# VARIABILITY STUDY IN PEARL MILLET (*Pennisetum glaucum* L.) LANDRACES FROM THE NORTHERN NIGERIA

***[1]Abubakar, A.,[1] Falusi, A.O., [1]Adebola, M.O., [2]Olayemi, I.K. & [1]Daudu, O.A.Y.**

[1]Department of Plant Biology, Federal University of Technology, PMB. 65, Minna, Nigeria.
[2]Department of Animal Biology, Federal University of Technology, Minna, PMB. 65, Minna, Nigeria.

***Corresponding author email**: abuakim2007@gmail.com **Tel:** +2348063458722

**Abstract**

*Genetic variation is the basic material for selection and improvement of any crop in breeding programme. These characters are fast eroding in pearl millet as natural habitats of wild cultivated species are being destroyed and modern cultivars replacing the traditional cultivars; in view of global climate change ravaging most savanna region of the country, pearl millet has now become a choice crop for cultivation in these areas, due to it drought tolerance and ability to survive under adverse conditions. This premise necessitate collection and characterisation of the crop germplasm for identification and selection of promising genotypes with high yielding traits that could be use for the crop improvement. A total of thirty five (35) pearl millet accessions were collected from the major cultivated states in Nigeria. These include; twenty five (25) landraces from farmers through direct contact and 10 genotypes from National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria. The genotypes were evaluated for morphological and yield parameters using a Randomised Complete Block Design (RCBD) with replicate three each. Significant ($P < 0.05$) wide range of variability was observed in all the morphological characters assessed with different trait been favoured by different genotypes. Highest plant height was recorded in KD-CK-01 (371.85 cm), followed by NGB 501 (336.99 cm) and the least height in accession NG-ZA-05 with the value of 170.58 cm. Days to anthesis among the accessions ranged from 66.33 to 90.00 days for early variety and 106.00 to 129.33 days for late varieties. In terms of panicle yield, highest panicle weight and weight of 1000 seeds were obtained in accession JG-DU-01 with the value of 75.55 g and 14.19 g respectively. Principal component analysis of the nine morphological parameters accessed; grouped the trait into nine components, which accounted for complete 100% variability among the accessions. Based on morphological similarity, cluster analysis grouped the accessions into three major clusters, with cluster I consisting 68.57% of the genotypes, 5.72% in cluster II and 25.71% in cluster III. The high variability recorded in the germplasm with further characterisation of the accessions using molecular tool could lead to the selection of accession(s) which could be explored in breeding programme of the crop.*

**Key words:** Germplasm, Landraces, Morphology, Pearl Millet, Variability

## INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an annual crop mostly cultivated in the arid and semi-arid regions of the world. The crop is ranked as the sixth most important global cereal crop grown by the resource poor farmers in the semi-arid regions of sub-Saharan Africa and the Indian subcontinent (Haussmann *et al*., 2012). Pearl millet serves as major sources of food and beverages for 500 million of the people living predominantly in parts of African and Asian countries, and specifically for over 40 millions subsistence farmers living in the most marginal agricultural lands of Northern Nigeria (Chandra-Sekara and Shahidi, 2012). It is highly valued for its nutritious quality among other cereal crop since long time ago. Pearl millet contains high levels of carbohydrate, dietary fibre, proteins, essential amino acid and minerals, some vitamins and antioxidants. These nutritional constituent helps in prevention of important human diseases such as diabetes, cancer, cardiovascular and neurodegenerative diseases (Jukanti *et al*., 2016). Due to its potential to withstand drought and adverse agro climatic conditions, it is mainly grown under marginal lands with low rainfall during *Kharif* season (Vidyadhar *et al.,* 2007) and (Bhoite *et al.,* 2008).

