Zagazig J. *Agric. Res. Vol. 20 No.* (5) *1993*

Genetic variability and diallel analysis of late wilt resistance and some other characters in maize

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Received in 1/8/1993

ABSTRACT: The present investigation was to study the genetic system controlling late wilt (*Cephalosporium maydis*) resistance, some other characters, i.e. (plant height, silking date, 100-kernel weight and grain yield / plant) and the correlation coefficient between them. Seven maize inbred lines were used as parents in a 7x7 half diallel crosses. Parents and 21 F_1'S were used in the analysis.

Inheritance of resistance to late wilt and other traits may depend mainly on the additive gene effects and/or non - additive gene effects. Additive gene effects are relatively more important as shown by GCA/SCA ratio.

The best general combiners for late wilt resistance were G.200, G.307,435329 and Ci. 516 and for plant height, G. 516 and 435329,were good combiners. The best for the other traits were G.2, R.95 and 420051. The best combinations for resistance to late wilt were (435329 x G.2), (G.307x435329), (G.516 x 42005 1) and (G.2 x G.200). For tallness, it was (G.307xG.2) and for shortness: (435329x G.2) and (G.516x420051). The promising combination for earliness and 100- kernel weight was (G.307xR.95),but for grain yield / plant the cross (420051 xR.9S) was the best.

Highly significant or significant negative or positive phenotypic and genotypic correlation coefficient were obtained among the studied characters.

INTRODUCTION

Late wilt disease in maize caused by *Cephalosporium maydis*, is a very serious problem affecting maize production in Egypt.. Breeding for resistant varieties is considered the most effective method for controlling this disease. More information is needed as to the mode of inheritance of resistance to this disease.

Shehata and Salem (1972) und **Salem (1977)** reported that additive. dominance and epistasis effects were significant and important in conditioning resistance to this disease and also to grain yield characters. Polygenic systems seemed to control the inheritance of resistant. **Salem et al. (1981)**, **Galat et al. (1985)**, **Nawar and Salem (1985) and EI-Sherbiney (1986)** found that the inheritance of resistance to late wilt and some other related characters depends mainly on the additive effects which playa major role in controlling these characters.

Kassem et al, (1979), **El-Itribu et al. (1984 and 1990)** and **Soliman (1992)** reported that both additive and non-additive gene effects were involved in controlling the inheritance of resistance to late wilt disease and plant height, silking date, 100-kernel weight and grain yield/plant.

The main objective of this work was to investigate the mode of inheritance for resistance to late wilt disease of maize and other related characters, i.e., plant height, silking date, 100- kernel weight and grain yield/plant at 15.5% moisture content.

Materials and Methods

Field experiments were conducted at the experimental farm of the Faculty of Agriculture, Moshtohor, Zagazig University during 1991 and 1992 seasons. Work included 7 parental inbred lines, i.e. G. 307, G.516, 420051, 435329, G.2, R.95 and G.200. All inbred lines were obtained from the Egyptian maize breeding program, ARC. Giza, Egypt. Genetic materials were selected to present a random set of parents. These parents were different in their response to late wilt disease and other characters. Parents were crossed in 1991 in half-diallel crosses. The experiments carried out on 1992 to test 21 F_1 crosses and 7 parents. Randomized complete block design having 3 replicates were used. The plot consisted of 5 rows of plants, spaced at 30 cm. Distance between rows 70 cm. The middle two rows were infected artificially by soaking maize seeds in the collected spore suspension of *Cephalosporium maydis* (5g/ l kg seeds). Data for resistance to late wilt were collected as number of resistant plants per plot at 40 days after mid-silking or after 105 days from planting (according to **Sabet et al, (1961)**, then adjusted as percentages of the total number of plants per plot. The angular transformation of the data was performed. (according to **Snedecor and Cochran 1967**), since resistance percentages ranged from zero to 100.

The analysis of variance for combining ability and estimation of various effects were done following the procedure of **Griffing (1956)** method II model II. Phenotypic and genotypic correlation coefficients according to **Robinson et at. 1951** were also done.

Results and Discussion

Results (Table 1) showed highly significant differences for the genotypes of all studied traits. General combining ability variances were highly significant for all studied traits. This reflects the importance of additive gene action controlling these traits.

