



GENOTYPE PERFORMANCES AND IDENTIFICATION OF AGRONOMIC TRAITS IN PARENTS AND CROSSES OF PEARL MILLET (*Pennisetum glaucum* L.R.Br.) IN SUDAN SAVANNA OF MAIDUGURI, BORNO STATE, NIGERIA

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ABSTRACT: The need to increase pearl millet productivity to meet the demand of the increasing world population in semi arid regions cannot be overemphasized. Although pearl millet is extensively grown in Nigeria, the average yield is still very low due to low and erratic rainfall, poor soil fertility, pest and diseases, poor management practices and low genetic potential of landraces. Partial diallel was used to cross five pearl millet parental lines to generate 10 crosses. Fifteen entries consisting of five parents and 10 crosses were evaluated in a randomized complete block design (RCBD) in Maiduguri for two years during rainy seasons (2015 and 2016). The objectives were to evaluate the genotype performances and identifications of agronomic traits on yield and yield components among the parents and crosses in pearl millet. The analysis of variance showed that both the parents and crosses had significant effects on most of the agronomic traits and indicated the presence of a large amount of genetic variability in the materials. Three crosses of SOSAT-C88 x DMR43, SOSAT-C88 x LCIC9702 and SOSAT-C88 x EX-GASHU'A showed negative significant SCA effects for days to 50% flowering and plant height (cm) indicating that these crosses could be improved for earliness and resistance to lodging in the windy environment. The study identified SOSATC-88, DMR43, EX-BORNO x SOSAT-C88, SOSAT-C88 x DMR43, SOSAT-C88 x LCIC9702 and DMR43 x LCIC9702 that have viable traits which could be exploited for the development of pearl millet with high grain yield.

Key Words: Genotype, Parents, Crosses, Millet, Traits, Yield

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1. INTRODUCTION

Pearl millet (*Pennisetum glaucum*) is a quick growing summer cereal, mainly cultivated in semi-arid regions and forms the staple food in Indian subcontinent and in Africa. It is the sixth most important cereal crop annually cultivated as rain fed crop on about 26 million ha in arid and semi-arid areas of Africa and the Indian continent (Govindaraj *et al.* 2011; Atif *et al.* 2012). It is

an important crop in Nigeria where moisture problem is the limiting factor for its optimal production. It has the potential of producing high total grain yield for the increasing population in this region under an ideal situation of moderate to high rainfall, rich in soil fertility improve varieties and good management practices. It is also grown in over 40 countries predominantly in Africa and Asia as a staple food grain and source of feed, fodder, fuel wood and construction

material in making thatch. Annual global millet production is around 30 million tonnes. Of the 30 million tonnes produced about 90% is utilized in the developing countries (Food and Agricultural Organization, 2007). Poor grain yield of unimproved cultivars of pearl millet is related to their low harvest index (FAO, 2007). To increase total grain yield pearl millet in Nigeria it is necessary to develop high grain yielding varieties that can be grown successfully in semi-arid area. Higher potential exists for making progress in the selection of traits pearl millet towards higher grain yield, because of higher genotypic variability existing among the landraces. However, most of the cultivars grown today in semi-arid areas are associated with problems relating to poor grain yield, non-tolerance to water logging and this shall be the reason why interest in the hybrid varieties is growing steadily in Africa because of their relatively high-yielding capabilities, drought tolerant and resistance to plant diseases (Izge *et al.* 2009). Breeding for high yielding varieties remain the main feasible method for poor farmers. This is the technology that is within the reach of the farmers and considered worthwhile by the farmer. However, the desired variability can be successfully utilized by various breeding methods. The main emphasis so far in pearl millet improvement was on grain yield and pest and diseases resistance, yet the effort to improve quality traits will definitely enhance the value of this crop in terms of consumer preference and industrial uses (Govindaraj *et al.* 2011). Identification and selection of agronomic traits with respect to earliness and high grain yield need to be exploited so as to design practical strategy for efficient choice of parental materials. These are the methods to use in developing productive base population for pearl millet grain yield improvement. It has also been important to be familiar with the interrelationship among yield and yield components as this could be useful in identifying traits that are most vital as selection criteria for improvement of crop yield.

