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Varietal evaluation of promising maize genotypes

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ABSTRACT

The selection efficiency can be broadened for certain traits using estimates of genetic parameters, which are fundamental for plant breeding. The present study was carried out with ten maize genotypes grown in October, 2016 to April, 2017 using randomized complete block design with three replications at research field of National Maize Research Program, Rampur, Chitwan, Nepal. The objective of this study was to estimate the variability and correlation of agro-morphological traits in maize genotypes. Variation was observed for all the growth, phenology, yield and yield attributing traits among the genotypes. The genotypes, ZM-627 (4984 kg ha^{-1}) and Across9942/Across9944 (4523 kg ha^{-1}) were identified as promising genotypes. Grain yield had significant positive correlation for ear length, number of grains per row, number of ears per plot and thousand grains weight. Path analysis showed that ear height, days to 50% tasseling, anthesis-silking interval, ear length, ear diameter, number of grain rows per ear, number of grains per ear, number of ears per plot and 1000 grains weight had direct and positive effects on grain yield. Moderate to high estimates of GCV, PCV, heritability and genetic advance were found for plant height, ear height, thousand kernels weight, tasseling days, anthesis-silking interval and grain yield. Therefore, these traits can be used as selection indices for indirect selection for the improvement of maize productivity.

INTRODUCTION

Maize (*Zea mays* L.) belonging to the family poaceae (Graminaceae) and tribe Maydeae has characteristics of wide adaptability in the different ranges of growing condition. Thus, it has gained adaptation and productivity in all continents through introductions and breeding. According to MOAD (2016/17), the maize sown area in Nepal is 924321 ha with a total production of 2336675 metric tons and productivity of 2.53 t ha^{-1}. In Nepal, the productivity of maize is low compared to other developed countries due to various factors that directly affect the productivity of maize. Thus high yielding maize varieties for normal planting season should be developed to overcome the food deficiency and yield gap can be narrowed by cultivation of improved varieties. Farmers and breeders want successful new maize hybrids that show high performance for yield and other essential agronomic traits. Genotype-environment interaction (GEI) causes difference among genotypes and their yield stability. The study tried to identify high yielding promising maize genotypes suitable for the existing cropping pattern in terai and inner terai of Nepal.

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MATERIALS AND METHODS

Genetic materials and experimental site

The research was conducted at National Maize Research Program (NMRP) of Rampur, Chitwan (27º 37' North and 84 º 29' East, 225 masl) from Nepal from October, 2016 to April, 2017.The soil type at this location is sandy loam (sand:slit:clay:75.4:16.9:7.7), pH=5.5, Total nitrogen=0.09, organic matter (2.01%), phosphorous (89.70%) and potassium (308.2%) (Kandel et al. 2018).

Total 10 genotypes of winter maize (Across9942/Across9944, ZM-627, Across9331RE, Rampur S10F20, Pool-15, KLY-POP, S03TEY FM(R), Rampur S03F04, ZM-401, S99TLYQ-HGAB) were used in this experiment.

Experimental design and crop husbandry

Ten maize genotypes collected from national maize research program were evaluated using randomized complete block design with three replications. The plot size was 5 m × 2 m with crop geometry of 60 cm × 25 cm. The applied fertilizer dose is 120:60:40 NPK kg ha^{-1}. And other intercultural practices were done as per recommendation of National Maize Research Program, Rampur, Chitwan, Nepal.

Data collection and analysis

From five randomly selected plants of each plot all the morphological data (quantitative) was collected except for day to 50% tasseling and Days to 50% silking. Yield attributing quantitative trait of maize were plant height, ear height, ear length, number of grains per row, number of grain rows per ear, number of ears per plot, ear diameter, anthesis-silking interval, thousand kernels weight and grain yield were collected and recorded and average values were taken for analysis.

Phenotypic coefficient of variation (PCV)

$$PCV=\sigma g/X$$

Genotypic coefficient of variation (GCV)

$$GCV = \sigma p/ X$$

where X =trait means, σg= genotypic standard deviation and σp= Phenotypic standard deviation

Value of GCV and PCV categorized as;

0 - 10% = Low

10 – 20 = Moderate

> 20 = High (Sivasubramaniah and Menon 1973)

Heritability (H)

$H= \sigma^2 g/ \sigma^2 p$ (Falconer, 1996)

The value of heritability Categorized as

0 - 30% = Low

30 – 60 = Moderate

> 60 = High (Robinson et al. 1955).

Genetic Advances (GA)

$GA = k.\sigma p.H$ (Johnson et al 1955).

Where: k = constant (selection differential where k = 2.056 at 5% selection intensity)

σp= phenotypic standard deviation

H = Heritability in broad sense

Genetic advances as percent of mean (GAM)

$GAM =GA/X \times 100$ (Falconer 1996).