In Nigeria, the crop is cultivated on 5 million hectares, corresponding to 20.84 percent of the 23.99 million hectares of the country's total arable land. The production of this crop in Nigeria increased progressively between 1985 and 1994, and reached a peak in 1988 and 1990, and then declined (Gaya *et al.*, 2012). Despite the desirable characteristics and importance of pearl millet as a staple cereal of the arid and semi-arid regions of Sub- Saharan Africa and Asia with potential nutritional and medicinal value, it has received inadequate attention from the scientific community and funding agencies as compared to other major cereals ((Jukanti *et al.*, 2016), and has suffered decline in production over the years. To surmount these challenges, sourcing for diverse and desirable agronomic traits among the available landraces has been considered as one of the viable and foremost options. However, Angarawai *et al.* (2016) reported that in Nigeria, exploitation of the local landraces which serve as greatest reservoir of useful traits for any source of improvement in this crop was done only to a limited extent in a very unsystematic manner. Genetic variation is the basic material for selection and improvement of any crop in breeding programme. This characters is fast eroding in pearl millet as natural habitats of wild cultivated species are being destroyed and modern cultivars replacing the traditional cultivars; in view of global climate change ravaging most savanna region of the country, pearl millet has now become a choice crop for cultivation in this areas, due to it drought tolerance and ability survive under adverse conditions This premise necessitate collection and characterisation of the crop germplasm for identification and selection of promising genotypes with high yielding traits that could be use for the crop improvement.

## MATERIALS AND METHODS

### Experimental Design and Morphological Studies of Pearl Millet Landraces

A total of thirty five (35) pearl millet accessions were collected from the major cultivated states in Nigeria; twenty five (25) landraces from farmers through direct contact and 10 genotypes from National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria. These accessions covered the accessible growing state (Adamawa, Gombe, Jigawa, Kano, Nassarawa, Niger, Kaduna, Sokoto, Taraba, and Zamfara) in Nigeria. The genotypes were evaluated for morphological and yield parameters using a Randomised Complete Block Design (RCBD) with each accession replicated three times. A total of 10 seeds per hill were sown for each accession on a ridge of 280 cm long with five hills per ridge. The germinated seedling were thinned to 5 plant per hill at two weeks after germination, given a total of 25 plants per plot and 75 plants per accession at a spacing of 50 cm for both inter and intra rows. Weeding was done manually using hoe when necessary. Application of NPK fertilizer was done two weeks after thinning and no pesticides were applied throughout the experimental period. Data were collected from ten (10) randomly selected plants per accession on 9 quantitative traits according to descriptors for pearl millet (IBPGR/ICRISAT, 1993) (Table 1).

**Table 1.0 Morphological Traits and Description of its Measurements**

| Traits | Description/scoring |
|---|---|
| **Quantitative** | |
| Plant height | From ground level to tip of panicle at dough stage |
| Number of leaves | Number of leaves on primary tiller at dough stage |
| Number of internodes | Number of internodes on primary tiller at dough stage |
| Stem diameter (mm) | Diameter of internodes between third and fourth nodes from top at dough stage |
| Days 50% flowering | Days from emergence to when 50% of plants in the plot were in flower |
| Spike length (cm) | From the base to tip of panicle at dough stage |
| Spike thickness (mm) | Maximum diameter of spikes excluding the bristles at dough stage |
| Weight of spike | Mass of spikes at 12.5% moisture content |
| Weight of 1000 seeds | Mass of 1000 grains at 12.5% moisture content |

**Source:** IBPGR/ICRISAT (1993)

**Data Analysis**

The data obtained on quantitative characters were subjected to analysis of variance (ANOVA) to determine the level of significance among the treatment while the post hoc test will be carried out using Duncan's Multiple Range Test (DMRT) to separate the means where necessary using SPSS software version 18. Correlation analysis was computed to examine the degree of association among the morphological traits. Also, the data were subjected to Principal Component analysis (PCA) to determine patterns of variation and major traits contributing to the delineation. principal components (PCs) with Eigen-values above one were considered significant in determining the agro-morphological variability in the accessions and component loadings greater than ±0.30 were considered to be meaningful (Hair *et al*., 1998). A cluster analysis was also done based on Euclidean distance matrix in a hierarchical way to determine the diversity and similarity of the accessions from diverse region of the state and country using PAST software.

