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Full Length Research

Performance of six pearl millet (*Pennisetum Glaucum* (L.)R.Br) varieties in the semi – arid Kitui County of Kenya

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Cereals are important crops grown and consumed globally,regionally and locally. However, world cereal yields and agriculture production have declined due to frequent droughts,erratic and unreliable rainfall especially in sub-saharan Africa.Pearl millet (*Pennisetum glaucum* (L) R. Br) accounts for almost half of the global production of the millet species. The limited adoption of improved hybrid pearl millet *(Pennisetum glaucum)* in the semi arid zone of South Eastern Kenya has been attributed to the lack of hybrids with sufficient adaptation to this Zone.Therefore, identifying high yielding pearl millet varieties with farmer preffered traits and adapted to drought stress is very significant and relevant for plant breeding. The objective of the study was to determine the stability and adaptability of pearl millet genotypes with a view to evaluating and identifying the high yielding pearl millet varieties for the ASALs. This study compared five pearl millet hybrids and one traditional landraces over three cropping seosons. The results indicated that genotype Pvs-Pm 1005 recorded significantly (P<0.05) for grain yield compared to other five genotypes. Kimbeere recorded low above ground biomass yield compared to all other pearl millet varieties (15.5, 10.6 and 10.3t/ha in season 1, 2 and 3 respectively.1000 grain weight was significantly (p<0.05) different across all the six pearl millet genotypes. Kimbeere (local variety) recorded significantly lower weight of 1000grain weight across all the three seasons. Across all the seasons the average grain yield ranged from 1049.1 kg ha^{-1} to 1694.3kg ha^{-1}. The mean grain yield of the local variety was lower to that of the hybrids which also provided significantly higher biomass and stover yield. In overall,the hybrids out yielded the landraces for grain productivity. These results confirm that even under well managed, but rainfed, arid zone environments, current hybrids offer farmers more advantage over their traditional landrace.

Key words: *Pennisetum glaucum,* Pearl millet, landraces, hybrids, grain yield, yield components.

INTRODUCTION

Pearl millet is an important cereal,forage and stover crop for arid and semi-arid regions of Africa and south Asia due to its high nutritional value and its exceptional tolerance to drought and high temperature(Sathya et al., 2013: National Research Council, 1996: Uzom et al., 2010: FAO, 2010: Dave, 1987). However, Pearl millet *(Pennisetum glaucum* (L) R. Br.) is a neglected and under-utilized traditional dryland crop in the drier parts of Arid and Semi-Arid Tropics (Obilana, 2003). Pearl millet has higher nutritional quality than many other cereal grains in terms of minerals and macronutrient quality (Saleh et al., 2013). As an orphan crop, the potential of pearl millet for climate-resilient agriculture has yet to be fully realized (Campell et al.,2014:Vershney et al.,2012).

In Kenya pearl millet is a traditional crop, which is grown in many parts of the country especially in the arid and semi-arid regions of Makueni, Machakos, Kitui, Embu, Mbeere, Coast and Kirinyaga (Maundu et al., 1999).It is grown mainly for subsistence use, but the crop lost favour with farmers when maize became the preferred crop and staple food after its introduction by the white settlers (Raschhke & Cheena, 2007).

Over the decades most farmers have abandoned pearl millet for maize (Nuss & Tanumihardjo, 2011). However, due to the desire to stabilize food security in the country there is now renewed interest in promoting drought-tolerant crops such as pearl millet and sorghum, which are known to be well adapted to harsh environments (GoK, 2009).

Ensuring food security in the world's arid and semi-arid regions is a great challenge due to rapid population growth and strong effects of climate change in these regions (Lobell et al., 2008). Food security in these regions would be strengthened by higher crop yields and greater yield stability of staple crops (Wheeler.,2013).