The value of GAM categorized as;

0 - 10% = Low

10 – 20 = Moderate

> 20 = High (Johnson et al. 1955)

Statistical analysis

The data recorded on different parameters from field were first tabulated in Microsoft Excel (MS- Excel, 2010), then Analysis of variance (ANOVA) for all data was statistically analyzed using R-Studio. Correlation coefficients of different traits were carried out using the formula given by Steel and Torrie (1980) by using SPSS 16 version.

RESULTS AND DISCUSSIONS

Plant height, Days to 50% silking and tasseling and thousand kernel weight possess highly significance difference among the ten tested genotypes and their improvement can lead to higher grain yield. Malik et al. (2010) observed highly significant variation in grain yield while comparing thirty maize genotypes. Gaire (2013) found that there was significant different among the genotypes for thousand kernels weight which strongly support the present finding.

Similarly ear height, ear length, anthesis-silking interval and number of ears per plot had significance difference and made impact on grain yield. There was no significance difference in ear diameter, number of grain rows per ear, number of grains per row and grain yield among the maize genotypes. Among tested genotypes, ZM-627 was found the most promising lines (4.98 t ha^{-1}).

Genetic Variability

Analysis of variance revealed significant differences for all growth, yield and yield attributing characters. Turi et al. (2007) observed considerable genotypic variability among various maize genotypes for different traits. Highest estimates of GCV, PCV, heritability and GAM was recorded for anthesis-silking interval followed by number of ear per plot and grain yield. These results were similar to results recorded by Singh et al. (2014) who found high to moderate estimates of heritability and genetic advance for ear height, plant height, cob length and seed index.

Correlation Analysis

Grain yield per plant exhibited high significant positive correlation with number of ears per plot followed by thousand kernel weight, number of grains per row and ear length indicating the importance of these traits in selection for yield. Similar results were reported earlier on maize by several researchers on different characters viz., for the association of grain yield with ear length (Bhole and Patil 1984; Tyagi et al. 1988; Kumar 1997;

Table1. Mean performance of maize genotypes

Genotypes	PH	EH	TD	SD	ASI	EL	NEP	TKW
1. Across 9942/Across 9944	171.93 bc	93.66 ab	68.33 c	70.33 c	4.00 b	11.77 b	31.33 abc	0.48 a
2. Across 9331 RE	182.00 ab	106.00 a	59.33 d	66.33 d	7.00 ab	12.58 ab	33.00 abc	0.40 bc
3. Pool -15	168.33 bc	94.00 ab	54.66 e	58.00 f	3.33 b	11.37 b	21.00 c	0.32 d
4. So3TEY-FM (R)	146.33 d	68.00 c	59.33 d	63.00 e	3.66 b	11.85 b	25.33 bc	0.40 bc
5. ZM-401	176.66 ab	95.33 ab	61.66 d	66.00 d	4.33 b	12.64 ab	40.00 a	0.42 abc
6. ZM-627	177.33 ab	87.33 abc	66.66 c	70.33 c	3.66 b	12.62 ab	38.66 a	0.44 ab
7.RampurS10F20	169.33 bc	81.33 bc	72.33 b	76.66 b	4.33 b	13.44 a	27.66 abc	0.43 abc
8. KLY-POP	192.66 a	100.00 ab	78.66 a	83.33 a	4.66 b	13.22 a	33.33 abc	0.38 bcd
9.RampurS03F04	154.00 cd	84.66 abc	75.00 b	84.66 a	9.66 a	12.68 ab	36.66 ab	0.38 bcd
10. S99TLYQ-HGAB	177.00 ab	98.00 ab	66.66 c	71.00 c	4.33 b	12.38 ab	36.33 ab	0.37 cd
Grand Mean	171.6	90.83	66.27	70.97	4.9	12.46	32.33	0.40
F test	**	*	**	**	*	*	*	**
LSD (0.05)	17.50	19.00	3.02	2.45	3.33	1.18	11.43	0.05
CV%	5.94	12.19	2.66	2.01	39.70	5.56	20.62	8.42

Genotypes with least one similar letter have not statistical difference. * and ** significant at P=0.05 and P= 0.01 level of significance respectively. PH= plant height (cm), EH= ear height (cm), TD= days to 50% tasseling, SD= Days to 50% silking, ASI= anthesis-silking interval, EL= ear length (cm), ED= ear diameter(cm), NRE= number of grain rows per ear, NGR= number of grains per row, NEP= number of ears per plot, TKW= thousand kernel weight (g) and GY=grain yield (t ha^{-1}).

