Pak. J. Agri. Sci., Vol. 47(3), 209-213; 2010
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
http://www.pakjas.com.pk

EVALUATION OF 99 S_1 LINES OF MAIZE FOR INBREEDING DEPRESSION

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The research was conducted to evaluate the performance of S1 lines for inbreeding depression regarding different parameters, using maize variety Azam. The maize variety was self-pollinated for one generation in spring season and in the next sowing season 99 S1 lines obtained from selfing was sown with a parental line. Days to silking, pollen-shedding, plant height , ear-height, ear-length, ear-diameter, number of ears/row, kernel rows/ear and 100 kernel weight showed inbreeding depression with varying degrees while yield kg/ha showed severe inbreeding depression with an average of 362.08 kg/ha. Average value of inbreeding depression for days to silking and pollen-shedding was calculated as 2.02 and 2.21 days, respectively. Average values of inbreeding depression for plant height and ear-height were recorded as 21.50 cm and 4.87 cm, respectively. While, for ear-length, ear-diameter, number of ears/row, kernel rows/ear and 100 grain weight, the average value of inbreeding depression was recorded as 1.80 cm, 0.2 cm, 2.5, 2.11 and 3.89 g, respectively. Grain yield was positively and significantly correlated with plant height, ear height and yield components. Maturity traits were positively and significantly linked with each other. It is concluded that by subjecting the maize to self-pollination nearly all the lines were affected; however, some lines were affected severely and others tolerated inbreeding to some extent. The lines showing tolerance against inbreeding depression was selected for further maize breeding.
Keywords: Maize, S1 lines, inbreeding depression, correlation, homozygosity

INTRODUCTION

Maize (*Zea mays* L) is one of the most important cereal crops of the world. It is third most important cereal crop after wheat and rice (Khan *et al*., 2002). It is used as staple food in Northern parts of country and provides valuable feed for poultry and also used in industry in the production of oil, starch, etc. (Karim, 1979).

Ultimate goal of various breeding methods in maize is the production of improved genotype. To obtain improved genotype identification of superior inbred lines l is most important pre-requisite. Testing of inbred lines in early generations for example $S_{1,}$ may prove to be more effective than in the later generations. While subjecting maize variety to self pollination superior or inferior lines with regard to their genetic potential can be identified: as increase in homozygosity results in bringing identical alleles together, therefore recessive characters no longer remain hidden; which in case of heterozygosity remain concealed in parents. So inbreeding is helpful in reducing the frequency of deleterious alleles in population that serve as parents of synthetic cultivars. Inbreeding depression can be noted in the characteristics like plant-height, ear-height, yield and yield components and maturity traits. Cleso *et al.* (2002) found yield reductions of the populations from S_0 to S_1 varied from 34% to 59% with an average of 49.1%. Inbreeding depression was greater in populations with a wider genetic base, which had never been exposed to inbreeding. It is due to shifting population from heterozygosity to homozygosity, which exposed the hidden alleles which were never exposed before. Benson and Hallauer (1994) observed inbreeding depression in maize for 19 of 22 phenotypic and agronomic characters. Some inbred lines may tolerate inbreeding depression and it may due favorable alleles which get together in the same plant. It may be assumed that S1 appear to have increased the gene frequency of genes which express themselves better in the inbred than in non-inbred genetic combinations (Genter and Alexender, 1966). Plant height, ear height and 100 seed weight are major factors contributing to yield; therefore, selection should be based on these criteria (Dash *et al*., 1992). The present research work was initiated to evaluate S_1 lines for the development of inbred lines to be used in future hybrid seed production.

