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RESPONSE OF PEARL MILLET (*Pennisetum glaucum* L.) VARIETIES TO SEED PRIMING IN SEMI ARID ECOLOGIES OF NIGERIA

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ABSTRACT

Field trials were carried out during 2016 rainy season at Bayero University Teaching and Research Farm, Kano and Demonstration Farm of Lake Chad Research Institute, Maiduguri to study the response of Pearl Millet varieties to seed priming. Treatments comprised of factorial combinations of five seed primers (Potassium chloride (KCl), Calcium chloride ($CaCl_2$), Cow urine, Cowdung extract and Control) and four pearl millet varieties (LCICMV-1, LCICMV-2, LCICMV-3 and LCICMV-4) and were laid out in a Randomized Complete Block Design in three replications. Data were collected on plant height, panicle length, one thousand grain weight, chlorophyll and relative water contents. Data were subjected to analysis of variance and treatments means were separated using Duncan Multiple Range Test at 5% level of probability. Results indicated that growth and yield parameters of pearl millet were significantly ($P< 0.05$) affected at both locations. Seed priming with KCl had significantly higher plant height, panicle length, one thousand grain weight and grain yield per hectare at both locations, except in Maiduguri where application of cowdung lead to higher chlorophyll content. Pearl millet varieties LCICMV-1and LCICMV-2 recorded higher grain yield of 1019 and 1055 kg/ha for Kano and Maiduguri, respectively. Conclusively, pearl millet varieties of LCICMV-1 or LCICMV-2 and KCl as seed priming substance is recommended in the arid ecologies of Nigeria.

Keywords: Pearl millet; seed priming; varieties

INTRODUCTION

Pearl Millet (*Pennisetum glaucum* L.) is cultivated on 16 million hectares with average grain yield of 800-1000 kg/ha in West and Central Africa (Izge *et al.,* 2009). Food and Agriculture Organisation (FAO) (2007) reported that annual production of pearl millet was about 8.2 million tons in Nigeria, where 6.4 million tons were used directly as food and 1.8 million tons was used as seeds. Pearl Millet production by smallholder farmers in Sub-Saharan Africa is faced by a myriad of production constraints which include; low yielding varieties, erratic rainfall pattern, and recurrent droughts (Ncube *et al*., 2009; Kurwakumire *et al*., 2014).

In Nigeria, soil moisture stress is a major limiting factor for determining its growth and yield (Manjunath, 2010). Therefore, there is a need to identify suitable ameliorative measures to overcome the moisture stress on pearl millet. Priming is one of the simple technique being employed to modify the morpho-physio-biochemical nature of the seed for favourable growth and development (Majunath and Dhanoji, 2011). However, little or no research work has been conducted to ascertain the effect of different priming substance on pearl millet. In view of the above, field trials were conducted with the aim of determining the best seed priming for pearl millet variety (s) in Sudan savanna, Nigeria.

MATERIALS AND METHODS

Study Area

Field experiments were conducted during 2016 rainy season at Bayero University Teaching and Research Farm, Kano (Latitude 11.58^0 N and Longitude 8^0 33' E with an altitude of 475 m above sea level) and Lake Chad Research Institute's Demonstration Farm, Maiduguri (Latitude 11.54 ^{0}N and Longitude 13.50 ^{0}E with altitude of 315.5 m above sea level) and both locations were situated within the Sudan savanna of Nigeria. The areas are characterized by natural vegetation with sparse trees (5-9 m tall), dominated by widely spaced shrubs and grasses (Abubakar, 2000). Short and erratic rainfall, usually falling between the months of June and September (500 – 800 mm/annum). Minimum and maximum temperature range from 35 ^{0}C – 37 ^{0}C; humidity is recorded to be constantly below 40% in the dry season (Nov./May) but can rise up to 70% during wet season (Kowal and Kassan, 1978). The soils in the study area are reddish-brown with little profile differentiation, generally described texturally as sandy and sandy loam with low organic matter content (Ogigirigi, 1993).

Treatments and Experimental Design

The treatments consisted of five seed priming substances ($CaCl_2$, KCl, Cow urine, Cowdung extract and Control) and four millet varieties (LCICMV-1 (SOSAT-C88), LCICMV-2 (LCIC9702), LCICMV-3 (SuperSOSAT) and LCICMV-4 (PEO5984). The treatments in a factorial combination were laid out in Randomised Complete Block Design (RCBD) in three replications. Individual plot size was 6 x 4.5 m (27 m^2) with 3 x 3 m (9 m^2) as net plot size.

