.40	35.65	100.00	197.18
LSD 0.05	1.89	15.04	8.14	21.52	1.06	2 80	5.40	30.70
0.01	2.48	19.79	10.72	28.32	1.39	3 68	7.20	40.80

Table 3: Mean performance of 8 inbred lines and their means from 7 F_1's to other 7 inbred lines for percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections with late wilt disease.

Inbred Line	Artificial infection				Natural infection			
	Resistance to late wilt disease (%)		Grain yield / plant (g)		Resistance to late wilt disease (%)		Grain yield / plant (g)	
	Per se mean	Mean over 7 crosses	*Per se* mean	Mean over 7 crosses	*Per se* mean	Mean over 7 crosses	*Per se* mean	Mean over 7 crosses
L 121	78.19	83.98	72.18	190.73	98.81	99.52	136.14	221.11
B 73	83.38	78.35	50.13	175.40	86.06	98.07	70.30	199.39
Gm 1002	83.40	85.58	59.95	180.71	91.0	97.02	71.08	206.12
Sk 7266	74.72	85.70	50.95	182.19	89.40	96.32	74.25	204.69
Sk 8118	90.62	91 23	52.81	178.85	98.91	98.5	73.49	189.57
Sk 9121	86.81	87.01	49.54	165.60	100.0	100.0	47.78	166.28
Sk 9203	95.11	94.01	57.21	190.94	100.0	98.98	74.3	218.4
SkN 8	75.38	78.05	52.91	183.16	88.29	97.67	57.48	206.37
Mean	83.45	85 49	55 71	180 95	94.06	98 26	75.60	201.49
r	0.752*		0.678		0.766*		0.647	

r :Correlation coefficient between *Per se* means of the inbred parents and their means from 7 F_1s to other inbred lines.

The correlation coefficient (r) between *per se* means of the inbred lines and their means from 7 F_1's for percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections are shown in Table3. The results showed significant percentage of resistance to late wilt disease under artificial and natural infections, indicating that resistance to late wilt disease was transmitted from inbreds to hybrids.

The analysis of variance for combining ability for six studied traits under artificial infection with late wilt disease and two traits under natural infection are presented in Table 4 The results revealed that the mean squares due to general combining ability (GCA) were highly significant for all studied traits. This finding indicated that additive gene effects were important in the inheritance of all studied traits. While, the mean squares due to specific combining ability (SCA) were highly significant for percentage of resistance to late wilt disease, Grain yield/ plant and ear length under artificial infection and grain yield/ plant under natural infection. It was evident, thus, non additive gene effects were important in the inheritance for these traits. The ratios between GCA and SCA mean squares were largely exceeded the unity for all studied traits. These results indicated that the additive gene effects played a major role than those non additive gene effects in the genetic control of all studied traits under artificial and natural infections. These results agreed with the findings of El-Hosary *et al* (1999) for silking date, Singh *et al.* (2002) for plant height, Galal *et al* (1985), El-Shenawy (1995) and Mosa (2001) for resistance to late wilt disease, Al-Naggar (1991). El-Shamarka (1995), Murariu (1998)and Rameeh *et al.* (2000) for grain yield, Nawar *et al.* (1979) for ear length, Pajic (1986) for grains/ row. The mean squares of interaction between years and both GCA and SCA combining ability were insignificant for all studied traits except plant height for GCA x Y and grain yield/ plant under artificial infection for both GCA x Y and SCA x Y. However, GCA x Y was higher than SCA x Y for all traits except grain yield/ plant under artificial infection. Zelleke (2000) found that GCA x years interaction was significant for grain yield and plant height.

Table 4: Analysis of variance for combining ability (GCA and SCA) for six traits under artificial infection with late wilt disease and two traits under natural infection.

S o v	d.f	Artificial infection with late wilt disease						Natural infection	
		Silking date (days)	Plant height (cm)	Resistance to late wilt disease %	Grain yield / plant (g)	Ear length (cm)	Number of kernels / row	Resistance to late wilt disease %	Grain yield /plant (g)
GCA	7	50.9**	1711 5**	1985 44**	4428 66**	47.35**	137.7**	50.78**	9838 9**
SCA	20	4.67	345.92	333.62**	3229 38**	2.60**	12.38	23.38	1345 11**
GCA X Y	7	5.71	1217 5**	64.32	1493.15**	1.98	15.04	-	-
SCA X Y	20	2.88	204.46	58.40	2132 44**	1.29	6.25	-	-
Error	210	3.75	235.6	69.13	482.37	1.18	8.21	14.66	473.39
GCA / SCA		10.89	4.94	5.95	1.37	18.21	11.12	2.17	7.31
GCA X Y / SCA X Y		1.98	5.95	1.10	0.70	1.53	2.40	-	-

**significant at the 0.01 level of probability.

The estimates of GCA effects of the parental inbreds for the six studied traits under artificial infection and two studied traits under natural infection are illustrated in Table 5.

