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Adaptability of promising CIMMYT maize hybrids across diverse maize growing environments in Sri Lanka

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Abstract

Maize is the most important cereal crop mainly grown as a rainfed upland crop in the Dry zone of Sri Lanka. Introduction of CIMMYT maize hybrids to local farmers can increase the availability of varieties with high yield potential and enhanced nutritional quality and environmental adaptability. Hence, introducing drought tolerant maize hybrids is vital for maize based cropping systems where unexpected intermittent drought is experienced even in rainy seasons. Testing adaptability and stability of CIMMYT drought tolerant single cross maize hybrids and selection of promising hybrids were carried out in multi-environmental trials conducted in maize growing areas in 2016, 2017 and 2018. A method where grain yield deviation of each variety from environmental mean in each environment was calculated to test adaptability and stability of varieties across environments. The maize hybrids, namely, VH112926, VH12264 and VH12263 were finally selected as the most adaptable and stable hybrids over diverse environments where they recorded an average yield of 5.81 to 5.95 t/ha with desirable ear characteristics. The selected hybrids showed 0-3 days of anthesis-silking interval, uniform ears, uniform color, better grain filling and good husk cover which are of highly concerned by maize farmers in Sri Lanka.

Key words: Adaptability and stability, Drought tolerant, Maize hybrids, Sri Lanka

Introduction

Maize is an imperative cereal in terms of the livelihood of Dry zone rain fed farmers covering second largest cereal extent in Sri Lanka. Maize is mainly used as an animal feed and a fodder while a small percentage is used for human consumption. Globally, 15-20% maize yield is lost each year due to drought (FAOSTAT, 2010). The regular occurrence of drought due to various atmospheric phenomenon causes severe yield losses in major maize growing areas, particularly rain-fed uplands in the Dry zone of Sri Lanka (Abeysekara, 2017). As a result, maize cultivation extent has reduced by 21% in 2017 (52,544 ha) compared to that of in 2016 (67,189 ha) (Agstat, 2018).

CIMMYT (International Maize and Wheat Improvement Center) has made a significant contribution towards productivity improvement of maize in sub-Saharan Africa, Asia and Latin America by developing and deploying climate smart maize varieties. Research programs are being continued at CIMMYT with maize germplasm for drought and heat stress tolerance, and to incorporate those trait into breeding lines (Cairns *et al*., 2013). Farmer participatory research has proven that new climate resilient CIMMYT maize varieties recorded a 20-25% greater yield than already cultivated commercial varieties under drought stress and low input conditions in Eastern and South Africa (Cairns and Prasanne, 2018).

Deploying CIMMYT maize hybrids in Sri Lanka opened avenues for local farmers to make use of high yielding varieties with enhanced nutritional quality and drought tolerance ability. Two maize hybrids developed from CIMMYT inbred lines, CML161/CML194 and CML451/CML286 (CL02450) were officially released as MI Maize Hybrid 01 and MI Maize Hybrid 02 in 2013 and 2016, respectively by the Department of Agriculture, Sri Lanka (Bentota, 2013; Kumari *et al*., 2018). The research collaboration between CIMMYT and the Department of Agriculture, Sri Lanka has focused on introduction and commercialization of high yielding stress resilient maize hybrids through adaptability testing across different agro-ecological zones where frequent intermittent drought periods are experienced even during rainy season.

The selection of the most adaptable and stable hybrids with comparatively higher yield potential under optimum growing condition is prime importance as high yielding imported maize hybrids dominate in the local seed market (Pandey and Koilara, 2017). A commonly used strategy at CIMMYT for drought stress breeding is to select single cross hybrids with short Anthesis- silking interval under drought stress with good yield potential under non-stress conditions (Magorokosho *et al*., 2003). Further selection under optimum growing conditions can also increase the performance in sub-optimum conditions (Russel, 1984). Therefore, objective of the present study was to test the adaptability and stability of maize hybrids developed by CIMMYT from drought tolerant inbred lines in multi-locational trials and selecting the most adaptable and high yielding hybrid/hybrids for maize farmers in Sri Lanka.

