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Performance of Test Crosses of Maize Variety Sarhad White with Jalal and Kiramat for Morphological Traits

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Abstract. This research was carried out at Khyber Pakhtunkhwa Agricultural University Peshawar to evaluate the performance of maize inbred lines derived from maize variety Sarhad White regarding grain yield and morphological traits and identifying superior inbred lines based on test cross performance. Test crosses were evaluated in replicated trial along with two tester, one check and 16 parental inbred lines for comparison in a 7×7 partially balanced lattice square design with two replications. Results revealed highly significant differences among the genotypes for most of the traits. Jalal TC-230-a and TC-63-1 took the maximum days to tasseling and Jalal TC-101-2 showed maximum days to anthesis. Maximum day to silking and anthesis silking interval were recorded in Jalal TC-94. Maximum plant height was observed in Jalal TC-33 (164.5 cm) and Kiramat TC-9-6-1 (141.50 cm). Maximum 100 kernal weight was recorded in Jalal TC-101-2 (40.55 g). Kiramat TC-89-b produced the highest grain yield (6808 kg ha^{-1}). From these results, it can be concluded that Kiramat TC-89-b, having highest yield, could be promoted for further selfing. Jalal TC-9-6, TC-9-6-1, TC-12-1, TC-63-1, TC-76-2b, TC-89b, TC-163, TC-205, TC-230a, TC-211 and Kiramat TC-9-6, TC-9-6-1, TC-12-1, TC-33, TC-76-2b, TC-89b, TC-94, TC-101-2, 150-c, TC-163, TC-230-a, 205, 211, 226-2 in addition to having satisfactory grain yield could be used for selfing. Among parental lines (selfed lines) 9-6-1, 9-6, 10-2, 226-2, 33, 63-1, 76-2, 163, 89-b, 205 and 211 were promising for grain yield and morphological traits.

Introduction

Maize (*Zea mays* L.) is one of the most popular oldest and powerful cereals crops, which is popularly used for food, fodder and also for medical purpose in the world [1]. It is the world's third leading cereal crop, after wheat and rice. It most probably originated in Central America, specifically Mexico and spread northward to Canada and southward to Argentina. All cultivated maize is classified as *Zea mays* L. [2]. In spite of high yielding and easily cultivated crop than any other cereal crop, maize production in Pakistan is still low as compared to other important maize growing countries of the world. To increase maize yield per unit area, it is imperative for the maize breeders to develop maize varieties that are high yielding, widely adapted, early maturing, disease resistant, responsive to improved production practices and adjustable in the existing cropping pattern. The ultimate goal of various breeding methods in maize is the production of improved genotypes. Hence short cut but efficient methods are needed for isolation and identification of superior genotypes which can be used in hybrid breeding programs [3]. For selection of inbred lines, tolerant to inbreeding depression and being superior in genetic potential, early generation testing is desirable [4]. Old germplasm of maize has less resistant to pest attack [5]. Performance of maize hybrids is also significantly affected by the growing conditions [6].

Availability of multiple-stress tolerant maize is critical for improvement in maize production [7]. Maize production has been increasing because its hybrids possess high yield potential [8]. Therefore, scientists have focused on breeding studies for maize. The choice of germplasm is an essential and crucial step which decides the success or failure of a breeding program [9]. Germplasm selected for use as parents in a breeding program should be genetically diverse and exhibit the desired traits. Inbred lines are used for the development of hybrids, and their significance is determined by their performance in combination with other inbred lines [10]. Bernardo *et al.* [11] studied testcross selection prior to further inbreeding in maize, their mean performance and realized genetic variance. They evaluated the usefulness of one cycle of testcross selection and recombination of F_3 families prior to further selfing and developed a method for estimating realized genetic variance. Their results showed that there was no evidence that genetic variance decreased after one cycle of testcross selection. They suggested that to compare several cycles of selection, realized genetic variance can be estimated with bulks of all families and bulks of the selected families instead of estimating genetic variance with large numbers of individual families in each cycle. Siamey et al. [12] concluded that all the accessions of maize in the study were found to be susceptible to *S. zeamais* infestation; accessions GH2354, GH3609 and GH3324 were identified as highly susceptible while accessions GH3239, GH6182 and OBATANPA variety were identified as susceptible.