Table5:Estimates of GCA effects of eight inbred lines for six traits under artificial infection with late wilt disease and two traits under natural infection.

Inbred line	Artificial infection with late wilt disease						Natural infection	
	Silking date (days)	Plant height (cm)	Resistance to late wilt disease %	Grain yield / plant (g)	Ear length (cm)	Number of kernels /row	Resistance to late wilt disease%	Grain yield / plant (g)
L121	0 994**	9 031**	-1 739	11 468**	0.687**	-0 255	1 489*	22 927**
B73	-0 651*	-0 864	-8 239**	-6 468*	-0 187	-0 046	-0 218	-2 364
Gm1002	-0 942**	5 468**	0 052	-0 302	-1 229**	-1 838**	-1.427	5 343
Sk7266	-0 942**	-0 989	0 239	1 406	0 104	0 786*	-2 260**	3 677
Sk8118	-0 963**	-7 927**	6 656**	-2 489	0.062	-0 213	0 281	-13 906**
Sk9121	1 286**	-3 302	1 760	-17 906**	-0 520**	-0 609	2 031**	-41 031**
Sk9203	1 286**	4 843*	9 864**	11 697**	1 958**	3 661**	0 822	19 677**
SkN8	-0 068	-6 260**	-8 593**	2 593	-0 875**	-1 486**	-0 718	5 677
LSD gi 0 05	0 54	4 06	2 2	5 81	0 28	0 75	1 46	8 30
0 01	0 71	5 34	2 89	7 64	0 36	0 98	1 93	11 00
LSD gi-gj 0 05	0 77	6 14	3 32	8 78	0 43	1 14	2 18	12 43
0.01	1 01	8 08	4 37	11 56	0 57	1 5	2 88	16 39

*,**significant differences from zero at the 0.05 and 0.01 levels of probability, respectively.

The results cleared that the parental inbred line Sk9203 was the best combiner for percentage of resistance to late wilt disease, grain yield/ plant, ear length and number of kernels/ row under artificial infection and grain yield/ plant under natural infection, significant desirable GCA effects were exhibited in the inbred line L121 for grain yield/ plant and ear length under artificial infection and percentage of resistance to late wilt disease and grain yield/ plant under natural infection, Sk8118 for silking date, plant height and percentage of resistance to late wilt disease under artificial infection, Sk7266 for silking date and number of kernels/ row, B73 and Gm1002 for silking date and Sk9121 for percentage of resistance to late wilt disease under natural infection, suggesting the possibility of utilizing these inbred lines in the local breeding program.

Table 6: Estimates of SCA effects of 28 F_1's for six traits under artificial infection with late wilt disease and two traits under natural infection conditions .

