Grain yield stability of early maize genotypes

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ABSTRACT

The objective of this study was to estimate grain yield stability of early maize genotypes. Five early maize genotypes namely Pool-17, Arun1EV, Arun-4, Arun-2 and Farmer's variety were evaluated using Randomized Complete Block Design along with three replications at four different locations namely Rampur, Rajahar, Pakhribas and Kabre districts of Nepal during summer seasons of three consecutive years from 2010 to 2012 under farmer's fields. Genotype and genotype × environment (GGE) biplot was used to identify superior genotype for grain yield and stability pattern. The genotypes Arun-1 EV and Arun-4 were better adapted for Kabre and Pakhribas where as pool-17 for Rajahar environments. The overall findings showed that Arun-1EV was more stable followed by Arun-2 therefore these two varieties can be recommended to farmers for cultivation in both environments.

Key words: Early maize genotypes, grain yield, stability

INTRODUCTION

Maize (*Zea mays* L.) is grown under diverse cropping pattern and environments in the hills and Terai. The cropping pattern exists there are maize-wheat, maize-barley, maize-potatoes, maize-fallow and farmers use shorter duration of maize varieties (80-90 days) to catch the winter and spring crops. The productivity of maize in mid and far western region is below the national average. The adoption rate of improved maize varieties is 30% lower than eastern and western mid-hills (Gurung, 1999). It might be due to longer duration of improved maize varieties which could not fit in the cropping pattern. So, there is need of improved early maize varieties which could fit in the cropping pattern and raise the productivity. The scope of early maize varieties is also in dry ecozones where monsoon is early, higher intensity and longer duration for the intensive cropping system.

The genotypes should be evaluated under different environments before recommending them to farmers. The estimates of GE (genotype-by-environment

interaction) is very important to establish the breeding objectives like the choice of genitors, identification of the ideal test conditions and recommendations for regional adapted varieties (Yan *et al.,* 2000). The information on stability of early genotypes under Terai and mid-hill environments of Nepal is not sufficient. So, these studies were carried out and the objective of this study was to evaluate the stability and adaptability of five early maize genotypes in four locations using the GGE biplot.

MATERIALS AND METHODS

Four early maize genotypes namely Pool-17, Arun1EV, Arun-4, Arun-2 and Farmer's variety were evaluated at four different locations namely Rajahar, Rampur, Pakhribas and Kabre during summer seasons of three consecutive years from 2010 to 2012 under farmer's fields. The experimental designs were randomized complete block design with three replications. The plot size was six rows of 3m length. The spacing for row to row and plant to plant was 0.75 m and 0.25 m, respectively. The NPK fertilizer was used @120:60:40 kg ha^{-1}. The half of N plus full dose of P_2O_5 and K_2O were used as basal dose application. The remaining half of the N was divided into two splits and used in two times i.e. at knee-high and pre flowering stages. Rest of agronomic practices was done as per recommendation of National Maize Research Program (NMRP), Rampur, Chitwan, Nepal. Grain yield was calculated using formula adopted by Carangal et al. (1971) and Shrestha et al. (2015) by adjusting the grain moisture at 15% and converted to the grain yield per hectare. Analysis of variance for grain yield was done using statistical analysis through Genstat programme. All the genotypes were evaluated under 5% level of significance., The GGE bi-plot software was used to analyze genotype and genotype × environment (GGE) effects on genotypes across environments (Yan & Kang, 2003).