Austin *et al.* [13] studied genetic mapping in maize with hybrid progeny across testers and generations for Grain yield and grain moisture. They also determined the correlations between the trait values observed in inbred and hybrid progeny. They determined the utility of QTL, detected in the two progeny types. Dhliwayo *et al*. [14] studied combining ability, genetic distances, and heterosis among elite CIMMYT and IITA tropical maize inbred lines. Their results revealed that the genetic distances were not significantly associated with hybrid performance, specific combining ability effects, or mid parent heterosis for grain yield, but they effectively grouped the lines according to known pedigree relationships and approximately according to heterotic patterns used by CIMMYT and IITA. They suggested that SSR-determined genetic distances were not useful to predict hybrid grain yield, they could be helpful for preliminary classification and use of exotic or poorly characterized germplasm. Kotey *et al*. [15] also reported that evidence based policy should be priority regarding the available maize varieties and their profitability under pest and weed management systems and agronomic conditions. Application of snail basal fertilizer also improved the corn performance by enhancing plant growth [16].

Rahman *et al.* [17] evaluated maize S2 lines in test cross combinations flowering and morphological traits for 24 maize S2 lines using line x tester analysis. The superior testcrosses TC-36, TC-13, TC-21 based on their performance for corresponding parameters mentioned above, were recommended to be included in further breeding programs for developing maize germplasm with earlier flowering and desirable plant and ear height attributes. Evaluation of early generation inbred lines in test crosses has been the primary method used in maize breeding. Greater attention is received by S_2 performance for superior genotypes identification. Visual selection of S_2 yield evaluation and agronomic traits offer greater opportunity for early generation testing. In early generation testing, S1 or second generation of selfed progeny (S2) are out crossed to a common tester for yield and general performance. Lines with poor combing abilities are discarded and only good performance lines are further selfed and selected in subsequent cycles of selection [18]. The present study was conducted with the major objectives to evaluate maize inbred lines derived from maize variety Sarhad white for grain yield and morphological traits and identification of superior inbred in maize lines based on test cross performance along with elimination of inbred lines that do not merit consideration for further inbreeding and selection.

Materials and Methods

Experimental Particulars and Breeding Material

Current study was conducted to evaluate the inbred lines for grain yield and morphological traits of maize (Cultivar Sarhad White) based on test cross progeny performance by using a 7 × 7 partially balanced lattice square design with two replications. Total 49 lines per replication were sown at the Malakandhar Agricultural Research Farm KPK, Agricultural University Peshawar, Pakistan. These 49 lines comprised of 32 test crosses with 16 of Kiramat and 16 of Jalal, 16 inbred lines with one check. The check used in the experiment was hybrid CS-King. Sowing was done with the help of hand hoe and then thinned to the required plant population. Row length was kept 400 cm with one-meter path between two consecutive blocks. Plant to plant spacing was 20 cm. Fertilizer was applied in the form of diamonium phosphate and urea at the rate of 150 and 250 kg ha^{-1} respectively. Field was well prepared by giving three ploughing followed by planking. Necessary plant protection measures were carried out uniformly to avoid the competition by weeds and keep the crop free from insects, pests and diseases. The crop was harvested and kept in the field for sun drying for a few days and after which threshed manually.

Agronomic and Yield Parameters

Data regarding days to tasseling were recorded as the number of days from the day of sowing to the day when at least 50% plants in a row emerged the tassels. Days to silking were recorded as the days counted from sowing until 50% plants in a row showed silks. The numbers of days counted from planting till 50% plants in a row started anthesis. Anthesis silking interval (ASI) was recorded as the difference between days to silking and days to anthesis. The distance in cm from the base of the plant to the base of flag leaf was recorded with the help of a meter rod for plant height. The data were measured as the average for five randomly selected plants from each replication. Ear height data were recorded as the distance from the bottom of plant to node from which the uppermost ear emerged. Five randomly selected plants were averaged for each row. The length of three randomly selected cobs was averaged for cob length. Three cobs in each row were randomly chosen and the number of kernel rows per cob were counted. After a few days of harvesting when the grain moisture was almost 15%, the weight of 100-kernals was recorded in the laboratory using the electric balance. The percent kernel moisture contents were determined at the time of harvest for each rows with help of grain moisture tester after shelling of grains. For the determination of grain yield, an area of one square meter was harvested from each plot at fully mature stage, grains obtained from each plot after threshing were weighed by a weighing balance.

