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Research Article

Genetic Stability of Grain Yield and Principal Component an analysis in Pearl Millet (*Pennisetum glaucum* L)

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ABSTRACT

An experiment was conducted to study Principal Component A analysis, yield potential and yield stability of thirty four pearl millet genotypes at Gezira Research Farm (GRF) and Rahad Research Farm (RRS) in the autumn of 2009. The genotypes were of different genetic backgrounds and origin. The experiment was arranged in randomized complete block design with three replications and was carried out during the rainy season. Data were collected on days to 50% flowering, plant height, panicle length, number of productive tillers, head weight, grain yield and 100 seed weight (TSW).Days to50% flowering, head weight, panicle length, number of productive tillers and TSW were significantly and positively associated with grain yield. The first three components of principal component analysis (PCA) accounted for 69% of the total variability attributable to grain yield. The PC scores were associated with days to 50% flowering, panicle length, head weight, number of productive tillers and TSW. Results from yield stability analysis showed that Baladi white was the most stable genotype in terms of grain yield followed by Dembi yellow and Ugandi across sites, while ICMV 155 was the most unstable genotype. At least three of the thirty four pearl millet genotypes, Baladi white, dembi yellow and Ugandi, were stable across the tow site. The three genotypes had grain yield and TSW slightly higher the overall means and could be used in breeding program to further exploit yield potential and stability.

Keywords: genotypes, yield stability, grain yield, Sudan.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* [L.] R. Br.) is an annual and cross pollinated crop, and have chromosome number of 2n=2x =14. It is believed to be originated in West Africa. The term millet is brooding applied over 140 species belonging to the Genus Pennisetum. It is planted as a grain and fodder crop across a wide range of environments around the world(Raemaekers 2001)

Pearl millet is of a great importance in the arid and semi–arid tropics, where it is the stable food for millions of people. Today millet cover the food needs for more than 500 millions people, areas planted primarily with millet are estimated by 15 millions ha annually in Africa and 14 millions ha in Asia. The major Pearl millet producing countries in West Africa are Nigeria, Niger, Brukinafaso, Chad, Mali, Mauritania and Senegal. In Eastern Africa, it is grown commercially in Sudan and Uganda. Sudan, pearl millet is grown mainly for human consumption. It is a staple food for the vast majority of poor farmers in Western Sudan. Thus it remains an important component of the diets in Western Sudan; its use is reflected in many traditional dishes (Vogel and Graham, 1979).

The food quality and energy density of pearl millet is relatively high, rising from its higher oil content relative to maize, wheat or sorghum (Hill and Hanna, 1990). Pearl millet contain 27 to 30% more protein than maize, higher concentrations of essential amino acids, twice the other extracts, and higher gross energy than maize (Ejeta *et al.*, 1987). Then**,** the area currently occupied by pearl millet in Africa will continue to be planted to this crop in the future, and the crop will continue to have an important place in African agriculture as growing population pressure require the cultivation of marginal lands that would be suitable for growing pearl millet rather than maize and sorghum.

The term stability analysis is often associated with the analysis of variety trials. It refers to a method of assessing the variations of each variety between the tested environments. The yield of a variety in each environment can be regressed linearly on the average yields of all varieties to determine its stability across to the tested environments. The resulting regression coefficient, or slopes, can be taken to indicate whether each variety is stable across environments or it is sensitive to the differences between them (Dayke et al., 1994).

The detection of significant genotype x environment (GE) interaction indicates that phenotypic responses to changes in the environment are not the same for all genotypes. This may mean that the best genotype in one environment is not the best in another environment. If the interaction components are relatively large compared to the genotypic components, and if they are related to predictable environmental factors, the breeder searches for a cultivar that has general adaptability and universal performance over the range of environments (Abdelrahman and Abdalla, 2006). The present study was conducted to evaluate and identify the pearl millet varieties with wider adaptation over a range of environments using stability analysis and Principal Component.

MATERIAL AND METHOD

The plant materials used in this study were thirty four pearl millet genotypes from different genetic background. Two released varieties, Ugandi and Ashana, were used as checks. These genotypes were introduced from International Crops Research Institute for the Semi- Arid Tropic (ICRISAT) and West African. An experiment was during main season at Gazira Research farm (GRF), Gezira State and at Rahad Research Station (RRS).

The experiment Design was arranged in a randomized complete block design (RCBD) with three replications for each site. Each entry was planted on a two row plot, five meters long with inter-row spacing kept at 75 cm and between hills at 50 cm apart. All plots were thinned to 2 plants per hill three weeks after crop emergence. The exact sowing dates for the two sites were 9 August and 25 July 2009 at GRF and RRS, respectively. The first irrigation was given on same days of planting and later given at irrigation intervals between 10 to 15 days according weather conditions. All recommended cultural practices for pearl millet followed from crop growth till harvest.

