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REGULAR ARTICLE

YIELD PERFORMANCE WITH HERITABILITY MEASUREMENTS OF HALF SIB FAMILIES OBTAINED FROM MAIZE VARIETY AZAM

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ABSTRACT

This study evaluated the performance of 64 half sib families (HSF) derived from "Azam" variety of maize using partially balanced lattice square design with two replications. Data were recorded on grain yield and other agronomic traits. Observations showed difference in half-sib families for studied traits. Among the 64 half-sib families, minimum days to 50% tasseling (51 d) were observed for HS-49 while maximum (57 d) for HS-63. Minimum days to 50% silking (56 d) were counted for HS-6 while maximum (63 d) for HS-23. Minimum days to 50% anthesis (55 d) were counted for HS-1 and HS-6 while maximum (62 d) for HS-23. Similarly, minimum ASI (-2 d) were observed in HS-1, HS-15, HS-16, HS-28 and HS-63 while maximum (2 d) in HS-48. Minimum (60 cm) ear height was recorded for HS-11 and maximum (93.5 cm) for HS-28. Minimum fresh ear weight (1.3 kg) was weighted for HS-17 while maximum (3.2 kg) for HS-21. Grain moisture was recorded minimum (19.35 %) for HS-19 and maximum (31.25%) for HS-2. HS-42 showed minimum (28 g) 100 kernel weight while HS-5 showed maximum (47 g). Grain yield was minimum (2323 kg ha^{-1}) for HS-17 and maximum (5742 kg ha^{-1}) for HS-21. Maximum heritability estimate (0.92) was recorded for fresh ear weight, while minimum (0.41) was observed for ear height.

Keywords: Azam, Heritability, ASI, Half-sibs, Breeding Material

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop grown in many countries. It belongs to family Poaceae, having diploid chromosome as 20. The plant is monoecious and cross pollinated in nature. It is a short duration crop and is grown twice a year i.e. spring and summer [1]. Maize is the third most important cereal crop in Pakistan following wheat and rice. It is a multipurpose crop, used for food, feed as well as fodder and has its place in industries [2].

Worldwide maize cultivation was on area of 161 million hectares with total production of 840 million tons and yield of 519461.1 kg ha^{-1}[3]. In Pakistan maize is being cultivated in significant portion of total cultivable land [4].

In Khyber Pakhtunkhwa, maize grown as a main crop in many of the cropping systems and staple food for people in rural areas in most of the province. A considerable area of approximately 500,000 ha in plains and high mountains is planted with maize [5]. Per hectare production is low in these areas compared with countries of similar climates. Lack of suitable maize varieties with superior attributes is one of these limiting factors.

Maize is the crop with highest per day productivity with a high yield potential. Development of improved varieties with high yield potential can be seen as a possibility to increase production per unit area. Such kind of varieties with improved qualitative and quantitative traits represents one of the most successful aspects of the modern agricultural technology [6]. For developing high yielding varieties to increase yield per unit area a lot of selection processes have been employed by maize breeders particularly mass-selection, modified mass-selection, ear-to-row selection and several methods of recurrent selection including selfed progenies derived from a base population.

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Recurrent selection is said to be the most effective method of improvement in maize crop and is planned for increasing the frequency of the favorable alleles in a breeding population and hence improves the performance of the population for one or more traits of interest [7].

Half-sib family selection, a type of recurrent selection in which the plants having only one parent in common [8]. The aims of the present investigation were to evaluate half-sib families developed from maize variety Azam for identifying superior families that can be used in future breeding programs for developing genotypes with desirable attributes.

MATERIALS AND METHODS

This experiment was carried out at Malakandher Research Farm, The University of Agriculture, Peshawar-Pakistan during the summer crop season (June-Nov) 2012. Experimental material consisted 64 entries of half-sib families of maize variety 'Azam' developed in the spring season at Cereal Crops Research Institute (CCRI) Pirsabak, Nowshera, Pakistan. Azam is a white, semi-flint, mid season growing variety, maturing about in 80-90 d, developed through a three-way cross of (Pirsabak 7930 × Zia) × Pirsabak 7930. It is of medium height with good resistance to lodging, moderate resistance to leaf blights. Its grains are bold and pearly white, released in 1983. It is considerably improved through half-sib family selection for disease resistance, uniformity and plant type. It is a very good variety for irrigated plains and is moderately drought tolerant. These 64 half-sib families were tested in 8 × 8 partial balanced lattice design with two replications. Plant to plant distance was kept as 25 cm and row-to-row distance was 75 cm with a row length of 5m. Fertilizer was applied in the form of di-ammonium phosphate (DAP) and urea at the rate of 150 and 250 kg ha^{-1}, respectively. Other cultural practices were carried out at standard level as and when needed.

