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GENETIC IMPROVEMENT AND CORRELATION IN CORN

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Abstract

Four populations of maize derived from a broad based population CIMMYT 31 on the basis of silking and black layer formation after 4 breeding cycles were evaluated for 10 quantitative characters. Significant improvement alongwith expected transgressive segregants for maturity and yield potential was observed and suggested to be exploited for maize production. Major emphasis was given to develop different populations on the basis of maturity phases and correlation of BLF with other physiological and agronomic characters revealed significant association of BLF with silking in EE, EL and LE populations but insignificant correlation in LL. The characters like Kernels per row, grain weight, kernels per plant, grain yield and leaf area did not exhibit any significant association between BLF and other yield contributing characters which might be due to linkage among genes responsible for phenotypic expression of these characters which can be broken by using selective diallel following recurrent selection. There was a reduction in grain yield in early populations, whereas, high variance observed in LE population alongwith early maturity suggested a potential source for earliness and high yield which could be attained by repeating more breeding cycles and finally to develop a composite variety within each population especially in LE population.

Introduction

Maize is a multipurpose crop used as food, feed, fodder, fuel and in the manufacture of industrial product. In Pakistan it is grown over 871.1 thousand hectare with the total production of 1259.4 thousand tons (Anon., 1997). In order to increase present corn production by fitting into the existing cropping system, breeding for producing high yielding and early maturing corn varieties can be helpful (Ordas *et al.*, 1996). Knowledge of genetic variation of developmental phases like vegetative development phase (VDP), grain filling duration (GFD), maturity period and their relationship with yield and yield components is necessary for the improvement of kernels yield. Variations for most agronomic traits appeared to be adequate to allow development of agronomically superior lines (San & Mass 1993). Spaner *et al.*, (1992) developed maize after six cycle of mass selection for early silk, the selected composite flowered 17 days earlier than original composite. Ordas *et al.*, (1996) reported significant reduction in days to silking, plant height and kernels yield. Aslam *et al.*, (1983) observed that late flowering and physiological maturity groups took more days for 50% silking and days from mid silking to black layer formation, respectively. A positive trend of increased plant and ear height was observed for late flowering. The general relationship between length of filling period and yield were only indirect rather than direct as reported by Daynard & Kannenberg (1976). There are evidences that many of these characters are related to maturity in one way or another and variation in different stages of maturity does effect these aspects of crop and ultimately the yield.

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Keeping in view the importance of early maturity alongwith other yield contributing characters in maize, four populations of different maturity and silking duration were developed from the broad base population CIMMYT 31 and genetic variability within and among the populations, and correlation among various characters were investigated.

Materials and Methods

Four sub population with differential silking and maturation periods as LL (late silking and late maturity), LE (late silking early maturity), EL (early silking late maturity) and EE (early silking early maturity) were derived from a broad based population of CIMMYT 31 received from Mexico in the National Coordinated Maize Programme, NARC, Islamabad. Maturity was based on black layer formation (BLF). The base population was used for crosses between plants silked after 47 days of planting and named as early silking whereas, crosses were made between the plants silked after 55 days of planting and named as late silking plants. On the bases of BLF both early and late silking plants were grouped as early and late BLF plants. These selected groups were crossed to raise 4 populations (EE, EL, LE, LL) and finally 57 ears of EE, 36 ears of EL, 26 ears of LL and 31 ears of LE group were selected and planted during spring 1995. Plants were crossed in all possible combinations within each population and same cycle of selection and hybridization was repeated during Autumn 1995 by selecting 65 ears for EE 40 ears for EL, 30 ears for LE and LL on the basis of BLF. Crossing was made between the plants silked on the same date in each group and 10 ears from each group were selected for head to progeny rows during spring 1996 and bulk pollination was made among the plants in each group. The seed thus collected from selected ears of each group was planted in RCBD with four replications at the experimental area of National Agriculture Research Center, Islamabad on 1st July, 1996. Each plot consisted of six rows of 5 meter length with 75 and 25 cm distance between and within rows, respectively.