All data were collated on 2 rows in each plot, Days to 50% flowering Plant height (cm), Panicle length(cm), Productive tillers (no), Head weight (kg plot-1), Grain yield (t ha-1) and 1000 seed weight(g).

Data were analyzed for each location separately and combined analysis across locations were performed for all traits and Analysis of variance (ANOVA) was carried out for grain yield using Statistical Analysis System (SAS, 1997). Stability analysis was carried across sites according to Finlay and Wilkinson (1963) only for grain yield and 1000 seed weight using the Participatory Plant Breeding software (PBSTAT 1.2).

RESULTS AND DISCUSSION

Analysis across tow sites revealed wide range of variation and significant differences among the thirty four pearl millet genotypes for grain yield, TSW,days to 50% flowering, panicle length and productive tillers are presented in table (Table 1). The combined analysis of variance showed significant differences for genotypes and genotypes × site interaction for most of the character, panicle length, productive tillers, grain yield and TSW this variation could be attributed to genetic and environmental effects as well as their interaction . Substantial variations in pearl millet have been reported by (Abdelrahman et al. 2002; Musa,2013) .

Table1: Genotypic, phenotypic variances and heritability estimates of 34 pearl millet genotypes

SOV	DF	Days 50% flowering (day)	Plant height (cm)	Panicle Length (cm)	Productive tillers (no.)	Head weight (kg/plot)	Grain yield (t/ ha-1)	1000 seed weight (g)
Site	1	60.4**	5917.4**	637.1***	37.7**	2.4**	5.4***	13.6**
Rep x Site	4	11.4	800.4**	28.1**	3.8	2.3***	1.4***	3.1**
Genotype	33	23.1***	192.4	16.7**	4.9*	0.4	0.3*	1.4**
Genotype ×Site	33	0.9	184.5	12.7*	5.6**	0.4	0.7**	1.2*
Error	132	6.9	129.5	7.4	3.1	0.4	0.2	0.7
Mean		56.4	169.8	24	6.1	2.3	1.3	9.5
C.V.		4.7	6.7	11.3	28.8	26	20.5	8.7

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respective.

The relationship between yield and some yield components was determined by simple correlations and principle components analysis. The analysis of simple correlation revealed that days to 50% flowering, panicle length, Number of productive tillers and head weight had significant and positive correlations with the grain yield (Table 2). Head weight had highly significant and strongest relationship (r=0.84***) with grain yield. The knowledge on correlation help in determining the contributions of components to yield.

Table 2. Simple Linear Correlation coefficients between yield and some yield components in pearl millet

Character	PH	PL	NPTL	HDW	GYLD	TSWT
FD	-0.17*	0.18*	0.02	0.06	0.15*	0.06
PH		0.01	-0.09	0.17*	0.06	0.20**
Panicle length (cm)(PL)			0.02	0.19**	0.27***	-0.01
Productive tillers/hill (no.) (NPTL)				0.24**	0.19**	-0.17*
Head weight (kgplot-1) (HDW)					0.84***	0.08
Grain yield (t ha-1)(GYLD)						0.03
1000 Seed weight (g) (TSW)						

*,**,*** Significant at 0.05, 0.01 and 0.001 probability levels respectively.

FD = 50% flowering (day); PH = **Plant height (cm);** PL = Panicle length; Number of productive tiller; HDW = Head weight ; GYLD = Grain yield ; TSWT = thousand seed weight.

The results suggest that head weight appreciable contribution to grain yield of pearl millet; other components such as panicle length and number of productive tillers had considerable contribution to grain yield and could be used as selection index for yield improvement. The positive correlation between days to 50% flowering and grain yield suggest that late maturing genotypes had high yield potential. These findings agree with that of Totok el al.(1998) who found significant correlations between grain yield, seed weight and panicle weight.

The extent of contribution of a particular yield component to grain yield may not be judged only from correlation, genotypic and phenotypic variations studies (Arulselvi el al., 2008), but also by using other statistics (Table 3) such as principal components analysis (PCA) that helps to explain the contribution of other components to yield.

Table 3. Eigenvectors of the first three principle component axes (PC1, PC2, PC3) for yield components of pearl millet.

Character	PC1	PC2	PC3
Days to 50% flower (day)	0.32	-0.55	0.37
Plant height (cm)	-0.05	0.72	-0.05
Panicle length (cm)	0.51	0.11	-0.06
Productive tillers (no.)	-0.56	-0.24	0.18
Head weight (kg plot-1)	-0.29	0.25	0.78
1000 Seed weight (g)	0.49	0.20	0.47
Proportion%	**28.37**	**22.41**	**17.85**

The first three components accounted for 86.63% of the total variability. PC1 accounted for 28.37% of the total variability, while PC2 and PC3 accounted for 22.14% and 17.87%, respectively, of the total variability (Table 3). The PC scores were associated with increase in number of productive tillers, panicle length, head weight. TSW and lateness (days 50% flowering) all which contributed to the total variation attributable to grain yield. These results confirmed panicle length, head weight and thousand seed weight contribution to grain yield of pearl millet.