Data on morphological and yield parameters were recorded during the course of the experiment at specific time. When 50% of the plants in the row showed tassels, silks and pollen shedding, data were recorded as the number of days needed for tasseling, silking and pollen shedding, respectively. The Anthesis silking interval was calculated as the difference between days to silking and days to pollen shedding. Data on ear height was recorded on five randomly selected plants as the distance from the ground level to the flag leaf node and the upper cob bearing node. Grain moisture content was recorded using grain-moisture tester after shelling the middle rows of three randomly selected ears at the time of harvest.

All the data were subjected to ANOVA appropriate for 8×8 lattice square design, using computer program "MSTATC" [9]. Means of all characters were compared among the half-sib families. Variance and broad sense heritability (h^2_{BS}) estimates were calculated following [2].

RESULTS AND DISCUSSION

Flowering traits (No. of days)

Highly significant differences ($P \leq 0.01$) were recorded in families for days to mid tasseling, mid silking while days to mid anthesis revealed significant ($P \leq 0.05$) differences. Low co-efficient of variation were observed for mid-tasseling (2.48), mid-silking (2.09) and mid-anthesis (2.75) (table 1). Anthesis silking interval calculated from the difference of days to mid anthesis and days to mid silking showed significant differences. These results are in agreement with those report [10] who also reported significant differences for flowering traits. Minimum days to 50% tasseling (51) were observed for half-sib family (HS) 49, whereas the maximum days to 50% tasseling (57) were observed for HS-63. Minimum and maximum days to 50% silking were counted 56 and 63 in half-sib family 6 and 23, respectively. Minimum value for days to mid anthesis was observed as 55 d for HS-1 and HS-6 while maximum value was 62 d for HS-23 (table 2). Heritability estimates for mid-tasseling, mid-silking and mid-anthesis were recorded as 51.19, 65.51 and 47.03%, respectively (table 1).

Plant breeder is interested in pollen silk synchronization and therefore low Anthesis Silking Interval is preferred because extended gap between pollination and silking could lead to low kernel setting and hence reduced grain yield [11]. Anthesis Silking Interval (ASI) ranged from-2 d for HS-1, HS-15, HS-16, HS-28 and HS-63 to 2 d for HS-48 (table 2). Heritability estimate of 0.4343.01% was observed for Anthesis Silking Interval.

Ear height (cm)

Plants having an optimum height and central or near central placement of cobs are more resistant to lodging and hence play a vital role in improving grain yield. Analysis of variance for ear height revealed significant ($P<0.05$) differences among 64 half-sib families. The coefficient of variation was 8.95% with low heritability estimate of 41.49 %(table I). Minimum ear height of 60 cm was observed for HS-11 while the maximum ear height of 93.5 cm was recorded for HS-28 (table 2). In a previous report, ear height after 10-cycles of full-sib recurrent selection was reported [12].

Fresh ear weight at harvest (kg)

Highly significant ($P \leq 0.01$) differences were observed for fresh ear weight among genotypes. Coefficient of variation (CV) for fresh ear weight was 5.34% with high heritability estimate of 92.64 (table 1). Minimum fresh ear weight was 1.3 kg for HS-17 while maximum weight was 3.3 kg for HS-21 (table 2).

Fresh ear weight is an important parameter contributing to grain yield. High fresh ear weight is a sign to high grain yield. Previous study recorded relationships among grain yield and components of 19 maize types [13].

Grain moisture content at harvest (%)

Grain moisture is one of the important traits in maize breeding as it helps in determining early and late maturity genotypes. ANOVA showed significant ($P \leq 0.01$) differences between half-sib families. The coefficient of variation was recorded as 3.44% which is considered as low with a high heritability estimate of 85.81% (table 1). HS-19 showed the minimum and HS-2 showed the maximum grain moisture content at harvest which was 19.35% and 31.25% respectively (table 2). [14] while working on comparison of S_1-recurrent selection in krug yellow dent maize population recorded significant differences for grain moisture at harvest.