MATERIALS AND METHODS

The research was conducted at KPK Agricultural University, Peshawar using maize variety Azam in two successive growing seasons: In the first season maize plants were self-pollinated. In the second season, seeds obtained from 99 selfed plants were selected and sown, using 10x10 simple lattice designs in two replications with parental variety Azam as a check in each replication. Each entry was planted in single row having 4m row length and row to row and plant to plant distance of 0.75 and 0.20 m, respectively. Data was collected for the parameters days to 50% pollen-shedding, days to 50% silking, ear-height (cm), plant-height (cm), ear-length (cm), ear-diameter (cm), number of ears/row, kernel rows/ear, 100 kernel weight (g) and grain-yield (kg/ha). These characters are very important in contributing to yield so these were selected for data recording. For parameters like days to 50% pollen-shedding and silking, date for each entry having 50% plants showing pollen-shedding and silking was recorded and the days were calculated by subtracting the date recorded from date of sowing. After anthesis ear-height and plant-height was measured from five randomly selected plants/plot. Plant-height was recorded from base of the plant to flag-leaf while ear-height was recorded from base to upper-most ear of the plants. Number of ears/row was also counted for each entry. All plants were hand-harvested and ear-length, ear diameter were recorded for 5 cobs from each entry. Kernel-rows/ear was also counted from five cobs from each entry. 100 grain weight (wt.) was found by taking 100 grains from the cob of each entry and weight was estimated through electronic balance. Grain-yield (kg/ha) was calculated for each entry using the following formula:

Grain yield (kg/ha)

$$= \frac{\text{Field wt. x (100-estimated wt.) x 10000 x0.8}}{\text{85 x plot area}}$$

Where

Field wt.: weight of ear/plot

0.8: shelling coefficient

85: grain moisture standard value at 15%

The data was analyzed using MSTATC software. Inbreeding depression was evaluated for all traits by subtracting the inbred mean from parental mean (non-inbred).

RESULTS AND DISCUSSION

Days To 50% Pollen-Shedding: All the entries were highly significantly different i.e. p> 0.01 for the parameter. Of the 99 S_1 lines 14 lines showed inbreeding depression at average value of 2.21 days (Table No.1). Inbreeding depression value ranged from 1-8. 11 lines were below the average value while 3 lines exceeded the average value. Thus smaller number of lines showed inbreeding depression. Similar were the findings of Kamran *et al.* (1994). The extent of inbreeding depression was not found to be severe this may be due to alleles for the traits in heterozygous conditions and remained hidden while, exposure of deleterious alleles tend to increase in days to maturity. My result matched with the study of Sing *et al.* (1967). The lines for the discussed parameter ranged between 49 to 67 days. Positive correlation of days to pollen-shedding was found with days to 50 % silking while correlation to plant-height and ear height was negative (Table 3). It may be assumed that traits for maturity may affect the growth of plants.

Days To 50% Silking: High significant difference i.e., p>0.01 was observed among S_1 lines for days to 50% silking. Inbreeding depression was recorded in 40 of 99 S_1 lines at average value of 2.02 days (Table No.1). Range of inbreeding depression was 0-6.15 lines were above the average value while 25 were below. Maximum and minimum days to silking ranged between 57 and 79. Significant correlation was recorded for the parameter with days to pollen-shedding. Our results contrasted to the study of El Saad *et al.* (1994) who found positive correlation between days to 50% silking and plant-height. Days to 50 % silking and pollen shedding were found to be positively correlated to each other; same were the finding of Kamran *et al*. (1994). Silking and pollen-shedding has synchronization however these traits may affect the growth of plants. As, when days to pollen-shedding and silking increase plants attain more height and grow vigorously.

Ear-Height (cm): Data recorded for ear height showed significant difference among S_1 lines i.e., p>0.01. 54 S_1 lines showed inbreeding depression of 4.8 cm. 24 lines were above while, 30 lines below the average ear-height. Range of inbreeding depression was 0.48-16.2. The maximum ear-height and minimum ear height was recorded to be 52.72 cm and 15.61cm, respectively. (Negative value of correlation was found for ear-height to days to pollen-shedding and days to silking, while it showed positive correlation to plant height, ear length, ear-diameter, kernel-rows/ear and yield (kg)/ha. Ear-height and plant height showed considerable inbreeding depression. It may be due to expression of deleterious alleles at any locus or due to genotypic interaction to environment which might have caused reduction in plant height. Same were the findings of Halluar and Sear (1973).

