Assiut Journal of Agricultural Science, Vol 37, No 2 , 2006

IMPLICATIONS OF SELECTION FOR LEAF AREA INDEX UNDER DIFFERENT MOISTURE STRESS CONDITIONS ON YIELD IN CORN (*Zea mays* L.)

M. M. El-Defrawy* ; Tahany H. I. Sherif*; S. E. Sadek~ and Eatemad M. H. Ahmad~

*Genetics department, Faculty of Agriculture, Assiut University, Assiut, Egypt and ~Maize Research Program, Agric. Res. Center, (ARC), Giza, Egypt.

Abstract: Twenty-one F_1 hybrids of a diallel cross involving 7 elite inbred lines, were grown over 10 environments with different moisture stress conditions. Several agro-physiological traits were recorded including: eighth leaf area (ELA), leaf area index (LAI), ear leaf area (ErLA) and grain yield/plant (GY).

All traits were reduced due to moisture stress with the greatest reduction being in grain yield/plant (70.81%) followed by LAI (54.82%), ErLA (43.7%), and ELA (42.3%).

Genes with mainly additive effects were controlling LAI which appeared to be the most promising trait for selection for grain yield improvement since it did not show genotype x environment interaction and was also genetically correlated with grain yield/plant under water stress conditions.

Two cycles of directional phenotypic selection for increased as well as decreased LAI were performed in the F_2's of the highest three F_1 hybrids in grain yield/plant under favourable (F) and moisture stress (S) conditions. Positive responses to selection for increased LAI in the favourable environment were obtained in the three populations, which averaged 9.62% and 7.13% of the control mean in the first and second cycles of selection, respectively. Such responses were greater than those obtained under strongly stressed conditions (4.78% and 3.74%, respectively). A reverse situation was obtained in the decreasing direction. Under the strongly stressed environmental conditions, greater responses to selection (14.43 and 12.53%, respectively) were obtained in mean LAI under stress than under favourable conditions (7.92 and 7.09, respectively). Consistent and parallel correlated responses were obtained in ELA, ErLA and grain yield. Correlated response to selection for increased LAI in grain yield/plant amounted to 13.07% and 12.53% under favourable conditions whereas it reached 17.09% and 7.18% under stress. However, selection for decreased LAI produced concurrent response in grain yield/plant which was reduced by an average of 10.6% and 11.50%. Reduction in grain yield in the stressful environment amounted to 15.48% and 9.4% for the first and second cycles, respectively. Results indicated that partitioning assimilates was not consistent in the different populations and should be considered while practicing selection for increased LAI.

Key words: leaf area, yield, moisture stress, corn.

Introduction

Despite intense selection for increased grain yield of maize (*Zea mays* L) by plant breeders in the past century, selection has not resulted in a genetic increase in photosynthesis per unit leaf area. Increased biomass accounted for most of the increase in grain yield (Russel, 1991 and Tollenaar, 1991). Harvest index is thought to be already close to the maximum value in maize and any further increase may only be counter-productive as it may also reduce biomass. It is therefore appropriate to focus on ways to increase biomass and thereby crop photosynthesis genetically (Richards, 2000). Devising ways to increase assimilate supply to meristems and to select actively growing tissues deserve attention. One way is to divert assimilates away from competing sinks of lesser importance. A second way for increasing assimilate supply to selected organs is to increase their duration of growth. If the total crop duration cannot be changed this may need to be at the expense of other less important organs.

The objectives of this investigation were:-

1-to evaluate 21 F_1's resulting from diallel cross involving 7 elite inbred lines under favourable and water stressed environments.

2- to study the genotype x environment interaction for leaf area index.

3- to assess the possibility of increasing biomass and yield using a physiological breeding approach through selecting for leaf area index.

4- to study the genetic correlation coefficients among different leaf area criteria as well as yield.

Materials and Methods

This study was carried out during the summer seasons of 1999 through 2003 at Assiut University Farm (favourable, clay-loam soil), El-Ghoraieb Experimental Station (in the eastern desert, 25 km south of Assiut, stressful sandy-calcareous soil) and at Mallawy Agricultural Res. Station (moderately stressful). Seven elite maize inbred lines were used namely: Sids-2 (P_1), Sids-7 (P_2), Gemmeiza-18 (P_3), Sids-34 (P_4), Sids-63 (P_5), Gemmeiza-1002 (P_6) and Gemmeiza 1021 (P_7) yellow, which were obtained from Sids Exp. Station.