The data were recorded on 30 plants in each replication for number of days taken to silking or vegetative phase duration (VPD), black layer formation (BLF) or days to maturity (DM), grain filling duration (GFD) or reproductive phase duration, leaf area, kernel rows per ear, kernels per row, kernels per plant, 1000-kernel weight and yield. The IPGRI descriptors for maize was followed for data recording. The data of individual plants were used for the analyses of range, mean, standard deviation and correlation using the computer software "MS EXCEL 7" for Windows 95.

Results and Discussion

The mean, SD, Ranges, and analyses of variance regarding four developed populations (EE, EL, LE, LL) alongwith BP for 10 quantitative characters are presented in Table 1. The analyses of variance revealed insignificant differences for all the characters except kernels per plant in BP. High variance and CV for all the characters in BP revealed the scope of further improvement from this population. The populations EE, EL and LE exhibited insignificant differences for all the characters under study for

Table 1. Range, means and standard deviation for 10 quantitative characters in maize.

Population		VPD	DM	GFD	KR	K/R	K/PL	GW	YLD	LA.	PH
BP	Range	53-66	86-105	23-46	10-18	25-48	401-751	156.88-313.59	92.35-183.51	417.64-762.3	190-227
	Mean+SD	59+2.85	91+4.78	32+5.29	13.9+2.15	39.1+4.75	549.0+90.89	242.82+32.35	134.1+21.67	546.32+72.61	214.23+9.25
	F.ratio (V)	0.86ns	1.18ns	1.09ns	2.05ns	0.74ns	2.45*	1.99ns	0.73ns	1.15ns	0.93ns
	F.ratio	0.59ns	0.15ns	0.79ns	0.44ns	3.61*	1.18ns	0.55ns	0.60ns	0.04ns	0.28ns
	CV	4.83	5.25	16.53	15.47	12.15	16.56	13.32	16.16	13.29	4.32
EE	Range	49-53	80-84	28-33	10-16	25-43	333-516	193.82-239.33	74.24-100.04	382.3-407.3	140-156
	Mean+SD	51+1.16	82+1.35	30+1.46	13.1+1.43	32.7+4.69	426.2+49.84	212.66+11.91	87.99+7.16	394.68+6.45	149.38+4.12
	F.ratio (V)	0.90ns	0.51ns	0.79ns	0.26ns	1.20ns	0.74ns	0.87ns	0.68ns	0.58ns	0.76ns
	F.ratio	2.15ns	10.17**	6.35**	2.99*	4.77**	2.20ns	8.55**	1.57ns	2.48ns	3.62*
	CV	2.18	1.30	4.04	11.07	12.39	11.51	4.50	8.27	1.62	2.58
EL	Range	50-53	88-91	36-40	12-14	26-37	371-483	256.1-281	97.46-122.12	468.8-525.5	140-163
	Mean+SD	51+.88	89+0.73	38+1.16	12.9+1.0	31.7+2.71	411.5+21.62	269.24+6.41	109.21+4.94	504.88+12.21	153.13+4.92
	F.ratio (V)	0.57ns	1.12ns	1.22ns	0.18ns	0.22ns	0.59ns	0.97ns	1.07ns	2.06ns	1.32ns
	F.ratio	2.14ns	0.30ns	2.31ns	0.71ns	2.68ns	5.35**	2.10ns	1.89*	0.93ns	6.11**
	CV	1.71	0.83	2.10	8.77	8.77	4.72	2.29	4.19	2.17	2.65
LE	Range	60-63	83-85	20-25	12-16	28-49	408-689	223.27-266.52	105.86-155.34	472.3-494.7	188-208
	Mean+SD	61+1.41	83+0.74	22+0.94	13.7+1.56	39.4+5.42	536.0+67.27	242.78+11.91	129.22+12.08	483.52+5.99	196.53+5.76
	F.ratio (V)	0.24ns	0.75ns	0.52ns	1.07ns	1.03ns	1.16ns	1.73ns	1.21ns	0.71ns	0.36ns
	F.ratio	1.79ns	0.66ns	1.32ns	2.99*	6.07**	2.26ns	1.28ns	0.56ns	2.13ns	0.49ns
	CV	2.31	0.89	4.27	11.39	13.76	12.55	4.91	9.35	1.24	2.93
LL	Range	58-61	99-103	38-45	16-20	24-41	442-775	255.29-341.39	126.7-202.3	521.7-549.2	184-213
	Mean+SD	59+1.00	100+1.19	41+1.72	17.4+1.39	36.2+3.97	629.7+78.74	276.59+32.35	173.57+15.5	532.94+8.06	198.98+7.56
	F.ratio (V)	1.05ns	0.27ns	0.38ns	0.65ns	0.87ns	0.82ns	1.04ns	0.99ns	4.39**	0.34ns
	F.ratio	2.16ns	4.39*	4.39*	1.07ns	1.11ns	0.19ns	0.31ns	0.23ns	1.78ns	0.32ns
	CV	1.69	1.19	4.20	7.99	10.97	12.50	11.70	8.93	1.51	3.80
LSD combined		**1.30**	**1.41**	**1.70**	**1.30**	**5.90**	**49.70**	**12.52**	**6.84**	**7.14**	**4.60**

