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Identification of consistence performing dual purpose maize (*Zea mays* L.) genotypes under semi-arid condition

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Abstract

Maize (*Zea mays* L.) being grown since centuries and a very popular crop in the low and mid-altitude areas across north-central India. Being important for fodder and grain purpose, the utilization from maize can be enhanced by growing it as dual purpose crop. Seven new maize lines were developed for dual purpose use (grain and stover) and evaluated for their consistence performance over years. Nine maize genotypes including two nationally adapted varieties (African tall and J-1006) were evaluated for three consecutive years. Pooled analysis of variance indicated that maize lines possessed significant variation for all the major traits of dual purpose. Significant differential response to the changing years for most of the traits except for the traits *viz.*, plant height, stem diameter, tassel length, green fodder yield and grain yield. Genotypes IGMF-1 was found to be with higher mean and showed consistent performance for most of the traits, including grain and stover yield, hence considered to be adaptive and stable. This may be used as a parent in hybridization programme for further improvement.

Keywords: Dual purpose maize, Fodder maize, Stability , Stover, *Zea mays*

Abbreviations: CD: Critical difference; **CV:** Coefficient of variance; **DF:** Days to flowering; **DM:** Dry matter; **En:** Environment; **GFY:** Green fodder Yield (Q/Ha); **GY:** Grain yield; **Gen:** Genotypes; **LL:** Leaf length; **LW:** Leaf width (Cm); **Lin:** Linear; **NL:** Number of leaves; **PH:** Plant height (Cm); **Rep:** Replication; **SD:** Stem diameter; **TL:** Tassel length (Cm); **SY:** Stover yield;

Introduction

Maize (*Zea mays* L.) is an important food crop grown world-wide, serving as food, livestock feed & fodder and provide industrial raw materials (Pandit *et al*., 2016). Globally as a grain crop the area under this crop was 176 million ha with 875 m mt production, thus low in area and high in productivity as compared to wheat and rice (FAOSTAT, 2012). In non-traditional areas it is largely replacing sorghum, as an important dual-purpose crop, the stover of which is highly valued for its quality fodder (Chaudhary *et al*., 2016). Under the prevalent fodder shortage in India, maize stover would be a substitute for sorghum stover. Hence, utilization from maize crop can be enhanced by growing dual purpose maize i.e., grain and stover purpose (Berhanu *et al*., 2012). Quantitative inheritance for dual purpose traits is affected by genotype x environment interaction (G x E) leading to variation in degree of expression across different environments (Pinnschmidt and Hovmøller, 2002). Understanding of these genetic component will helps in identification of stable lines that will be used for strengthening the maize breeding programme for dual purpose.

Materials and Methods

Genotypes and field experiments: A set of nine newly developed maize genotypes including two national forage maize checks (African tall and J-1006) were used. The lines were developed by continuous selection and recombination among the desirable plants. The experiments were carried out for three years in *kharif* 2011, 2012 and 2013 at CR farm, Indian Grassland and Fodder Research Institute, Jhansi. In each year, genotypes were sown in a randomized complete-block design with three replications. Each experimental unit consisted of six rows of 4 m length. Standard agronomic practices were followed.

Morphological traits: Observations were recorded in all the years for nine characters namely days to flowering, plant height was measured at complete tassel emergence stage, stem diameter was measured at the middle of first internode from ground, number of leaves, leaf length of the third leaf from the top of the plants, leaf width of the third leaf from the top of the plants, tassel length, dry matter percentage, green fodder yield at days to anthesis, grain yield and stover yield.

Statistical analysis: Data for each trait was analyzed for analysis of variance in each year to test differences among cultivars following Singh and Chaudhary (1985). Combined analysis, variation was partitioned into relevant sources of variation to test for differences among genotypes and for the presence of G x E. The G x E interaction and stability was analyzed through the Eberhart and Russell (1966) using Indostat 7.5 software. Higher mean value for economic traits was considered desirable except the trait days to flowering where earliness is desirable. The further interpretation was done using method suggested by Finlay and Wilkinson (1963) and Sharma (1988). The significant deviation from regression (non-stable) genotypes is indicated by black dots.