Materials and methods

Experimental location

A multi-locational field experiment was conducted during four consecutive seasons (*Maha* 2015/16, *Yala* 2016, *Maha* 2016/17, *Yala* 2017 and *Maha* 2017/18) from October 2015 to February 2018 at seven experimental locations (Table 1). The seven locations represented four different agro-ecological regions of Sri Lanka (Punyawardane *et al*., 2008). The distinct difference between the two cropping seasons is rainfall. *Maha* is the main cropping season receiving rains from the North-East monsoon with the seasonal rainfall ranging from 300 to 800 mm depending on the location (Panabokke and Punyawardane, 2009). In contrast, *Yala* is the minor cropping season with comparatively lower seasonal rainfall of 100-400 mm from the South-West monsoon.

Experimental treatments and design

Twelve CIMMYT drought tolerant single cross maize hybrids along with standard check hybrids were evaluated in the selected sites in *Maha* 2015/16 (October 2015-February 2016) and in *Yala* 2016 (April 2016-July 2016) seasons. Subsequently five hybrids were selected and evaluated in multi-locational trials in *Yala* 2017 (April 2017-July 2017) and *Maha* 2017/18 (October 2017-February 2018) seasons. The plot size was two rows of 5 m in length and 1.2 m in width with between and within raw spacing of 0.6 m and 0.3 m, respectively. Each experiment was laid out in a Randomized Complete Block Design with two replications. Trials were managed under irrigated condition both at research stations and farmers' fields (Table 1). Fertilizer was applied at sowing (100 kg/ha of Urea, 50 kg/ha of Muriate of Potash and 100 kg/ha of Triple Super Phosphate) and at four to five weeks after sowing (250 kg/ha of Urea) as a top dressing. Weeding was done manually and insect pests were controlled by chemicals. Mature and dried cobs were harvested at 105-110 days after sowing.

Table 1. Details of locations and seasons of the multi-locational trials conducted in the study

Season	Number of entries	Location *	Location abbreviation	Agro ecological zone**	Coordinates
Maha 2015/16	12 +3 checks	FCRDI, Mahailluppallama	MI	DL 1b	8.07° N, 80.28° E
		ARS, Thiruneveli, Jaffna	TH	DL 4	9.66° N, 80.02° E
		Parasangaswewa -Anuradhapura	AN 1	DL 1b	8.16^{0} N, 80.40 E
Yala 2016	12 +3 checks	FCRDI, Mahailluppallama	MI	DL 1b	8.07° N, 80.28° E
		GLORDC, Agunakolapalasse	AK	DL 1b	6.44° N, 81.02° E
Yala 2017	5 + 3 checks	FCRDI, Mahailluppallama	MI	DL 1b	8.07° N, 80.28° E
		ARS, Thiruneveli, Jaffna	TH	DL 4	9.40^{0} N, 80.02^{0} E
		GLORDC, Agunakolapalasse	AN	DL 1b	6.08^{0} N, 80.54^{0} E
		Rajanganaya -Anuradhapura	AN2	DL 1b	8.26^{0} N, 80.25^{0} E
		Nachchiyaduma -Anuradhapura	AN3	DL 1b	8.16^{0} N, 80.40 E
		Vavuniya	VV	DL 1f	8.75° N, 80.49° E
Maha 2017/18	5 + 3 checks	FCRDI, Mahailluppallama	MI	DL 1b	8.07° N, 80.28° E
		GLORDC, Agunakolapalasse	AK	DL 1b	6.08^{0} N, 80.54^{0} E
		Monaragala	MO	IL 1c	6.75° N, 81.25° E

FCRDI - Field Crops Research and Development Institute, GLORDC - Grain Legumes and Oil crops research and development Center, ARS - Agriculture Research Station (Punyawardhana et al., 2003)*

Data recording and analysis

A total of eight agronomic traits were measured. Days to 50% tasseling and silking, anthesis-silking interval (ASI, in days) were recorded in plot basis while plant characteristics; plant height at flowering (cm), height to upper most ear (cm) and tassel length (cm) were measured in four randomly selected plants in a plot and ear characteristics; ear length (cm), number of seed rows per ear, and ear aspects (score of 1-5: 1- very bad, 5- very good) were measured from randomly selected three ears from each plot after harvesting. Grain yield of whole plot of 5 m x 1.2 m along with grain moisture (%) were recorded and adjusted to 14.5%.

The data were subjected to parametric analysis using the General Linear Model (PROCGLM) in Statistical Analysis Software (SAS), Version 9.0. Analysis of variance was done for yield to estimate variety effect and variety x environment interaction effect (GE). Descriptive statistics were obtained for other agronomic characteristics by using MINITAB 14 software. Means were separated using Duncan's Multiple Range Test at $p = 0.05$.