Statistical Analysis:

Data collected regarding growth and yield parameters of maize were analyzed statistically using computer program "Statistix 8.1". The data were subjected to ANOVA appropriate for 7 × 7 partially balanced lattice square design. Microsoft Excel was used for average and descriptive statistics calculations.

Results and Discussion

Days taken to tasseling, anthesis, silking and anthesis silking interval

Data regarding crop development showed that days taken to tasseling, anthesis and silking were significantly affected among the genotypes of maize. Coefficient of variation (CV) of days taken to tasseling, anthesis and silking were recorded 3.79%, 4.08% and 3.47% respectively (Table 1). Among the inbred lines, minimum days taken to tasseling (59.5) were observed for Sarhad white inbred line-163 whereas the maximum days to tasseling (69.5) were observed for inbred line-10-2a (Table 2). Among the test crosses of Jalal, minimum days to tasseling (61.50) was observed for Jalal TC-205 while maximum days taken to tasseling (70.5) was observed for Jalal TC-230-a and TC-63-1 (Table 3). In case of test crosses of Kiramat, minimum days to tasseling (58.5) was observed for Kiramat TC-9-6 and 230-a, whereas the maximum days to tasseling (69) was observed for Kiramat TC-94 (Table 3). Mean days to 50% tasseling for a check was (67.5) (Table 2). Table 1 reveals that only three inbred lines showed greater days to tasseling than check mean and one inbred line was similar to check mean. Other 12 inbred lines showed lower days taken to tasseling than check mean. Overall days taken to tasseling of all inbred progenies were 64.32 (Table 2). Minimum days taken to anthesis (55) were recorded for Sarhad White inbred lines 150-c while maximum days to anthesis (71) was recorded for inbred line 33 (Table 2). Minimum days to anthesis (61) was recorded for Jalal TC-205, where maximum days to anthesis (71.5) was recorded for Jalal TC-101-2 (Table 3). Minimum days to anthesis (61.5) were recorded for Kiramat TC-230-a while maximum days to anthesis (72) was recorded for Kiramat TC-226-2 (Table 3). Mean days taken to anthesis for check was 69 (Table 2). Only one inbred line out of 16 inbred progenies evaluated in the present study took similar days to anthesis as check. About 14 inbred progenies took less to time to anthesis than check. Sarhad White, inbred lines150-c took minimum days to silking (56) while maximum days to silking (72) were observed in inbred lines-33. Jalal TC-205 showed minimum days to silking (62) while maximum days to silking (73) were recorded in Jalal TC-94 and TC-101-2 (Table 3). Minimum days to silking (66.5) was observed for Kiramat TC- 230-a and maximum days to silking (73.5) were recorded for Kiramat TC-226-2 (Table 3). Mean days to 50% silking of check was 70 (Table 2). Mean values regarding days to silking indicated that three inbred progenies showed greater days to silking than check mean (Table 2). Highly significant ($P \leq 0.01$) differences were observed for anthesis silking interval (ASI) among the genotypes. Greater coefficient of variation was observed as 81.15% ASI (Table 1). Minimum ASI (0.00) for Sarhad White, inbred lines, 10-2a. It can be observed from the table 2 that inbred lines10-2a has 0.00 ASI while 9-6-1, 9-6, 205 and 226-2 showed an excellent level of synchronization with 0.50 ASI. Jalal TC-76-2b and TC-163 were showed a good level of synchronization with 0.50 anthesis silking interval while Kiramat TC-63-1, TC-33, TC-12-1 and TC-10-2a showed an excellent level of synchronization with zero anthesis silking interval (Table 3).