Cross	Artificial infection with late wilt disease						Natural infection	
	Silking date (days)	Plant height (cm)	Resistance to late wilt disease%	Grain yield / plant (g)	Ear length (cm)	No of kernels /row	Resistance to late wilt disease%	Grain yield /plant(g)
L121 X B73	0 420	-7 84	1 131	-0.830	-0 053	0.083	0.470	9 41
L121 X Gm1002	0 086	0 71	6 339*	-23.25**	-0 386	0 125	1.679	-18.80*
L121 X Sk7266	-1.539*	2.16	-6.598**	14.29*	0 404	0.500	-0.738	-5.88
L121 X Sk8118	-1.018	8 6	-1 765	7.69	0 571	0.500	-0.030	3 2
L121 X Sk9121	0 982	-2 40	3.131	21 23**	-0 610*	-0 720	-1.780	-11.67
L121 X Sk9203	0 607	-3 79	5.152*	-29 12**	0.550	-0.250	-0.571	-8 63
L121 X SkN8	0.461	2.56	-7 39**	9 98	-0 491	-0.229	0 970	32 37**
B73 X Gm1002	-0 018	-4 15	-0 911	2.69	0 613*	1.712	2.387	8 24
B73 X Sk7266	1 357*	10 56*	-4 348	-7.39	-0.865**	-1.958	2 22	-13 84
B73 X Sk8118	0 128	1 12	8 985**	22 25**	-0 303	1.167	-1.821	10 99
B73 X Sk9121	-0 747	0 87	-6.369*	10.67	0 279	0.563	-0 071	8 62
B73 X Sk9203	-0.997	0.10	-2 973	-7.18	0.550	-0 408	-2.863	-15 59
B73 X SkN8	-0.143	-0 67	4 485	-20.21**	-0.241	-1.438	-0.321	-7.84
Gm1002 X Sk7266	0.524	4.48	0 985	-11 81	-0.428	-1.717	-4 071*	-22 05*
Gm1002 X Sk8118	0.420	-8 71	-1.557	-2.91	0.488	0.333	-3.115	-2 71
Gm1002 X Sk9121	-0.455	2.04	-1.036	-5.62	-0 428	-0.896	1.137	14 91
Gm1002 X Sk9203	0.295	5 64	-9 765**	31 90**	-0.282	-0 042	0 345	8 95
Gm1002 X SkN8	-0.851	0 0001	5 943*	9 0	0.425	0 604	1.637	11 45
Sk7266 X Sk8118	-0.080	-14 88**	-1 869	-22 5**	-0.720*	-0 542	2 72	-13 55
Sk7266 X Sk9121	0 170	1 62	12 402**	5 42	1 113**	2 729**	1.97	24 33**
Sk7266 X Sk9203	-0.705	-3.77	4 298	36.32**	0 133	0.833	3 170	23 62*
Sk7266 X SkN8	0.274	-0.17	-4 869*	-14.33*	0.432	0.354	-5.28**	7 37
Sk8118 X Sk9121	0 065	-1.57	0 110	-9 31	-0.220	-0.896	-0 571	-19 34*
Sk8118 X Sk9203	0.815	10 66*	-4 494	-20.54**	0.300	0 083	0 637	23 45*
Sk8118 X SkN8	-0.330	4 77	0.589	25 32**	-0 116	-0 646	2.179	-2 05
Sk9121 X Sk9203	-0 310	-1 46	-0 848	-12.00	-0.741*	-1 271	-1.113	-3 67
Sk9121 X SkN8	0 295	0 89	-7.39**	-10 39	0 61*	0 500	0.429	-13 17
Sk9203 X SkN8	0 295	-7 38	8 031**	0 63	-0 511	0.85	0 387	-28.13**
LSD Sij 0 05	1.13	8 98	4 86	12 86	0 61	1.72	3.23	18 38
0.01	1 48	11 82	6 40	16 92	0 86	2.26	4 16	24 35
LSD Sij-Skl 0 05	1 54	12 28	6 65	17 57	0 86	2 29	4.33	24 87
0 01	2 03	16 16	8 75	23 13	1 14	3 01	5 71	32 78

*** and ** significant difference from zero at the 0.05 and 0.01 levels of probability , respectively .**

The estimates of SCA effects of 28 F_1's for the six studied traits under artificial infection with late wilt disease and the two traits under natural infection are shown in Table 6. The results indicated that significant and desirable SCA effects were shown for one cross for silking date, plant height and number of kernels/ row, six crosses for both percentage of resistance to late wilt disease and grain yield/ plant and three crosses for ear length under artificial infection. Besides, four crosses exhibited desirable SCA effects for grain yield/ plant under natural infection. In addition the desirable single crosses that showed SCA effects for most traits were those of SC Sk7266 x Sk9121 for percentage of resistance to late wilt disease, ear length, number of kernels/ row under artificial infection and grain yield/ plant under natural infection, SC Sk7266 x Sk9203 for grain yield/ plant under artificial and natural infections, SC B73 x Sk8118 for percentage of resistance to late wilt disease and grain yield/ plant under artificial infection and SC L121 x Sk7266 for silking date and grain yield/ plant under artificial infection.

Correlation coefficients between percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections are presented in Table 7. The results revealed that correlation coefficient between percentage of resistance to late wilt disease under artificial and natural infections was insignificant. Consequently resistance to late wilt disease under natural infection would not be used as an estimation of resistance to late wilt disease under artificial infection. Insignificant correlations were recorded between percentage of resistance to late wilt disease under artificial infection and grain yield/ plant under natural infection. However, highly significant positive correlation was recorded between percentage of resistance to late wilt disease under natural infection and grain yield/ plant under artificial infection (0.445**), indicating that percentage of resistance to late wilt disease under natural infection was related with grain yield/ plant under artificial infection. Thus highly yielding crosses under artificial infection exhibited high resistance to late wilt disease under natural infection and vice verse. Highly significant positive correlation coefficient was found between grain yield/ plant under artificial and natural infections with late wilt disease (0.93**), indicating that the association between the two traits is high.Therefore, grain yield/ plant under artificial infection with late wilt disease could be used as an estimation of grain yield/plant under natural infection conditions.

Table7: Correlation coefficients between percentage of resistance to late wilt disease and grain yield/ plant under artificial and natural infections conditions.