When the same set of hybrids was tested in several locations in different seasons, a location x season combination was considered as an environment. Adaptability and stability of maize hybrids were statistically analyzed following the method proposed by Abeysiriwardena *et al*. (1991). Anputhas *et al*. (2011) also successfully used this method in testing adaptability of rice over diverse environments calling it as environment-centered yield in two-way ANOVA model. In this method, deviation is the difference between plot yield of the genotype from environmental mean in each environment and mean of these deviations over environments was the mean deviation parameter (D) (Equation 1). Stability parameter (S^2) is the variance of genotypic deviations across environments (Equation 2). The most adaptable genotypes are those with significantly higher positive mean deviation and non-significant S^2 across environments. The most stable genotypes are selected solely based on non-significant S^2.

$$D_i = \frac{\sum_{i=1}^{n} \overline{d_{ij}}}{n} \qquad \text{(Eq. 1)}$$

$$S^2_i = \frac{\sum_{j=1}^{n} d^2_{ij} - \frac{\left(\sum_{j=1}^{n} d_{ij}\right)^2}{n}}{q(n-1)} \qquad \text{(Eq. 2)}$$

Where:
D_i - Mean deviation parameter- (Mean deviation of the ith genotype across environments), S^2 -Stability parameter - (Variance of genotypic deviations across environments), d_{ij}.- Plot deviation (difference between plot yield of ith genotype in jth environment and mean yield of jth environment), n - number of environments and q - number of replications within an environment.

Results and discussion

Multi-environmental trials conducted in *Maha* 2015/16 and *Yala* 2016

Significant differences were observed in grain yield among the tested hybrid varieties ($P<0.05$) in the combined analysis of variance over five growing environments where location x season was considered as an environment. Further, the variety x environment (VE) interaction was found to be not significant (Table 2). Although the VE interaction was not significant, S^2 for each hybrid was calculated as there is a possibility of masking of some significant VE interaction effects due to average effects of non-significant interactions as the total number of hybrids used was as high as fifteen. Flavia *et al*. (2012) reported that selection of maize varieties is challenging when presence of VE interaction which can hinder the precise selection. However, in the present study variety selection is not challenging as the GE interaction is not significant on the average and varieties can be selected solely based on mean deviation parameter.

Table 3, illustrates average grain yield of hybrids in each environments and their mean across environments. The grain yield of hybrids varied among environments from 3.54 t/ha at MI in *Maha* 2015/16 to 8.01 t/ha at AK in *Yala* 2016. However, mean yield of hybrids across environments ranged from 4.06 t/ha to 6.51/ha. The standard check 3 (MI Maize hybrid 02) and standard check 2 (imported hybrid) showed the lowest and highest mean grain yield, respectively across environments. Among the tested CIMMYT hybrids, VH112926 showed significantly the highest positive mean deviation parameter with a mean grain yield of 5.56 t/ha across environments. Although, this is the only hybrid showed significant S^2 among all the hybrids in the test., it was selected for its specific adaptability as it has given the highest grain yields in *Maha* 2015/16 at MI and TH where the best standard check has given much lower yields than that of this hybrid. Among the rest of the hybrids, VH12263, VH12264, VH1210 and VH10490 showed positive D values with non-significant S^2 indicating that they are comparatively more adaptable and stable hybrids over maize growing environments. Hence, five CIMMYT hybrids were selected for further evaluation in multi-environmental trials.

Table 2. Combined Analysis of variance for grain yield deviations of maize hybrids evaluated in multi-environmental trials

Source of variation	DF	MS	F Probability
Blocks (Environment)	5	4.23	0.0003
Variety	14	2.12	0.0028
Variety × Environment	56	1.01	0.1346
Error	70	0.77	

Morphological characteristics

All hybrids were medium duration hybrids with days to flowering ranging from 55-62 days and can be harvested within 105-115 days after planting (Table 4). This crop duration is ideal for both cultivation seasons in Sri Lanka where, rainy *Maha* season runs from the end of September to February in following year and relatively drier *Yala* season runs from the end of March to August in the same year. The maize hybrids showed minimum anthesis-silking interval which was 0-3 days as trials were conducted under supplementary irrigation.

