African Journal of Biotechnology Vol. 11(11), pp. 2759-2762, 7 February, 2012
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.1837
ISSN 1684–5315 © 2012 Academic Journals

Full Length Research Paper

Development And Release Of Indigenous Maize Hybrids To Enhance Maize Yield In North-West Frontier Province, Pakistan

Kiramat Khan[1]*, Hassan Sher[2], Muhammad Iqbal[3] and MN Al-yemeni[2]

[1]Centre of Botany and Biodiversity Conservation, University of Swat, Pakistan.
[2]Department Botany and Microbiology, King Saud University P.O. Box. 2455 or 11451 Riyadh, Saudi Arabia.
[3]Cereal Crops Research Institute Pirsabak Nowshera, Pakistan.

Accepted 18 February, 2011

Maize is the second most important summer cereal crop, after wheat, in the North-West Frontier Province (NWFP) occupying more than 27% of the total cropped area of the province. This crop is grown on about 0.530 million ha of land with grain production of 0.820 million t annually, having a very low average yield of 1.6 t ha^{-1} compared to an achievable potential yield of 10 t ha^{-1} in the NWFP. Such a low average yield is primarily due to a widespread use of low-yielding open-pollinated maize cultivars by farmers in the province. Hybrid-oriented maize breeding research work for the development of indigenous maize hybrids was initiated in the public sector at the Cereal Crops Research Institute (CCRI) Pirsabak Nowshera in the year 2000. The main objective was to evolve single-cross maize hybrids of high yield potential, white kernel and low to medium maturity for the environments of NWFP. A large number of replicated field experiments, both on-station and on-farm, were carried out in 2005 and 2006 to evaluate the experimental hybrids. Grain yield, Stover yield and maturity were among the important traits used in these investigations. A highest grain yield of 9.84 t ha^{-1} and a Stover yield of 30.56 t ha^{-1} with maturity earlier than other hybrids, including a leading maize hybrid of private sector (Pioneer-3025), were observed for one of the experimental hybrids, FRW-2 X FRW-8 with very few exceptions. This hybrid was invariably found higher yielding and early maturing compared to other hybrids included in the trials. Results of these investigations provided a sound basis for the approval of this experimental hybrid by the Provincial Seed Council and its registration by the Federal Seed Certification and Registration Department for commercial cultivation in the NWFP in the name given Kiramat.

Key words: Maize hybrid, grain yield, member of the society of teachers of the Alexander technique (MSTAT).

INTRODUCTION

Maize is the second most important summer cereal, after wheat, in North-West Frontier Province (NWFP) with an area of about 0.530 million ha of land with grain production of 0.820 million annually (MINFAL, 2007). It occupies more than 27% of the total cropped area of the province, which is the second largest to wheat with 42% of the total cropped area (Khan et al., 2004). Maize is an important source of both green and dry fodder for livestock for most of the province, especially the mountainous areas, besides its uses as staple food by the farming community (Khan et al., 2003). More than 80% of the farmers use either traditional or old improved open-pollinated maize cultivars which have grain and stover yield much lower than the single cross hybrids (CCRI, unpublished reports).

There has been a modest increase of 2% in the average yield per hectare of NWFP in the last 10 years compared to 100% increase in the average yield of maize

*Corresponding author: E-mail: hassan.botany@gmail.com and hassansher_2000@yahoo.com.

Abbreviations: NWFP, North-West Frontier Province; **CCRI,** Cereal Crops Research Institute.

Table 1. Summary of five experimental and two commercial check hybrids evaluated on farmers' field at six locations in plains during the fall, 2006.

S/N	Hybrid	50% Silk (days)	Plant Pop./ha (No.)	Ear Pop./ha (No.)	Grain Yield (t ha-1)
1	FRW2 x FRW8 (Kiramat)	52.33	56139	57203	8.67
2	WD- 3 x 6	45.50	60248	63036	7.42
3	Sd (W) x (3 x 6)	54.83	57778	58166	7.97
4	CSCW	47.17	60907	64389	6.97
5	9845 x 9864	55.50	57335	57537	6.42
6	Babar	57.17	57694	58111	7.93
7	P-3025	56.83	57277	57203	8.30

Table 2. Summary of five experimental and two commercial check hybrids evaluated on farmers' field at three locations in Mid-hills during the fall, 2006.