VPD- vegetative phase duration, DM- days to maturity, KR- kernel rows, K/R- kernels per row, GW- 1000-grain weight, K/PL- kernels per plant, YLD- yield per plant, GFD- grain filling duration, PH- plant height and LA- leaf area.

individual analyses of variance which revealed that these derived populations are quite homogeneous for maturity and yield performance and hence, could be considered the basis for selected parameters. The population LL was observed uniform for most of the characters under study except leaf area which might be influenced by the environmental fluctuation. The higher limits for most of the characters in the derived populations than BP revealed the presence of transgressive segregants after successive selection and hybridization cycles. As the resultant populations are product of breeding work conducted for 4 recurrent cycles and hence genes responsible for superior performance are fixed which indicated that 4 cycles of breeding in the crop like maize could be sufficient for improving BLF and yield potential from a wide based population.

Significant differences were observed among different populations for all the characters (Table 1). The populations LL, LE took more than a week to silking as compared with EL and EE which started silking after 51 days. Days to BLF in LL and EL took 18 and 7 more days than EE and LE, respectively. Populations LL and LE took maximum days to GFD whereas LE took only 23 days to complete GFD. The three important phases as VPD, GFD, and DM influenced differently on yield and yield components in all the four populations. LL possessed higher VPD, higher GFD and DM and at the same time it had highest 1000 kernels weight, kernels per plant and kernel yield per plant whereas higher leaf area and plant height was also observed. EE possessed lowest VPD, GFD and DM and at the same time it had lowest 1000 kernels weight plant height, leaf area and kernels yield per plant. LE possessed highest VPD lower DM and lowest GFD and it had lower 1000 kernels weight and leaf area but higher in kernels per plant, plant height and kernels yield per plant. EL possessed lower VPD, higher GFD, and DM and it had higher 1000 kernels weight and leaf area, lowest kernels per plant and lower kernels yield per plant and plant height. It is concluded that VPD is directly associated with number of kernels per plant and plant height whereas GFD effects positively 1000 kernels weight as already mentioned by earlier researchers such as Aslam *et al.*, (1983), Ordas *et al.*, (1996), Daynard & Kannenberg (1976), Cork & Kannenberg (1989), Singh *et al.*, (1989), Debnath & Azad (1993).

Correlation within Populations: The correlation among 10 quantitative characters for each population presented in Table 2 revealed that association of BLF with silking was significantly positive in EE, EL and LE populations indicating the influence of silking on BLF in these populations. Kernel rows was positively correlated with silking for all the populations but it was significant in EL population only whereas, kernel rows was positively correlated with BLF in all the populations except BP where it was negligible. VPD had positive significant association with kernel row in EL and non significant .lh7 association with kernels per row, number of kernels per plant and 1000 kernels weight. Kernel per row was negatively correlated with silking, BLF and kernel row in all the populations except in LL. Silking and BLF did not exhibit any significant influence in determining grain yield which might be due to undesirable linkage between these characters. This undesirable linkages might be broken due to selective diallel followed by recurrent selection or grain yield can be exploited indirectly through the manipulation of kernel rows, kernels per row and kernels per plant. Similarly negative associations

Table 2. Correlation among 10 characters in 4 population of maize derived from one base population.