The analysis of variance across sites showed significant differences among genotypes for grain yield and TSW, which made it necessary for running stability analysis. Results from the stability analysis showed that Baladi white was the most sable genotype in terms of grain yield (bi =-0.79, SDi =0.3) and TSW (bi = -0.76, SDi =0.1) followed by Dembi yellow and Ugandi across sites, while ICMV 155 was the most unstable genotype. The three genotypes had grain yield slightly above the over all mean (1.3 tha-1) Although SADC Togo exhibited high grain yield across sites, it is not stable across the sites (Table3). described that genotypes with regression slope (b)significantly greater than unity were specifically better adapted to favorable environments and those having regression slope significantly lower than the unit were considered to be adapted to poor environments The Peterson (1988) and Finlay and Wilkinson (1963).

Table 4. Estimates of yield and 1000 seed weight stability in thirty four pearl millet genotypes.

	Grain yield stability			1000 Seed weight stability		
Genotype	(t ha-1)	bi	SDi‡	(g)	bi	SDi‡
ICMV 91059	1.17	0.42	0.8	8.77	0.39	0.5
ICMV 221	1.41	0.14	0.5	9.67	1.30	0.8
BALABI White	1.32	-0.79	0.3	9.81	-0.76	0.1
ISC III	1.10	0.52	0.6	9.92	3.57	0.9
BEMBI Yellow	1.31	-0.55	0.2	9.69	0.08	0.3
OKASHANA-3	1.59	1.04	0.7	9.22	3.44	0.8
BAUDA	1.39	1.51	0.9	9.40	2.84	0.7
SADAC (Togo)	1.70	2.88	0.7	9.93	1.03	0.9
BAHABAYA	1.32	0.65	0.4	9.77	1.69	0.7
SADAC (Long)	1.50	1.54	0.6	9.46	3.06	0.4
SUDAN I	1.38	2.04	0.8	9.63	1.14	0.6
IP 19743	1.14	1.48	0.3	9.14	0.56	0.8
MCNELC	1.24	0.65	0.3	8.62	2.38	0.7
GB 8735	1.23	0.31	0.5	9.83	3.23	0.4
IP 19854	1.48	2.74	0.7	10.20	3.34	0.6
ICMV.155 White	1.28	0.82	0.3	8.17	1.95	0.8
SDMV 95030	1.30	1.51	0.5	9.06	2.80	0.3
ICMV.155 Bristled	1.18	-0.66	0.2	9.44	1.69	0.4
SUDAN III	1.28	1.93	0.4	10.08	0.29	0.6
SUDAN II	1.49	0.65	0.6	9.39	1.51	0.8
BALADI Yellow	1.42	1.15	0.8	10.00	-1.29	0.2
IP 19745	0.75	-0.50	0.3	9.05	0.21	0.5
OKASHANA-1	1.47	0.42	0.3	9.62	-1.49	0.3
IP 19706	1.29	0.96	0.5	9.32	2.51	0.8
ISC II	1.19	1.29	0.7	9.34	-2.55	0.1
Top-Cross polli.	1.39	1.16	0.3	9.08	-1.00	0.4
ICMV.155	1.17	3.07	0.8	9.30	2.45	0.4
MCSRC	1.51	1.89	0.4	9.90	0.89	0.6
ASHANA	1.40	2.88	0.6	10.16	-0.68	0.2
IP 19827	1.40	2.75	0.8	8.92	-1.62	0.3
UMGARFA	1.14	-0.21	0.3	9.66	1.25	0.4
SOSAT-C8	1.22	0.94	0.7	10.36	-2.49	0.1
UGANDI	1.33	-0.02	0.2	10.01	0.05	0.2
SDMV 95032	1.15	-0.63	0.3	9.57	2.21	0.6
Mean	1.30			9.51		

bi = regression coefficient SDi‡ = deviation from regression l

CONCLUSIONS

The stability across tow site showed significant interaction among thirty four genotypes for tow traits (grain yield, TSW) and these yield components contributed positively to grain yield as demonstrated by simple correlation coefficients, and principal components. At least three of them, Baladi white, Dembi yellow and Ugandi, were stable across the two sites and three had grain yield and TSW slightly higher than the overall, and could be used in breeding program to further exploit their yield potential and stability.

COMPETING INTEREST

Authors have declared that no competing interests exist.

AUTHOR'S CONTRIBUTION

This work was carried out in collaboration between the two authors, the authors read and approved the final manuscript.

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