S/N	Hybrid	Maturity (days)	Grain yield (t ha-1)	Stover yield (t ha-1)
1	FRW2 x FRW8 (Kiramat)	145.00	9.84	30.56
2	WD- 3 x 6	135.00	8.32	24.80
3	Sd (W) x (3 x 6)	150.00	8.70	27.93
4	CSCW	136.67	7.41	22.41
5	9845 x 9864	141.67	7.24	23.47
6	Babar	151.67	8.20	26.57
7	P-3025	153.67	9.25	27.67

in Punjab province, which is primarily due to the use of maize hybrids, especially single crosses in that province. In NWFP, normally open-pollinated maize cultivars, are being used, which have low yield potential compared to those of hybrids. The present yield gap between the average and the achievable potential in the province could be easily filled with the cultivation of single cross hybrids by farmers on commercial basis. The present research was initiated to develop indigenous maize hybrids for NWFP environments and extract maize inbred lines for the development of superior single cross maize hybrids with desirable gene combinations for high grain and stover yield, white flint kernel type and low to medium maturity.

MATERIALS AND METHODS

Breeding work for the development of indigenous single cross maize hybrids was initiated at the Cereal Crops Research Institute (CCRI), Pirsabak, Nowshera in the year 2000. Plant material for the present research study included a large number of S_1 lines (Khan et al., 2003) derived from the F_2 populations of two parental single cross hybrids of Babar hybrid (commercial double cross hybrid). These S_1 lines were advanced to S_2 and subsequently to S_3 generations through selfing procedure in the breeding nursery. Superior lines were advanced to S_4 and then to S_5 through sibbing. The S_5 lines were evaluated in partial diallel mating design to determine their combining abilities and select the superior lines for hybrid combination. Superior S_5 lines were further advanced to S_6 through sibbing. Based on the preliminary yield trials, 12 superior hybrids were selected for evaluation as advanced yield trials at various locations at other stations and farmers' fields in 2005 and 2006 to determine their adaptation and yield performance across locations/environments.

The preliminary yield trial was laid out as a randomized complete block design with 4 replications. A plot size of 4 rows each of 5 m long and 75 cm between rows was used. A plant to plant distance of 25 cm was kept in plot. The characteristics measured in the preliminary study included grain yield, stover yield, shelling percentage, fresh cob weight, plant population, plant height, ear height and days to flowering. However, grain yield, stover yield, days to flowering and days to maturity were among the characteristics measured in the advance yield trials on farmers' fields and experiment stations.

The data collected on various traits were analyzed using analysis of variance procedure appropriate to the design, using MSTAT-C computer software program. Means of various traits were compared using the Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

The newly developed experimental single cross hybrids were tested in 17 replicated field experiments at various locations on farmers' fields in NWFP and the CCRI, Pirsabak, Nowshera, in the fall and spring seasons during 2005 and 2006. Means of selected experimental maize hybrids and those of approved public and private sector commercial hybrids for various traits are presented only for 10 out of 17 locations in Table 1 (three locations), Table 2 (six locations) and Table 3 (one on-station trial). With few exceptions, the newly developed experimental single cross hybrid (FRW-2 X FRW-8) out yielded all other hybrids including exotic and indigenous commercial

Table 3. Comparison among selected white grain earlier maturing hybrids including commercial hybrid (as a check) at CCRI, Pirsabak (Nowshera) during spring, 2005.

S/N	Hybrid	Plant Height (cm)	Ear Height (cm)	Plant Pop. ha^{-1} (No.)	Ear Pop. ha^{-1} (No.)	Shelling (%)	Grain Yield (t ha^{-1})
1	WD- 1 × 2	172	84	60000	57778	85	8.53
2	WD- 1 × 2	151	73	65333	63111	86	6.61
3	WD- 1 × 4	184	88	60000	59111	86	8.22
4	WD- 1 × 5	162	75	59555	58667	84	8.01
5	WD- 1 × 6	152	69	64889	60889	85	8.44
6	FRW2 × FRW8	186	89	64000	68222	86	9.77
7	WD- 5 × 7	163	75	60444	60444	83	8.20
8	CSCW	165	80	63111	64000	83	7.73
9	FRW4 × 9815	161	73	60889	52889	83	6.79

hybrids. A highest grain yield of 11.46 t ha^{-1} was recorded for this new hybrid at CCRI during the fall 2006 (data not shown). Moreover, an average yield of 9.34 t ha^{-1}, across locations and across years, was found for the newly developed experimental hybrid compared to 7.88 t ha^{-1} for indigenous commercial hybrid Babar (a double cross hybrid of CCRI) and 8.18 t ha^{-1} for Pioneer hybrid P-3025 (an exotic single cross commercial hybrid of a private seed company). The new indigenous experimental maize hybrid (FRW-2 X FRW-8), showed an average grain yield superiority of 1.16 and 1.46 t ha^{-1} over Pioneer 3025 and Babar, respectively. The number of days to maturity for this hybrid was comparable to those of Babar and P-3025 across environments and across years.

