Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 3 (2): 163-166, 2004
ISSN 1682-3974

Screening of Sub-tropical Maize Germplasm from CIMMYT, Mexico for Desirable Traits and its Implication in Indigenous Maize Breeding Program

Tahir Sajjad, Abdul Azim, Muhammad Sadiq, Manzoor Akbar, Zubair Shah,
Kiramat Khan, Fazli Subhan and Nazeer H. Shah
Cereal Crops Research Institute, Pirsabak, Nowshera, NWFP, Pakistan

Abstract: A set of 28 sub-tropical CIMMYT maize germplasm, along with 2 local checks were evaluated at experimental farm of Cereal Crops Research Institute, Pirsabak, Nowshera, NWFP Pakistan during Kharif growing season of year 2000 for desirable alleles, to be incorporated in indigenous maize breeding programme. CIMMYT entry no. 12 significantly out yielded (6.5 tons ha^{-1}) all entries, had significantly lowest (58 days) days for mid silking and plant height (187.7 cm) remained under desirable range with cob placement (98.6 cm) at favorable height with lodging frequencies at permissible limits is recommended for induction in indigenous maize breeding program. CIMMYT entries no. 21 and 6 also had significantly highest grain yields (6.4 and 5.9 tons ha^{-1}) with other factors significantly higher or ad-par with checks are also recommended for source of desirable alleles for improvement of elite maize populations.

Key words: Maize, evaluation, sub-tropical germplasm, desirable alleles, improvement programme

INTRODUCTION

Maize is second most important crop, after wheat in North West Frontier Province (NWFP) of Pakistan[1]. In Pakistan maize is usually grown in Kharif growing season (July-October), however spring growing season (March-June) also gave higher yields. NWFP environment is unique, and is suitable for both Kharif and spring season maize plantation[2]. NWFP has very erratic environmental, climatic and soil conditions, thus dividing it in various agro-ecological zones. It has dry tropical sandy conditions in southern regions; sub-tropical moderate and loamy soils in central plains and sub-tropical to temperate to alpine zones towards northern mountainous regions in shape of long valleys. Maize is grown almost in all regions. Although, soil and environmental conditions are very conducive in majority of maize growing areas of NWFP, yet the average yield obtained is far below than rest of the world[3], mainly due to unavailability of suitable and improved varieties/hybrids of maize for each of the agro-ecological zones of NWFP. Development of high yielding, disease resistant and adoptable maize varieties/hybrids for different agro-ecological zones of NWFP is vital for reduction of the present big yield gap.

Success of breeding programs always depends upon availability of wide range of genetic resources, to be used in indigenous breeding cycles[4]. Thousand of maize scientists are working all over the world for the improvement and development of maize using different breeding techniques. These scientists are interlinked with one another for the exchange of germplasm, not only for their testing in various agro-ecological zones of the word but also provide the scientist best opportunity to select best suited alleles to be incorporated in their own breeding programs. CIMMYT, Mexico is one of the biggest umbrella for exchange of maize germplasm. Choice off an appropriate donor, for desirable alleles is crucial to success of maize breeding program. Pedigree method of breeding, involving selection of desirable and appropriate donor alleles and then its incorporation in maize breeding cycles is commonly used method in commercial maize breeding improvement programs[5,6]. Dudley *et al.*[4] studied 20 improved exotic maize populations as source of favorable alleles and selected 15 of them on the basis of high yield potential and lower cob placement.

The ultimate objectives of the present study was:

- To screen and evaluate the sub-tropical maize germplasm received form CIMMYT, Mexico under Peshawar valley conditions.
- To identify the entries having favorable and desirable donor alleles for various genotypic and phenotypic traits.
- Implication of selected donor alleles in indigenous breeding program, for development of new high yielding, disease resistant and more adoptable maize varieties/hybrids for various agro-ecological zones of NWFP.