2. MATERIALS AND METHODS

The parental materials used in this study were obtained from Lake Chad Research Institute (LCRI) and Borno State Agricultural Development Programme (BOSADP). They are early to medium maturing varieties between 54 to 63 days to maturity. The five varieties were crossed in a partial diallel design and generated 10 F₁ crosses during 2015 under irrigation. Evaluation were done during 2015 and 2016 rainy seasons at the Department of Crop Production Teaching and Research Farm University of Maiduguri

(Latitude 11° 53'N Longitude 13° 16'E) with average annual rainfall of 500 mm. During evaluations five parents together with 10 crosses were grown in randomized complete block design (RCBD) replicated three times each. Each entry was made in two rows which were 5 m in length and planted at inter-row spacing of 75 x 50 to enhance plant population. Each plot was drilled and later thinned to two seedlings per hill at three weeks after sowing. Compound fertilizer (NPK) was applied at 60 kgN/ha in split doses. The first dose of 35 kgN/ha was applied as basal while the second dose of 25 kgN/ha was applied as top dressing three weeks after sowing. Weeding was done manually at third and seventh after sowing according to Onwueme and Sinha (1991). Parameters measured were: 50% days to flowering, tiller count, plant height (cm), panicle length (cm), panicle weight (g), threshing%, 1000 seed weight (g) and grain yield (kg/ha). Data collected were subjected to analysis of variance using diallel design for the five parental lines and their 10 F₁ crosses for millet grain yield and other agronomic traits.

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance for the Eight Agronomic Traits in Pearl Millet across Years

The analysis of variance for five parents and 10 crosses for eight agronomic traits of pearl millet evaluated for two years combined (2015 and 2016) during rainy seasons are presented in Table 1. The result shows that there was high significant difference for years in all the traits except for 1000 seed weight (g). This suggests differential response of genotypes to factors of environment (climatic condition) in the two years. This report agrees with that of Bello and Olaoye (2009) who noted significant differences due to climatic condition across the years. Similarly, the significant differences observed among the genotypes and their crosses for most of the traits indicated that an appreciable amount of genetic variability exist in the population used in this study. Falconer (1989) had observed that the amount of improvement that is obtained by selection among a number of crosses is dependent on the amount of variation between the crosses and intensity of selection applied. The existence of variability between the parental lines and the crosses therefore, implies that both the parent population and their crosses would most likely respond to selection pressure (Izge *et al.* 2007). Hybrid mean squares had a significant effect on almost all the traits measured except 1000 seed weight (g), indicating that these materials could be selected for the improvement of grain yield in pearl millet.

Table 1. Mean Squares from the Analysis of Variance for Eight Agronomic Traits in Pearl Millet across Years (2015 and 2016 Combined)

Source of Variation	DF	Days to 50% flowering	Tillers count	Plant height (cm)	Panicle length (cm)	Head weight (g/plot)	Threshing %	1000 seed weight (g)	Grain Yield (Kg/ha)
Years	1	217.61**	36.42**	1466.96**	547.22**	86432756.11**	671.24**	8.18	7684023.11**
Genotypes	14	30.63*	32.68*	2178.16**	41.60*	564825.00**	121.09	5.93	759432.08**
Parents	4	10.44	30.36*	293.29	25.68	127341.68	103.11	8.59	64962.68
Hybrids	9	48.57*	20.348*	2811.80**	47.08*	648397.02**	190.99*	4.41	695723.54**
Parents Vs Hybrids	1	16.42	2.67	312.92	1.50	926653.95**	89.06	5.42	334962.35*
Genotypes x Years	14	38.73**	37.80*	552.17*	47.21*	1352471.35**	110.61	7.40	7901127.08**
Parents x Years	4	7.79	2.05	286.16	40.42*	183645.36	98.73	6.30	68674.56
Hybrids x Year	9	20.25*	31.14*	447.01*	29.04	6342961.07**	179.99*	8.39	5668783.37**
Parents Vs Hybrids x Years	1	17.07	7.89	424.17*	12.08	318433.01	67.81	5.97	864309.07*
Pooled error	14	12.58	23.46	89.48	21.19	3284.05	64.71	4.93	215427.08
Total	71								