In the summer season of 1999 all possible cross combinations among the 7 inbred lines were produced excluding reciprocals. In the seasons 2000 through 2003, the 21 F_1 hybrids of the diallel cross were grown in Assiut University Farm and El-Ghoraieb Experimental Station environments using a randomized complete block design RCBD with three replications in each environment. Each F_1 was represented by a plot of two rows of 3 m long with rows set 70 cm from each other and plants spaced 30 cm apart. Irrigation was applied each 12 day in the favourable environment and each 10 day in the stressful sandy soil. Fertilizers were applied at the rate of 120 kg nitrogen/feddan, before the first and second irrigations. Normal agronomic practices were adopted as recommended.

In each of the two following summer seasons 2001and 2002, hybrids were sown in three different environments, namely Assiut University Farm, El-Ghoraieb Experimental Station and Mallawy Agricultural Res. Station. Irrigation was applied each 12 days in the favourable and moderately stressed environments and each 8 days in the stressful sandy soil.

In May 2001, 500 F_2 seeds of each of the three highest F_1 grain yielder under the favourable and the strongly stressed environments were used. Before flowering, the 10% plants exhibiting highest and lowest eighth leaf area were selected in each population. Then selected plants were reduced at flowering to only 5% based on leaf area index. Selected plants in each direction were polycrossed together and were left until maturity. Two cycles of selection were adopted and t test was used for determining the significance of the deviations from the control (F_2 populations).

Data were recorded on individual plant basis for the following characters:

1 – Grain yield per plant (g).

2- The eighth leaf area (ELA) and Ear leaf area (ErLA) (cm^2) measured according to Francis *et al.,* (1969) using the equation: (ELA and ErLA) = leaf length x maximum leaf width x 0.75.

3- Leaf area index (L.A.I.) was measured as: (The ear leaf length x maximum leaf width x 0.75 x number of leaves per plant) / 70 x 30

1- Evaluation of F_1's:

The general and the specific combining ability values for each single environment were calculated according to Griffing Method 4 model I (1956).

2- Stability analysis:

Stability parameters for studied characters on the 21 F_1's in the 10 environments were calculated according to the model of Eberhart and Russell (1966).

3- Correlations:

Genotypic correlation coefficients were calculated among general (GCA) as well as specific combining (SCA) ability estimates for all studied traits.

Results and Discussion

Leaf area index (LAI)

Averaged over the 21 F_1's, the leaf area index recorded in the 10 environments ranged from 7.057 under the favourable condition (E1) to 3.188 in the strongly stressed environment (E4) indicating a 54.82% average reduction due to moisture stress (Table 1). Generally, the F_1 plants showed comparably greater leaf area index in the favourable environments E1, E3, E6 and E9 (7.057, 6.488, 5.772 and 5.685, respectively) than in the stress environments E2, E4, E7 and E10 (4.781, 3.188, 4.627 and 4.411, respectively). The average leaf area index over all environments ranged from 4.403 for hybrid (P_5xP_6) to 5.868 for the white commercial hybrid (P_2xP_5). The combined analysis of variance revealed that the differences between environments as well as among 21 F_1's were highly significant whereas no significant G x E interaction was found.

For grain yield per plant, the genetic analysis revealed that under the favourable environments the general combining ability (GCA) variance was greater in magnitude than the specific combining ability (SCA) variance indicating mainly additive gene effects in accordance with Omara *et al.* (1991) and Abd El-Sabour (1997). However, in the stress environments, the reverse was true indicating that gene effects were mostly non-additive.

Under both favourable and stressful conditions, the (GCA) variance was uniformly larger by far than the (SCA) variance for leaf area index (LAI) in the four seasons, indicating that additive gene effects were predominating under both conditions which reveal the feasibility of selection for such trait. The additive component of variance (GCA) was greater in magnitude than non-additive component (SCA) for the 4 seasons under both favourable and moisture stressed environments for LAI. These results agree well with Rutger *et al.,* (1971) results. They found that the general combining ability accounted for a larger proportion of the variation for leaf measurements than for grain yield. A similar trend was observed for ErLA but in 2 out of 4 seasons. That grain yield/plant was mainly governed by genes with additive effects under favourable conditions agrees with the results of El-Hosary(1989), El-Zeir *et al.* (1993a), El-Sherbieny *et al.* (1996), Mathur *et al.* (1998), Tulu and Ramachandrappa (1998), Gado (2000) and Amer *et al.* (2003) who found a GCA/SCA ratio for the gene effects controlling that trait.