Results and Discussion

Variance: The analysis of variances for the individual years for all the characters revealed significant difference indicating existence of genetic difference among the maize genotypes. The pooled data were further analyzed to detect the role of genotypes, environments, and their interaction. It was observed that variance among the genotypes was highly significant. Difference for all the traits indicates that the maize lines used for this experiment possessed significant variation for all the characters except PH, LL, LW and SY (Table 1). Since these traits were multigene governed or highly associated with other traits and together showed stable response for these traits over environments (correlation table not presented). Significant mean square due to years confirming critical differences between the years, which influenced the expression of most of the traits except PH. The non-significant differences for the PH over the years may attribute to the selection criteria during the development of the genotypes. Although all the genotypes were developed from different populations but the selection criteria was restricted to higher GY and SY along with standard PH in the segregating generations, which may leads towards the accumulation of maximum favorable gene for PH in the population.

Interaction component: The effects of genotypes and environments are statistically non-additive, which means that differences between genotypes depend on the environment for some traits. Mean square arising due to genotype x environments interaction (G x E interaction) revealed that significant differential response to the

Table 1. Pooled analysis of variance for agro-morphological traits of maize genotypes

Sources of Variation	DF	DF	PH	SD	NL	LL	LW	TL	GFY	DM%	G Y	SY
Rep. within En.	6	3.26	271.07	0.07**	2.16*	48.89	0.69	15.75	893.07*	3.3	2	172.96
Gen.	8	58.17**	273.04	0.09**	1.35*	45.43	0.71	19.53*	1042.52**	18.34**	112.25**	2159.91
En. + (Gen. x En.)	18	16.4	425.48*	0.01**	4.18**	82.62*	2.32	12.43	17820.90**	64.83**	4.89	6968.25*
En.	2	114.23**	1158.82	0.06*	35.75**	634.03**	17.72**	76.55**	147051.94**	575.56**	26.07**	56224.39**
Gen. x En.	16	4.17*	333.81	0.01	0.23*	13.69*	0.40**	4.42	1667.02	0.99*	2.24	811.23*
En. (Lin.)	1	228.47**	2317.64**	0.12**	71.51**	1268.06**	35.43**	153.10**	294103.88**	1151.11**	52.13**	112448.77**
Gen. x En. (Lin.)	8	7.18**	114.95	0	0.39**	22.35*	0.76**	4.92	151.76	1.74**	1.56	1329.38*
Pooled deviation	9	1.04	491.27	0.01	0.06	4.47	0.03	3.48	2828.69	0.22	2.6	260.51
Pooled error	48	2.9	268.24	0.02	0.33	9.13	0.14	5.91	878.99	1.08	1.56	111.67

* and ** indicates significance at 5% and 1% respectively

Table 2. Environmental indices value of 2011, 2012 and 2013 for different character in maize genotypes

Traits	DF	PH	SD	NL	LL	LW	TL	GFY	DM%	GY	SY	Average
2011	-3.2	0.76	0.01	2.13	8.8	1.58	2.44	28.47	5.75	1.96	-15.19	3.05
2012	-0.65	10.95	0.08	-0.32	-0.87	-0.49	0.78	-139.66	3.38	-1.04	-70.35	-18.02
2013	3.84	-11.71	-0.09	-1.81	-7.92	-1.1	-3.23	111.19	-9.13	-0.92	85.53	14.97

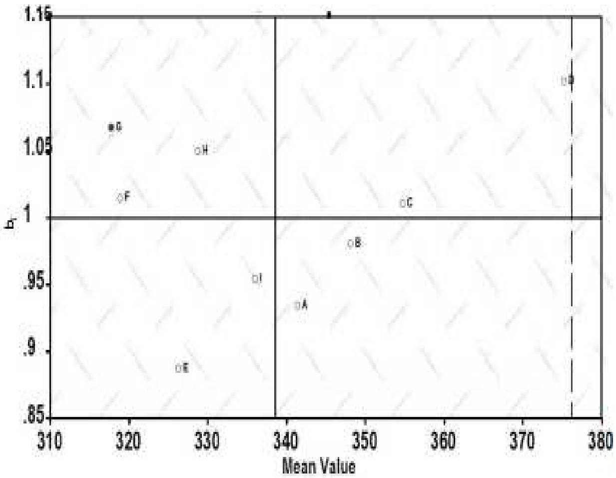

Fig 1. Scattered plot for mean vs bi for green fodder yield Black dark dot indicates non-stable for this character.

