Adaptability and Stability Testing of CIMMYT Maize Hybrids in Sri Lanka

W.M.R. Kumari[1], D.C.S.M.I. Wijewardhana[1], N.A.P.S.G. Upasantha[1], D.M.J.K. Dissanayake[1] and W.M.W. Weerakoon[2]

[1]*Field Crops Research and Development Institute, Maha-Illuppallama, Sri Lanka.*

[2]*Deparment of Agriculture, Peradeniya, Sri Lanka*

INTRODUCTION

Maize is the second most important cereal crop in terms of cultivation extent and production in Sri Lanka. Since 1998, to increase productivity of maize, high-yielding exotic maize hybrids have been introduced to Sri Lanka both by the Department of Agriculture and private companies. With this introduction, productivity gradually increased upto 3600 kg/ha in 2016 (Department of Agriculture, 2017) and as a result, these hybrid varieties became popular among farmers.

First maize hybrid variety named "Sampath" was introduced by the Department of Agriculture in 2004. In 2013, quality protein maize (QPM) hybrid "MI Maize Hybrid 02" was developed from CIMMYT inbred lines recommended for cultivation. The yield of this hybrid is at least 15% higher than the yield of "Sampath" (Kumari *et al.,* 2013).

In the process of variety development, sixteen improved single crosses hybrids received from CIMMYT were evaluated at Field Crops Research and Development Institute Maha-Illuppallama and five promising hybrids were selected for multi-locational trials in 2012 (Anon, 2013). The objective of the study was to identify a superior CIMMYT single cross maize hybrid from those five promising hybrids based on the agronomic performance, ear characteristics, yield adaptability and stability under local conditions.

MATERIALS AND METHODS

Multi-locational variety testing trials of multi-location yield evaluation of five promising CIMMYT hybrids along with two checks (Pacific 339 and MI Maize Hybrid 01) were conducted at three locations i.e, Field Crops Research and Development Institute, Maha-Illuppallama (MI), Grain Legumes and Oil Crops Research and Development Center, Angunakolapelessa (ANK) and Regional Agriculture Research and Development Center, Killinochchi (KILL) during *Maha* 2013/14 and *Yala* 2014.

***** Short Communication***

Experiments were arranged in Randomized Complete Block Design with three replicates. Plants were grown in plot of 5m x 1.2 m at a spacing of 60cm x 30cm and fertilizer was applied at the recommended application rate.

Two best promising hybrids out of five hybrids that are tested at research fields were selected and evaluated against two check varieties in Varietal Adaptability Trials (VAT) at farmer's felid in Anuradhapura and Killinochchi during *Maha* 2014/15. Treatments were arranged in Randomized Complete Block Design with two replicates. The plot size used was 5m x 2.4m. All the trials were managed under irrigated conditions in all locations and yield and other agronomic characters were recorded.

The Analysis of Variance for each location was done by using SAS software and means were compared using Duncan Multiple Range Test. Gene x environment interaction was analyzed using Variance Component method and adaptability and stability parameters (interaction variance) were calculated using the method proposed by Abeysiriwardhana *et al.,* 1991 for multilocation trial data. The deviations of the plot yield from the maximum plot yield in a given environment were computed for VAT data using the methodology proposed by Abeysiriwardhana, 2001.

RESULTS AND DISCUSSION

Multi-locational variety testing trials

The mean grain yield over locations of hybrids, CLQRCYQ59/CLQRCYQ49 and CML451/CL02450 showed comparable yield with the commercial check hybrid Pacific 339 during *Maha* 2013/14 (Table 1). The maize yield of trials conducted in both Maha-Illuppallama and Killinochchi research fields ranged between 4.85–9.61t/ha. In general, the average grain yield of trials conducted at Angunakolapellessa was less than the yield observed in other two stations and the yield of Pacific 339. However, trials of CLQRCYQ59/49 and CLQRCYQ 59/CML161 conducted in Angunakolapelessa exhibited a higher yield than the Pacific 339 during *Yala* 2014 (Table 1).

Indicating a higher adaptability, the recorded mean deviation value of the promising hybrid CLQRCYQ59/49 and CML451/CL02450 exhibit positive values. Further, CML451/CL02450 showed non-significant gene x environment interaction. Hence it was stable over the environments during *Maha* 2013/14 (Table 1) indicating better adaptability during *Yala* 2014. The highest mean deviation value was exhibited by CLQRCYQ59/49 and CLRQCYQ59/CML161. However, CLQRCYQ59/49 was the only stable hybrid with non significant stability parameter over locations during *Yala* 2014 (Table 1).