Genetic correlation:

a- Among GCA estimates

Genetic correlations between GCA estimates for all studied traits under favourable and strongly stressed conditions are presented in Table (2). A highly significant genetic correlation coefficient was found between the GCA values of eighth leaf area (ELA) and those for leaf area index (LAI) under both favourable and strongly stressed conditions. A significant correlation was also found between GCA values for ear leaf area (ErLA) and those for (LAI) under favourable condition. Significant correlation coefficients were found

Table(2): Genetic correlation among GCA estimates for all studied traits for the 21 F_1's grown under favourable (F) and stressed (S) conditions

Traits	Enviro-nment	Ear leaf area	Leaf area index	Grain yield/plant
Eighth leaf area	F	0.706	0.897**	0.554
	S	0.930**	0.940**	0.695
Ear leaf area	F		0.908**	0.423
	S		0.961**	0.847*
Leaf area index	F			0.429
	S			0.739

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

Table(3): Genetic correlation among SCA estimates of all studied traits for the 21 F1's grown under favourable (F) and stressed (S) environment

Traits	Enviro-nment	Ear leaf area	Leaf area index	Grain yield/plant
Eighth leaf area	F	0.505*	0.414	0.586**
	S	0.728**	0.665**	0.480*
Ear leaf area	F		0.503*	0.456*
	S		0.741**	0.650**
Leaf area index	F			0.386
	S			0.675**
100-kernel weight	F			0.540*
	S			0.407

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

between ear leaf area and eighth leaf area, leaf area index and grain yield/plant under the strongly stressed condition.

Positive and highly significant correlations were obtained between GCA values for LAI and those for eighth leaf area and ear leaf area in both environments.

b- Among SCA estimates.

Genetic correlation coefficients among SCA estimates for all studied traits over the four seasons under both favourable and strongly stressed conditions are presented in Table (3). Positive correlation was obtained between eighth leaf area (ELA) and ear leaf area (ErLA), leaf area index (LAI), and grain yield/plant under both favourable and strongly stressed conditions, except with leaf area index (LAI) where it was non–significant under favourable conditions. Positive and significant correlation coefficient was obtained between ear leaf area and leaf area index and grain yield/plant under the favourable conditions. Meanwhile a highly significant correlation was found between ear leaf area and leaf area index, and grain yield/plant under strongly stressed. A significant correlation coefficient was found between SCA estimates for leaf area index (LAI) and ear leaf area under favourable conditions similar correlations were obtained between LAI and eighth leaf area, ear leaf area, and grain yield/plant under strongly stressed conditions.

Generally, dry matter/plant was genotypically correlated with all of LAI, ErLA, ELA and grain yield/plant under both favourable and moisture stressed environments. Grain yield/plant was genotypically correlated with ELA and ErLA under both favourable and moisture stressed environments and was correlated with LAI only under stress. LAI was genotypically correlated with ErLA under both favourable and moisture stressed environments. Positive genetic correlations between GCA or SCA estimates in favourable conditions and their corresponding estimates in strongly stressed environments for all of LAI, ErLA, ELA, and grain yield were obtained indicating the possibility to select for such traits under either one of these two environments and expecting to have a similar response in the other. Selection under irrigation was as effective as selection under dryland conditions for increasing yield in moisture-stressed environments and resulted in greater responsiveness of selected populations to favorable environments (Johnson and Geadelmann 1989).

Response to selection for leaf area index (LAI):

Leaf area index (LAI) values were normally distributed in the F_2 (500 plants) under both favourable and water-stressed environment. Under the former environment, the variability, as reflected by C.V. values (15.51, 18.35 and 17.34% for populations P_1xP_2, P_2xP_3, and P_2xP_7, respectively), was lower than that recorded under strongly stressed condition (21.46, 22.91 and 23.424% for populations P_1xP_6, P_4xP_5, and P_4xP_7, respectively). Under the favourable environment, LAI ranged from 2 to 8 and under water stress conditions it ranged from 1 to 6 .