3.2 Mean Performance of Parents and Crosses Combined across Years

The mean performance combined over two years for eight agronomic traits in pearl millet are presented in Table 2. The results showed significant differences between the genotypes for growth, yield and yield components. Days to 50% flowering and shorter plant height (cm) had been of paramount importance for earliness. This study identified SOSAT-C88 (53.251), LCIC9702 (56.013), SOSAT-C88 x DMR43 (55.664), SOSAT-C88 x LCIC9702 (55.890) and DMR43 x LCIC9702 (56.176) for these traits. They are important in stress and windy environment (Aminu and Izge, 2014). Hallauer (1965) reported that crosses among early x early plant within synthetic are expected to mature earlier than the crosses among late and late plant. These varieties can be hybridized to produce early maturing crosses that could be adapted to areas in the Sahel with lower and short rainfall duration. Plant height (cm) has been of permanent importance in the acceptance of a pearl millet variety in a local community. In a windy environment, shorter height is required to avoid crop logging. Similarly, farmers in Senegal and Niger Republic were not willing to accept dwarf pearl millet varieties because of the use longer pearl millet stalks in fencing and building of houses (Ounedeba *et al.* 1993). This study identified most of the varieties except SOSATC-88 (177.934g), DMR43 (185.068g), LCIC9702 (186.167cm), SOSATC-88 x DMR43 (180.074cm) and SOSATC-88 x LCIC9702 (178.748cm) that are shorter in height. Panicle length

(cm) and head weight (g) are also some of the important agronomic traits in acceptance of variety by farmers in semi-arid regions of Africa (Izge *et al.*, 2007). This study found DMR43 (34.462cm and 2320.218g), EX-GASHU'A (30.450cm and 2066.864g), EX-BORNO (28.863cm and 2241.781g), EX-BORNO x DMR43 (32.361cm and 2348.097g), SOSATC-88 x DMR43 (33.985cm and 2462.673g) and DMR43 x LCIC9702 (34.721cm and 2411.842g) having the longest panicle length (cm) and at the same time significant higher head weight (g). High potentials exist for varieties such as: SOSATC-88 (10.615g), EX-BORNO x SOSAT-88 (10.947g), EX-BORNO x DMR43 (10.790g), SOSATC-88 x DMR43 (10.648g) and DMR43 x LCIC9702 (10.348g) in terms of seed weight (g). This reveals that characters can be improved via selection for yield increase in pearl millet. Therefore, selection for these traits would lead to indirect selection for grain yield. The total grain weight varied considerable among the parental lines and crosses. Similar results had been reported by Nevado and Cross (1990) and Gravois (1994) in rice and maize respectively. Identification of high yielding crosses of pearl millet is helpful, because approximately one third of the world pearl millet are grown in Africa and 70% of that is in arid and semi arid regions of the Africa (Kumar, 1989). The most outstanding genotypes for grain yield were SOSATC-88 (1201.063kg/ha), DMR43 (1178.980kg/ha), EX-BORNO x SOSATC-88 (1286.718kg/ha), SOSATC-88 x DMR43 (1337.238kg/ha), SOSATC-88 x LCIC9702 (1248.064kg/ha) and DMR43 x LCIC9702 (1206.451kg/ha).