These results corroborate those of Shah [19] whose analysis of variance for maize inbred lines indicated highly significant ($P<0.01$) genetic variation in Sarhad white maize population for days to 50% tasseling, 50% silking and days to 50% pollen shedding. Earlier tasseling will lead to earlier pollen shedding and silking, which will eventually affect the overall maturity duration of maize plants. Ceballos *et al*. [20] expressed that late maturing genotypes with the same genetic background were more resistant to diseases than early maturing genotypes. Highly significant differences were observed by Carlone and Russell [21] for days to 50% anthesis while evaluating testcrosses of maize synthetic 'BSSS' lines with two unrelated testers. Data regarding days to 50% anthesis was recorded as a measure of maturity. These results are in conformity to those of Menkir and Charles [18] who observed significant variation for days to 50% anthesis in test cross evaluation of exotic maize accessions. Our result revealed that 25% inbred progenies were having greater days to 50% anthesis when compared with mean of testcrosses. Days required to 50% silking along with other maturity traits are commonly used by plant breeders as basis of determining maturity of maize. For regions with short growing seasons, early maturing varieties (hybrids) are needed. These results corroborate those of Peiris and Hallauer [22] who reported significant variability among half and full sib families in a maize recurrent selection program. Similar results were observed by Rahman *et al* [17] wherein they reported highly significant differences for days to 50% silking in 24 maize lines using line × tester analysis. Using WD 2×8 as a tester, they observed (62) maximum days to silking for TC-B. Our result showed that 25% inbred progenies were having greater days to 50% silking as that of day to 50% silking of testcrosses mean and 68.75 % inbred progenies were having less days to 50% silking when compared with mean of testcrosses. These results revealed highly significant variations for anthesis-silking interval among the genotypes. Highly significant variations among testcrosses for anthesis-silking interval were observed by Carlone and Russell [21] in testcrosses evaluation of maize synthetic 'BSSS' lines. Similar results were observed by Ajmone *et al.* [23]. The result portion shows that 31.25% inbred progenies were having lower ASI than the mean of all testcrosses and 31.25% inbred progenies were having ASI which was greater than the mean ASI of all the testcrosses.

Growth and yield attributes

Highly significant (*P<0.01*) difference was recorded among the genotypes of maize regarding growth parameters like plant height, ear height, cob length and grain moisture (Table 1). Coefficient of variation (CV) of plant eight, ear height, cob length and grain moisture are 15.09%, 29.56%, 15.99% and 15.03% respectively.

Minimum plant height (50 cm) was observed for Sarhad White, inbred line 94, whereas the maximum plant height (165.5 cm) was observed for inbred line 226-2 (Table 4). Minimum plant height (88.5 cm) was observed for Jalal TC-9-6-1, whereas the maximum plant height (164.5 cm) was observed for Jalal TC-33 (Table 5). Minimum plant height (75 cm) was observed for Kiramat TC-33 (S) whereas the maximum plant height (141.5 cm) was observed for Kiramat TC-9-6-1 (Table 5). Mean plant height for check was 125 cm (Table 4). Table 4 reveals that only 5 inbred progenies were having greater plant height than check mean and one line almost similar plant height as that of check mean. About 11 inbred progenies were having less plant height than check mean. Mean plant height for all progenies were 113.53 cm (Table 4).

Sarhad White, inbred line 12-1 produced minimum ear height (20.5 cm) while maximum ear height (93 cm) was produced by inbred lines 9-6 (Table 4). Jalal TC-205 produced minimum ear height (40.5 cm) while Jalal TC-12-1 produced maximum ear height (82.5 cm) (Table 5). Minimum ear height (29.5 cm) was produced by Kiramat TC-33, whereas the maximum ear height (65.5 cm) was produced for Kiramat TC-9-6 (Table 5). Mean to ear height for check was 61 cm (Table 4). Table 4 shows that only 6 inbred lines were having greater ear height than check mean. About 9 inbred progenies were having less ear height than check mean. Mean ear height for all inbred progenies were 52.34 cm (Table 4).

Highly significant (*P<0.01*) differences were observed for cob length among the genotypes. Coefficient of variation (CV) for cob length was 15.99% (Table 1). Sarhad White inbred line 226-2 produced maximum cob length (16.5 cm) while inbred line 10-2a produced minimum cob length (8 cm) (Table 4). Jalal TC-9-6 (S) produced maximum cob length (18 cm) while Jalal TC-226-2 produced minimum cob length (8.5 cm) (Table 5). Kiramat TC-163 produced maximum cob length (16.5 cm) while Kiramat TC-230-a produced minimum cob length (9 cm) (Table 5). Mean cob length for check was 14 cm (Table 4). Table 4 shows that only one inbred progeny was having greater cob length than check mean and two inbred progenies were having the almost similar cob length as that of check. About 13 inbred progenies were having less cob length than check mean. Mean cob length for all inbred progenies were 12.16 cm (Table 4).