Corresponding Author: Tahir Sajjad, House No. C-1, Pakistan Foresty Institute Colony, Peshawar, NWFP, Pakistan

MATERIALS AND METHODS

A set of 28 sub-tropical maize hybrids received from CIMMYT, Mexico (Table 1) were grown at experimental farm of Cereal Crops Research Institute (CCRI), Pirsabak, Nowshera, NWFP Pakistan along with 2 local well established and improved checks during Kharif-2000 growing season. Seed of these 30 entries were sown in plots having two rows, 5 m long 0.75 m apart on hills 20 cm apart, arranged in RCB design with entries replicated three times on July 19, 2000. Initially 2-3 seed were sown per hill and then thinned to one plant per hill at 4-5 leaf stage to get desirable and uniform plant population. Prior to sowing seeds were treated with Confider seed dresser @ 10 gm kg^{-1} seed. Uniform fertilizer doses were applied to all the plots at recommended rate of 200-100-50 kg ha^{-1} fertilizer, in three split doses. Weeds were controlled by spray of weedicide (Primextra), a day after sowing as pre-emergence herbicide @ one liter ha^{-1} followed by frequent hand weeding when required. Irrigations were applied as flood irrigation on need basis. Furadon granules were applied @ 10 kg ha^{-1}, 20 days and 50 days after sowing for the control of maize stem borer.

Data were recorded on days to mid silking, which is time frame between sowing date and date when about half of plants appeared silk. Plant height measured in centimeters, which is distance from soil surface to the base of flag leaf. Cob height also measured in centimeters and is distance from soil surface to the base of lowest cob. Stem and root lodging measured as percent plants lodged in each plot. For estimation of stand count ha^{-1}, number of plants were counted in each plot. Yield data were recorded by harvesting all pre counted cobs and taking their fresh ear weight and moisture percentage by moisture meter. Yields were than adjusted at 15% moisture content.

All the recorded data were statistically analyzed using analysis of various procedure for randomized complete block design, using M-stat C programme and means were then compared using Duncan Multiple Range Test (DMRT), at 5% level of significance[7].

RESULTS AND DISCUSSION

Days to mid silking: It is measure of the time when actual pollination/fertilization of maize takes place and is the measure of duration for crop maturity. For specific agro-ecological zone, silking and maturity periods should correlate cropping patterns. For most of the maize growing areas of NWFP, mid silking from 55 to 60 days is under permissible limits. The number of days taken to mid silking by the germplasm under study (Table 1), showed highly significant differences. Checks (entry no. 29 and 30) and CIMMYT germplasm no. 12 had taken similar, yet significantly lowest no. of days than rest of the entries. Entries no. 26 and 27 had significantly similar days (60.6 and 60.3 days, respectively) under permissible limits while the entries 20 to 25 had days significantly higher than checks yet could be considered while rest of the entries had taken higher days, than permissible range. The tropical and sub-tropical maize germplasm, usually are late in silking and maturity when grown under Peshawar valley conditions[8].

Plant and cob height: Both plant and cob height of entries (Table 1) showed highly significant differences. These differences were not unexpected due to germplasm from varying sources and origin. Taller plants and increased ear height are controlled by dominant alleles[4]. If breeding efforts are directed in improving yield of elite population, selection of wrong accessions should be avoided, that could result in undesirable taller plants with greater ear heights[9]. In most of agro-ecological zones of NWFP, maize heights up to 200 cm with cob placement below 110 cm is desirable character. CIMMYT entries no. 4 and 5 (Table 1) had significantly tallest plants than rest of the entries out of desirable range. Rest of the CIMMYT entries had heights, significantly ad-par with the checks, however some entries had significantly lower plants than checks yet remain under desirable limits. CIMMYT entries no. 4, 5, 13, 11, 3, 19 and 10 (Table 1) had significantly similar among themselves, yet higher cob placement than the checks and are out side the desirable range while rest of all the entries had heights significantly ad-par with checks and are under desirable range.