		VPD	DM	KR	K/R	GW	K/PL	YLD	GFD	PH
DM	BP	0.273								
	EE	0.329*								
	EL	0.437**								
	LE	0.499**								
	LL	-0.112								
KR	BP	0.034	-0.099							
	EE	0.184	0.438**							
	EL	0.380*	0.317*							
	LE	0.132	0.146							
	LL	0.094	0.134							
K/R	BP	-0.227	-0.133	-0.231						
	EE	-0.081	-0.262	-0.518**						
	EL	-0.291	-0.199	-0.693**						
	LE	-0.141	-0.091	-0.315*						
	LL	0.188	0.026	0.136						
GW	BP	0.033	0.099	-0.534**	0.080					
	EE	0.040	-0.084	-0.569**	-0.100					
	EL	0.014	0.015	-0.112	-0.368*					
	LE	-0.172	-0.132	-0.184	-0.507**					
	LL	-0.227	-0.252	-0.638**	-0.586**					
K/PL	BP	-0.045	-0.203	0.726**	0.400*	-0.450**				
	EE	0.107	0.091	0.319*	0.612**	-0.611**				
	EL	0.092	0.126	0.297	0.464**	-0.629**				
	LE	-0.022	-0.007	0.535**	0.553**	-0.636**				
	LL	0.200	0.087	0.699**	0.786**	-0.742**				
YLD	BP	0.098	-0.088	0.280	0.329*	0.308	0.641**			
	EE	0.128	0.111	0.006	0.718**	-0.176	0.832**			
	EL	0.199	0.160	0.459**	-0.025	-0.043	0.591**			
	LE	-0.015	-0.018	0.674**	0.302	-0.346*	0.899**			
	LL	0.147	-0.076	0.432**	0.718**	-0.323*	0.852**			
GFD	BP	-0.254	0.759**	-0.103	-0.011	0.003	-0.175	-0.192		
	EE	-0.485**	0.666**	0.260	-0.179	-0.109	0.000	0.002		
	EL	-0.643**	0.408*	-0.116	0.126	-0.002	0.014	-0.066		
	LE	-0.707**	0.171	-0.010	0.028	0.143	-0.005	0.001		
	LL	-0.666**	0.816**	0.046	-0.090	-0.057-	0.051	-0.142		
PH	BP	0.054	-0.251	0.034	-0.008	0.054	0.122	0.230	-0.258	
	EE	0.176	0.408*	0.227	-0.030	-0.021	0.274	0.332*	0.240	
	EL	0.288	0.218	0.457*	-0.334*	-0.038	0.183	0.616**	-0.107	
	LE	0.399*	0.013	0.038	0.176	-0.219	0.204	0.190	-0.401*	
	LL	-0.124	0.087	0.052	0.039	-0.047	0.062	0.061	0.137	
LA	BP	0.070	0.054	0.122	0.374*	0.101	0.438**	0.569**	0.020	0.155
	EE	0.030	-0.219	-0.058	0.164	-0.053	0.175	0.220	-0.226	-0.073
	EL	0.195	0.332*	0.346*	-0.152	-0.015	0.227	0.427**	0.085	0.576**
	LE	-0.230	-0.205	0.280	0.012	0.079	0.195	0.221	0.089	-0.317*
	LL	-0.055	-0.095	-0.072	0.055	-0.027	-0.012	-0.017	-0.039	0.252

VPD- vegetative phase duration, DM- days to maturity, KR- kernel rows, K/R- kernels per row, GW- 1000-grain weight, K/PL- kernels per plant, YLD- yield per plant, GFD- grain filling duration, PH- plant height and LA- leaf area.

between characters pairs like kernels per row vs 1000-grain weight and kernels per plant vs 1000-grain weight are also likely to impose restrietion direct exploitation of these important yield contributing characters. Farhatullah (1989) found non signifieant positive correlation of grain yield with VPD,GFD and days to maturity. Daynard & Kennenberg (1976) observed significant positive correlation of grain yield with VPD, days to maturity and GFD. Debnath & Khan (1991) found non significant positive correlation between grain yield and VPD. Debnath & Azad (1993) found positive non significant correlation of yield with kernel rows and kernels per row and positive significant correlation with grain yield per plant.

Plants in EE population tend to be shorter and less yielding whereas, the population LE was medium statured and high yielding with minimum days to BLF which is a combination of an early maturity and maybe a consequence of recombination and presence of transgressive segregants. As it is also obvious in the population LL that grain yield was significantly higher than BP which might be exploited after confirming the yield potential under a wide range of environments.