Such significant differences of specific combining ability observed for all studied traits, show the important of the non-additive variance in the inheritance of these traits. In this respect, **El-Itribu et al. (1984 and 1990**) reached the same results. To reveal the nature of the role of genetic variance, GCA/SCA ratio was computed. High values exceeding unity (i.e.>.l.0) were obtained (Table 1). Thus, the largest part of the total genetic variability was associated with additive gene action. These results are in agreement with those reported by **Salem et al. (1981), Galal et al. (1985), Nawar and Salem (1985), EI-Sherbiney (1986) and Soliman (1992)**.

Table (1): Mean squares from the analysis of variance for combining ability for late wilt resistance and other characters in maize.

Source	df	Late wilt resistance	Plant height	Silking date	100-kernel weight	Grain yield/plant
Genotypes	27	97.680**	124.659**	20.037**	53.193**	19.151**
CCA	6	414.717**	432.156**	8.0316**	20.894**	7.006**
SCA	21	70.983**	368.029**	2.803**	8.693**	4.606**
Error	54	5.988	3.917	0.151	0.965	0.419
GCA/SCA	-	5.842	1.174	2.867	2.403	1.521

** Significant at 1 % level of probability.

Table (2): General combining ability effects in the F_1 for late wilt resistance and other characters in maize.

No.	Genotypes / Parents	Late wilt resistance	Plant height	Silking date	100-kernel weight	Grain yield/plant
1	G.307	9.707**	0.912	0.974**	-1.552**	-0.630
2	G.516	4.683**	-18.103**	1.307**	-2.547**	-1.704
3	420051	-10.700**	11.134*	-1.212**	1.884**	0.741
4	435329	7.522**	-14.495**	0.307*	-2.304**	-1.037
5	G.2	-8.441**	12.949**	-2.286**	3.036**	2.037
6	R.95	-18.108**	10.912	-1.545**	3.771**	2.074
7	G.200	15.337**	-3.310	2.455**	-2.289**	-1.481
L.S.D. gi	5 %	1.517	9.602	0.240	0.609	0.402
	1 %	2.022	12.800	0.321	0.812	0.535
L.S.D. gi-gj	5 %	2.297	5.926	0.367	0.930	0.614
	1 %	3.062	7.900	0.489	1.240	0.817

** Significant at 5 % and 1 % level of probability, respectively.

Data presented in Table (2) show that all the studied parents exhibited highly significant effect for GCA in almost all cases with positive and negative sign. Considerable general combining ability (gi) effects were obtained for resistance to this disease. A P7 (G.200), P1 (G.307), P4 (435329) and P2 (G.516). On the other side, the parents P6 (R.95), P3 (420051) and P5 (G.2) were the poor general combiners for the resistance to this disease. With regard to plant height, P2 (G.516) and P4 (435329) are good combiners for shortness, while P5 (G.2), P3 (420051) and P6 (R.95) were good combiners for tallness. Selection for shortness or tallness is considered a desirable character which depends on the aim of the breeding program. For earliness, 100 kernel weight and grain yield /plant the parents, P5 (0.2), P6 (R.95) and P3 (420051) seemed to be the best combiners for all these traits.

Determination of specific combining ability effects for the 21 crosses regarding the 5 studied traits are found in Table (3). Significant positive SCA effects for resistance to the disease were obtained in the crosses P4xP5 (435329 x G.2), P1xP4 (G.307x435329), P2xP3 (G.516x420051) and P5xP7 (G,2 x G.200). For plant height only two crosses PI xP5 (G.307xO.2) and P3xP4 (420051 X435329) showed significant positive SCA effects towards tallness. On the other hand, i.e. crosses, P4xP5 (435329xG.2) and P2xP3 (G.5I6x420051) showed significant negative SCA effects towards shortness which agree with those of **Sedhom 1984 and El-Itribu et al. 1990.**

These data showed important fact, that the best combinations for late Wilt resistance (P4xP5) and (P2xP3) were the same best combination for shortness of plant height.