Under both favourable and strongly stressed environments, the selection for increased leaf area index was effective and produced significant responses in the three populations (Tables 4, 5 and Figure 1 a and b). The positive response obtained in the favourable environment amounted to 0.33 and 0.39 in the first and second cycles of selection, for population (P_1xP_2) which represented 7.32% and 8.55% of the control mean, respectively. Similar responses of 0.53 and 0.20 in the first and second cycles of selection were obtained for population (P_2xP_3) which represented 11.04% and 4.02% of the control mean, respectively. Responses of 0.48 and 0.39 were obtained in the S1 and S2 cycles, for population (P_2xP_7) representing 10.50% and 8.82% of the control mean, respectively.

Meanwhile under the strongly stressed conditions the positive responses to selection for increased LAI in the three populations were less than those obtained under favourable conditions and amounted to 0.21 and 0.18 in the first and second cycles for population (P_1xP_6) representing 5.54% and 4.88% of the control mean, respectively. Similar responses of 0.18 and 0.13 were obtained in the first and second cycles for population (P_4xP_5) which represented 4.40% and 3.02% of the control mean, respectively. Responses of 0.18 and 0.13 were obtained in the first and second cycles for population (P_4xP_7) representing 4.41% and 3.32% of the control mean, respectively.

However, under the favourable conditions, selection for decreased leaf area index (LAI) was effective in reducing the mean by 0.24 and 0.31 in the first and second cycles for population (P_1xP_2) which represented 5.32% and 6.80% of the control mean, respectively. Similar responses of 0.55 and 0.46 in the first and second cycles were obtained in population (P_2xP_3) which represented 11.45% and 9.26% of the control mean, respectively. Responses of 0.32 and 0.23 were obtained in the first and second cycles for population (P_2xP_7) representing 7.00% and 5.20% of the control mean, respectively (Table 4 and Fig.1b). Meanwhile in the strongly stressed environment greater responses of 0.63 and 0.52 were obtained the first and second cycles for population (P_1xP_6) representing 16.62% and 14.09% of the control mean, respectively. Similarly, greater responses of 0.47 and 0.54 were obtained the first and second cycles for population (P_4xP_5) which represented 11.49% and 12.53% of the control mean, respectively. The obtained responses of 0.62 and 0.43 the first and second cycles for population (P_4xP_7) represented 15.19% and 10.97% of the control mean, respectively (Table 5 and Fig. 1a).

Correlated response in grain yield

Under both favourable and strongly stressed environments, selection for increased leaf area index (LAI) produced significant correlated responses in the grain yield per plant in the three populations (Tables 4 and 5). The correlated responses obtained in the favourable environment amounted to 17.47g and 14.89g for the first and second cycles for population (P_1xP_2) which represented 13.09% and 11.46% of the control mean, respectively. Similar responses of 13.06g and 15.15g were obtained in the first and second cycles for population (P_2xP_3) which represented 11.54% and 12.18% of the control mean, respectively. Correlated responses of 18.43g and 18.39g were obtained in the first and second cycles for population (P_2xP_7) representing 14.58% and 14.02% of the control mean, respectively. Meanwhile under the strongly stressed condition, the correlated responses were smaller than those obtained under favourable conditions in the three populations. In the increasing direction, such responses amounted to 6.62g and 10.85g in the first and second cycles for population (P_1xP_6), which represented 8.94% and 10.54% of the control mean, respectively. Similar responses of 19.22g and 5.67g were also obtained in the first and second cycles for population (P_4xP_5), which represented 18.82% and 5.52% of the control mean, respectively. Correlated responses of 23.21g and 6.05g were obtained in population (P_4xP_7) representing 23.50% and 5.47% of the control mean, respectively.

