Varietal Evaluation and Clustering of Early Maize Genotypes in Mid-Western Hilly Region of Nepal

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Abstract

Eleven early maize (*Zea mays*) genotypes were evaluated for their yield and yield component traits at the research block of Regional Agriculture Research Station (RARS) Lumle, Kaski, Nepal during Kharif season of 2016. The experiment was laid out in randomized complete block design (RCBD) with three replications. Results showed that all the studied genotypes differed significantly for grain yield as well as other yield component traits except number of kernel per row. Out of tested genotypes COMPOZ-NIPB, EEYC1, POP-445/POP-446 were three top performer genotypes yielding 6.89, 5.38 and 5.19 t ha^{-1}. Early mid Katamari, Rajahar local, Manakamana-5, EEYC1 were statistically at par with Arun-4(standard check) and will be needed further evaluation and improvement by a selection of desirable traits. Eleven genotypes occupied three different clusters and showed that early maize genotypes suggest considerable genetic diversity among themselves. Genotypes belong to cluster one having the highest yield potentials so need to be further evaluation in different location of mid hill and recommended best variety for that domain.

Key words: early maize, grain yield, performance evaluation, cluster analysis

INTRODUCTION

Maize is the second most important staple cereal food in terms of area and production in Nepal (MoAD, 2017/18). At present, the maize sown area in Nepal is 9,24,321 ha with a total production of 23,36,675 MT and productivity of 2.53 t ha^{-1} (MoAD, 2017/18). Ranum *et al.* (2014) reported that 98 g/person/day was the per capita maize consumption in Nepal, that was the highest in South Asia. It is a principal food crop of the hilly farmers and source of animal feed for different feed industries in theTerai region of Nepal (KC *et al*., 2015). Maize is considered as Kharif season crop in the hilly and mountainous areas, but it can be successfully cultivated both kharif and rabi season in Terai and inner Terai.

Early maize matures 15-25 days earlier than normal season maize. Generally, it's mature 90-130 days after sowing allow growing of the short duration crops like coriander, radish etc. which increase the cropping intensity as well as farmer income. The existing cropping patterns are maize-wheat, maize-barley, maize-potatoes, maize-fallow, rice-maize-maize, and farmers use a shorter duration of maize varieties to catch the winter crops. Early maize has only the option in rice-maize-maize system in the unirrigated land of terai. The adoption rate of improved maize varieties is low in eastern and western mid-hills than Terai (Gurung, 1999). It might be due to the longer duration of improved maize varieties which could not fit in the cropping pattern. Kunwar *et al*. (2014) also reported there are limited option of higher yielding early maize for maize growers which could suited to different cropping pattern. So, there is a need for improved early maize varieties that could fit in the cropping pattern and raise productivity. There were few researches were carried out to evaluate early maize in Nepal. Previous researcher such as Prasai *et al*. (2013) evaluate eight early maize with two check varieties at RARS Doti during 2011/12-2012/13. Dhakal *et al.* (2017) evaluate 14 early maize at RARS Doti during 2015-2016. Kandel *et al*. (2017) studied genetic variability of early maize at RARS Lumle. The present study was carried out with objectives to evaluate available early maize genotypes in term of yield potentials, flowering and maturity behaviors.

MATERIALS AND METHODS

A varietal trail on early maize genotypes was conducted at the research farm of RARS Lumle during Kharif 2016. Eleven maize genotypes were laid out in RCBD design with three replications. The research station is situated at an altitude of 1740 meters above mean sea level in the south-facing slopes at 28.29° north and 83.81° east coordinates. Each genotype received the plots of 9 m^2 area with the net plot area of 99 m^2 per block/replication. Each plant received 75 cm×25cm crop geometry. Initially, two seeds per hill were sown and later on one plant was thinned to maintain single plant per hill. Fertilizer was applied at the rate of 120:60:40 NPK kg ha^{-1}. Nitrogen was applied in two splits dose first at knee-high and second as pre-tasseling/silking stages. Recommended cultural and crop protection practices were followed. All the data were obtained from sample row from ten randomly selected plant except for phenological traits such as 50% tasseling, 50% silking and maturity days. Observation on yield and yield component such as number of kernels per row, number of kernel rows per ear, ear length (cm), ear diameter (cm), ear weight (g) and test weight (g) and grain yield (t ha^{-1}) after moisture adjustment at 12.5 %. Similarly, observations made on growth traits such as plant height (cm) and ear height (cm). Ear aspect was a score on a scale of 1 to 5 where, 1 = clean, uniform, large and well-filled ears and 5 = rotten, variable, small, and partially filled ears (UPOV Maize 2009). All the collected data were entered into MS Excel and statistical analysis by using computer software's statistical package R version 3.6.0 and clustering of genotypes was carried out by Minitab version 14.