Plant population: Plant population is an important determinant of grain yield of maize[10]. Plant population of maize is effected by poor germination or removal of plants by attack of various insects/pests and diseases. Plant population of all the entries under present trial (Table 1) remained statistically uniform except entry no. 27 and 28, which has lowest plant population among all the entries. Due to significant differences among the entries, co-variance analysis of yield factor was done, using plant population as co-variate.

Stem and root lodge: Mean comparison values for stem and root lodging of CIMMYT entries along with the checks are presented in Table 2. Significant differences were found between the entries for stem and root lodging, respectively. Entry no. 10, 19 and 11 had significantly highest values for stem lodging, while rest of the entries had statistically similar stem lodging percentages among

Table 1: Hybrid codes, Pedigree and Place of origin of 28 sub-tropical maize germplasm received from CIMMYT, Mexico along with 2 local checks

Entry No.	Hybrid code	Pedigree	Origin
1	CMS 975089	CML 78 X CML 373	TL99B 6118-1 X 2
2	CMS 975281	CML 373 X CML 321	TL99B 6118-3 X 4
3	CMT 975285	[CML 321 X CML 373] X CML 216	TL99B 6118-5 X 6
4	CMT 976273	[CML 312 X CML 314] X CML 216	TL99B 6118-7 X 8
5	CMT 985005	[CML 264 X CML 311] X CML 334	TL99B 6118-9 X 10
6	CMS 975057	CML 374 X CML 384	TL99B 6118-11 X 12
7	CMS 975087	P43SR-139-1-2-3-2-3-B-B X CML 311	TL99B 6118-13 X 14
8	CMS 975063	CML 264 X CML 311	TL99B 6118-15 X 16
9	CMS 975003	CML 78 X CML 373	TL99B 6118-17 X 18
10	CMS 975115	CML 216 X CML 384	TL99B 6118-19 X 20
11	CMS 975117	CML 320 X CML 384	TL99B 6118-21 X 22
12	CMS 975247	CML 375 X CML 311	TL99B 6118-23 X 24
13	CMS 975193	CML 216 X CML 311	TL99B 6118-25 X 26
14	CMS 975293	CMS946375-B-4-2-4-4-1-B X CML 384	TL99B 6118-27 X 28
15	CMS 975295	CML 384 X (CR X 95-041) 1-2-4-4-2	TL99B 6118-30 X 29
16	CMS 975297	CR X 95-041) 1-2-4-4-2 X CML 384	TL99B 6118-31 X 32
17	CMS 975299	CMS 946359-B-5-3-1-1 X CML 384	TL99B 6118-33 X 34
18	CMS 975301	(CRX95-04) 1-2-2-3-1 X CML 384	TL99B 6118-35 X 36
19	CMS 975303	(CRX95-04) 1-2-2-2-1 X CML 384	TL99B 6118-37 X 38
20	CMS 975305	CMS 946359-B-5-1-2-1-1-2 X CML 384	TL99B 6118-39 X 40
21	CMS 975307	(CRX95-04) 1-2-4-4-4 X CML 311	TL99B 6118-42 X 41
22	CMS 975309	(CRX95-04) 4-4-1-3-1 X CML 311	TL99B 6118-43 X 44
23	CMS 975311	CMS946375-B-4-2-1-7-1 X CML 311	TL99B 6118-45 X 46
24	CMS 975313	CMS946375-B-4-2-5-4-2 X CML 311	TL99B 6118-47 X 48
25	CMS 975059	CML 311 X CML 247	TL99B 6118-48 X 6952-2
26	CMS 935005	CML 78 X CML 321	TL99B 6129 1 X 2
27	CMT 985001	[CML 264 X CML 311] X CML 331	TL98B 6139 21 X 22
28	CMT 005001	[CML 78 X CML 373] X CML 387	TL99A 1219-101 X 1223-2
29	Local Check-1	Babar (double cross hybrid)	-
30	Local Check-2	Sarhad White (OPV)	-

Table 2: Days to 50% silk, plant height, cob height and plant population per hectare of 28 CIMMYT maize hybrids along with two local checks