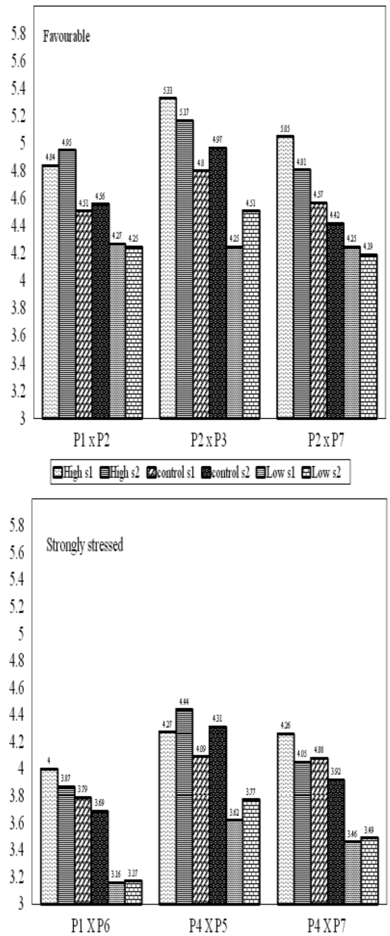
Meanwhile, selection for decreased leaf area index (LAI) under both favourable and strongly stressed conditions produced significant correlated responses in grain yield/plant. The correlated responses obtained in the favourable environments amounted to 24.86g and 25.20g in reductions in the first and second cycles of selection for population (P_1xP_2) representing 18.62% and 19.39% of the control mean, respectively. Similar responses of 14.80 g and 10.44 were also obtained in the first and second cycles for population (P_2xP_3) representing 13.07% and 8.39% of the control mean, respectively.

Table(4): Response to selection in the high (increase) and low (decrease) directions for leaf area index, eighth leaf area, ear leaf area, and grain yield/plant in the favourable environment.

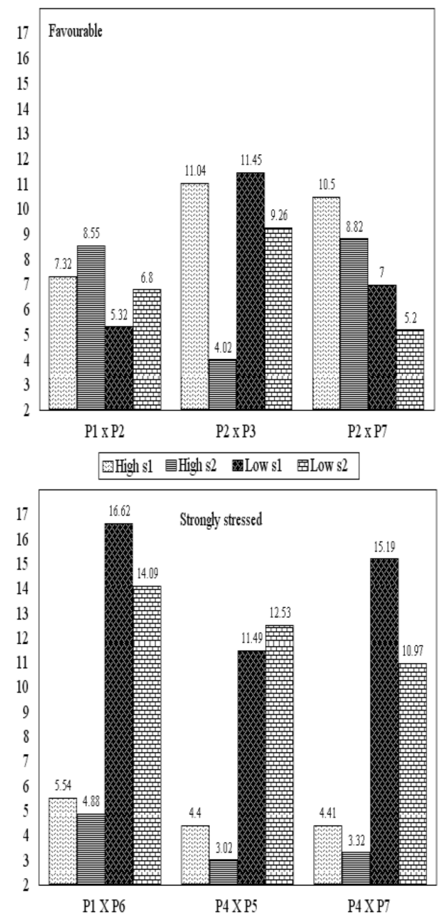
Traits	Pop.	Selection Cycles	Response to selection			
			Absolute values		% of control mean	
			Increase	Decrease	Increase	Decrease
Leaf area index	P_1xP_2	S_1	0.33	0.24	7.32**	5.32**
		S_2	0.39	0.31	8.55**	6.80**
	P_2xP_3	S_1	0.53	0.55	11.04**	11.45**
		S_2	0.20	0.46	4.02**	9.26**
	P_2xP_7	S_1	0.48	0.32	10.50**	7.00**
		S_2	0.39	0.23	8.82**	5.20**
Eighth leaf area	P_1xP_2	S_1	31.50	85.00	5.26**	14.20**
		S_2	13.82	76.24	2.03**	11.17**
	P_2xP_3	S_1	98.72	42.68	16.63*	7.19**
		S_2	82.87	36.79	13.01**	5.77**
	P_2xP_7	S_1	37.72	47.47	6.00**	7.55**
		S_2	19.80	53.39	2.94**	7.94**
Ear leaf area	P_1xP_2	S_1	75.71	64.75	12.31**	10.52**
		S_2	40.84	51.04	6.16**	7.70**
	P_2xP_3	S_1	87.50	49.17	13.47**	7.57**
		S_2	86.67	45.84	13.45**	7.11**
	P_2xP_7	S_1	95.26	32.69	15.16**	5.20**
		S_2	66.87	31.89	10.70**	5.10**
Grain yield /plant	P_1xP_2	S_1	17.47	24.86	13.09**	18.62**
		S_2	14.89	25.20	11.46**	19.39**
	P_2xP_3	S_1	13.06	14.80	11.54**	13.07**
		S_2	15.15	10.44	12.18**	8.39**
	P_2xP_7	S_1	18.43	0.58	14.58**	0.10^{ns}
		S_2	18.39	8.83	14.02**	6.73**

Table(5): Response to selection in the high (increase) and low (decrease)directions for leaf area index, eighth leaf area, ear leaf area, and grain yield/plant in the strongly stressed environment.