MATERIALS AND METHODS

Description of experimental site

The current field investigation was conducted at South Eastern Kenya University main campus research farm to determine growth and yield of six pearl millet (*Pennisetum Glaucum* (L.)R.Br) varieties in the semi-arid Kitui county of Kenya. The SEKU site is located at Kwa Vonza division in the Lower Yatta, Kitui County, 17 Kilometers off Kwa Vonza Market, along the Kitui-Machakos main road. This area is in eco-zone V (Jaetzold and Schmidt 1983). It is a semi-arid area with the annual rainfall amount ranging between 400mm-800mm, temperature ranging between 14^0 C- 34^0 C latitude 1^0 22 57 S, longitude 38^0 00 19 E and 1152m above sea level. The soil type of the experimental area are predominantly sandy to loamy sand texture, hence they are susceptible to erosion and are limited in their capacity to retain water and nutrients. The soils are generally poorly drained and easily eroded by runoff (Borst & De Haas, 2006).The area is mainly characterized by crop+Livestock mixed farming system comprising non legumes like maize,sorghum,Finger millet,pearl millet;legumes such as beans,cowpeas,pigeon peas besides banana,mango and pawpaw.

Description of the experimental materals

Plant materials

In the present study, pearl millet varieties Pvs-Pm 1005, Pvs-Pm 1006, Pvs-Pm 1002, Pvs-Pm 1003, Pvs-Pm 1004 and Kimbeere (local variety) were used.

Experimental design and plot management

The experiment was laid out in a completely radomized design with three replications. The experiment was established on piece of land previously ploughed and harrowed using a tractor. The land was leveled to provide a medium fine tilth seedbed for the growth of the crops. Measuring and marking of the plot and sub plots was done thereafter in accordance with the layout .Gross plot size was 41m long and 15.75m wide. The plot was further divided into smaller plots of 5m long and 5.25m wide. Alley ways were created between the replicates of width 1m. Sowing was done at spacing of 75cm between rows by drill between plants. The plants were later thinned to intra row spacing of 30 cm after two weeks of germination. Weeds were managed by hand weeding after weed emergence and late-emerging weeds were also removed by hand hoeing to avoid competition for nutrients.

Crop Data collection

Data collection was done on the net plot i.e. three inner rows of each plot on the following characters according to Izge *et al.(*2005) and Nwasike *et al.(*1992). Plant characteristics recorded were:

- Millet above ground biomass
- Thousand Grain Weight (TGW): Mass (g) of 1000 grains of pearl millet.
- Grain yield per net plot: Mass of harvested grains per net plot (g)-This was taken from threshed and winnowed grain for each plot
- Harvest index

Crop growth parameters:

Yield and yield components: Five pre-tagged randomly selected plants were considered for determination of above ground dry biomass weight by drying in sunlight for ten days till a constant dry weight was attained, and thousand seeds of pearl millet was counted and weighed (g) using sensitive balance from the bulk of the seeds of pearl millet and adjusted to 13.5% moisture level. Number of effective tillers / plant was counted at physiological maturity. Grain yield (Kg/ha) was recorded after harvesting from the central three rows of the net plot. Seed yield was adjusted to 13.5% moisture using moisture tester and converted to Kg ha^{-1} for statistical analysis.

Statistical analysis

All data collected were subjected to the analysis of variance (ANOVA) using Genstat 15th Edition(VSN-International, 2012). Where treatment means are significant, the Duncan multiple range test at alpha=5% was adopted for mean comparison.

RESULTS AND DISCUSSIONS

Yield Components of six pearl millet genotypes in three seasons.

Table 1, shows that 1000 grain weight Pvs-Pm 1005 was significantly ($p<0.05$) different across all the 6 pearl millet genotypes. Kimbeere recorded significantly lower weight of 1000 grain weight compared to other five genotypes (Table 1). There is a notable trend in weight of 1000 grains across the three season which were significantly ($p<0.05$) different from each other with the season 1 (2012) recording higher weight of 1000 grain weight compared to season two and three. The trend in 1000 grain weight in all the three season reveal that Pvs-Pm 1005 and Pvs-Pm 1002 recorded higher grain weight (>15 g) in all the three seasons.

The data recorded on Stover yield reveals that Kimbeere consistently recorded low above ground biomass yield compared to all the other pearl millet varieties (15.5, 10.6 and 10.3t/ha in season 1, 2 and 3 respectively). A diminishing trend of above ground

Table 1: Yield and Yield Components for six genotypes of pearl millet in three seasons.