The experimental hybrid (FRW-2 X FRW-8) proved superiority both in grain yield and flowering traits over the two check cultivars, Babar and Pioneer-3025, in six locations including Mardan, Charsadda and Swabi in the plains of NWFP as shown in Table 1. A similar superiority for these two traits of economic importance and that for stover yield was also exhibited in the 3 experiments conducted in the Mid-hill environments of Swat, Dir and Malakand during summer, 2006 (Table 2). Moreover, this new hybrid exhibited better resistance to foliar diseases and stalk rots as compared to Babar and other experimental hybrids in these trials (data not shown).

The present results were expected since grain yield, stover yield, maturity and disease resistance were the main selection criteria during the whole process of inbred line development, which might have resulted in accumulation of favorable genes in the parental inbred lines. The primary objective of most maize breeding programs is the evolution of high yielding and well adapted cultivar accompanied with other desirable attributes. Breeding for improved varieties is a continuous process and requires a thorough understanding of the genetic mechanisms governing yield and yield components (Saleem et al., 2002; Khan et al., 2003). Several breeding procedures have been established to increase the grain yield of maize populations and the hybrids derived from order to choose the best hybrid combinations, a large number of subjecttively chosen inbred lines are crossed to each other (Khan et al., 2003).

Mean comparisons of the nine experimental indigenous maize hybrids (Table 3) indicated that FRW-2 X FRW-8 had the highest grain yield of 9.77 t ha^{-1} and with the highest shelling percentage compared to other hybrids included in the trial during spring season in the plains of NWFP at the CCRI, Pirsabak, Nowshera. Moreover, high shelling percentage of this hybrid could be a result of the positive association between the two traits in the selection for high grain yield during inbred line development. These results were in good agreement with those reported earlier by Kadubiee and Kurianta (2004) and Rafique et al. (2004) who also reported significant association between shelling percentage and grain yield in maize. Positive association between these two traits was reported by Sujiprihati et al., (2003) but their magnitudes were non significant, which could be attributed to the differences in environmental conditions and genetic make-up of the materials studied.

Conclusion

Based on the results of the present research work, it may be concluded that the available breeding material possesses enough genetic potential for the extraction of desirable maize inbred lines, which could be a reliable source in the development of indigenous superior maize hybrids for NWFP environments and the approval and release of the experimental hybrid, FRW-2 X FRW-8, as a new maize hybrid (KIRAMAT) for commercial utilization could be a useful step towards enhancing maize yield in the food-deficient province of NWF.

Acknowledgement

We are thanks full for the financial support provided by

Excelent Centre of Biotechnology Research of King Saud University. This support has enable us to successfuly complete this study.

REFERENCES

Kadubiee W, Kurianta R (2004). Multiple analysis of traits determining grain yield of inbred lines and hybrids F_1 of maize Biuletyn Instytutu Hodowli i Aklimatyzacji Roslin. 23(1): 419-424.

Khan K, Iqbal M, Shah Z, Ahmad B, Azim A, Sher H (2003). Grain and stover yield of corn with varying times of plant density reduction. Pak. J. Biol. Sci. 6(19): 1641-1643.

Khan K, Karim F, Iqbal M, Sher H, Ahmad B (2004). Response of maize varieties to environments in two agro-ecological zones of NWFP: Effects on morphological traits. Sarhad J. Agric. 20(3): 395-399.

Khan K, Iqbal M, Karim F, Sher H (2003). Grain and stover yield of corn with varying time of plant density reduction. Pak. J. Biol. Sci. 6(19): 1641-1643.

MINFAL (2007). Agricultural statistics of Pakistan (2006-2007). Govt. of Pakistan. Ministry of Food, Agriculture and Livestock. Economics Wing, Islamabad.

Rafique M, Hussain A, Mahmood T, Alvi AW, Alvi MB (2004). Heritability and inter section ship among grain yield and yield components in maize (*Zee mays* L.). Int. J. Agri. Biol. 6(6): 1113-1114.

Juan G, Jorge L, Federico G, Juan E Garberi, Julian P , Miguel G, Luis S , Alcides T(2011). Diagnosis of Mycobacterium tuberculosis using molecular biology technology Asian Pac. J. Tropical Biomed.1(2): 85-88.

Saleem M, Shahzd K, Javid M, Ahmad A (2002). Genetic analysis for various quantitative traits in maize (*Zea mays* L.) inbred lines. Int. J. Agric. Biol. 4(3): 379-382.

Sujiprihati S, Saleh GB, Ali ES (2003). Heritability, performance and correlation studies on single cross hybrids of tropical maize. Asian J. Plant Sci. 2(1): 51-57.