RESULTS AND DISCUSSIONS

Mean Performance and Analysis of Variance

Phenological traits

The result revealed that genotypes have significantly differed for days to 50% tasseling (Table 2). Genotypes such as Rajahar local and EEYC1 had delayed 50 % tasseling days as compared to Arun-4 (Standard check) and remaining genotypes were statistically at par with Arun-4. It reflected that all mention genotypes had 50 % tasseling days of 60-70 after sowing. The genotypes were highly significant for 50 % silking days shown

Table 1. List of genotypes used in research

Entry No.	Treatments	Source
1	Early mid Katamari	NMRP, Rampur
2	Rajahar local	NMRP, Rampur
3	S97TEYGHAYB(3)	NMRP, Rampur
4	POP-445/POP-446	NMRP, Rampur
5	COMPOZ-NIPB	NMRP, Rampur
6	R.C/POOL-17	NMRP, Rampur
7	SO3TEY/LN	NMRP, Rampur
8	Arun-4 (standard check)	NMRP, Rampur
9	Manakamana-5 (local check)	NMRP, Rampur
10	ZM-621/POOL-15	NMRP, Rampur
11	EEYC1	NMRP, Rampur

in Table 2. The result showed that all studied genotypes were statistically at par with Arun-4. Prasai *et al*. (2014) evaluated nine early maize genotypes in Doti during 2011/12 -2012/13 reported that male and female flowering period ranges from 36-51 and 41-54 respectively which was earlier than our findings. Kuwnar *et al*. (2014) also reported variation of flowering in early maize which is also accordance to our findings. Maturity days were highly significant for studied genotypes (Table 3). Rajahar local which was late maturing genotype whereas genotypes such as Early mid Katamari, R.C/POOL-17, SO3TEY/LN, ZM-621/POOL-15, Manakamana -5 and POP-445/POP-446 were earlier maturing genotypes that were statistically at par. Sharma *et al.* (2018) evaluate ten maize genotypes at Rampur, Nepal reported significant different for a phenological trait which was according to our findings.

Growth traits

The result showed a highly significant difference in the plant height for the genotypes (Table 2). Maximum plant height had been shown by COMPOZ-NIPB and minimum PH had been shown by Rajahar local, Early mid Katamari was statistically similar to Arun-4. The observed difference in plant height between the genotypes must be due to genetic variation present in the population. Our findings partially agreed with Ali (1994). However, he reported that variation in plant height is genetic as well as environmental influences. Ear height also significantly differ for all the studied genotypes (Table 2). Maximum ear height had been shown by COMPOZ-NIPB and minimum ear height had been shown by Rajahar local, Early mid Katamari, POP-445/POP-446, SO3TEY/LN and MANAKAMANA-5 were found statistically at par with Arun-4 (Table 2). Parsai *et al*. (2014) reported significant differences were for growth traits, which was according to our findings.

Yield and yield components traits

The result showed a significant difference in no. of kernel row per ear (NKRPE) for genotypes (Table 3). Highest NKRPE has been observed in R.C/POOL-17 and lowest has been shown by Early mid Katamari. Genotypes S97TEYGHAYB(3), POP-445/POP-446, COMPOZ-NIPB, SO3TEY/LN and Manakamana-5 were statistically at par with Arun-4 . The result showed non-significant difference in no. of kernel per ear (NKPR) for the genotypes (Table 3). Ghimire *et al*. (2015) in their experiment variety S97TEYGHAYB(3), Rajahar local, POP-445/

Table 2. Means for yield and yield attributes of eleven early maize genotypes at RARS, Lumle, Nepal, 2016