Table 3. Grain yield deviation, Grain yield (t/ha) (within parenthesis), mean yield, mean deviation (D) and variance in deviation (S^2) across environments of promising maize hybrids evaluated in multi-environmental trials in *Maha* 2015/16 and *Yala* 2016

Entry	Environments					Mean yield	Deviation	
	MI, 2016	**AK, 2016**	**AN1, 2015/16**	**MI, 2015/16**	**TH, 2015/16**		**Mean ** (D)**	**Variance (S^2)**
VH12105	-0.87 (3.95)	-0.3 (5.42)	0.44 (5.8)	-1.16 (3.54)	0.75 (6.16)	4.97[bc]	-0.21[bc]	1.35
VH1210	0.54 (5.36)	-0.18 (5.9)	0.64 (6.00)	-0.10 (4.60)	0.12 (5.53)	5.48[bc]	0.27[bc]	0.19
VH12177	-0.04 (4.78)	-0.18 (5.90)	0.00 (5.36)	-1.05 (3.65)	-0.62 (4.79)	4.90[bc]	-0.31[bc]	0.53
VH12263	-0.62 (4.20)	-0.54 (5.18)	-0.31 (5.05)	0.55 (5.25)	1.16 (6.57)	5.25[bc]	0.05[bc]	1.2
VH12264	-0.69 (4.13)	0.76 (6.48)	0.64 (6.00)	-0.50 (4.21)	1.08 (6.49)	5.46[bc]	0.26[bc]	1.27
VH125	0.48 (5.3)	-0.14 (5.58)	0.01 (5.35)	-0.18 (4.53)	-0.38 (5.04)	5.16[bc]	-0.04[bc]	0.21
VH112888	-0.03 (4.79)	-0.20b (5.52)	0.09 (5.45)	-0.65 (4.05)	-0.38 (5.04)	4.97[bc]	-0.23[bc]	0.17
VH112926	-0.11 (4.71)	-0.84 (4.88)	-1.01 (4.35)	2.16 (6.86)	1.57 (6.98)	5.56[b]	0.35[b]	4.12*
VH112944	-0.54 (4.28)	-0.54 (5.18)	0.43 (5.79)	0.00 (4.70)	-0.02 (5.39)	5.07[bc]	-0.13[bc]	0.34
VH10490	0.97 (5.79)	0.09 (5.81)	0.36 (5.72)	-0.02 (4.69)	-0.65 (4.77)	5.35[bc]	0.15[bc]	0.69
VH123014	0.36 (5.18)	-0.02 (5.70)	-1.30 (4.06)	0.43 (5.14)	-0.14 (5.28)	5.07[bc]	-0.13[bc]	0.97
VH112497	-0.64 (4.18)	-0.99 (4.73)	-1.04 (4.32)	0.08 (4.78)	-0.28 (5.13)	4.63[bc]	-0.58[bc]	0.45
Std.check 1	0.14 (4.96)	0.53 (6.25)	-0.21 (5.15)	0.21 (4.91)	-1.39 (4.03)	5.06[bc]	-0.14[bc]	1.1
Std.check 2	1.50 (6.32)	2.30 (8.01)	1.93 (7.29)	0.67 (5.37)	0.17 (5.58)	6.51[a]	1.31[a]	1.56
Std.check 3	-0.46 (4.36)	-0.45 (5.27)	-0.67 (4.69)	-0.44 (4.27)	-1.01 (4.41)	4.6[c]	-0.6[c]	0.12
CV%	18	15	11	20	19	16		
Environmental mean	**4.82**	**5.72**	**5.36**	**4.70**	**5.41**			

*Std. check 1 - MI Maize Hybrid 01, Std. check 2- Imported. maize hybrid, . Std. check 3 - MI Maize hybrid 02 ** Mean deviations values with the same letter are not significant at 0.05 level of probability * Significant at 0.05 level of probability.*

The tassel length of hybrids varied from 32 cm to 48 cm. Parvez (2007) reported that even though the smaller tassels lead to higher yields, maize hybrids with longer and larger tassels are selected for stress environments to ensure adequate pollen availability. VH112497, VH12264 and VH12177 showed relatively lower tassel length. Longer ear is an attractive characteristic when introducing new hybrid to farmers. Except VH121056 and VH125, other hybrids showed 19-22 cm of ear length. Anjorin and Ogunniyan (2014) reported that ear length was correlated with the number of seed rows and plant height. They have further observed a strong positive association of ear length with grain yield.