Other Agronomic characters of promising hybrids

Days to flowering of all the hybrids were mostly similar. Therefore, The harvesting of all hybrids was done 105-110 days after sowing. The plant height of CML451/CL02450 and CML451/CLQRCYO17 were shorter as compared to other hybrids. The highest ear length was observed in MI Maize Hybrid 01. All the other hybrids showed the similar ear length. However, ear circumference was higher in CML451/CL02450, Pacific 339 and MI Maize Hybrid 01. Ear shape is cylindrical in CML451/CL02450 and Pacific 339 with semi flint seed texture (Table 2). Hence external ear appearance is similar in both hybrids (Figure 1).

Considering the yield potential and the agronomic characteristics, CML451/CL02450 and CLQRCYQ59/CLQRCYQ49 were selected for the farmer's field adaptability trials.

Farmer's adaptability trials

The evaluation of farmer's field trials revealed that the promising hybrid CML451/CL02450 produces comparable grain yield with commercial hybrid in all three locations. The yield deviation as well as the yield variance (during *Maha* season) are low in this variety (Table 3). The gene by environment interaction showed that two tested hybrids were stable as the interaction variance was non-significant. The highest adaptability with least deviation value from the maximum plot yield was shown by exotic hybrid.

Table 1. Mean grain yield, adaptability parameter and stability parameter of five promising maize hybrids and two check hybrids evaluated in multi-locational trials during *Maha* 2013/14 and *Yala* 2014

Entry	Mean grain yield t/ha *Maha* 2013/14			Mean grain yield t/ha *Yala* 2014			Mean grain yield locations (t/ha)		Mean deviation over locations (Adaptability parameter)		GxE Interaction variance (stability parameter)		Adaptability rank	
	MI	KILL	ANK	MI	KILL	ANK	2013/14	2014	2013/14	2014	2013/14	2014	2013/14	2014
CML451 / CL02450	7.37^{a}	7.63^{bc}	3.1^{a}	5.94^{b}	4.23^{bc}	3.17^{ab}	6.03^{ab}	4.45^{b}	0.28	-0.32	0.088	0.10*	3	3
CLQRCYQ 59 / CLQRCYQ 49	6.97^{a}	9.61^{a}	4.04^{a}	6.86^{a}	5.89^{b}	4.47^{a}	6.87^{a}	5.74^{a}	0.98	0.97	0.354*	0.01	1	2
CLQRCYQ 59/ CML161	4.85^{b}	6.13^{cd}	4.13^{a}	7.19^{a}	7.07^{a}	4.45^{a}	5.04^{d}	6.24^{a}	-0.79	1.47	0.502*	0.10*	8	2
CLQRCYQ 71 / CLQRCYQ49	6.03^{ab}	6.94^{cd}	3.42^{a}	4.86^{c}	2.82^{c}	2.75^{bc}	5.46^{cd}	3.47^{b}	-0.092	-1.3	0.089	0.23*	6	6
CML 451 /CLR-CYO 17	6.67^{a}	6.75^{cd}	4.14^{a}	4.43^{c}	5.50^{b}	3.67^{ab}	5.85^{bcd}	4.53^{b}	-0.03	-0.24	0.11	0.26*	5	3
MI Maize H 01	6.69^{a}	6.08^{d}	2.89^{a}	7.89^{a}	7.75^{a}	4.11^{a}	5.22^{dc}	6.58^{a}	-0.5544	1.81	0.186	0.41*	7	1
Pacific 339	7.23^{a}	8.76^{ab}	3.21^{a}	3.89^{d}	5.03^{b}	2.75^{bc}	6.4^{ab}	3.89^{b}	0.9144	-0.88	0.043	0.25*	2	7
CV%	12%	11%	29%	11%	25%	23%	14%	20%	14%	20%				

Mean values with same letter were not significantly different at $p<0.05$
*Stability parameter significant at $P<0.05$
GXE – Genotype by environment interaction

Table 2. Seasonal mean and standard error of other agronomic characters measured *Maha* 2013/14 and 2014 at Maha-Illupallama