Mean treatment Genotypes	Characters					
	TD	SD	PH (cm)	EH (cm)	ED (cm)	EL (cm)
Early mid Katamari	62^{c}	64^{ab}	191^{abc}	92^{abc}	3.99^{abc}	14.1^{b}
Rajahar local	70^{a}	70^{a}	152^{c}	73^{c}	4.18^{ab}	16.9^{ab}
S97TEYGHAYB(3)	62^{bc}	64^{ab}	173^{bc}	80^{bc}	4.02^{ab}	14.4^{b}
POP-445/POP-446	64^{bc}	66^{ab}	179^{bc}	89^{abc}	4.10^{ab}	14.8^{b}
COMPOZ-NIPB	64^{abc}	67^{ab}	228^{a}	119^{a}	4.22^{ab}	18.7^{a}
R.C/POOL-17	62^{c}	62^{b}	178^{bc}	82^{bc}	4.06^{ab}	14.2^{b}
SO3TEY/LN	68^{ab}	68^{ab}	208^{ab}	105^{ab}	3.59^{c}	14.8^{b}
Arun-4(standard check)	63^{bc}	65^{ab}	193^{abc}	105^{ab}	3.93^{bc}	13.9^{b}
Manakamana-5 (local check)	65^{abc}	66^{ab}	182^{bc}	91^{abc}	4.22^{ab}	15.2^{b}
ZM-621/POOL-15	66^{abc}	70^{a}	181^{bc}	86^{bc}	4.18^{ab}	14.4^{b}
EEYC1	66^{a}	68^{ab}	172^{bc}	80^{bc}	4.39^{a}	15.8^{ab}
LSD(0.05)	5.50	5.13	36.26	26.78	0.34	2.84
CV(%)	4.25	4.05	11.57	17.28	4.97	11.05
F Test	*	**	**	**	**	**
Grand mean	64.72	66.36	185.07	91.50	4.08	15.19

Note: (**) significant at 0.01, (*) significant at 0.05, ns = non-significant, TD=50% tasseling days, SD=50% silking days, PH=Plant height, EH=Ear height, ED= Ear diameter, EL= Ear length

Table 3. Means for yield and yield attributes of eleven early maize genotypes at RARS, Lumle, Nepal, 2016

Mean treatment Genotypes	Characters						
	NKRPE	NKPR	EW (g)	TKW (g)	EA	DPM	GY (t ha^{-1})
Early mid Katamari	12.0^{c}	28	55.64^{bc}	298.7^{ab}	3.3^{a}	116^{b}	4.44^{bc}
Rajahar local	13.6^{ab}	24	60.64^{bc}	262.5^{b}	3.0^{ab}	125^{a}	4.72^{abc}
S97TEYGHAYB(3)	13.0^{abc}	25	57.39^{bc}	256.0^{b}	3.5^{ab}	120^{ab}	4.02^{bc}
POP-445/POP-446	12.9^{abc}	27	66.53^{ab}	272.9^{ab}	3.6^{a}	119^{b}	5.19^{abc}
COMPOZ-NIPB	13.1^{abc}	29	84.8^{a}	331.7^{a}	2.1^{b}	122^{ab}	6.89^{a}
R.C/POOL-17	14.2^{a}	23	53.76^{bc}	268.5^{ab}	3.5^{a}	116^{b}	3.94^{bc}
SO3TEY/LN	13.3^{abc}	25	41.41^{c}	240.7^{b}	3.1^{a}	118^{b}	2.97^{c}
Arun-4(standard check)	12.2^{bc}	26	52.17^{bc}	285.3^{ab}	3.0^{ab}	122^{ab}	5.76^{ab}
Manakamana-5(local chk)	13.5^{abc}	26	60.09^{bc}	305.3^{ab}	3.6^{a}	119^{b}	4.89^{abc}
ZM-621/POOL-15	13.7^{ab}	23	57.4^{bc}	283.7^{ab}	3.0^{ab}	118^{b}	4.63^{bc}
EEYC1	13.7^{ab}	27	69.06^{ab}	304.5^{ab}	3.6^{a}	121^{ab}	5.38^{ab}
LSD(0.05)	1.62	3.82	16.41	41.89	0.84	5.43	1.58
CV(%)	7.22	8.75	16.18	9.71	15.28	2.47	19.51
F Test	*	ns	**	**	**	**	**
Grand mean	13.20	25.72	59.89	254.67	3.25	129	4.80

Note: (**) significant at 0.01, (*) significant at 0.05, ns= non-significant; EA=Ear aspect, EL=Ear length, ED=Ear diameter, EW=Ear weight, NKRPE=Number of kernel row per ear, NKPR=Number of kernel per row, TKW=Thousand kernel weight, DPM=Days to physiological maturity, GY=Grain yield .