	Season 1			**Season 2**			**Season 3**		
Varieties	**1000 grain weight(g)**	**Stover Yield(t/ha)**	**Grain yield(Kg/ha)**	**1000 grain weight(g)**	**Stover Yield(t/ha)**	**Grain yield(Kg/ha)**	**1000 grain weight**	**Stover Yield(t/ha)**	**Grain yield(Kg/ha)**
Pvs-Pm 1005	15_{e}	30.3_{e}	2131_{e}	13.1_{c}	18.9_{d}	1224_{d}	8.7_{b}	19.23_{d}	1005.7_{b}
Pvs-Pm 1006	13.5_{d}	27.63_{d}	1330_{b}	10.9_{b}	17.4_{d}	1834.3_{c}	9.5_{bc}	14.97_{bc}	1012.7_{b}
Pvs-Pm 1002	8.7_{a}	23.23_{c}	2022_{d}	15.1_{d}	15.13_{c}	952.3_{ab}	10.8_{bc}	15.3_{c}	1188.3_{c}
Pvs-Pm 1003	11.1_{c}	23.93_{c}	1482_{c}	13.6_{c}	12.8_{b}	682_{a}	8.7_{b}	13.33_{b}	1334.7_{d}
Pvs-Pm 1004	8.9_{a}	21.37_{b}	2069_{d}	11.4_{b}	12.8_{b}	921.3_{ab}	7.3_{a}	10.67_{a}	1123.7_{c}
Kimbeere	9.9_{ab}	15.5_{a}	1132_{a}	6.2_{a}	10.6_{a}	680.3_{a}	6.7_{a}	10.33_{a}	704_{a}
LSD	1.0	1.4	110.1	1.0	1.4	110.1	1.4	1.4	110.1

Values followed by the same subscript letters in the same column are significantly different ($P<0.05$) from each other at 5% level according to ANOVA protected LSD test.

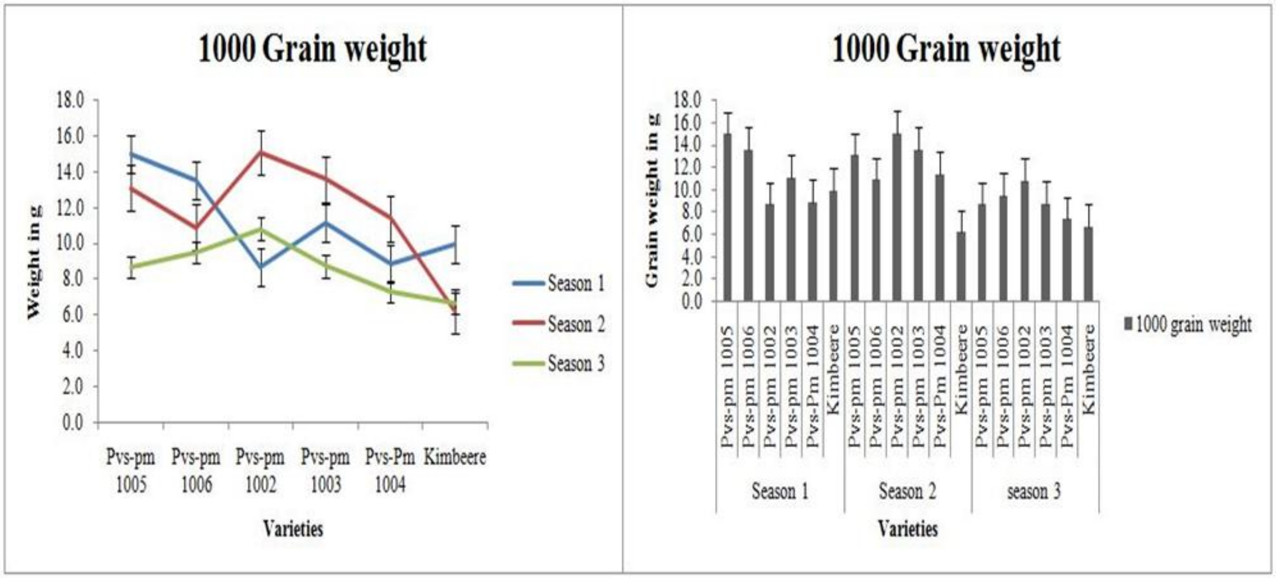

Figure 1: 1000 grain weight of pearl millet varieties across three cropping seasons (2012, 2013 and 2015)

biomass yield was noted across the three seasons in all the 6 pearl millet varieties and this was attributed to the low and unreliable rainfall that is shown in the graph above. Pvs-Pm 1005 recorded the highest above ground biomass in the first and second season while it was Pvs-Pm 1002 that recorded significantly (p<0.05) high above ground biomass in season 3.