At harvest, highly significant differences (*P<0.01*) were observed for grain moisture among genotypes. Coefficient of variation (CV) for grain moisture contents was 15.13% (Table 1). The lowest grain moisture (16.35%) were observed for Sarhad White, inbred lines 9-6 and the highest grain moisture (35.7%) was recorded for Sarhad White, inbred line 226-2 (Table 4). The lowest mean grain moisture (20.15%) was observed for Jalal TC-226-2, while the highest grain moisture (37.15%) was recorded for Jalal TC-94 (Table 5). The lowest grain moisture (13.9%) was observed for Kiramat TC-9-6-1, while the highest grain moisture (43.80%) were recorded for Kiramat TC-150-c (Table 5). Mean grain moisture at harvest for check was 28.55% (Table 4). Table 4 shows that only six inbred progenies were having greater grain moisture at harvest than check and one inbred progenies were having almost similar grain moisture at harvest as that of check. About 9 inbred progenies were having less grain moisture at harvest than check. Mean grain moisture at harvest for all inbred progenies was 26.59% (Table 4).

Significant differences (*P<0.05*) were observed for number of kernel rows per cob among the genotypes. Coefficient of variation number of kernel rows per cob was 12.68% (Table 1). The lowest mean number of kernel rows per cob (9) was observed for Sarhad White maize inbred line150-c while highest number of kernel rows per cob (14.5) was recorded for Sarhad White maize inbred line 211 (Table 5). The lowest mean number of kernel rows per cob (11.5) were observed for Jalal TC- 226-2, TC-89-b, TC-33 and TC-10-2a, while the highest number of kernel rows per cob (14.5) was recorded for Jalal TC-163 (Table 5). The lowest mean number of kernel rows per cob (9.5) were observed for Kiramat TC-9-6-1 while the highest number of kernel rows per cob (15.5) were recorded for Kiramat TC-205 (Table 5). Mean number of kernel rows per cob for a check was 12 (Table 5). Mean for the number of kernel rows per cob in table 5 shows that three inbred progenies out of 16 inbred lines were having greater number of kernel rows per cob than check and 4 inbred progenies were having almost similar number of kernel rows per cob as that of check. About 9 inbred progenies were having less number of kernel rows per cob than check mean. Mean number of kernel rows per cob for all inbred progenies were 11.63 (Table 5).

Coefficient of variation of 100-kernel weight was 19.45% (Table 1). Highly significant difference ($P<0.01$) were observed for hundred kernel weights among the genotypes. Sarhad White, inbred line150-c produced minimum 100-kernel weights (11.65 g) whereas inbred line-76-2b produced maximum 100-kernel weights (33.9 g) (Table 5). Among the test crosses of Jalal, Jalal TC-33 produced minimum 100-kernel weights (18.9 g) whereas Jalal TC- 101-2 produced maximum 100-kernel weights (40.55 g) (Table 5). In case of Kiramat test crosses, Kiramat TC-230-a produced minimum 100-kernel weight (24.40 g) whereas Kiramat TC-150-c produced maximum 100-kernel weight (39.85 g) (Table 5). Mean 100-kernel weights for a check was 33.2 g (Table 5). Mean values for 100-kernel weights in table 5 shows that one inbred progenies out of 16 inbred lines were having greater kernel weights than check while 12 inbred progenies were having less 100 kernel weight than check. Mean 100 kernel weight for all inbred progenies was 26.28 g (Table 5).

Grain yield was not affected significantly ($P>0.05$) among genotypes. Coefficient of variation for grain yield was higher as 33.17% (Table 1). Sarhad White Inbred line 205 (5366 kg ha^{-1}) produced maximum grain yield while lowest grain yield was recorded for inbred line 150-c (3318 kg ha^{-1}) (Table 5). Lowest grain yield was recorded for Jalal TC-33 (958 kg ha^{-1}) while the highest grain yield was recorded for the Jalal TC-12-1 (5913.5 kg ha^{-1}) (Table 5). Lowest grain yield was recorded for Kiramat TC- 10-2a (2519 kg ha^{1}) while the highest grain yield was recorded for the Kiramat TC-89-b (6808 kg ha^{-1}) (Table 5). Grain yield for check was 4919.50 kg ha^{-1} (Table 5).