For silking date, 5 crosses showed significant negative SCA effects towards earliness. These were P1 x P6 (G.307 x R.95), P4 x P7 (435329 x G.200), PlxP5 (G.307xG.2), P4xP5 (435329xG.2) and P5xP7 (G.2 x G.200). These results were in agreement with those obtained by **Soliman (1992).**

For 100-kernel weight, only the 2 crosses of P1 x P6 (G.307xR.95) and P5xP7 (G.2 x G.200) showed significant positive SCA effects. For grain yield/plant, the crosses P3xP6 (420051xR.95), P2xP3 (G,516x420051) and P2xP7 (G.516xG.200) showed highly significant positive effect for SCA, therefore these crosses may be the best combination for breeding this trait. These results agree with that mentioned by **Sedhom (1984) and EI-Itribuet al. (1990).**

The phenotypic and genotypic correlation coefficients among the studied characters are presented in Table (4). Resistance to late wilt disease showed highly significant negative phenotypic correlation with plant height (-0.583) and showed highly significant positive phenotypic correlation (0.828) and significant positive genotypic correlation (0.276) with silking date. These results agree with those obtained by **El-Itribu et al. (1984) and Soliman (1992).**

Highly significant negative phenotypic correlation coefficients were obtained between late wilt reaction and each of 100-kernel weight (-0.801) and grain yield/plant (-0.715), respectively.

Genotypic correlation of late wilt reaction with the same 2 traits showed significant negative values (-0.239 and -0.267), respectively. This indicates that the infection by *Cephalosporium maydis* have caused a reduction in 100-kernel weight and also in grain yield/plant.

Plant height showed highly significant negative phenotypic correlation (-0.569) with silking date and showed highly significant positive phenotypic correlation with each of lOO-kernel weight (0.661) and grain yield/plant (0.609). There was a significant positive genotypic correlation between plant height and 100-kernel weight (0.220).

Silking date showed highly significant negative phenotypic correlation with 100-kernel weight and grain yield /plant (-0.755 and -0.685), whereas silking date showed significant negative genotypic correlation with the previous traits (-0.252 and -0.229). These findings are in agreement with those of EI-Sherbieny (1986) and Soliman (1992).

Table (3): Specific combining ability effects in the F_1 for late wilt resistance and other characters in maize.

No.	Characters / Crosses	Late wilt resistance	Plant height	Silking date	100-kernel weight	Grain yield/plant
1	G.307 x G.516 (P 1 x P 2)	-2.512	4.133	0.065	-0.342	0.750
2	G.307 x 42005l (P 1 x P 3)	-1.128	-2.104	-0.417	-1.189	-0.361
3	G.307 x 435329 (P 1 x P 4)	4.650*	-2.807	0.065	-2.588**	-0.250
4	G.307 x G.2 (P 1 x P 5)	-2.721	12.081 * -	1.343**	-1.265	0.009
5	G.307 x R.95 (P 1 x P 6)	-8.054**	-4.548	-2.083**	1.617*	-1.694**
6	G.307 x G.200 (P 1 x P 7)	0.830	-5.659	0.917**	-1.940*	-0.472
7	G.516 x 42005l (P 2 x P 3)	4.562*	-12.756*	0.250	-1.122	-1.330**
8	G.516 x 435329 (P 2 x P 4)	0.007	5.874	0.731*	1.110	0.491
9	G.516 x G.2 (P 2 x P 5)	0.970	10.096	0.324	-0.150	0.083
10	G.516 x R.95 (P 2 x P 6)	-3.030	3.467	-0.417	-0.372	0.380
11	G.516 x G.200 (P 2 x P 7)	2.859	-0.311	-0.417	0.131	1.269**
12	420051x435329 (P 3 x P 4)	2.391	11.637*	0.250	-0.271	0.380
13	420051 x G.2 (P 3 x P 5)	-4.646*	-5.141	0.509	0.769	0.972
14	420051 x R.95 (P 3 x P 6)	0.687	-8.104	0.102	1.204	2.602**
15	420051 x G.200 (P 3 x P 7)	0.242	-8.104	0.102	1.204	-0.176
16	435329 x G.2 (P 4 x P 5)	8.465**	-0.215	-0.898**	-0.713	-0.250
17	435329 x R.95 (P 4 x P 6)	-9.869**	-36.17~*	1.324**	-2.510**	0.380
18	435329 x G.200 (P 4 x P 7)	-3.313	0.081	-1.417**	0.898	0.269
19	G.2 x R.95 (P 5 x P 6)	2.761	8.859	-0.417	-0.295	1.306*
20	G.2 x G.200 (P 5 x R 7)	4.316	0.081	-1.417**	0.898	-0.139
21	R.95 x G.200 (P 6 x P 7)	1.983	8.748	0.176	1.222	-0.843
	L.S.D. gi 5 %	3.755	9.602	0.595	1.507	0.994
	1 %	5.005	12.800	0.793	2.009	1.325
	L.S.D. gi-gj 5 %	12.799	32.732	2.029	5.138	3.389
	1 %	17.061	43.632	2.706	6.849	4.517

** Significant at 5 % and 1 % level of probability, respectively.

The 100-kernel weight showed highly significant positive phenotypic correlation (0.754) and significant positive genotypic correlation (0.251) with grain yield/plant.