Land Preparation and Crop Management

Cowdung extract was obtained by pouring the cowdung into a bowl and water was added in order to make a paste, which was pressed firmly to release the liquid from the paste. Pearl millet seeds were soaked for six hours separately in 2% solution of $CaCl_2$, KCl, Cow urine, Cow dung extract and Control (ordinary water). The seeds were later dried under shade for 24 hours and then sun dried for three hours to bring them back to their original moisture content and used for sowing. The spacing used was 75 x 50 cm at 3 cm depth, given a population density of 26666.67 plants per hectare. Fertilizer was applied at the rate of 60, 30 and 30 kg N, P_2O_5 and K_2O, respectively using NPK (15:15:15) and urea (46% N). The fields were weeded twice at 4 and 7 WAS.

Data Collection and Analysis

Parameters measured are;

Plant height (cm): Plant height was taken from five tagged plants using meter rule. Measurement was done from ground level to the height at harvest.
Panicle length (cm): Panicle length was measured at harvest from five tagged plants using meter rule, and mean recorded thereof.
One thousand-Seed weight (g): Grain yield was determined by counting and weighing 1000 grains from the panicle yield of each net plots.
Grain yield ha^{-1}: Seed yield/hectare was determined by weighing all the seeds harvested from each net plot and converted to kilograms/hectare.

$$\text{Grain yield kg}^{-1} = \frac{\text{Grain yield/net plot}}{\text{Net plot area}(\text{m}^2)} \times 10{,}000\ \text{m}^2$$

Chlorophyll content: This was determined at 6 WAS using metre model Minolta SPAD 502.
Relative water content: This was obtained by subtracting weight of dry weight from weight of fresh leaves weight at 6 WAS.

Data generated were subjected to Analysis of Variance using Statix 8.0 Statistical Package and multiple comparison of treatment means were carried out using Duncan Multiple Range Test (Little and Hills, 1978) at 5% level of probability.

RESULTS AND DISCUSSION

Effect of Chemical treatments and Varieties on Growth Characters

Plant height, chlorophyll and water contents at maturity were statistically affected by seed priming and varieties (Table 1). Pearl millet treated with KCl recorded statistically taller plants in the two locations than those treated with $CaCl_2$ and cow dung extract which was statistically similar while control produced the shortest millet plants (Table 1). At Kano, LCICMV-1 and 2 were statistically (P<0.05) taller than LCICMV-3 and 4 which were at par while at Maiduguri LCICMV-1 and 4 gave taller plants than other varieties that were statistically similar.

Seed priming and pearl millet varieties had significant (P<0.05) effect on chlorophyll content in both locations (Table 1). In both locations cowdung extract recorded significantly higher chlorophyll content, although at Kano, chlorophyll content were similar on plots treated with KCl. Similarly, at Maiduguri, with the exception of cowdung extract, KCl recorded significantly higher chlorophyll contents than all other treatments which were statistically similar. Millet varieties had significant (P<0.05) effect on chlorophyll content at Maiduguri with LCICMV-1 and 4 had higher but similar chlorophyll content while LCICMV-2 and 3 produced statistically similar chlorophyll content.

Application of KCl on pearl millet varieties resulted in significantly (P<0.05) higher relative water content than other treatments (Table 1). However, $CaCl_2$ produced significantly (P<0.05) higher relative water content than cowdung and cow urine while control recorded the least effect. From Table 1, result indicated that LCICMV-1 and 3 recorded the highest water content for Kano and Maiduguri, respectively.

Table 1: Response of pearl millet (*Pennisetum glaucum* L.) to seed priming at Kano and Maiduguri, during 2016 raining season

Treatments	Kano			Maiduguri		
	PLH (cm)	CHLC	RWC	PLH (cm)	CHLC	RWC
Primers (A)						
Control	85.25^{d}	23.49^{b}	2.04^{e}	85.34^{d}	22.94^{c}	1.87^{e}
$CaCl_2$	122.35^{b}	22.30^{b}	4.09^{b}	117.53^{b}	22.55^{c}	4.10^{b}
KCl	129.93^{a}	27.68^{a}	5.26^{a}	128.82^{a}	26.83^{b}	5.72^{a}
Cow urine	97.76^{c}	24.15^{b}	2.69^{d}	96.62c	22.12$_{c}$	2.75^{d}
Cow dung extract	119.10^{b}	28.53^{a}	3.47^{c}	105.23^{b}	29.20^{a}	3.56^{c}
SE±	1.244	1.097	0.125	1.3988	0.566	0.115
Millet Variety (B)						
LCICMV-1	115.68^{a}	25.11	4.63^{a}	111.13^{a}	26.14^{a}	3.58^{b}
LCICMV-2	118.63^{a}	25.02	4.03^{b}	107.45^{b}	23.71^{b}	3.37^{b}
LCICMV-3	102.63^{b}	24.30	2.99^{c}	105.01^{b}	23.17^{b}	5.08^{a}
LCICMV-4	104.58^{b}	26.49	2.38^{d}	111.27^{a}	25.89^{a}	2.37^{c}
SE±	1.113	0.981	0.112	1.2511	0.506	0.103
Interaction						
A × B	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment column are not significantly different at 5% level of probability using DMRT. NS = Not significant at 5% probability level, PLH = plant height, CHLC = chlorophyll content, RWC = relative water content.