Plant height is an important agronomic character. Low plant height is desired, because such plants are more resistant to lodging. However, low plant heights beyond a certain level will start affecting the yield negatively. Plant heights after flowering were studied of their relationship with grain yield, maturity and lodging [24]. Similar results were found in Sarhad white population using S_1 line recurrent selection [25]. Rahman *et al.* [17] observed significant variation for plant height in Sarhad White population using S_1 line recurrent selection. The results for plant height shows that 62.5% inbred progenies showed inferior performance than the mean of testcrosses. While 37.5% showed higher performance as compared with the test crosses mean. Ear height will indirectly increase yield through reduction in lodging, but it seems like that there should be a threshold level for it too. Reducing the ear height beyond that will affect the yield negatively. Burgess and West [26] reported that after 10 cycles of selection for low ear height, grain yield had declined 29% in Tennessee Late Low-Ear synthetic. Highly significant differences were observed for ear height by testing 24 maize lines using line × tester analysis [17]. Our results for the ear height shows that 50% inbred progenies were having lower ear height than the mean of testcrosses while 50% showed higher ear height as compared to mean of test crosses. These results are also in accordance with findings of Carlone and Russell [21] who obtained significant differences for ear length among lines of maize synthetic 'BSS' after testcross evaluation. Like other yield associated traits that affects the final grain yield, ear length also has an effect on the final grain yield. Our result reveals that 43.75% inbred lines showed superior ear length as compared to test crosses mean. Highly significant results were obtained by Abel and Pollak [27] when testcrosses of exotic maize accessions with a number of testers were evaluated for percent grain moisture and other traits. Grain moisture at harvest can be used as an indirect method of differentiating early and late maturing genotypes.

A higher number of kernel rows per cob resulted in greater yield. However, short rows in a short ear could not contribute to the total yield as much as long rows in a long ear. Along with greater number of rows, large size of grain, heavy weight of grain and more number of grains per cob resulted in greater yield. Number of kernel rows per cob along with ear length, ear diameter and grain weight contributes to the final grain yield. Manivannan [28] suggested that ear diameter and number of kernel rows per cob should be given more importance while doing selection for grain yield improvement in maize. Similar results were observed by Austin *et al.* [13]. 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. The grains weight has a remarkable role in increasing the grain yield in relation with other yield related components Manivanan [28]. These results are similar to those of Rahman *et al.* [17] who also reported significant differences ($P<0.05$) for this trait while comparing original and selected maize population for grain yield. Grain yield improvement is one of the major aims of every plant breeding programs and it is the combined outcome of both genetic potential and environmental interaction [29]. Shah *et al.* [25] observed high expected response to selection (750.76 kg ha^{-1}) in Sarhad White population verifying the results of proposed study.

Conclusion

It can be concluded from the results of study that inbred progenies produced less grain yield than check whereas four inbred progenies produced higher grains than the check (king). Kiramat TC-89-b, Jalal TC-12-1 and Sarhad White Inbred line 205 are suggested for further experimentations regarding growth traits especially more yield.

Table 1 Mean squares and coefficient of variation for various parameters of maize variety Sarhad White

Plant Trait	Replication	Genotypes	Blocks	Error	CV (%)
Days to tasseling	0.000	24.125**	4.857	6.520	3.7951
Days to anthesis	7.439	19.009*	10.391	6.899	4.0798
Days to silking	0.367	16.713**	6.439	5.455	3.4663
Anthesis silking interval	4.939	4.829**	1.605	1.800	81.0557
Plant height (cm)	40.500	1029.184**	136.143	395.48	15.0953
Ear height (cm)	114.653	477.625**	69.796	303.49	29.4578
Cob length (cm)	0.255	10.220**	4.279	4.497	15.99
Grain moisture %age	7.549	59.11**	17.938	17.245	15.0264
Kernel rows per cob	6.898	4.169*	2.255	2.47	12.68
Hundred kernel weight (g)	4.102	81.869**	11.119	40.78	19.4531
Grain yield (Kg ha^{-1})	349.235	2426153.687^{NS}	1074704.663	2318804.06	33.0696

NS = Non-Significant
* = Significant at 5% level of significance
** = Significant at 1% level of significance

Table 2 Means for days to tasseling, days to anthesis, days to silking and anthesis silking interval (ASI) of 16inbred lines of maize variety Sarhad White and one check.