Traits	Pop.	Selection Cycles	Response to selection			
			Absolute values		% of control mean	
			Increase	Decrease	Increase	Decrease
Leaf area index	P_1xP_6	S_1	0.21	0.63	5.54**	16.62**
		S_2	0.18	0.52	4.88**	14.09**
	P_4xP_5	S_1	0.18	0.47	4.40**	11.49**
		S_2	0.13	0.54	3.02**	12.53**
	P_4xP_7	S_1	0.18	0.62	4.41**	15.19**
		S_2	0.13	0.43	3.32**	10.97**
Eighth leaf area	P_1xP_6	S_1	12.10	87.23	2.25**	16.23**
		S_2	41.86	88.08	7.96**	16.74**
	P_4xP_5	S_1	51.55	96.76	9.44**	17.73**
		S_2	31.64	73.32	5.46**	12.66**
	P_4xP_7	S_1	42.80	78.78	7.33**	13.50**
		S_2	22.25	26.29	4.16**	4.91*
Ear leaf area	P_1xP_6	S_1	13.06	59.07	2.40*	10.84**
		S_2	18.07	59.48	3.20*	10.55**
	P_4xP_5	S_1	34.06	86.87	5.59*	14.26**
		S_2	21.45	67.96	3.47**	11.01**
	P_4xP_7	S_1	50.02	54.94	8.66**	9.51**
		S_2	53.89	22.9	9.93**	4.22**
Grain yield /plant	P_1xP_6	S_1	6.62	5.55	8.94^{ns}	7.49^{ns}
		S_2	10.85	8.40	10.54**	8.16**
	P_4xP_5	S_1	19.22	14.21	18.82**	13.92**
		S_2	5.67	5.71	5.52*	5.56*
	P_4xP_7	S_1	23.21	24.72	23.50**	25.03**
		S_2	6.05	16.01	5.47^{ns}	14.48*



(A)



(B)

Fig. (1,a): Average response to selection for leaf area index of S_1 and S_2 in three different populations grown in favourable and strongly stressed environments.

Fig. (1,b): Response to selection percent (from the control) for leaf area index of S_1 and S_2 in three different populations grown in favourable and strongly stressed environments.

Responses of 0.58g and 8.83g were also obtained in the first and second cycles for population (P_2xP_7) which represented 0.10% and 6.73% of the control mean, respectively (Table 4). Meanwhile, under the strongly stressed environment responses of 5.55g and 8.40g were obtained in the first and second cycles for population (P_1xP_6) which represented 7.49% and 8.16% of the control mean, respectively. Similar responses of 14.21g and 5.71g were obtained in the first and second cycles for population (P_4xP_5) representing 13.92% and 5.56% of the control mean, respectively. Greater responses of 24.72g and 16.01g were obtained in the first and second cycles for population (P_4xP_7), which represented 25.03% and 14.48% of the control mean, respectively in the strongly stressed environment (Table 5). As for grain yield/plant, what was not expected is the non-significant difference in grain yield of the first cycle (for population P_2xP_7) of decreased plants in LAI and the control. But the explanation came from Richards (2000) who concluded that high yields can still be achieved despite substantial reduction in photosynthetic area. Photosynthesis is more easily regulated through the control of leaf area and leaf senescence and through the daily duration and extent of stomatal opening (Richards 2000).

Strikingly, the phenotypic association between leaf area index and eighth leaf area was consistently present in the F_2's (r=0.585** for P_1xP_2, r=0.175** for P_3xP_2, r= 0.130* for P_7xP_2), as well as in the first cycle of selection (r=0.219** for P_1xP_2, r=0.429** for P_3xP_2, r= 0.566** for P_7xP_2) and second cycle of selection (r=0.144* for P_1xP_2, r=0.281** for P_3xP_2, r= 0.284** for P_7xP_2) cycles of selection under favourable conditions in the positive direction indicating that selection for increased leaf area index did not alter such association.