Character	Days to 50% male flowering	Days 50% female Flowering	ASI*	Plant Height cm	Height to ear cm	Tassel length cm	Shelling %	No. of bad husk	No. of rows	Length of ear cm	Ear circum-ference cm	1000 grain weight g	Ears per plant	Seed texture	Ear shape
CML 451/CL0 2450	55± 1.5	58± 1.0	3± 0.5	162±13.6	68± 6.7	41± 3.3	84± 0.7	1± 0.3	15± 1.0	18± 1.0	17± 0.5	331± 0.5	1.0±0.0	Semi flint	Cylindrical
CLQRCYQ59/ CLQRCYQ 49	53± 1.3	56± 1.0	3± 0.4	182±17.0	79± 6.1	42±4.5	85±0.33	2±0.9	14± 0.0	17± 1.0	15± 0.5	287± 9.5	1.2±0.1	Flint	Conical
CLQRCYQ 59 / CML161	52± 1.9	56± 1.8	3± 0.3	164±10.2	70± 3.5	42± 3.8	85± 0.2	2± 0.3	15± 1.0	16± 1.5	14± 0.0	246±34.0	1.2±0.0	Flint	Conical
CLQRCYQ71/ CLQRCYQ49	55± 0.5	58± 0.3	4± 0.3	170±19.3	70± 8.9	38± 1.8	80± 0.6	2± 0.3	13± 1.0	17± 1.0	15± 0.5	293±18.0	1.1±0.1	flint	Conical
CML 451/CLR-CYO 17	55± 1.2	57± 1.2	3± 0.3	159±16.3	66± 5.4	39± 3.4	84± 1.2	1± 0.6	15± 1.0	18± 0.0	15± 0.0	300± 1.5	1.2±0.1	flint	Cylindrical
MI Maize H 01	54± 1.1	57± 0.9	3± 0.6	177±14.2	86± 7.2	43± 4.0	79± 0.6	3± 0.7	15± 1.0	20± 0.5	16± 0.0	310± 1.5	1.0±0.0	flint	Conical
Pacific 339	54± 0.9	56± 0.8	2± 0.3	166± 7.7	81± 2.7	41± 1.9	89± 0.3	0± 0.3	14± 0.0	18± 0.0	17± 0.5	333±19.5	1.0±0.0	semi flint	Cylindrical

*-ASI- Anthesis Silking Interval

Figure 1: Harvested ears of promisisng maize hybrids and exotic check hybrid

Table 3. Mean grain yield, deviation from maximum plot yield (adaptability parameter) and stability parameter (interaction variance) of maize hybrids evaluated during Maha 2014/15

Entry	Mean yield t/ha			Mean yield over locations	Deviation from the maximum Plot yield	GxEinteraction variance
	Anuradhapura- 1	Anuradhapura- 2	Kill-inochchi			
CML451/CL02450	5.18^{ab}	6.94^{ab}	4.56^{a}	5.56^{ab}	1.19^{ab}	0.593^{ns}
CLQRCYQ59x CLQRCYQ 49	4.55^{b}	6.60^{ab}	4.47^{a}	5.20^{b}	1.54^{a}	0.770^{ns}
MI Maize Hybrid 01	4.78^{b}	6.31^{b}	4.20^{a}	5.10^{b}	1.65^{a}	0.825^{ns}
Pacific 339	6.08^{a}	7.55^{a}	5.34^{a}	6.32^{a}	0.43^{b}	0.213^{ns}
CV%	10	9.80	19		13	

Mean values with same letter were not significantly different at Probability <0.05
GXE – Genotype by environment interaction, ns – non- significant at Probability<0.05

CONCLUSIONS

Based on the yield stability and other important ear characteristics,CML451/CL02450 was nominated to the Varietal Release Committee, 2016. It was released as MI Maize Hybrid 2 as a CIMMYT introduction.

ACKNOWLEDGEMENT

The NCVT and VAT collaborators for maize hybrids trials conducted during 2013/14, 2014 and 2014/15 were greatly acknowledged. Collaborators of multilocational varietal trial and variety adaptability trials for maize hybrids conducted during 2013/14, 2014 and 2014/15 were greatly acknowledged.

REFERENCES

Abeysiriwardhana, D.S. de Z., G.R. Buss and P.F. Reese Jr. 1991. Analysis of Multi-environmental yield trials for testing adaptability of crop genotypes. Tropical Agriculturist. 147: 86-97.

Abeysiriwardhana, D.S. de Z. 2001. Statistical Analysis on farm yield trials for testing adaptability of rice. Euphytica. 121: 215-222.

Anon. 2013. Annual Research Report. Field Crops Research and Development Institute, Mahailluppallama. Department of Agriculture: 162.

Department of Agriculture. 2017. AgStat, Pocket book of agriculture statistics. Socio economic and planning center, Department of Agriculture, Sri Lanka: 16.

Kumari, W.M.R., G.A. Gunawardhana, A.M. Perera, H.M.S. Bandara and S.S. Paththinige. 2013. Evaluation of Quality Protein Maize (Opeque 2) as substitutes for conventional Maize Cultivars in Sri Lanka. Annals of the Sri Lanka Department of Agriculture. 15: 37-49.