## RESULTS AND DISCUSSION

### Morphological Characterisation of Pearl Millet Accessions

The results of morphological characterisation show that different trait was favoured by different accession of the collected pearl millet (Table 4.1). The highest plant was obtained from KD-CK-01 (371.85 cm), followed by NGB 501 (336.99 cm). These height values were significantly different ($p < 0.05$) from one another and the height of all other accessions. The least plant height was recorded from accession NG-ZA-05 with the value of 170.58 cm. This value was not significantly different from the value of accessions KD-JB-01 (160.80 cm) and ZF-AA-01 (168.54). The highest number of leaf per plant was recorded in NS-YEL-02 (15.50) and the least was obtained in NGB 523 with the value of 8.00. This highest value was not significantly from number (15.11) obtained in NS-GAN-05. Accession NG-ZA-01, NG-ZC-03, ZF-AA-01 had the same number of leaves with the value of 10.00. The number of internode per plant also varied significantly from one accession to other with a range value of 7.50 per plant in NGB 523 to 16.00 in NS-YEL-02. Stem diameter ranged from 0.97 cm in accession NG-ZA-01 to 1.58 cm in NS-GIN-03. These values were significantly different from one another and from the value of all other accessions. On the basis of days to anthesis, the accessions could be group into early and late maturity. The early maturity days to anthesis ranged from 66.33 to 90.00 days and 106.00 to 129.33 days.

**Yield Evaluation of Collected Accessions**

A wide range of variation in yield traits was recorded among the accessions (Table 4.2). The panicle length ranged from 22.67 to 66.25 cm. The highest panicle length (66.25 cm) recorded in accession NG-ZA-01 is significantly different from the value of all other accessions while the least (22.67 cm) obtained in NG-ZB-03 was not significant from the values of accessions NGB 606, NG-ZA-02, NG-ZA-05, NG-ZA-03, KD-JB-01, NS-YEL-02, NS-GAN-04, NS-GIN-03 and JG-BIR-01. The panicle diameter varied significantly with the highest diameter recorded in accession KN-AB-02 with the value of 3.13 cm. This value is not significantly different from the value (2.79 cm) of accession NG-ZC-03, but significant from the value of all other accession. Accession NG-ZA-01 had the least panicle diameter with the value of 1.09 cm. This value is different significantly different from the values recorded in NGB 589 (1.28 cm), NG-ZA-01 (1.09 cm), NG-ZA-02 (1.27 cm) and KD-JB-01 (1.26 cm). The highest panicle weight and weight of 1000 seeds were obtained in accession JG-DU-01 with the value of 75.55 g and 14.19 g respectively (Table 4.2). This highest panicle weight (75.55 g) is significantly different from the panicle weight of all other accessions; while the highest (14.19 g) weight of 1000 seeds recorded in the accession was not significant from the value of NG-ZC-02 (13.10 g) and KN-AB-02 (13.42 g). Accession NG-ZA-02 had the least panicle weight and weight of 1000 seeds with the value of 9.30 g and 5.25 g respectively. Weight of 1000 seeds obtained from accessions NGB 501(11.73 g), NG-ZB-01 (11.21 g), NS-YEL-06 (11.71 g) and NS-GAN-05 (11.18 g) were not significantly different from one another.