Table 1: Mean square values, coefficient of variation and broad sense heritability (h^2_{BS}) estimates for flowering, ear and yield traits of half-sib families

S. O. V	DT	DS	DA	ASI	EH	FEW	GMC	HKW	GY
Replication	0.78	21.12	34.03	1.35	1155.60	0.07	66.99	15.12	363165
Treatment	3.69**	4.99**	4.69*	1.73*	69.91*	0.31**	8.71**	28.25**	979409**
Block	2.22	5.30	8.49	1.19	100.27	0.02	4.83	3.35	315221
Error	1.78	1.49	2.56	1.06	44.71	0.016	0.91	14.18	185014
CV (%)	2.48	2.09	2.75	60.82	8.95	5.33	3.43	9.07	10.35
h^2_{bs} (%)	51.19	65.51	47.03	43.01	41.49	92.64	85.81	49.87	76.17

DT = Days to tasseling, DS = Days to silking, DA = Days to anthesis, ASI = Anthesis silking interval, EH = Ear height, FEW = Fresh ear weight, GMC = Grain moisture content, HKW = 100-kernel weight, GY = Grain yield *, ** = Significant at 5 and 1% level of significance, respectively.

Table 2: Grand means, maximum and minimum values for flowering, ear height and yield traits of half-sib families

Variables	DT	DS	DA	ASI	EH	FEW	GMC	HKW	GY
Max. Value	57.00	63.00	62.00	2.00	93.50	3.25	31.25	47.00	5742.00
Family	HS-63	HS-23	HS-23	HS-48	HS-28	HS-21	HS-02	HS-05	HS-21
Min. Value	51.00	56.00	55.00	-2.00	60.00	1.30	19.35	28.00	2323.50
Family	HS-49	HS.06	HS-01,06	HS-01,15,16,28, 63	HS-11	HS-17	HS-19	HS-42	HS-17
Grand mean	53.87	58.40	58.23	0.17	74.67	2.34	27.76	37.79	4152.21

100-kernel weight (g)

Kernel weight is an important yield component and is usually used as a selection criterion in maize breeding programs due to its strong positive association with grain yield [15].

Highly significant ($P \leq 0.01$) differences were recorded for hundred kernel weight among the genotypes. Mean value ranged from 47g (HSF-05) to 28g (HSF-42) while the grand mean was recorded as 37.79g (table 2). [16] also reported similar results for this character while comparing original and selected maize population. Co-efficient of variation was recorded as 9.07% with moderate heritability estimates of 49.87% (table 1). Earlier reports support our findings [17, 18].

Grain yield (kg ha^{-1})

Grain yield improvement is one of the major aims of every plant breeding programs and it is combined outcome of both genetic potential and environmental interaction [19]. Highly significant ($P \leq 0.01$) differences among 64 half-sib families were observed. Coefficient of variation for grain yield was 10.35% with high heritability estimate of 76.17% (table 1). The lowest grain yield was 2323 kg ha^{-1} for half-sib family 17 and the highest grain yield was 5742 kg ha^{-1} for half-sib family 21, while the grand mean for grain yield was 4152 kg ha^{-1} (table 2). [20] observed high expected response to selection (750.76 kg ha^{-1}) in Sarhad White population verifying the results of proposed study. There are four main types of procedures practiced for improving yield in maize like mass selection, half-sib progeny performance, full-sib progeny selection, and selfed progeny selection [7]. Present study is in accordance to [21] [22] who evaluated 15, 6 and 37 maize varieties in Zimbabwe, Pakistan and Brazil respectively and succeeded in identifying high yielding varieties among different cultivar tested.

Conclusions and recommendations

Present study revealed the presence of significant variation among the half sib families for grain yield and related traits, therefore the ongoing recurrent half sib family selection need to be continued. Among the 64 families HSF-01, 6, 20, 62 and 64 took minimum for days for maturity traits and can be used in the further breeding programs for early maturity. HSF-01, 8, 19 and 63 also have satisfactory grain yield and thus could be used as a potential line in the future maize breeding programs.

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