This study showed that seed priming had significant ($P<0.05$) effect on measured growth characters of pearl millet. The disparity observed with regards to response on different seed primers could be attributed to their peculiar mode of action. This was corroborated by the findings of Manjunath and Dhanoji (2011) who reported that mode of action of seed differs. The reason for the reduction in plant height in the control may be due to reduced cell size and cell thickening, while the increase in plant height with seed priming might be as a result of cell enlargement and improvement in normal cell division (Ginzo, 1977). Similarly, Pawar *et al.* (2003) reported increase in plant height and yield of sunflower and attributed it to active synthesis of proteins and soluble sugars in the first phase of germination which have advantages for subsequent growth phases. Similarly, the higher chlorophyll content recorded by seed priming over control may be due to maintenance of cell turgidity, denser cytoplasm and inhibition of chlorophyll breakdown. Similar results were earlier reported by Cheema *et al.* (1975) and Shasidhar *et al.* (1981) independently on barley and wheat, respectively. Furthermore, the reduction in relative water content as observed in the control plots might be triggered by water deficit in the soil as a consequence of water lost through the stomata. This was in agreement with the findings of Siddique *et al*. (2000) on wheat and Pirdashti *et al.* (2009) on rice.

Effects of Chemical treatments and Varieties on Yield Characters

The influence of priming showed that at both locations, KCl recorded significantly ($P<0.05$) higher panicle length (Table 2). Panicle produced by treated $CaCl_2$ was longer than cowdung extract while the later produced longer millet panicle than cow urine. The least panicle length was obtained from the control. It was observed that varieties LCICMV-2 and 3 recorded longer but similar panicle length than others in Kano. However, LCICMV-4 was shorter than LCICMV-1. At Maiduguri, LCICMV-1 gave significantly longer panicle than LCICMV-2 but was at par with LCICMV-3.

Table 2. Yield and yield components of pearl millet (*Pennisetum glaucum* L.) varieties as affected by seed priming at Kano and Maiduguri, during 2016 raining season

	Kano			Maiduguri		
Treatments	PNL (cm)	TGW (g)	GYDH (kg)	PNL (cm)	TGW (g)	GYDH (kg)
Primers (A)						
Control	19.97[e]	8.99[e]	422.2[e]	21.01[e]	8.52[d]	395.9[e]
$CaCl_2$	26.67[b]	12.73[b]	1240.0[b]	29.63[b]	9.63[b]	1281.5[b]
KCl	31.54[a]	13.97[a]	1527.4[a]	32.97[a]	10.58[a]	1601.[a]
Cow urine	21.72[d]	10.18[d]	684.1[d]	23.64[d]	9.14[c]	727.8[d]
Cow dung extract	24.28[c]	11.55[c]	966.3[c]	26.07[c]	9.32b[c]	1033.0[c]
SE±	0.435	0.168	4.824	0.487	0.135	16.111
Millet Variety (B)						
LCICMV-1	24.69[b]	11.57[b]	1019.0[a]	28.47[a]	8.81[b]	988.7[bc]
LCICMV-2	26.33[a]	10.44[c]	970.7[b]	26.29[b]	9.78[a]	1055.4[a]
LCICMV-3	25.83[a]	11.67[b]	959.1[b]	27.53[ab]	10.11[a]	1024.6[ab]
LCICMV-4	22.48[c]	12.25[a]	923.3[c]	24.36[c]	9.07[b]	963.3[c]
SE±	0.389	0.150	4.315	0.436	0.121	14.41
Interaction						
A × B	NS	NS	*	NS	NS	*

Means followed by the same letter(s) within a treatment column are not significantly different at 5% level of probability using DMRT. NS = Not significant at 5% probability level, PNL = panicle length, TGW = thousand grain weight, GYDH = grain yield per hectare

It was observed that application of KCl recorded the highest 1000-grain weight of millet than plots treated with other chemicals at both locations (Table 2). The lowest 1000-grain weight was obtained from the control. Millet variety significantly influenced 1000-grain weight at both locations. Millet varieties had also recorded a significant effect on 1000-grain weight. At Kano, LCICMV-4 gave higher grain weight than the other varieties while LCICMV-2 recorded least. In Maiduguri, LCICMV-2 and 3 gave statistically similar but higher 1000-grain weight than LCICMV-1 and 4 that were statistically similar.