Inbred lines	Days to Tasseling	Days to Anthesis	Days to Silking	ASI
9-6	65.50	62.00	62.50	0.50
9-6-1	60.50	67.00	67.50	0.50
10-2a	69.50	68.50	68.50	0.00
12-1	60.00	62.50	67.50	5.00
33	65.00	71.00	72.00	1.00
63-1	68.00	69.00	70.00	1.00
76-2b	61.50	67.50	68.50	1.00
89-b	66.00	59.50	65.00	5.50
94	68.00	67.50	71.00	3.50
101-2	64.50	67.00	71.50	4.50
150-c	61.00	55.00	56.00	1.00
163	59.50	63.00	67.50	4.50
205	65.00	67.00	67.50	0.50
211	67.50	66.50	67.50	1.00
226-2	65.00	68.00	68.50	0.50
230-9	62.50	68.00	69.50	1.50
King	67.50	69.00	70.00	1.00
Mean of Inbred lines	64.3125	65.56	67.53	1.97
Mean of check (King)	67.50	69.00	70.00	1.00
Mean testcrosses of Jalal and kiramat	65.48	67.90	69.20	1.32
$LSD_{(0.05)}$	4.9676	5.5463	4.8263	2.6608
$LSD_{(0.01)}$	6.6268	7.4370	6.4716	3.5495

ASI = Anthesis silking interval

Table 3 Means for days to tasseling, days to anthesis, days to silking and anthesis silking interval

Testcrosses	Days to Tasseling	Days to Anthesis	Days to Silking	ASI
16 Jalal testcrosses of maize variety Sarhad White				
TC-9-6	68.00	67.00	68.00	1.00
TC-9-6-1	68.50	67.00	69.0	2.00
TC-10-2a	66.00	67.00	67.50	0.50
TC-12-1	67.50	67.50	69.50	2.00
TC-33	68.50	68.00	69.0	1.00
TC-63-1	70.50	69.50	71.00	1.50
TC-76-2b	69.50	66.50	67.00	0.50
TC-89-b	66.00	68.50	69.00	1.00
TC-94	69.50	66.50	73.00	6.50
TC-101-2	70.00	71.50	73.00	1.50
TC-150c	69.50	68.00	70.00	2.00
TC-163	64.50	68.50	69.00	0.50
TC-205	61.50	61.00	62.00	1.00
TC-211	64.00	66.50	68.00	1.50
TC-226-2	66.50	69.00	70.00	1.00
TC-230-a	70.50	68.00	71.00	3.00
16 Kiramat testcrosses of maize variety Sarhad White.				
TC-9-6	58.50	68.00	69.50	1.50
TC-9-6-1	60.50	68.00	70.0	2.00
TC-10-2a	65.50	70.00	70.00	0.00
TC-12-1	60.50	68.50	68.50	0.00
TC-33	61.50	67.00	67.00	0.00
TC-63-1	67.50	70.00	70.00	0.00
TC-76-2b	62.50	67.50	68.00	0.50
TC-89-b	65.50	67.50	68.50	1.00
TC-94	69.00	70.00	72.00	2.00
TC-101-2	61.00	68.50	70.00	1.50
TC-150-c	60.50	67.50	68.50	1.00
TC-163	63.50	67.50	68.00	0.50
TC-205	66.50	67.00	68.50	1.50
TC-211	64.50	66.00	69.0	3.00
TC-226-2	67.50	72.00	73.50	1.50
TC-230-a	58.50	61.50	66.50	5.00

TCs = Testcrosses of Jalal and Kiramat, ASI = Anthesis silking interval

Table 4 Means for plant height, ear height, ear length, grain moisture, kernel rows per cob, 100-kernel weight and grain yield of 16 inbred lines of maize variety Sarhad White and one check of Maize

Inbred lines	Plant height (cm)	Ear height (cm)	Cob length (cm)	Grain moisture (%)	Kernel rowsper cob	100-kernel weight (g)	Grain yield (kg ha^{-1})
9-6	134.00	93.00	13.00	16.35	9.50	18.50	5248.50
9-6-1	88.00	66.00	11.50	25.30	11.50	18.70	4099.50
10-2a	80.50	67.50	8.00	20.05	10.00	16.35	4014.00
12-1	99.50	20.50	13.50	20.60	12.00	23.10	3711.50
33	116.50	72.50	13.50	29.30	11.50	27.50	5123.00
63-1	124.00	63.00	13.00	31.70	13.00	33.80	4020.50
76-2b	113.50	31.00	11.00	28.50	11.50	33.90	3924.50
89-b	89.50	25.00	12.00	19.75	12.00	30.80	4213.50
94	50.00	23.50	8.00	27.15	11.00	26.05	3902.00
101-2	112.50	37.50	12.00	25.55	12.00	23.65	3386.50
150-c	96.00	48.00	10.00	26.60	9.00	11.65	3318.00
163	146.00	50.50	11.50	30.25	11.50	30.30	4531.00
205	100.00	33.50	12.50	31.65	11.00	26.70	5366.00
211	139.50	85.00	14.00	26.50	14.50	28.80	5170.00
226-2	165.50	61.50	16.50	35.70	13.50	37.25	3786.00
230-a	161.50	59.50	14.50	30.50	12.50	33.55	3409.50
King	125.00	61.00	14.00	28.55	12.00	33.20	4919.50
Mean of inbredlines	113.53	52.34	12.16	26.59	11.625	26.28	11.625
Mean of check	125.00	61.00	14.00	28.55	12.00	33.20	4919.50
Mean TCs of Jalal and Kiramat	123.78	53.29	12.59	28.34	12.59	31.29	4306.59
LSD(0.05)	36.5607	31.4759	4.2379	8.4627	3.13	11.62	2848.99
LSD(0.01)	48.7723	41.9891	5.6534	11.3477	4.17	15.49	3800.58