In general, for late wilt reaction, the inbreds; G.307 (P1, local) and 435329 (P4, exotic) and their single cross (P1 x P4) were the best combination for resistance to this disease. Although the local inbred P5(G.2) was not resistant to this disease, but the single cross (P4xP5), (exotic x local) was the best single cross in this respect. For the rest of the studied characters, the 7 inbreds and their 21 F_1 single crosses were varying according to the inbred and the trait.

Table (4): Phenotypic (ph) and genotypic *(G)* correlation coefficients among the studied characters in maize.

Characters		Plant height	Silking date	100-kernel weight	Grain yield/plant
Late wilt resistance	Ph	-0.583**	0.828**	-0.801**	-0.715**
	G	-0.194	0.276*	-0.239*	-0.267*
Plant height	Ph		-0.569**	0.661**	0.609**
	G		-0.189	0.220*	0.203
Silking date	Ph			-0.755**	-0.685**
	G			-0.252*	-0.229*
100-Kernel weight	Ph				0.754**
	G				0.251*

*, ** significant at 5% and 1% level of Probability, respectively.

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الاختلاف الوراثى والتحليل الداى اليلى للمقاومة للذبول المتأخر و بعض الصفات الاخرى فى الذرة الشامية

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أجرى هذا البحث لدراسه النظام الوراثى المتحكم في وراثه مرض الذبول المتأخر المتسبب عن الفطر *Cephalosporium maydis* ودراسة بعض الصفات الأخرى مثل إرتفاع النبات وميعاد التزهير، رزن المائة حبه ومحصول حبوب النبات في الذرة الشاميه وكذا دراسة معامل الارتباط بين هذه الصفات.

استخدم سبعة سلالات تربيه داخليه من الذرة الشامية كأباء واشتمل التحليل الداي دليلي في اتجاه واحد على كل من الاباء وهجن الجيل الأول ال 21.

أوضحت النتائج أن وراثه المقاومه للذبول المتأخر والصفات الأخرى تعتمد أساسأ علي التأثيرات الجينية المضيفة فقط أو تعتمد على كل من التأثيرات الجينية المضيفه والغير مضيفه معا. ومن العلاقه بين القدرة العامة والخاصه على الائتلاف يفترض أن التأثيرات الجينية المضيفه هي الأكثر أهميه في وراثة الصفات المدروسه من التأثيرات الجينية الغير مضيفه.

أتضح أن أفضل الأباء فى مقدرتها العامه بالنسبه للمقاومه لمرض الذبول المتأخر هي ألاباء ج 200، ج 307، 435329، ج 516 وبالنسبه لارتفاع النبات كانت الاباء ج 516، 435329، هى الافضل بينما بالنسبه لباقى الصفات كانت الاباء ج2، ار 95، 420051 هي الافضل.

ومن دراسة القدرة الخاصه على الائتلاف اتضح أن افضل الهجن الفرديه في اتجاه المقاومه لمرض الذبول المتأخر هي (ج 2 × 435329)، (ج 307 × 435329)، (ج 516 × 420051)، (ج2 × ج 200) وافضل الهجن فى أتجاه زيادة طول ساق النبات هي (ج 307 × ج 2) و فى اتجاه قصر طول ساق النبات هى (ج 2 × 435329)، (420051 × ج 516). أفضل الهجن بالنسبه للتبكير في التزهير ووزن ال100 حبه هو الهجين (ار95 × ج 307) بينما بالنسبه لمحصول حبوب النبات كان الهجين الفردي (ار95 × 420051) هو الافضل، وكان معامل الارتباط المظهري والوراثى عالى المعنويه أو معنوي بقيم سالبه أو موجبه بين الصفات المدروسه بعضها البعض.