Application of KCl leads to significantly higher grain yield/ha in both locations followed by $CaCl_2$ (Table2). Least grain yield of 422.2 and 395.9 kg/ha for Kano and Maiduguri, respectively was obtained from the control. Pearl millet varieties were observed to affect grain yield per hectare at both locations. At Kano, LCICMV-1 gave significantly higher grain yield while LCICMV-2 outperformed all other varieties at Maiduguri.

Increased yield and yield components due to application of KCl may be attributed to increase in chlorophyll and relative water contents as compared to the control. Thus, it implies that seed priming modifies the physiological and biochemical nature of seeds for enhance growth and ultimate grain yield. Pawar *et al.* (2003) observed increased grain yield as a result of seed primed with KCl. Farooq *et al*. (2006) corroborated that in rice, mere water soaking reduced days for emergence while priming using KCl or $CaCl_2$ was found to reduce it even further and increased yield and yield components. This was also in conformity with Manjunath and Dhanoji (2011) who stated that treating wheat seeds with 0.25% $CaCl_2$ or 2.5% KCl increase the grain yield compared to the control. The decline in grain yield by the control could be due to decrease in source capacity which led to the reduction of grain weight, since water stress during seed development affect irreversibly the sink demand of panicles in pearl millet (Winkel *et al*., 1997).

The influence of seed priming on the varieties evaluated showed that variety LCICMV-1 and LCICMV- 2 were found to outperform other varieties in terms of growth and yield. Although variety LCICMV- 1 recorded higher plant height, chlorophyll content, relative water content and grain yield and was therefore the best. This was in agreement with a study conducted on other pearl millet varieties which were attributed to genotypic variations and varietal adaptability (Khanna *et al*., 1994; Abdalla and El-khoshiban, 2007).

Interaction effect between seed priming and pearl millet varieties on grain yield per hectare was significant at both locations (Table 3). At Kano, LCICMV-1 in combination with KCl gave significantly higher grain yield per hectare than all the other varieties using either of the treatments examined while at Maiduguri, LCICMV-2 and LCICMV-3 in combination with KCl gave significantly higher grain yield per hectare.

Table 3: Interaction effects of seed priming and pearl millet (*Pennisetum glaucum* L.) varieties on grain yield in Kano and Maiduguri, during 2016 raining season

	Kano					Maiduguri				
Primers	Control	$CaCl_2$	KCl	CU	C E	Control	$CaCl_2$	KCl	CU	C E
Variety										
LCICMV-1	508.1^{m}	1302.2^{d}	1546.7^{a}	743.7^{j}	994.1^{g}	382.2^{ij}	1274.1^{cd}	1548.1^{b}	733.3^{gh}	1005.9^{ef}
LCICMV-2	376.3^{o}	1275.6^{d}	1537.8^{ab}	653.3^{l}	1010.4^{g}	380.7^{ij}	1333.3^{c}	1685.9^{a}	789.6^{g}	1087.4^{e}
LCICMV-3	414.8^{n}	1222.2^{e}	1515.6^{bc}	685.9^{k}	957.0^{h}	459.3^{i}	1283.0^{cd}	1657.8^{a}	737.8^{gh}	985.2^{f}
LCICMV-4	389.6^{no}	1160.0^{f}	1509.6^{c}	653.3^{l}	903.7^{i}	361.5^{j}	1235.6^{d}	1515.6^{b}	650.4^{h}	1053.3^{ef}
SE±			13.645					45.568		

Means followed by the same letter(s) are not significantly different at 5% level of probability using DMRT. NS = Not significant at 5% level of probability. CE = cowdung extract, CU = cow urine

CONCLUSION

From the findings, it's concluded that all the chemicals can be used as seed priming for pearl millet because they recoded higher yield than the control, but KCl was the best seed primer in both locations because significant effect was observed on growth and yield characters of pearl millet. Millet varieties LCICMV-1 at Kano and LCICMV-2 at Maiduguri were found to show better response because they recorded higher plant height, chlorophyll content, relative water content and grain yield. Thus, pearl millet variety LCICMV-1 and 2 primed with KCl is recommended for Sudan and Sahel-arid agro ecologies.

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