Entry No.	Silking 50% (days)	Plant height (cm)	Cob height (cm)	Population (000 plants/ha)
1	61b-f	168.3e-k	99.0g	53.3a-d
2	60c-f	189.0c-e	96.6fg	54.2a-d
3	63a-c	196.7bc	116.7a-d	57.7ab
4	63a-c	225.0a	125.7a	57.7ab
5	64a-c	212.0ab	122.7ab	57.3ab
6	61b-f	184.0c-g	100.7e-g	56.8a-c
7	63a-c	173.3c-j	104.0d-g	53.7a-d
8	65ab	175.0c-j	95.6fg	53.7a-d
9	63a-c	152.3jk	95.0fg	57.3ab
10	65a	181.7c-h	113.0a-e	51.5b-d
11	63a-c	185.0c-f	116.7a-d	55.1a-d
12	58d-f	187.7c-f	98.6e-g	57.3ab
13	63a-c	195.0b-d	119.0a-c	59.1a
14	65ab	149.0k	93.3fg	56.8a-c
15	65ab	160.0h-k	97.3fg	52.0b-d
16	63a-c	188.3c-e	108.7b-f	54.2a-d
17	66a	157.7i-k	97.6fg	55.5a-c
18	64a-c	161.0g-k	96.7fg	52.8a-d
19	62a-c	190.7c-e	116.3a-d	54.2a-d
20	66a	154.0jk	95.0fg	55.1a-d
21	61b-f	178.0c-i	99.0e-g	57.7ab
22	62a-c	180.3c-i	91.0g	57.3ab
23	60c-f	169.3e-k	100.7e-g	55.5a-c
24	62a-d	164.3f-k	100.0e-g	55.5a-c
25	62a-f	180.0c-i	104.3c-g	56.8a-c
26	62a-d	183.3c-h	93.3fg	56.8a-c
27	63a-c	175.5c-j	98.3e-g	50.6cd
28	64a-c	180.7c-i	106.7c-f	48.8d
29	57f	172.0d-k	96.6fg	53.3a-d
30	58ef	184.0c-g	96.6fg	53.1a-d
LSD (5%)	3.32	19.60	12.65	52.00
C.V.%	3.24	6.72	7.52	5.81

*Means followed by same letters with in each column are statistically similar to each other at 5% level of probability

Table 3: Percent stem lodge, root lodge and grain yield of 28 CIMMYT sub-tropical germplasm (hybrids) along with 2 local checks

Entry No.	Stem lodge (%)	Root lodge (%)	Grain yield (tons ha^{-1})
1	7.3d	3.2ab	4.7a-f
2	0.0d	0.8b	4.9a-f
3	6.1d	0.8b	6.1a-c
4	9.8d	0.8b	6.1ab
5	0.8d	1.2ab	5.7a-d
6	1.6d	2.7ab	5.9a-c
7	6.5d	3.3ab	3.7e-i
8	2.6d	0.7b	4.0d-h
9	0.7d	0.0b	3.9d-i
10	75.4a	0.8b	2.7g-i
11	45.9c	3.0b	2.4hi
12	0.7d	2.3b	6.5a
13	2.8d	2.6b	5.3a-e
14	9.3d	1.9b	3.3f-i
15	5.9d	2.1b	4.1c-i
16	1.7d	3.7a	4.8a-f
17	3.2d	1.3b	2.6g-i
18	0.8d	1.6b	5.0a-f
19	58.7b	2.5b	2.3I
20	2.5d	1.3b	3.3f-i
21	1.5d	2.4b	6.4a
22	3.0d	3.7a	4.4b-g
23	0.8d	0.7b	4.6a-f
24	4.1d	0.7b	5.0a-f
25	5.4d	1.5b	4.0d-i
26	3.8d	2.3b	4.2b-h
27	5.3d	1.8b	3.8d-i
28	2.3d	0.8b	4.8a-f
29	4.7d	2.6ab	4.4b-f
30	2.9d	0.3b	4.5b-g
LSD (5%)	11.16	1.41	1.572
C.V.%	14.57	18.70	11.390