Table 4. Agro-morphology and yield components traits of early maize genotypes within and among three cluster

Variables	Cluster 1	Cluster 2	Cluster 3
50 % tasseling days	75.81	77.78	77.33
50 % silking days	74.61	74.44	77.000
Maturity days	129.57	131.22	128.33
Plant height	178.41	196.24	198.17
Ear height	87.35	99.17	97.59
Ear length	14.85	16.36	14.09
Ear diameter	4.06	4.24	3.72
Ear weight	57.42	70.89	44.22
Number of kernel row	13.28	13.22	13.66
Number of kernel per row	25.20	27.89	23.64
Test weight	247.73	283.51	216.79
Grain yield	4.59	5.82	3.21

POP-446, SO3TETEY/LN, EEYC1, Pool-27, Pool-15 were statistically similar to Arun-2.

The result showed the highly significant difference in ear diameter for genotypes (Table 2).The highest ear diameter was observed in EEYC1 and the lowest has been found in SO3TEY/LN. The genotypes were highly significant for ear length in which the highest EL has been shown by COMPOZ-NIPB and minimum has been shown by Early mid Katamari, Rajahar local, S97TEYGHAYB(3), POP-445/POP-446, R.C/POOL-17, SO3TEY/LN, Manakamana-5 and ZM-621/POOL-15 were statically at par with Arun-4 . Highly significant difference obtained in ear weight for the genotypes. Maximum ear weight had been shown in COMPOZ-NIPB and minimum had been showed in SO3TEY/LN, Early mid Katamari, Rajahar local, R.C/POOL-17 S97TEYGHAYB(3), Manakamana-5, ZM-621/POOL-15 were statistically similar to Arun-4 . The result demonstrated a highly significant difference in test weight for genotypes (Table 3). Maximum TKW has been shown by COMPOZ-NIPB and minimum were showed in S97TEYGHAYB (3), Rajahar local and SO3TEY/LN which were statistically at par. Ghimire and Timsina (2015) reported that Rajahar local has a low five hundred kernel weight which in accordance with our findings. The result showed a highly significant difference in the grain yield t ha^{-1} for the genotypes. Among the tested genotypes, COMPOZ-NIPB has been found high yield potential and genotype SO3TEY/LN had the lowest yielder. The genotypes POP-445/POP-446, Farmers variety and EEYC1, were found to be statistically at par with ARUN-4 for grain yield kg ha^{-1}. COMPOZ-NIPB, POP-445/POP-446, and EEYC1 were the promising early maize genotype at mid-hill condition of Nepal. Arun-2, POP 445 and EEYC1 were identified as superior genotypes of maize (early) in the coordinate varietal trail (CVT) experiment of 2013 (Prasai *et al*., 2015), which was in accordance with this finding. Kunwar *et al*. (2016) reported that Arun-4 were better adapted for Kabre and Pakhribas whereas pool-17 for Rajahar environments. Prasai *et al*. (2014) reported contradict finding in which SO3TEY/LN has the highest yield potential at lower hills and river basin agro-environment of far western hill of Nepal but in our case, SO3TEY/LN had the lowest yield. This is because, SO3TEY/LN has low thousand kernel weight, low ear length and highest ear aspect were recorded in this experiment.