Table 1. Description of maize genotypes used in experiments

SN	Genotype	Parentage
1	Pool-17	Crosses of the early and late flint materials from mexico, the Caribean, South and Central America and Asia
2	Arun-4	Formed using local and elite germplasm
3	Arun-1 EV	Crosses of the late flint and early materials from mexico, the Caribean, South and Central America and Asia
5	Arun-2	UNCAC-242 × Philippines DMR
6	Farmers Variety	-

Table 2. Geographic description of experimental locations

Location	Longitude	Latitude	Elevation (m)
Rampur (Chitwan)	84˚19' E	27˚40' N	228
Rajahar (Nawalparasi)	84° 14' E	27° 41' N	192
Pakhribas (Dhankuta)	87°17' E	27°02' N	1720
Kabre (Dolakha)	86° 9' E	27° 38' N	1788

RESULTS AND DISCUSSION

Analysis of variance derived from four environments for yield (Table 4) indicated the significant effects of genotype, highly significant effects for environments and their interaction on yield. The maize genotypes were significant for grain yield in different terai and mid hill environments. The Pool-17 produced the significantly highest grain yield (3624 kg ha^{-1}) in Rajhar and Arun-2 (3461 kg ha^{-1}) for Rampur condition excluding Farmer's Variety. The maize genotypes Arun-4 and Arun-2 produced significantly higher grain yield under hills condition. This findings were similar to research findings obtained by Fan et al. (2007). The diverse genetic backgrounds of parent genotypes cause the differences among locations. Obi (1991) and Akande and Lamidi (2006) reported that various agronomic characteristics are controlled by diverse genetic factors therefore genotypes perform differently in a particular location.

Table 3: Combined Grain yield of 5 early maize genotypes in Rajahar, Rampur, Pakhribas and Kabre three years of 2010, 2011 and 2012.

Genotypes	Rajahar	Rampur	Pakhribas	Kabre	Combined
Arun-1 EV	3062	3040	4115	4987	3801
Arun-4	3285	2890	4820	6126	4280
Pool-17	3624	2367	3390	4021	3351
Arun-2	2676	3461	4861	5185	4046
Farmer's variety	2754	4140	3989	4280	3791
Grand mean	3080	3180	4235	4920	3854
CV%	11.3	15.4	5.7	5.5	12.1
LSD$_{0.05}$	462.9	558.0	672.1	748.2	979.2
F-test G	*	*	*	**	*
E					**
G × E					**

According to Yan and Kang (2003), an ideal genotype gives the highest yield across tested environments and is stable in its performance. An "ideal" view is drawn (Figure 1) that showed Arun-2 was the closest to the ideal genotype, followed by Arun-1 EV. A genotype closer to the "ideal" genotype is more desirable. The genotypes would be more stable when they are close to the performance line. The biplot (Figure 2) represents a polygon indicating that the vertex genotypes were Arun-2, Arun-4, Pool-17 and Farmer's Variety.

Table 4. ANOVA for grain yield for the five maize genotypes tested across 4 environments in Nepal (2010-2012).

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	1	2151	2151	0.01	
Genotypes	4	3828763	957191	4.37	0.011
Environment	3	23344058	7781353	35.55	<.001
Genotypes × Environment	12	9459798	788316	3.6	0.006
Error	19	4158583	218873		
Total	39	40793352			