Table 2. Mean Performance of Genotypes for Eight Agronomic Traits in Pearl Millet across Years (2015 and 2016 Combined)

Genotypes	Days to 50% flowering	Tillers count/plant	Plant height (cm)	Panicle length (cm)	Head weight (g/plot)	Threshing %	1000 seed weight (g)	Grain Yield (Kg/ha)
EX-BORNO	61.420 ^{ab}	1.972	215.674 ^a	28.863 ^{ab}	2241.781 ^{ab}	59.463 ^a	9.162 ^b	663.713 ^b
SOSAT-C88	53.251 ^c	2.074	177.934 ^b	27.103 ^b	2371.053 ^a	63.230 ^a	10.615 ^a	1201.063 ^a
DMR43	58.531 ^b	2.435	185.068 ^b	34.462 ^a	2320.218 ^a	60.674 ^a	9.067 ^b	1178.980 ^a
LCIC9702	56.013 ^c	1.964	186.167 ^b	26.962 ^b	2201.964 ^a	65.870 ^a	9.452 ^b	865.803 ^b
EX-GASHU'A	62.782 ^b	1.762	220.905 ^a	30.450 ^a	2066.864 ^{ab}	63.907 ^a	8.085 ^b	554.162 ^{bc}
EX-BORNO x SOSAT-C88	59.953 ^{ab}	2.231	205.125 ^a	25.853 ^b	2399.406 ^a	58.564 ^a	10.947 ^a	1286.718 ^a
EX-BORNO x DMR43	60.075 ^{ab}	2.434	216.967 ^a	32.361 ^a	2348.097 ^a	54.783 ^{ab}	10.790 ^a	942.078 ^b
EX-BORNO x LCIC9702	58.065 ^b	1.985	197.083 ^a	25.046 ^b	1810.105 ^{ab}	58.561 ^a	10.107 ^{ab}	825.803 ^b
EX-BORNO x EX-GASHU'A	62.674 ^b	2.275	218.541 ^a	23.980 ^b	1732.326 ^b	52.089 ^b	8.740 ^b	769.752 ^b
SOSAT-C88 x DMR43	55.664 ^c	1.935	180.076 ^b	33.985 ^a	2462.673 ^a	60.742 ^a	10.648 ^a	1337.238 ^a
SOSAT-C88 x LCIC9702	55.890 ^c	2.403	178.748 ^b	26.063 ^b	2438.275 ^a	65.034 ^a	9.261 ^b	1248.064 ^a
SOSAT-C88 x EX-GASHU'A	57.031 ^{bc}	2.113	199.395 ^a	29.621 ^a	1826.659 ^b	62.895 ^a	9.573 ^{ab}	896.346 ^b
DMR43 x LCIC9702	56.176 ^c	2.230	187.086 ^{ab}	34.721 ^a	2411.842 ^a	57.094 ^a	10.328 ^a	1206.451 ^a
DMR43 x EX-GASHU'A	63.275 ^a	2.011	207.233 ^a	33.742 ^a	1745.325 ^b	60.803 ^a	8.806 ^b	869.663 ^b
EX-GASHU'A x LCIC9702	64.754 ^a	1.983	199.863 ^a	23.894 ^b	1703.135 ^b	57.954 ^a	8.705 ^b	769.462 ^b
Mean	59.554	2.120	198.391	29.140	2138.6482	60.111	9.619	974.353
SE±	1.624	0.879	14.412	3.321	468.142	6.033	0.873	354.825

4. CONCLUSION

1. The analysis of variance indicated that, the parents and crosses mean squares showed significant differences for most of the agronomic traits.
2. The analysis also revealing the presence of genetic variability which could be exploited to enhance selection for further population improvement.
3. The study has identified SOSATC-88, LCIC9702, DMR43, SOSATC-88 x DMR43, SOSATC-88 x LCIC9702 and DMR43 x LCIC9702 as the best parents and crosses in term of breeding for earliness, against lodging and grain yield per hectare.
4. The information generated in this study should further be worked upon for hybrids pearl millet production through selection in various locations.

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