Table 04. Average measurements of morphological characteristics over locations of CIMMYT maize hybrids evaluated at FCRDI, Mahailluppallama in *Yala* 2016 and ARS, Thirunneveli in *Maha* 2015/16

Hybrid	Characteristics ± SD									
	DT days	DS days	ASI days	PH cm	EH cm	TL (cm)	EL cm	SR (No)	ST	EA (score)
VH12105	58±1	59±1	2.0±0	159±39	70±21	35±2	19.7±1.5	14	SF	3
VH1210	57±1	58±1	1.5±0.5	154±32	74±18	44±1	20±1.7	16	SF	3
VH12177	57±2	59±1	3.0±1	163±27	75±12	36.5±0.5	20.3±1.2	16	SF	3
VH12263	58±2	60±2	3.0±0	170±41	90±22	41.5±0.5	20.3±2.1	16	SF	5
VH12264	57±2	59±3	2.5±1.5	157±40	64±21	36.5±0.5	20.7±0.6	16	SF	5
VH125	58±2	60±1	2.0±0	159±24	76±15	42±2	18.7±1.2	14	SF	3
VH112888	57±1	60±2	4.0±0	159±30	72±16	39.5±6.5	20.3±2.1	14	F	3
VH112926	58±1	60±2	3.0±1	161±29	60±15	41.5±1.5	20.3±2.1	12	SF	4
VH112944	57±1	59±2	2.5±1.5	172±31	70±19	42.5±0.5	20±2.6	18	SF	4
VH10490	56±1	58±1	2.0±0	164±30	68±9	44±2	16.3±0.6	14	F	3
VH123014	57±1	59±1	1.5±0.5	160±29	61±15	45.5±2.5	19.7±2.1	16	F	4
VH112497	55±2	57±2	1.5±0.5	169±36	87±24	34±2	19±1.7	14	SF	3
MIMZ Hy01	58±2	60±2	2.0±0	164±31	75±21	38±2	20.7±3.2	14	SF	4
Imported maize hy.	58±3	60±2	3.5±0.5	152±17	71±8	42.5±0.5	20±1	14	SF	5
MIMZ Hy02	58±2	60±1	3.0±0	144±28	57±18	42±0	20±1	16	SF	4

DT -Days to 50% Tasselling, DS -Days to 50% Silking, PH-Plant Height (cm), EH -Height to Ear (cm), TL-Tassel Length (cm), SR - No. of Seed Rows, , EA- Ear Aspect (1-5 core:1-very bad and5 - very good), ST-Seed Texture; F-flint, SF - Semi Flint, EL - Ear Length, ASI - Anthesis-Silking Interval, SE - Standard Error of mean.

Tested hybrids were almost similar in plant height but with a high standard deviation across the environments. Score of ear aspects indicates the uniformity of ear, grain filling and pest and disease infections (CIMMYT, 1985). Eight hybrids showed comparatively higher score of 4 and 5 representing better ear aspects of hybrids. The better ear score of new hybrids is important as farmers often used to make judgment of new varieties initially based on ear score.

Other agronomic characteristics become particularly useful in breeding programs as the direct selection on yield is difficult due to inconsistent environmental factors affecting grain yield. The grain yield traits are often associated with other agronomic characteristics. The five hybrids that showed comparatively higher adaptability also showed acceptable ear aspects. Therefore, those five maize hybrids were selected for further evaluation.

Multi-environmental trials conducted in *Yala* 2017 and *Maha* 2017/18

In the combined analysis of variance for grain yield deviation of five promising hybrids selected from the previous test and standard checks (Table 5), VE interaction was found to be not significant indicating that different varieties responded the same to different environments so that stability of all five hybrids across environments was the same. However, the variety effect was found to be significant so that varieties could be selected solely based on mean deviation parameter. The standard check 2 (imported hybrid) showed comparatively higher yields across environments and the highest D value indicating that this is the most adaptable hybrid in the test (Table 6). This is confirmed by the fact that this is the most popular hybrid among the local farmers at present. Among the new set of tested hybrids, VH12264, VH112926 and VH12263 showed positive D values and average grain yield across environments ranging from 5.81 to 5.95 t/ha. However, both local standard check hybrids (MI Maize Hybrid 01 and 02) recorded negative mean deviations. Finally, VH12264, VH112926 and VH12263 were selected as the most adaptable maize hybrids developed by CIMMYT from drought tolerant inbred lines with comparatively higher yield performance over local standard maize hybrids.