The genotypes positioned on the vertexes have the longest distance from the biplot origin, they are supposed to be the most responsive either best or the poorest at one or every environment (Yan & Rajcan, 2002). The allocation of potential mega-environments are shown by "which won where" graph (Yan et al., 2000). The lines perpendicular to the polygon separates the mega-environments. The Arun-1EV and Arun-4 were suitable for Pakhribas and Kabre environments where as Pool-17 for Rajahar and Farmer's variety for Rampur environments (Figure 2).
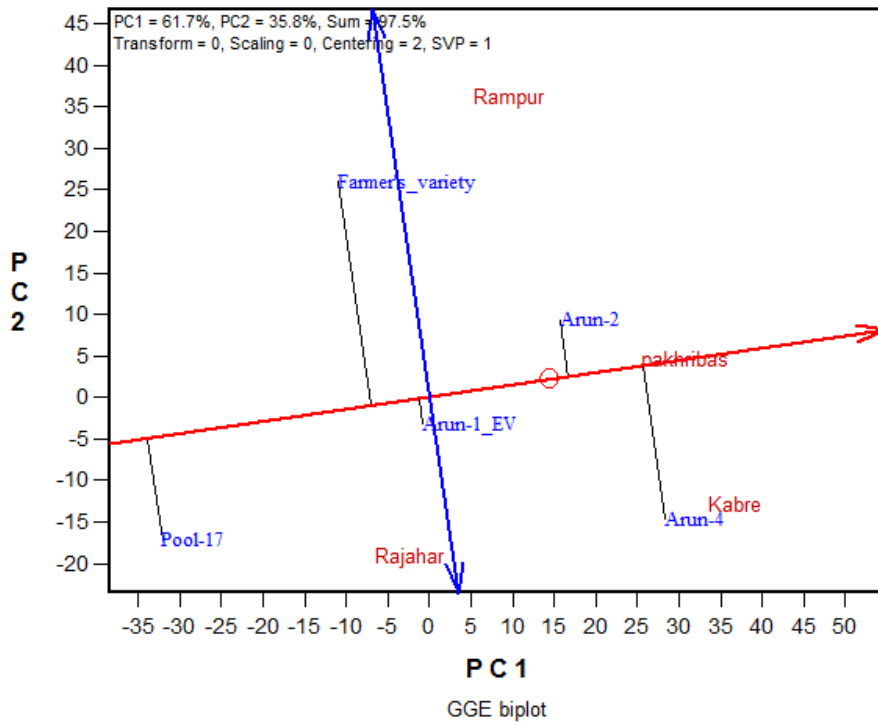

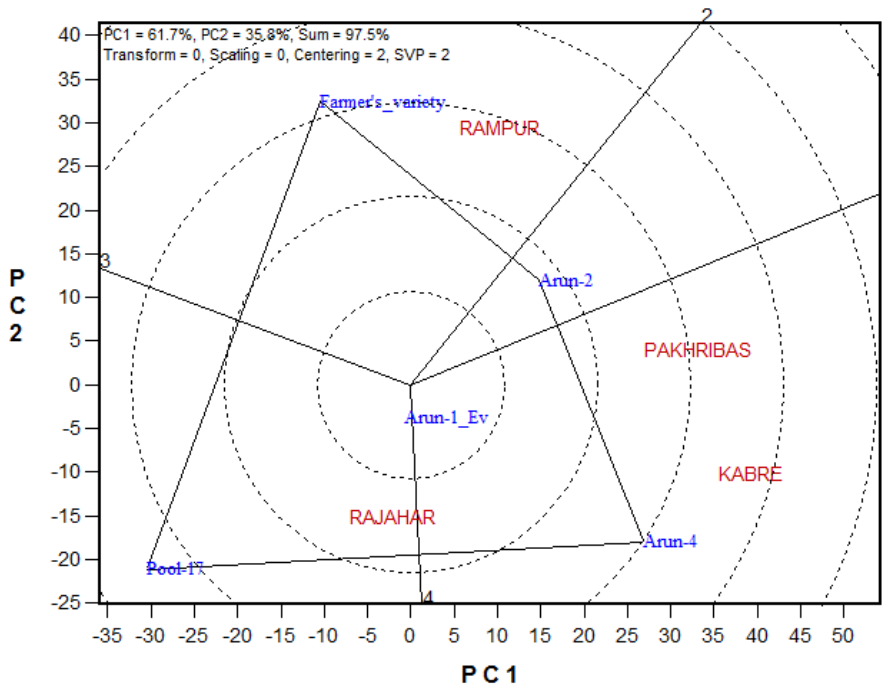**Figure 1. GGE biplot showing ranking of genotypes for mean yield and stability.**

Figure 2. A genotype + genotype × environment interaction bi-plot showing early maize genotype performance in each environment

CONCLUSION

Early maize genotypes showed considerable variation in grain yield under the various terai and hill environments in Nepal. The genotypes Arun-1 EV and Arun-4 were more suitable for mid hills and pool-17 for terai. So Arun-1 EV and Arun-2 can be recommended to farmers for general cultivation.

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