*Means followed by same letters with in each column are statistically similar to each other at 5% level of probability themselves. This very high percent stem lodging for the above entries may be due to genetic factor leading to very weak stems, that could not uphold strong winds during growth periods or they could be severely attacked by stem rust disease present in the area causing stems to lodge near to maturity. These entries are totally discarded. The entries also showed significant differences for root lodging, that could be due to poor root development or due to irrigation of fields at lateral stages causing plants to lodge due to heavy load of plants. Entry no. 16 and 22 had significantly highest percent root lodge while rest of the entries had statistically same root lodging frequencies.

Grain yield: It is most important factor for determination of suitability of germplasm to be selected for further breeding program. Highly significant differences were found among the entries for grain yield. Entry no. 12 (6.5 tons ha^{-1}) and entry no. 21 (6.4 tons ha^{-1}) gave significantly highest grain yield among all the treatments. Among remaining entries 12 entries (Table 3) out yielded the checks in grain yield, 9 entries remain ad-par with the checks while rest of the entries had grain yield significantly lower than the checks. Significant differences in average grain yield is function of dominant gene effects[11] and were considered as favorable source of alleles for improvement of elite maize populations[12].

Recommendations: CIMMYT entry no. 12, has significantly highest yield among all entries and lowest days to 50% silk and its plant and cob height remained under permissible limits and has lowest values for stem and root lodging is recommended to be included in breeding cycles for improvement of elite maize population. Similarly CIMMYT entries no. 21 and 6, as had out yielded checks and their other factors remained under desirable range is also recommended for further breeding programme.

REFERENCES

1. Byerlee, D. and S. S. Hussain, 1986. Maize production in NWFP: A review of technological issues in relation of farmer's circumstances. PARC/CIMMYT, paper no., 38: 1-86.
2. Khan, S. Zada, M. Shafi and M. Arif, 1991. Yield potential of conventional and relay cropping patterns of maize cultivars. Sarhad J. Agric., 7: 437-445.
3. Anonymous, 1995. Agric. Statistics of Pak., Govt. of Pak., Ministry of Food, Agriculture and Livestock, Economic Wing, Islamabad, Pakistan, pp: 107.
4. Dudley, J.W., K.R. Lamkey and J.L. Geadelmann, 1996. Evaluation of populations for their potential to improve three maize hybrids. Crop. Sci. J., pp: 36.
5. Bernardo, R., 1990. Identifying populations useful for improving parents of a single cross based on net transfer of alleles. Theor. Appl. Genet., 80: 349-352.
6. Bernardo, R., 1990a. An alternative statistics for identifying lines useful for improving parents of an elite single cross. Theor. Appl. Genet., 80: 105-109.
7. Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics, a biometrical approach. 2nd Ed., Mc-Graw-Hill Book Co., New York.
8. Anonymous, 2002. Annual Technical Progress Report. Cereal Crops Research Institute (CCRI), Pirsabak, Nowshera, Pakistan, pp: 28-30.
9. Kraja, A. and J.W. Dudley, 2000. Identification of tropical and temperate maize populations having favorable alleles for yield and other phenotypic traits. Crop Sci. J., 40: 941-947.
10. Cardwill, V.B., 1982. Fifty years of Minnesota: Corn production source of yield increase. Agron. J., 74: 984-990.
11. Gamble, E.E., 1962. Gene effects in corn (*Zea mays* L.): Separation and relative importance of gene effects for yield. Can. J. Plant. Sci., 42: 339-348.
12. Trifunovi, S., I. Husi and M. Ivanovi, 1998. Generation means analysis for grain yield from RCBD and new experimental design in maize (*Zea mays* L.). 2nd Balkan symposium on field crops, 16-20 June, Novi Sad, Yugoslavia.