Plant Height (cm): Significant difference was found among S1 lines of maize for plant-height. 69 S_1 lines showed inbreeding depression at average value of 21.50 cm. Of 69 lines, 31 were above the average while 38 lines were below the average inbreeding depression (Table 1). Range of inbreeding depression was 0.25-47.85 cm. Plant-height ranged between 53.47 cm and 105.30 cm. Plant-height showed positive correlation with ear-height, ear-length, ear-diameter, kernel rows/ear, 100 grain weight and grain-yield. Similar were the findings of Mutisya *et al*. (1987). While negative correlation was found with the parameters like days to 50% pollen-shedding and silking.

Ear-Length (cm): All the entries were significantly different. 85 lines showed inbreeding depression of 1.80 cm. 35 lines were above while 50 were below the average. Range of inbreeding depression was 0.11-6.02 cm. Maximum ear length 17.47 cm, while minimum ear length was 7.1 cm. The yield traits were affected severely by inbreeding. It may be concluded that deleterious alleles for yield components got together in the same genotype in homozygous state and expressed themselves or there was no dominant allele in the combination to encounter the deleterious alleles. Positive correlation of ear-length was recorded to ear diameter, kernel rows/ear, 100 kernel weight and grain yield/ha. The result matched with the findings of Sharma *et al*. (1982). Actually yield components have effect on each other in positive way which may due to same genes controlling these traits.

Ear Diameter (cm): Significant difference among S_1 lines was observed. Inbreeding depression was in 69 lines at average value of 0.23 cm. 31 lines were above, while 38 were below the average value. Range of inbreeding depression was 0.01 to 0.62 (Table No.1). Maximum value for ear diameter was 4.19 cm while the lowest value was 3.1 cm. Positive correlation was recorded for the parameter to plant height, ear-length, kernel rows/ear, and 100 kernel weight and yield kg/ha. Similar were the findings of El-Saad *et al*. (1994) and Umakanth *et al*. (2000)

Number of Ears/Row: Data recorded for number of ears/row showed significant difference among S_1 lines (Table 1). 27 S_1 lines showed inbreeding depression at average 2.56 ears/row. 12 lines were above the average while 15 were below the average. Maximum No of ears/row and minimum No of ears/row were recorded to be 18 ears/row and 4 of ears/row, respectively. Positive correlation was found with number of ears/row to days to 50% pollen-shedding.

Kernel Rows/Ear: Significant difference was found among S_1 lines for Kernal rows/ear. 72 S1 lines showed inbreeding depression at average of 2.11. 25 lines were above while 52 were below the average (Table 1). Inbreeding depression value ranged from 0.5 to 5.Highest value for kernel rows/ear was found to be 16 k-rows/cob while lowest value was 8 k-rows/ear.

Kernel rows/ear showed positive value of correlation with plant height, ear length, ear-diameter, ear-height and grain yield (kg/ha).This is the most important factor in determination of yield. Higher the number of kernel rows/ear higher will be yield.

100 Grain Weight: Significant difference was found among S_1 lines for 100 kernel weight.70 S1 lines showed inbreeding depression at average value of 3.89 gm/100 grains (Table 1). The reason for sever inbreeding depression for the 100 grain-weight may be due to expression of yield reducing genes in homozygous state or due to reshuffling of genes responsible for this trait which may have masked the yield-increasing genes. Of the 70 lines 33 were above the average value. Inbreeding depression value ranged from 0.41 to 10.9 g. The highest value for 100 kernel weight was 34.01g while the lowest value was 12.11 g. The parameter showed positive correlation with ear-length, ear-diameter and grain yield/ha, while negative correlation was found with kernel rows/ear. Due to increase in kernel rows/ear grains do not find enough space to gain maximum weight. In this way kernel-rows/ear affected kernel weight.