Umakanth and Sunil 2000; Kumar and Satyanarayana 2001; Choudhary and Chaudhary 2002; Mohan et al. 2002) thousand kernel weight

(Panchanadhan et al. 1978; Kumar and Kumar 1997; Umakanth and Sunil 2000; Kumar and Satyanarayana 2001; Mohan et al. 2002; Farzana 2005) and number of grains per row (Hemavathy et al. 2008). The correlation among the yield components other than grain yield is considered as concerning issue which might aid in understanding an idea of plant type. Plant height had high significant positive correlation with ear height. Similar observations were observed by (Bhole and Patil 1984). Days to 50% tasseling had significant positive correlation with Days to 50% silking and ear length. Thousand kernel weight showed positive significant correlation with ear diameter. Similar observation was reported by

Table 2. Grain yield and yield attributing traits of maize genotypes

Genotypes	ED	NRE	NGR	GY
1. Across 9942/Across 9944	4.62	14.86	26.53	4.52
2. Across 9331 RE	4.57	15.06	27.20	4.25
3. Pool -15	3.95	12.80	25.93	2.52
4. So3TEY-FM (R)	4.26	12.53	24.80	3.29
5. ZM-401	4.28	14.20	27.06	4.25
6. ZM-627	4.56	14.93	26.66	4.98
7.RampurS10F20	4.40	14.33	26.20	3.26
8. KLY-POP	4.34	14.00	27.06	3.67
9.RampurS03F04	4.22	14.00	26.80	3.75
10.S99TLYQ-HGAB	4.30	14.40	26.26	3.82
Grand Mean	4.35	14.11	26.45	3.84
P value	0.093	0.076	0.901	0.069
F-test	NS	NS	NS	NS
CV%	5.58	7.09	7.12	21.33

ED= ear diameter (cm), NRE= number of grain rows per ear, NGR= number of grains per row, GY=grain yield (t ha-1).

(Panchanadhan et al. 1978). Days to 50% silking had positive and significant correlation with anthesis-silking interval and ear length. Number of grains per row had high positive and significant correlation with ear length.

Path Analysis

Path analysis reveals the direct and indirect effects of characters on grain yield (Table 5). Direct and positive effect on yield was exhibited by ear height, days to 50% tasseling, anthesis-silking interval, ear length, ear diameter, number of grain rows per ear, number of grains per ear, number of ears per plot and Thousand kernel weight indicating the effectiveness of direct selection, whereas direct and negative effects were exhibited by plant height and Days to 50% silking. Among these, days to 50% tasseling exhibited highest positive direct effect on grain yield while Days to 50% silking had highest negative direct effect on grain yield. Days to 50% tasseling recorded maximum positive direct effect on yield and Days to 50% silking had maximum negative direct effect on yield. Similar findings were reported earlier by (Kumar et al. 2006). Similarly, Singh et al. (1998) also mentioned that grain yield of maize was directly influenced by number of grains per row. The high direct effect of these traits appeared to be the main factor for their strong association with grain yield. Hence, direct selection for these traits would be effective.

CONCLUSIONS

The maize genotypes, ZM-627 and Across9942/Across 9944 were identified as most promising genotypes for grain yield. The maize genotypes showed significant differences for all the characters under study depicting the presence of substantial amount of genetic variability. Characters which showed strong and direct positive

Table 3. Estimation of genetic variability parameters for 12 different traits in maize

Traits	$\sigma^2 g$	$\sigma^2 p$	σg	σp	*X*	GCV	PCV	H	GA	GAM
PH	499.90	604.00	22.36	24.58	171.6	13.03	14.32	0.83	41.90	24.42
EH	314.30	437.00	17.73	20.90	90.83	19.52	23.02	0.72	30.97	34.10
ED	0.08	0.20	0.28	0.45	4.35	6.52	10.31	0.40	0.37	8.50
EL	1.08	1.56	1.04	1.25	12.46	8.33	10.02	0.69	1.78	14.26
NRE	1.84	2.85	1.36	1.69	14.11	9.62	11.96	0.65	2.25	15.96
NEP	96.96	141.43	9.85	11.89	32.33	30.46	36.78	0.69	16.79	51.95
TKW	0.01	0.01	0.07	0.08	0.4	18.69	20.58	0.82	0.14	34.96
SD	144.81	362.03	12.03	19.03	70.97	16.96	26.81	0.40	15.68	22.09
TD	173.39	176.50	13.17	13.29	66.27	19.87	20.05	0.98	26.89	40.57
GY	1.28	1.95	1.13	1.40	3.84	29.44	36.34	0.66	1.89	49.11
ASI	10.22	14.01	3.20	3.74	4.9	65.25	76.38	0.73	5.63	114.83
NGR	0.34	3.90	0.59	1.97	26.45	2.21	7.47	0.09	0.36	1.35

σ^2 g = genotypic variability, σ^2 p= phenotypic variability ,σ g=genotypic standard deviation, σ p= phenotypic standard deviation, *X*= mean, GCV= genotypic standard deviation, PCV= phenotypic standard deviation, H= broad sense heritability, GA= genetic advance, GAM=genetic advance as percentage of mean, PH= plant height (cm), EH= ear height (cm), TD= days to 50% tasseling, SD= Days to 50% silking, ASI= anthesis-silking interval, EL= earlength (cm), ED= ear diameter (cm), NRE= number of grain rows per ear, NGR= number of grains per row, NEP= number of ears per plot, TKW= thousand kernel weight (g) and GY=grain yield (t ha^{-1}).