Improved biological efficiency of crops might be associated with an increase in seasonal absorption of incident radiation through an increase of LAI and leaf area duration. LAI appeared to be the most promising trait for indirect improvement of grain yield in the present material since it was not affected by genotype x environment interaction over the 10 environments used, was mainly governed by the additive genetic component under both favourable and water stressed conditions and was also genetically correlated with grain yield/plant under water stressed conditions. Consistent and parallel correlated responses were obtained in ELA and ErLA, which increased wherever LAI increased and decreased in the same manner. What deserved attention was the correlated response in grain yield. The correlated response under both favourable and stressed environments was expected as a result of increasing total leaf area exposed to incident light which increases photosynthesis per unit ground area. Maize increase in biomass account for most of the increase in grain yield (Russel, 1991, Tollenaar, 1991 and Richards, 2000). When the leaf area of well-watered wheat plants was halved 5 days after anthesis no reduction in grain number and no reduction in grain weight was found (Richards, 1996).

References

Abd El-Sabour, A.G. (1997). Genetic structure of (*Zea mays* L.) populations adapted to dry conditions. M.Sc. Theses, Fac. of Agric., Assiut Univ., Egypt.

Amer, E.A.; A.A. El-Shenawy and A.A. Motawei (2003). Combining ability of new maize inbred lines via line x tester analysis. Egypt. J. Plant Breed. 7 (1): 229-239.

Eberhart, S.A. and W.A. Russell (1966). Stability parameters for comparing varieties. Crop Sci., 6: 36-40.

El-Hosary, A.A. (1989). Heterosis and combining ability of six inbred lines of maize in diallel crosses over two years. Egypt. J. Agron., 14 (1): 47-58.

El-Sherbieny, H.Y.S.; G.M.A. Mahgoub and M.A.N. Mostafa (1996). Combining ability between newly developed white inbred lines of maize. Bulletin of Faculty of Agriculture, University of Cairo, 47 (3): 369-378. (C.F. Plant Breed. Abst., 66: 12599, 1996).

El-Zeir, F.A.; M.A. Younis; F.M. Omer and A.A. Galal (1993,a). Estimation of genetic variability in a composite variety of maize using design-1 and S_1 families. J. Agric. Res., Tanta Univ., 19 (1): 114-122.

El-Zeir, F.A; A.A. Abd El-Aziz and A.A. Galal (1993,b). Estimation of heterosis and combining ability effects in some new topcrosses of maize. Menofiya J. Agric. Res., 4 (1): 2179-2190.

Francis, C.A.; J.N. Rutger and A.F.E. Palmer (1969). A rapid method for plant leaf area estimation in maize (Zea mays L.). Crop Sci., 9: 537-539.

Gado, H.E. (2000). Estimates of combining ability of some yellow maize inbred lines in topcrosses. J. Agric. Sci. Mansoura Univ., 25 (3): 1495-1510.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Australian J. Biol. Sci., 9: 463-493.

Johnson, S. S. and J. L. Geadelmann (1989). Influence of water stress on grain yield response to recurrent selection in maize. Crop Sci., 29: 558-564.

Mathur, R.K.; Chunilal; S.K. Bhatnagar and V. Singh (1998). Combining ability for yield, phonological and ear characters in white seeded maize. Indian Journal of Genetics & Plant Breeding, 58 (2) 177-182. (C.F. Plant Breed. Abst., 68: 12885, 1998).

Omara, M.K.; Tahany H.I. Sherif; E.M. El-Frash; M.Y. Hussein and N.T. Hamdoon (1991). A genetic analysis of flowering characteristics in maize hybrids and its relationships with yield under drought stress. Assiut J. Agric. Sci. 22 (2): 307-327.

Richards R.A. (1996). Increasing the yield potential in wheat: manipulating sources and sinks. In: Rajaram MP, McNab S,Reynolds A, eds. Increasing yield potential in wheat: breaking the barriers. Mexico, DF: CIMMYT , 134-149.

Richards R.A. (2000). Selectable traits to increase crop photosynthesis and yield of grain crops. J. Experimental Botany 51:447-458.

Russel, W.A. (1991). Genetic improvement of maize yields. Advances in Agronomy 46: 245-298.

Rutger, J.N.; C.A. Francis and C.O. Grogan (1971). Diallel analysis of ear leaf characteristics in maize (Zea mays L.). Crop Sci., 2: 194-195.

Tollenaar, M. (1991). Physiological basis of genetic improvement of maize hybrids in Ontario from 1959 to 1988.Crop Sci. 31:119-124.