Yield (Kg/Ha): Significant difference among S1 lines was observed. 95 S1 lines showed inbreeding depression at average value of 362.08 kg/ha (Table 1). Yield Kg/ha was much affected due to inbreeding depression and as stated above this may be due to deleterious alleles in homozygous state which were hidden in heterozygous state in the cross pollinated plants. In cross-pollination, deleterious alleles may pair with non deleterious alleles and remain in heterozygous state, hence remain recessive but in case of self-pollination, the alleles from male and female gametes come from the same plants so the possibility of pairing of homozygous deleterious alleles increases. Of the 95 lines, 35 lines were above the average value while 60 were below the average value Range of inbreeding depression was calculated to be 9.5-1276.2 kg/ha.Same were the findings of Caragel *et al*. (1971) who found higher inbreeding depression for yield than any other parameter. However our result contrasted to study of Magoja (1991) in which inbreeding depression was found to be 40%. Highest value of yield was recorded to be 1978.80 kg/ha, while lowest value was recorded to be 666.60 kg/ha.

Table 1. Number of S_1 lines showing inbreeding depression and vigor for maturity and yield related traits

Character	Inbreeding depression			Negative inbreeding depression		
	No. of lines	Range	Average	No. of lines	Range	Average
Days to 50% pollen shedding	14	1-8	2.21	85	1-6	3.64
Days to 50% silking	40	0-6	2.02	59	1-6	3.81
Ear-height (cm)	54	0.48-16.2	4.87	45	0.15-20.7	5.19
Plant-height (cm)	69	0.25-47.8	21.5	30	0.15-17.75	5.35
Ear-length (cm)	85	0.11-6.02	1.80	14	0.08-4.35	1.80
Ear diameter (cm)	69	0.01-0.62	0.2	30	0.01-0.47	0.15
No. of ears/row	27	1-5	2.55	72	0-9	2.91
Kernel rows/ear	72	0.5-5	2.11	27	0-2.5	0.40
100 grain weight (g)	70	0.41-10.9	3.89	29	0.27-21.11	2.0
Yield (Kg/ha)	95	9.5-1276.2	362.08	4	2.5-36	19.85

Table 2. Mean squares for days to pollen-shedding (DPS), silking (DS), ear-height (EH), plant-height (PH), ear-length (EL), ear diameter (ED), no. of ears/row (ER), kernel rows/ear (KR), 100 grain weight (GW), yield kg/ha (Y)

SOV	Df	DPS	DS	EH	PH	EL	ED	ER	KR	GW	Y
Replications	1	588.2	662.4	292.1	2157.2	2.18	0.14	44.18	0.24	76.76	25742.49
Treatments	99	18.37	31.58	81.3	218.6	4.79	0.12	19.61	4.10	32.86	218329.7
Block Blocks within Rep.	18	22.27	30.3	63.3	182.7	1.81	0.057	18.7	1.42	13.70	111247.3
Error-RCB Design	99	9.14	12.9	28.5	89.6	1.68	0.059	9.92	2.38	9.686	107898.6
Error-Intra-block	81	6.22	9.1	20.8	68.9	1.65	0.0607	7.96	2.60	8.78	107154.4

Table 3. Simple correlation for morphological parameters and yield components of 99 S_1 lines of maize

	Silking	Ear-ht	Plant-ht	Ear-dia	Ear-length	k-rows /ear	Ears/row	100 ker.wt	Yld.
Pollen-shedd	0.78**	-0.10*	-0.20**	-0.08ns	0.01ns	-0.11ns	0.076**	0.05ns	-0.01ns
Silking		-0.20ns	-0.30ns	-0.19ns	-0.06ns	-0.23ns	-0.034**	0.03ns	-0.21ns
Ear-ht			0.71**	0.24**	0.48**	0.24**	0.135ns	0.16*	0.33**
Plant.ht				0.30**	0.55**	0.18**	0.234ns	0.18**	0.42**
Ear-dia					0.55**	0.45**	0.212ns	0.42**	0.57**
Ear-length						0.22**	0.364ns	0.43**	0.62**
k-rows/ear							0.20ns	-0.18**	0.26**
Ears/row								0.318ns	0.405ns
100 kernel wt.									0.34**

ns: Non significant; *: Significant; **: Highly significant

Yield showed positive correlation with ear-height and plant-height. Ear-height causes increase in yield in the way that higher it is the more ears can develop from the nodes below. Kaur *et al*. (1985) and Umakanth *et al*. (2000) reported the similar observations in their study.