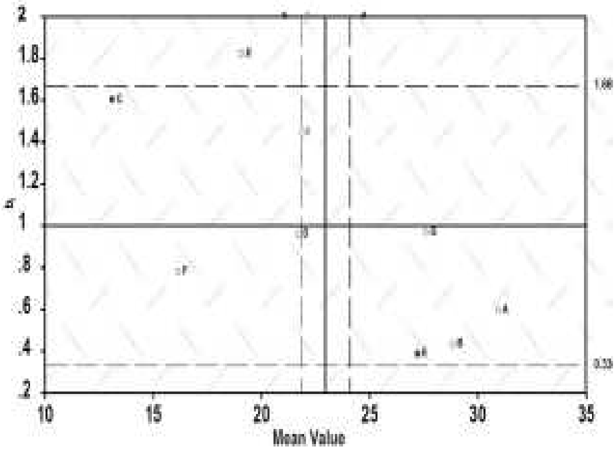

Fig 2. Scattered plot for mean vs bi for grain yield (Black dark dot indicates non-stable for this character.)

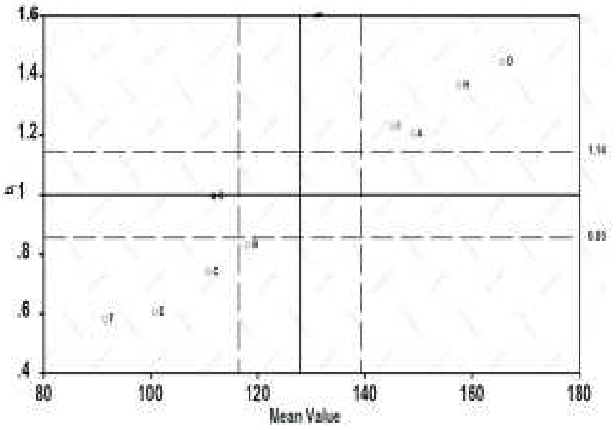

Fig 3. Scattered plot for mean vs bi for stover yield A-IGMF-1, B-IGMF-2, C-IGMF-3, D-IGMF-4, E-IGMF-5, F-IGMF-6, G-IGMF-7, H-African tall and I-J-1006. B

changing environments for all the traits except for PH, SD, TL, GFY and GY (Table 1). Similar findings for genotypic variation under different environments were also observed by Bhagirath *et al*. (2013).

Linear and non-linear components: The mean square due to G x E (Linear) were significant for all the traits except DF, NL, LL, LW, DM and SY revealing that the performance of the genotypes could be predicted for significant characters over the environments(Table 1). Similar analysis results for G x E were also observed by Muralia *et al*. (2002) and Aboud El-Nasr (2006). However, mean squares due to G x E(linear) for PH, SD, TL, GFY and GY indicating possible absence of genetic differences among the genotypes for their regression on the environments index and it was difficult to predict the performance for these traits. Since, non-linear responses for the traits PH, SD, TL, GFY and GY form non-significant G x E (Linear) interaction and linear response from non-linear component *i.e*., pooled deviation, the genotype differed with respect to stability of these.

Environmental indices and stability: On the basis of the value of the environmental indices for different traits the environment may be categorized as average in 2011, poor in 2012 and favorable in 2013 (Table 2). Stability depends upon expression of the characters in a steady state but allowing others to vary. The selections of stable with good performing genotypes were presented in figure 1 to 3. In the present study the genotypes showing average stability (bi=1) and higher mean than the population mean were IGMF-2 and IGMF-6 for DF; IGMF-4 for PH; IGMF-1, IGMF-4, IGMF-7 and African tall for SD; IGMF-4 and African tall for NL; IGMF-3 and IGMF-5 for LL; IGMF-5 and African tall for TL; IGMF-1, IGMF-2 and IGMF-7 for GY.

Genotype showing below average stability (bi significant and >1) with average to high mean than the population mean and specially adapted to favourable environments were IGMF-7 for DF; IGMF-1 for NL; IGMF-1 for LL; IGMF-1 and IGMF-7 for LW; IGMF-1 for TL; IGMF-5 and J-1006 for DM%; J-1006 for GY/ha; IGMF-1, IGMF-4, African tall and J-1006 for SY (Fig. 1 to 3).Genotypes showing above average stability (bi significant < 1) under poor environment with average or higher mean than the population mean and specially adopted to poor environment were IGMF-6 for LW; IGMF-1 and IGMF-3 for DM% (Fig. 1 to 3).

Conclusion

Considering the stability parameters it has been found that one genotype IGMF-1 was found to be higher mean and stable for maximum number of characters including GY and SY. This genotype is considered to be adaptive, hence stable.

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