Tulu, L. and B.K. Ramachandrappa (1998). Combining ability of some traits in a seven parent diallel cross of selected maize (*Zea Mays* L.) populations. Crop Research, 15(2/3): 232-237. (C.F. Plant Breed. Abst., 68: 11715, 1998).

آثار الانتخاب لدليل مساحة الورقة في الذرة الشامية تحت ظروف إجهاد رطوبي مختلفة على المحصول

محمد محمود حسيب الدفراوى*، تهانى حسن اسماعيل شريف*، صادق الشحات صادق#، إعتماد محمد حسين أحمد#

*قسم الوراثة، كلية الزراعة، جامعة أسيوط # قسم الذرة الشامية، مركز البحوث الزراعية، الجيزة، مصر.

تم إجراء تهجين دائري بين سبع سلالات نقية متميزة من الذرة. زرع الواحد والعشرون هجيناً الناتجة في عشر بيئات تمثل ظروف إجهاد مائي مختلف. وقد أخذت النتائج على الصفات التالية: 1- مساحة الورقة الثامنة (م و ث) 2- دليل مساحة الورقة (د م و) 3- مساحة ورقة الكوز (م و ك) 4- محصول الحبوب للنبات الفردي.

وتأثرت كل الصفات بالإجهاد الرطوبي وكانت الصفات الأشد تأثراً بالجفاف هي على التوالي: انخفاض محصول الحبوب للنبات بمقدار 70.81% يليه الانخفاض في دليل مساحة الورقة بمقدار 54.82%، ثم مساحة ورقة الكوز بمقدار 43.7%، ثم مساحة الورقة الثامنة بمقدار 42.3%.

وبدى أن دليل مساحة الورقة كان أكثر الصفات الواعدة في التحسين غير المباشر بالنسبة لمحصول الحبوب حيث أنه كان غير متأثرا بالتفاعل بين البيئة والوراثة على مدار البيئات. كما أنه كان محكوماً أساساًَ بالمكون الوراثي المضيف تحت كل من الظروف المواتية وظروف الإجهاد. وكان أيضاً متلازماً وراثياً مع محصول الحبوب للنبات تحت ظروف الإجهاد الشديد.

أجريت دورتا إنتخاب لزيادة وخفض دليل مساحة الورقة في نسل أعلى ثلاثة هجن محصولاً في الظروف المواتية وأعلى ثلاثة هجن محصولاً تحت ظروف الإجهاد .فكانت الإستجابة الموجبة لزيادة دليل دليل مساحة الورقة، في المتوسط على مستوى الثلاث عشائر(9.62% و 7.13%)، كانحراف عن الشاهد (المقارنة)، أعلى تحت الظروف المواتية في الدورة الأولي والثانية لـلإ نتخاب عنها تحت ظروف الإجهاد الرطوبي (4.78% و3.74% على التوالي). أما بالنسبة للإستجابة لخفض دليل مساحة الورقة فقد أظهر سلوكا معاكسا، إذ أنة تحت ظروف الإجهاد الرطوبي كان الإنخفاض في دليل مساحة الورقة أكبر (14.43 %و 12.53%) مما حدث تحت الظروف المواتية (7.92% و 7.09%). وكانت الاستجابة المتلازمة في كل من مساحة الورقة الثامنة ومساحة ورقة الكوز ووزن الحبوب للنبات الواحد متسقة ومتوازية مع الاستجابة للانتخاب لزيادة مساحة دليل الورقة .وتلازم مع الاستجابة لزيادة دليل مساحة الورقة زيادة في محصول النبات الواحد مقدارها (13.07% و 12.53%) في دورتي الانتخاب تحت الظروف المواتية بينما كانت الزيادة تحت ظروف الاجهاد الرطوبي (17.09% و 7.18%). أما الانخفاض في المحصول الذي صاحب الانخفاض في دليل مساحة الورقة فقد وصل إلى (10.60% و11.50%) تحت الظروف المواتية بينما وصل الانخفاض إلى (15.48% و 9.40%) في دورتي الانتخاب تحت ظروف الاجهاد الرطوبي. وأظهرت النتائج أن توزيع المواد الناتجة عن التمثيل الضوئي لم يكن متسقاً في العشائر المختلفة وينبغي أخذ ذلك في الاعتبار عند الانتخاب لزيادة دليل مساحة الورقة عند التحسين غير المباشر للمحصول.