Table 5. Combined analysis of variance for grain yield deviations of maize hybrids evaluated in multi-environmental trials

Source of variation	DF	MS	F probability
Environments	8	0.01	1.000
Block (Environments)	9	3.30	0.0016
Variety	7	6.01	0.0001
Variety x environment	55	1.31	0.1093
Error	62	0.949	

Table 6. Grain yield deviation and Grain yield (t/ha) (within parenthesis), mean yield, mean deviation (D) and variance in deviation (S^2) across environments of promising CIMMYT hybrids evaluated in multi-environmental trials at different locations in *Yala* 2017 and *Maha* 2017/18

Hybrid	Environments									Mean yield	Deviation	
	MI 2017	AK 2017	TH 2017	VV 2017	AN2 2017	AN3 2017	MI 2017/18	AK 2017/18	MO 2017/18		Mean(D)**	Variance (S^2)
VH 101490	-0.51 (4.1)	1.98 (5.7)	-1.68 (4.3)	-0.38 (4.2)	-0.2 (4.1)	NE	0.71 (7.3)	0.93 (7.5)	-0.56 (5.2)	5.30^{bc}	-0.46^{bc}	1.8
VH 112926	-0.7 (3. 9)	1.07 (8.8)	0.35 (6.3)	-0.03 (4.6)	-0.74 (3.5)	0.18 (6.3)	0.43 (7.0)	-0.36 (6.2)	0.27 (6.0)	5.85^{b}	0.05^{b}	0.6
VH 12264	0.07 (4.7)	-0.21 (7.5)	0.02 (6.0)	0.19 (4.8)	-0.16 (4.1)	0.24 (6.3)	-0.39 (6.2)	0.15 (6.7)	0.25 (6.0)	5.81^{b}	0.02^{b}	0.09
VH 12263	-0.94 (3.7)	-0.25 (7.5)	0.76 (6.7)	0.23 (4.8)	0.33 (4.6)	0.46 (6.6)	1.1 (7.7)	-0.55 (6.0)	0.27 (6.0)	5.95^{b}	0.16^{b}	0.72
VH 1210	-1.00 (3.6)	-0.65 (7.1)	0.49 (6.4)	-0.59 (4.0)	-2.07 (2.2)	-0.62 (5.5)	-1.88 (4.7)	0.6 (7.2)	-1.04 (4.7)	5.05^{c}	-0.75^{c}	1.45
Std. Check 1 MI MZ Hy 01	0.16 (4.8)	-0.97 (6.7)	-0.6 (5.3)	-0.06 (4.6)	0.09 (4.4)	-0.12 (6.0)	0.71 (7.3)	0.01 (6.6)	-0.63 (5.2)	5.64^{bc}	0.16^{bc}	0.45
Std. Check 2 Imported hyb.	2.11 (6.7)	2.64 (10.4)	0.64 (6.6)	0.68 (5.3)	2.63 (6.9)	0.11 (6.2)	1.29 (7.9)	-0.39 (6.2)	1.37 (7.2)	7.03^{a}	1.23^{a}	2.06
Std. Check 3 MI MZ Hyb 02	0.82 (5.4)	0.34 (8.1)	0.02 (6.0)	-0.03 (4.6)	0.14 (4.4)	-0.24 (5.9)	-1.96 (4.6)	-0.39 (6.2)	0.06 (5.8)	5.66^{bc}	-0.14^{bc}	1.04
Environmental mean	**4.59**	**7.72**	**5.94**	**4.61**	**4.27**	**6.1**	**6.58**	**6.58**	**5.78**			
CV%	27	6	16	26	24	16	18	8	11	17		

*NE- not evaluated. * Significant at 0.05 level of probability. ** Mean deviation values with the same letter are not significantly different at 0.05 level of probability*

Conclusion

Based on adaptability and stability tests conducted in Sri Lanka, the CIMMYT maize hybrids; VH12263, VH12264 and VH112626 were selected out of 12 hybrids tested as highly adaptable hybrids under Sri Lankan conditions. Other agronomic characteristics such as minimum anthesis-silking interval (0-3 days), ears with uniform size and color, better grain filling up to tip of the ear and good husk cover were also considered in selecting varieties.

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