Trait	Artificial infection with late wilt disease	
	Resistance to late wilt disease %	Grain yield / plant (g)
Resistance to late wilt disease % (under natural infection)	0.304	0 445**
Grain yield / plant (g) (under natural infection)	0.045	0.93**

** Significant at 0.01 level of probability.

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القدرة علي الائتلاف لمقاومة مرض الذبول المتأخر والمحصول والعلاقة بينهم تحت ظروف العدوى الصناعية والعدوى الطبيعية في الذرة الشامية

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الذبول المتأخر واحد من أخطر الأمراض التي تصبب الذرة الشامية في مصر حيث يسبب نقص ملحوظ في محصول النبات.تم التهجين بين ٨ سلالات صفراء من الذرة الشامية بنظام التهجين الدائري في أتجاه واحد وذلك في موسم ٢٠٠٢. قيمت سلالات الأباء الثمانية والهجن ال٢٨ الناتجة منها في تجربتين في محطة البحوث الزراعية بسخا. التجربة الأولي أقيمت خلال موسم ٢٠٠٣ تحت ظروف العدوى الطبيعية و التجربة الثانية قيمت خلال موسمي ٢٠٠٣و٢٠٠٤ تحت ظروف العدوى الصناعية بمرض الذبول المتأخر.وقد تم التحليل الوراثي طبقا لجرفنج ١٩٥٦ (الطريقة الرابعة الموديل الأول) ويمكن تلخيص أهم النتائج فيمايلى :

- أظهر تباين القدرة العامة علي الائتلاف معنوية لجميع الصفات تحت الدراسة بينما كان تباين القدرة الخاصة علي الائتلاف معنويا لصفة نسبة المقاومة لمرض الذبول المتأخر، محصول الحبوب للنبات، طول الكوز تحت ظروف العدوى الصناعية ومحصول الحبوب للنبات تحت ظروف العدوى الطبيعية. وقد زادت النسبة بين تباين القدرة العامة علي الائتلاف إلى تباين القدرة الخاصة علي الائتلاف عن الواحد لجميع الصفات تحت الدراسة وهذا يعني أن تباين الفعل الوراثي المضيف يلعب دورا اكثر أهمية من الفعل الوراثي غير المضيف في وراثة جميع الصفات التي درست تحت ظروف العدوى الطبيعية والصناعية.
- أظهرت السلالة سخا ٩٢٠٣ قدرة عامة جيدة علي الائتلاف لصفات نسبة المقاومة لمرض الذبول المتأخر، محصول الحبوب للنبات، طول الكوز وعدد الحبوب بالصف تحت ظروف العدوى الصناعية ومحصول الحبوب للنبات تحت ظروف العدوى الطبيعية كما أعطت السلالة ١٢١ قدرة عامة جيدة علي الائتلاف لصفات محصول الحبوب للنبات، طول الكوز تحت ظروف العدوى الصناعية ونسبة المقاومة لمرض الذبول المتأخر ومحصول الحبوب للنبات تحت ظروف العدوى الطبيعية. كذلك اظهر الهجين سخا٧٢٦٦ ×سخا٩٢٠٣ قدرة خاصة جيدة علي الائتلاف لصفات محصول الحبوب للنبات تحت ظروف العدوى الصناعية والطبيعية.
- كان متوسط الهجن أعلي من متوسط السلالات لصفة نسبة المقاومة لمرض الذبول المتأخر ومحصول الحبوب للنبات تحت ظروف العدوى الطبيعية والصناعية وترجع تلك الزيادة إلى تأثير قوة الهجين. ينخفض متوسط كلاً من السلالات والهجن فى مقاومة مرض الذبول المتأخر و محصول الحبوب للنبات تحت ظروف العدوى الصناعية مقارنة بظروف العدوى الطبيعية .
- أظهر التلازم بين متوسطات السلالات ومتوسط كل سلالة في هجنها معنوية لصفة نسبة المقاومة لمرض الذبول المتأخر تحت كلا من العدوى الطبيعية والصناعية ويعني ذلك ان المقاومة تنتقل من الأباء الي النسل الناتج منها بينما التلازم بين نسبة المقاومة لمرض الذبول المتأخر تحت ظروف العدوى الطبيعية والصناعية غير معنوي ويعني ذلك أن الاختبار تحت العدوى الطبيعية لا تغني عن الاختبار تحت العدوى الصناعية.بينما كان التلازم بين صفة المحصول للنبات تحت ظروف العدوى الطبيعية والصناعية عالي المعنوية وبالتالي يمكن الاعتماد علي تقدير المحصول للنبات تحت ظروف العدوى الصناعية.