Table 4. Correlation coefficients among yield and yield attributes of maize genotypes

	PH	EH	TD	SD	ASI	EL	ED	NRE	NGR	NEP	TKW	GY
PH	1.00											
EH	0.71**	1.00										
TD	0.14	-0.03	1.00									
SD	0.06	-0.05	0.94**	1.00								
ASI	-0.20	0.08	0.18	0.47**	1.00							
EL	0.28	0.10	0.45*	0.38*	-0.05	1.00						
ED	0.25	0.13	0.17	0.15	0.10	0.02	1.00					
NRE	0.34	0.33	0.22	0.26	0.25	-0.02	0.42*	1.00				
NGR	0.24	0.23	0.17	0.09	-0.06	0.74**	-0.01	-0.08	1.00			
NEP	0.18	0.06	0.30	0.31	0.08	0.36	0.15	0.22	0.25	1.00		
TKW	0.06	0.04	0.20	0.05	-0.20	0.22	0.44*	0.18	0.16	0.30	1.00	
GY	0.26	0.29	0.14	0.04	-0.10	0.45*	0.32	0.28	0.50**	0.66**	0.53**	1.00

* and ** are significant at P=0.05 and P= 0.01 level of significance respectively. PH= plant height (cm), EH= ear height (cm), TD= days to 50% tasseling, SD= Days to 50% silking, ASI= anthesis-silking interval, EL= ear length (cm), ED= ear diameter (cm), NRE= number of grain rows per ear, NGR= number of grains per row, NEP= number of ears per plot, TKW= thousand kernel weight (g) and GY=grain yield (t ha^{-1}).

Table 5. Path coefficient analysis indicating direct and indirect effects of components on grain yield in ten genotypes of maize

Characters	PH	EH	TD	SD	ASI	EL	ED	NRE	NGR	NEP	TKW
via PH	**-0.16**	-0.11	-0.02	-0.01	0.03	-0.04	-0.04	-0.05	-0.04	-0.03	-0.01
via EH	0.11	**0.15**	-0.01	-0.01	0.01	0.01	0.02	0.05	0.03	0.01	0.01
via TD	0.27	-0.07	**1.93**	1.82	0.35	0.88	0.33	0.42	0.33	0.58	0.38
via SD	-0.13	0.12	-2.24	**-2.37**	-1.13	-0.91	-0.34	-0.62	-0.22	-0.73	-0.13
via ASI	-0.11	0.04	0.10	0.27	**0.57**	-0.03	0.05	0.14	-0.03	0.05	-0.11
via EL	0.07	0.02	0.10	0.09	-0.01	**0.23**	0.00	0.00	0.17	0.08	0.05
via ED	0.03	0.01	0.02	0.01	0.01	0.00	**0.10**	0.04	0.00	0.01	0.05
via NRE	0.06	0.06	0.04	0.04	0.04	0.00	0.07	**0.16**	-0.01	0.04	0.03
via NGR	0.03	0.03	0.02	0.01	-0.01	0.09	0.00	-0.01	**0.12**	0.03	0.02
via NEP	0.11	0.04	0.18	0.18	0.05	0.21	0.09	0.13	0.15	**0.60**	0.18
via TKW	0.00	0.00	0.02	0.00	-0.02	0.02	0.03	0.01	0.01	0.02	**0.08**
Sum	**0.26**	**0.29**	**0.14**	**0.04**	**-0.10**	**0.46**	**0.32**	**0.28**	**0.51**	**0.66**	**0.53**

PH= plant height (cm), EH= ear height (cm), TD= days to 50% tasseling, SD= Days to 50% silking, ASI= anthesis- silking interval, EL= ear length (cm), ED= ear diameter (cm), NRE= number of grain rows per ear, NGR= number of grains per row, NEP= number of ears per plot, TKW= thousand kernel weight (g) and GY=grain yield (t ha^{-1}).

effect on the grain yield were ear height, days to 50% tasseling, anthesis-silking interval, ear length, ear diameter, number of grain rows per ear, number of grains per ear, number of ears per plot and thousand kernel weight. Any increase in one of these or all of these characters will results in overall increase in the yield.

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