In the data computed for grain weight Pvs-Pm 1005 recoded significantly (p<0.05) higher grains compared to other 5 genotypes of pearl millet variety while it was Pvs-Pm 1003 that recorded significantly (p<0.05) more grains in season 3 compared to other pearl millet varieties (Table 1).Across the season there was observed a decline in grain recorded progressively starting 2013 all the way to 2015 and this was attributed to low and unreliable rainfall that was received in the study area.

1000 Grain Weight

The data below (Figure 1) shows that 1000 grain weight was significantly (p<0.05) different across all the 6 pearl millet genotypes. Kimbeere recorded significantly lower weight of 1000 grain weight compared to other five genotypes. There is a notable trend in weight of 1000 grains across the three season which were significantly (p<0.05) different from each other with the season 1 (2013) recording higher weight of 1000 grain weight compared to season two and three. The trend in 1000 grain weight in all the three season reveal that Pvs-Pm 1005 and Pvs-Pm 1002 recorded higher grain weight (>15 g) in all the three seasons (Figure 1).

Millet above Ground Biomass

The data recorded on Stover yield reveals that Kimbeere consistently recorded low above ground biomass yield compared to all the other pearl millet varieties (15.5, 10.6 and 10.3t/ha in season 1, 2 and 3 respectively). A diminishing trend of above ground biomass yield was noted across the three seasons in all the 6 pearl millet varieties and this was attributed to the low and unreliable rainfall that is shown in the graph below (Figure 2). Pvs-Pm 1005 recorded the highest

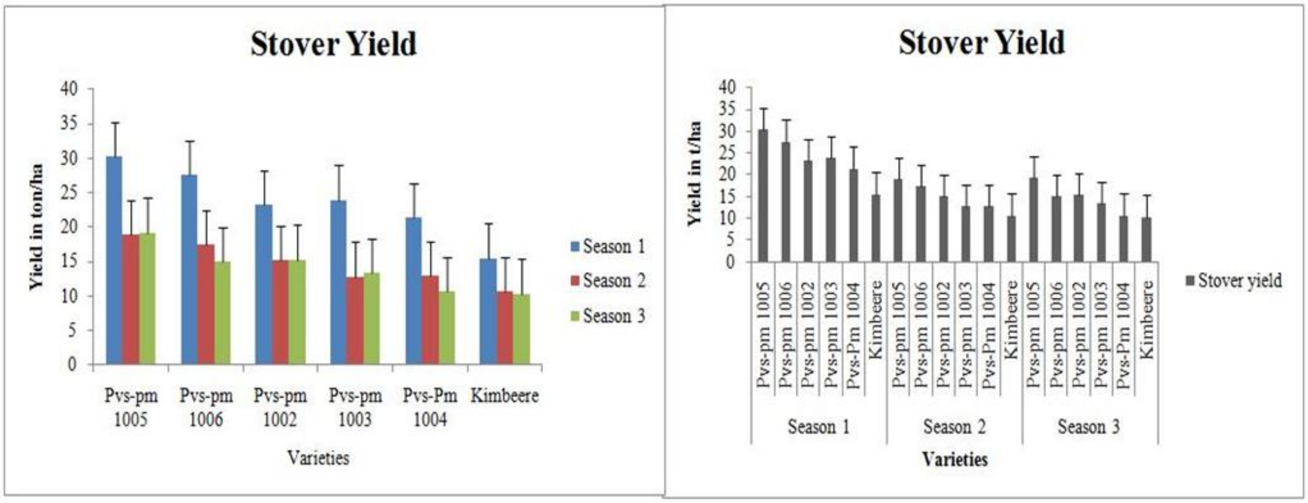

Figure 2: Above Ground Biomass of six pearl millet across three cropping seasons (2012, 2013 and 2015)