REFERENCES

Benson, D.L., and A.R. Hallauer. 1994. Inbreeding depression rates in maize populations before and after recurrent selection. J. Hered.Breed. 85:122-128.

Caragal, V.R., S.M. Ali, A.F. Koble, A.H. Rinke and J.C. Sentz. 1971. Comparision of S_1 lines with testcross evaluation for recurrent selection in maize. Crop Sci. 11(5):685-661.

Cleso, A.P.P, M.X. Santos, C..D. Cruz, S.N.

Parentoni, P.E. Oliveira, H.G Guimarães, E.E.G. Gama, Á.E. Silva, H.W.L. Carvalho and P.A.V. Júnior. 2002. Inbreeding depression of 28 maize elite open pollinated varieties. Genet. Mol. Biol. 25 (4):12-14.

Dash, B., S.V. Singh and J.P Shahi. 1992. Character association and path analysis in S_1 lines of maize (*Zea mays* L). Orissa Journal of Agricultural Research 5(1):10-16.

El Saad, S.F.A., M.M.A. Regheb and A.A.A. Aziz. 1994. Gentic variance and correlation studies in a yellow maize population. Bulletin of faculty of Agriculture, University of Cairo 45(4):811-826.

Genter, C.F. and M.W. Alexandar. 1996. Development and selection of productive S_1 lines of corn (*Zea mays* L). Crop Sci. 6(5): 429-431.

Halluar, A.R. and J.H. Sears. 1973. Change in quantitative traits associated with inbreeding in a synthetic variety of maize. Crop Sci. 13(3):327-330.

Kamran, S., K.B. Marwat and H. Rahman. 1994. Evaluation of maize (*Zea mays* L.) S_1 lines for yield and inbreeding depression. Sarhad J. Agric. 10(5):553-558.

Karim, F. 1979. Maize demonstration trials in NWFP. Proceeding of First National Seminar on maize, millet and sorghum research and production in Pakistan. April 10-12, CCRI, Pirsabak (Nowshera), pp.56-61.

Kaur, G.P., M. Dhillon and B.S. Dhillon. 1985. Agronomic and anatomical characters in relation to cold-tolerance and grain-yield in maize composite. Proceedings Indian National Sciences Academy and Biological Sciences 51(4):490-495.

Khan, A., H. Rahman, F. Ahmad and H. Khan. 2002. Evaluation of maize synthetics for maturity and yield under Haripur conditions. Sarhad J. Agric. 18 (3):299-302.

Magoja, J.L. 1991. Perennial introgressed population of maize, behaviour of half sib families and S_1 derived lines. Maize Genetics Cooperation News Letter 65 (4):37-39.

Mutisya, F.M. 1987. Source traits for the genetic improvement of early maturing maize. Dissertation Abstracts International Sciences and Engineering 47(7):2684.

Sharma, S.R., A.S. Khehra, B.S. Dhillon and R.K. Malhotra. 1982. Evaluation of S_1 lines of maize crossed in diallel system. Crop Improvement 9(1):42-47.

Sing, C.F., R.H. Moll and W.D. Hanson. 1967. Inbreeding in two populations of maize. Crop Science 7(6): 631-636.

Umakanth, A.V., E. Satyanarayana and M.V.N. Kumar. 2000. Correlation and heritability study in Ashwini maize. Annuals of Agricultural Research 21(3): 328-330.