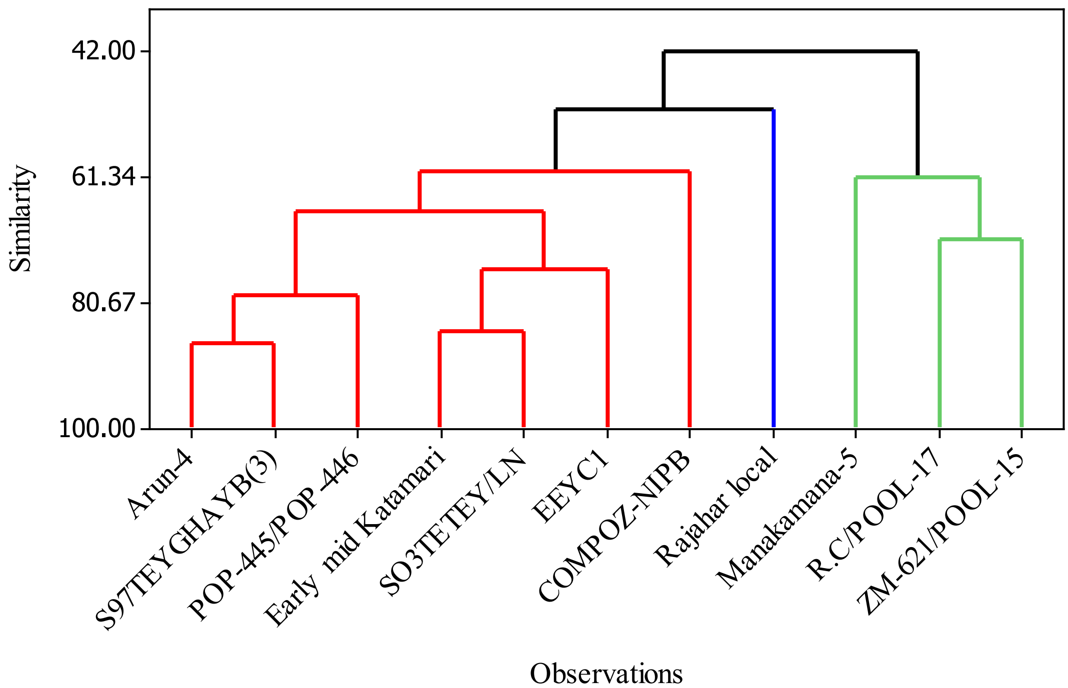

Figure 1. Clustering of early maize genotypes based on agro-morphological and yield components traits

Ear Aspect (EA)

The highly significant differences obtained in EA for the genotype (Table 2). Maximum ear aspect reported for EEYC1 whereas minimum for COMPOZ-NIPB. COMPOZ-NIPB has low ear aspect value (i.e. cob is less damage) which ultimately gives higher grain yield. With an increase in the value of ear aspect (i.e. cob is more damage) which ultimately reduced the grain yield.

Cluster analysis

Cluster analysis is frequently used to classify maize accessions and can be used by breeders to identify accessions that have potential utility for specific breeding. Many researchers such as Kandel *et al*. (2019), Rohman *et al*. (2015) etc, used to classify maize accession by using cluster analysis. Eleven early maize genotypes were grouped into 3 clusters based on various agro-morphological and yield components traits (Figure 1). Cluster I consists of seven genotypes having the lowest plant and ear height and medium yielder. Cluster II consists of one genotype having early silking but delay maturity with the highest ear length, ear weight, ear diameter, no. of kernel per row, test weight and grain yield. Cluster III consists of 3 genotypes with delay silking and early maturity with the lowest ear length, ear diameter, ear weight, test weight, no. of kernel per ear, no. of kernel per row and the lowest grain yield, however, plant height was maximum. Kandel *et al*. (2019) also groped 10 hybrid maize genotypes in three different clusters.

CONCLUSION

From the analysis of data, all studied genotypes were flowering at 60-70 days after sowing. COMPOZ-NIPB, EEYC1 and POP-445/POP-446 were top yielder genotypes. Early mid Katamari Rajahar local, POP-445/POP-446, EEYC1 and Manakamana-5 were statistically at par with the standard check. These genotypes need to be included for further testing in farmer field trail. In case of maturity behaviour Early mid katamari , R.C/ POOL-17 and SO3TEY/LN were earlier maturity whereas Rajahar local mature later. Cluster analysis showed that genotypes possess variability so occupied three different clusters. Top yielder genotypes belong to cluster 1.

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