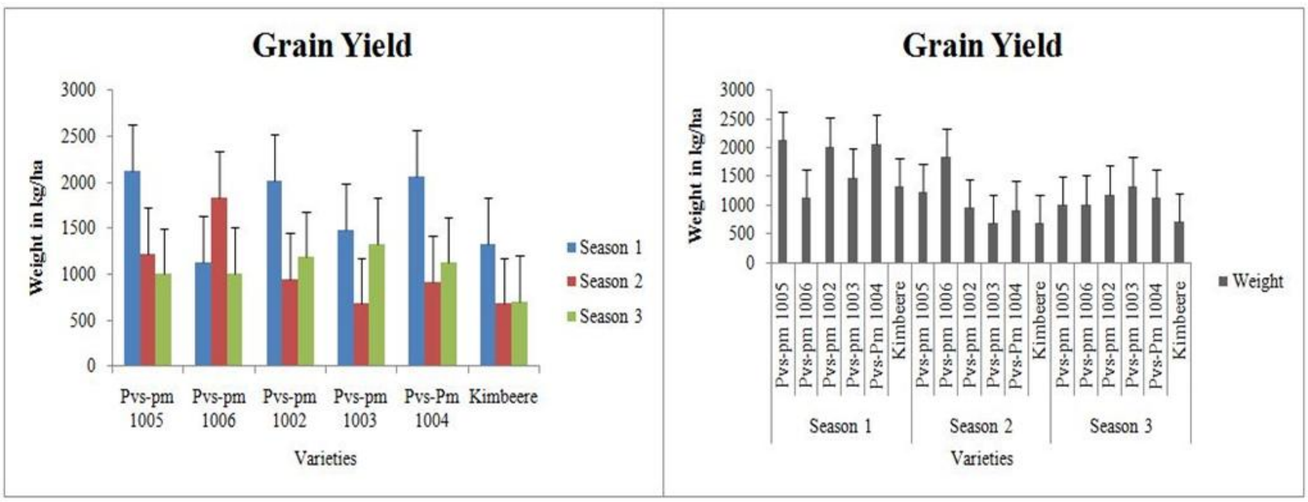

Figure 3: Grain yield of each Pearl millet varieties in every cropping season

above ground biomass in the first and second season (30.3 t/ha and18.9 t/ha respectively) while it was Pvs-Pm 1002 that recorded significantly ($p<0.05$) high above ground biomass in season 3. Stover yield followed a trend like that of grain yield with the better performers also producing higher straw yields compared to their lower yielding counterparts.

The results presented in figure 2 indicated that the five hybrid varieties yielded significantl dry matter in comparison with the local variety(Kimbeere).Kimbeere variety has shown poor performance with respect to dry matter yield because of its poor plant at the time of germination.Similar results were reported by Begg and Burton(1973)

Grain Yield

In the data computed for grain weight Pvs-Pm 1005 recorded significantly ($p<0.05$) higher grains compared to other 5 genotypes of pearl millet variety while it was Pvs-Pm 1003 that recorded significantly ($p<0.05$) more grains in season 3 compared to other pearl millet varieties (Figure 3). The yield should not be considered as a single trait but rather a group of traits, composed of the many components and is the final result of a plant life cycle (Borojevic, 1990). The total grain yield varied considerably among the genotypes.Gravois (1994) reported similar results in rice and in maize by Nevado and Cross, (1990). The greater perfomance of the hybrids could be as a result of hybrid vigor existing among the hybrid.The varieties which ripened earlier yielded more grain and the ones which ripened lately yielded more dry matter content.Other characters like spike length and number of tiller per plant were also in favour of grain yield.Similar results were reported by Sachdeva (1981).

CONCLUSION AND RECOMMENDATIONS

This study which characterised pearl millet genotypes in order to establish a basis for exploiting the genetic potential for the development of high yielding (hybrid) varieties in Kenya revealed significant variability among the genotypes for most of the characters studied pointing to potential for genetic improvement in pearl millet as superior ones can be isolated from the rest. The work confirmed that even under well managed, but rainfed, arid zone environments, current hybrids offer farmers more advantage over their traditional landrace. On the basis of growth and yield of the six pearl millet varieties ,Pvs-Pm 1005 and Pvs-Pm 1002 were identified as superior for semi arid conditons of South Eastern Kenya.

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