Table 5 Means for plant height, ear height, cob length, grain moisture, kernel rows per cob, 100-kernelweight and grain yield of test crosses

Testcrosses	Plant height (cm)	Ear height (cm)	Cob length (cm)	Grain moisture (%)	Kernel rowsper cob	100-kernel weight (g)	Grain yield(kg ha^{-1})
16 Jalal testcrosses of maize variety Sarhad White							
TC-9-6	131.50	55.50	30.40	30.40	12.50	36.60	4913.00
TC-9-6-1	88.50	71.50	29.45	29.45	12.50	35.10	5601.00
TC-10-2a	128.50	64.50	26.85	26.85	11.50	43.45	3088.50
TC-12-1	114.50	82.50	25.25	25.25	12.50	33.85	5913.50
TC-33	164.5	45.00	28.10	28.10	11.50	18.90	958.00
TC-63-1	117.00	50.50	27.95	27.95	12.50	28.60	5259.00
TC-76-2b	122.50	51.00	34.30	34.30	12.00	35.37	5329.00
TC-89-b	127.50	56.00	28.50	28.50	11.50	29.70	4924.50
TC-94	140.50	58.00	37.15	37.15	14.00	34.80	2400.00
TC-101-2	129.00	56.00	29.55	29.55	13.50	40.55	2907.50
TC-150-c	140.00	58.00	32.60	32.60	12.00	40.30	3401.00
TC-163	117.00	46.00	27.10	27.10	14.50	29.25	5436.00
TC-205	102.00	40.50	28.00	28.00	13.00	28.25	4771.00
TC-211	122.50	55.50	23.65	23.65	14.00	26.00	4033.50
TC-226-2	111.50	41.50	20.15	20.15	11.50	25.10	1545.00
TC-230-a	130.50	67.50	25.45	25.45	12.00	27.75	4261.00
16 Kiramat testcrosses of maize variety Sarhad White							
TC-9-6	127.00	65.50	13.50	20.95	11.50	30.00	4962.50
TC-9-6-1	141.50	44.00	12.50	13.90	9.50	26.55	5402.50
TC-10-2a	117.50	44.50	13.50	22.40	11.00	30.20	2519.00
TC-12-1	116.50	47.00	13.00	37.55	14.00	28.00	4305.00
TC-33	75.00	29.50	12.00	34.75	10.00	29.80	4729.00
TC-63-1	112.50	56.50	13.00	26.95	12.50	26.20	4296.00
TC-76-2b	127.50	49.00	13.00	28.25	14.50	28.95	5105.00
TC-89-b	99.50	33.50	14.50	28.00	13.00	29.40	6808.00
TC-94	119.50	45.50	13.50	25.85	12.00	34.70	4432.00
TC-101-2	137.50	49.50	12.50	34.60	13.50	32.70	5386.00
TC-150-c	151.00	59.00	13.00	43.80	12.00	39.85	4550.00
TC-163	137.50	57.50	16.50	28.10	13.50	32.60	4784.50
TC-205	132.00	62.00	12.50	25.70	15.50	29.50	3733.00
TC-211	128.00	59.50	14.00	25.40	15.00	27.75	3785.00
TC-226-2	131.50	65.00	13.00	29.00	13.50	36.95	3320.50
TC-230-a	119.50	38.50	9.00	27.05	11.00	24.40	4951.50

TCs = Testcrosses

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