As the major emphasis was given to develop different populations on the basis of maturity phases from a broad based population obtained from CYMMIT, Mexico, therefore, correlation of BLF with other physiological and agronomic characters were calculated (Table 3). It is evident from the results that association of BLF with DS was positively significant in EE, EL and LE populations indicating the influence of silking on BLF whereas, negative but insignificant correlation in LL revealed that increase in days to silking reduced days to BLF. Kernel rows had significant positive association with BLF in EE and EL. The correlation of BLF with GFD was observed significant for BP, EE, EL and LL whereas, it was insignificant for the population LE. Plant height revealed significant positive association with BLF in EL population only. The important characters like K/R, GW, K/P, Yld and LA did not exhibit any significant association between BLF and other yield contributing characters which might be due to linkage among genes responsible for phenotypic expression of theses characters. To break these undesirable linkages, selective diallel following recurrent selection for more cycles is suggested.

Table 3. Correlation between BLF and other characters in developed populations of maize.

	BP	EE	EL	LE	LL
Vegetative phase duration	0.273	0.328*	0.437**	0.499**	-0.112
Kernal rows	-0.098	0.437**	0.316*	0.145	0.133
Kernels per row	-0.133	-0.262	-0.199	-0.090	0.026
Grain weight	0.098	-0.084	0.014	-0.131	-0.252
Kernels per plant	-0.202	0.091	0.125	-0.007	0.086
Yield per plant	-0.088	0.111	0.160	-0.017	-0.075
Grain filling duration	0.758**	0.666**	0.407*	0.171	0.815**
Plant height	-0.251	0.408*	0.218	0.012	0.086
Leaf area	0.053	-0.290	0.331*	-0.204	-0.094

The primary interest of the populations EE and LE was to develop a high yielding cultivars with early maturity. There was a reduction in grain yield in early populations, whereas, high variance observed in LE population alongwith early maturity suggested a potential source for earliness and high yield which could be attained by repeating more breeding cycles and finally to develop a composite variety within each population especially in LE population.

Referrences

Anonymous. 1997. *Agricultural Statistics of Pakistan*. Statistic Div., GOP, Islamabad, Pakistan.

Aslam. M., C.E. Wassam and K. Fischer. 1983. Relationship of maturity stages and agronomic traits in corn. *Pak. J. Agric.*, 4: 211-225.

Corke, H. and L.W. Kannenberg. 1989. Selection for vegetative phase and actual filling period duration in short season maize. *Crop Sci.*, 29: 607-612.

Daynard, T.B. and L.W. Kanenberg. 1976. Relationship between length of the actual and effective grain filling periods and the grain yield of corn. *Canadian J.*, 56: 237-242.

Debnath, S.C. and M.A.K. Azad. 1993. Responses to environmental changes of the components of variation and other genetic parameters in maize. *Pak. J. Sci. Ind. Res.*, 36: 244-247.

Debnath, S.C. and M.F. Khan. 1991. Genotypic variation, co-variation and Path coefficient analysis in maize. *Pak. J. Sci. Ind. Res.*, 34: 391-394.

Farhatullah. 1989. The association of vegetative, grain filling and maturity phases and total protein with grain yield in maize. *Sarhad J. of Agric.*, 5: 619-622.

Ordas, A., I. Santiago, R.A. Malvar and M.I. Vales. 1996. Six cycle of selection for adaptation in two exotic populations of maize. *Euphytica*, 92: 241-247.

San, V.E.M. and A.R.H. Mass. 1993. Selection for adaptation in antigua maize (*Zea mays* L.) composite. *J. Iowa Academy Sci.*, 100: 9-12.

Singh, G. and M. Sing. 1993. Correlation and path analysis in maize under midhills of silking. *Crop Improvement*, 20: 222-225.

Singh, S.J., B.D. Agrawal and J.P. Shahi. 1989. Effect of developmental stages on maturity period in some populations of maize. *Crop Improvement* 16: 38-42.

Spaner, D., D.E. Mather and R.I. Hamilton. 1992. Genetic and agronomic evaluation of short season quality protein maize. *Canadian J. Plant Sci.*, 72: 1171-1181.

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