**Table 1 Morphological Characterisation of Accessions of Pearl Millet landraces**

| Accessions | Plant Height | Number of Leaves | Number of Internodes | Stem Diameter | Days to Anthesis |
|---|---|---|---|---|---|
| NGB501 | 336.99±11.14$^{h}$ | 13.80±0.58e | 13.40±0.51e | 1.40±0.04$^{de}$ | 76.00±2.08$^{b}$ |
| NGB514 | 262.87±15.96$^{def}$ | 10.13±318bc | 9.88±0.74bc | 1.18±0.05$^{ab}$ | 71.33±2.40$^{ab}$ |
| NGB523 | 198.94±7.21$^{b}$ | 8.00±0.51a | 7.50±0.96a | 1.26±0.13$^{b}$ | 66.33±1.67$^{a}$ |
| NGB528 | 243.10±16.13$^{cd}$ | 10.40±0.51$^{c}$ | 10.40±0.51$^{bc}$ | 1.40±0.08$^{de}$ | 86.00±2.08$^{d}$ |
| NGB571 | 274.07±14.44$^{defg}$ | 13.00±0.55$^{d}$ | 12.80±0.49$^{de}$ | 1.22±0.03$^{b}$ | 71.00±2.31$^{ab}$ |
| NGB575 | 215.57±8.78$^{bc}$ | 9.50±0.34$^{abc}$ | 9.50±0.22$^{b}$ | 1.12±0.18$^{ab}$ | 82.33±1.76$^{cd}$ |
| NGB578 | 214.00±12.34$^{bc}$ | 8.33±0.67a | 8.33±0.67$^{ab}$ | 1.39±0.04$^{de}$ | 122.00±3.05$^{gh}$ |
| NGB589 | 251.09±10.16$^{de}$ | 13.30±0.40$^{de}$ | 13.40±0.40$^{e}$ | 1.13±0.04$^{ab}$ | 121.67±2.40$^{gh}$ |
| NGB594 | 271.18±4.75$^{defg}$ | 8.50±0.64$^{ab}$ | 9.00±0.58$^{ab}$ | 1.33±0.0$^{c}$ | 69.67±5.36$^{a}$ |
| NGB606 | 304.94±4.89$^{g}$ | 15.40±0.24$^{f}$ | 15.40±0.24$^{g}$ | 1.25±0.05$^{b}$ | 124.33±1.67$^{gh}$ |
| NG-ZA-01 | 253.89±10.32$^{de}$ | 9.60±0.31$^{abc}$ | 10.00±0.30$^{bc}$ | 0.97±0.07$^{a}$ | 124.67±1.33$^{gh}$ |
| NG-ZA-02 | 189.96±11.80$^{ab}$ | 9.14±0.63$^{ab}$ | 9.14±0.63$^{ab}$ | 1.12±0.03$^{ab}$ | 118.67±1.76$^{g}$ |
| NG-ZA-05 | 170.58±7.22$^{a}$ | 8.25±0.85$^{a}$ | 8.00±0.71$^{a}$ | 1.27±0.10$^{bc}$ | 120.67±1.33$^{g}$ |
| NG-ZA-08 | 284.40±11.69$^{efg}$ | 13.43±0.37$^{de}$ | 12.29±0.18$^{d}$ | 1.18±0.10$^{ab}$ | 70.67±1.33$^{ab}$ |
| NG-ZB-01 | 287.39±3.47$^{efg}$ | 14.60±0.34$^{ef}$ | 13.60±0.31$^{e}$ | 1.38±0.06$^{d}$ | 72.33±2.60$^{ab}$ |
| NG-ZB-03 | 188.32±8.42$^{ab}$ | 10.00±0.41$^{bc}$ | 10.25±0.48$^{bc}$ | 1.46±0.06$^{ef}$ | 77.00±3.46$^{b}$ |
| NG-ZC-01 | 287.46±7.97$^{efg}$ | 12.90±0.41$^{d}$ | 12.80±0.49$^{de}$ | 1.35±0.05$^{cd}$ | 78.67±1.67$^{bc}$ |
| NG-ZC-02 | 292.20±12.57$^{fg}$ | 12.00±0.32$^{cd}$ | 11.40±0.25$^{c}$ | 1.11±0.04$^{ab}$ | 77.00±2.08$^{b}$ |
| NG-ZC-03 | 297.54±4.67$^{fg}$ | 10.00±0.57$^{bc}$ | 10.67±0.33$^{c}$ | 1.29±0.04$^{bcd}$ | 77.00±3.79$^{b}$ |
| KD-KG-01 | 181.55±9.99$^{ab}$ | 8.80±0.51$^{abc}$ | 8.40±0.40$^{ab}$ | 1.27±0.06$^{b}$ | 122.67±0.67$^{gh}$ |
| KD-CK-01 | 371.85±7.19$^{i}$ | 12.00±0.00$^{cd}$ | 12.50±0.29$^{d}$ | 1.43±0.06$^{e}$ | 122.00±2.31$^{gh}$ |
| KD-JB-01 | 160.80±5.12$^{a}$ | 8.60±0.40$^{ab}$ | 9.20±0.58$^{ab}$ | 1.09±0.05$^{a}$ | 73.00±1.00$^{ab}$ |
| KD-JM-01 | 272.30±11.45$^{defg}$ | 14.33±0.88$^{e}$ | 15.00±1.15$^{g}$ | 1.16±0.07$^{ab}$ | 129.33±3.53$^{h}$ |
| NS-YEL-02 | 276.70±5.25$^{defg}$ | 15.50±1.26$^{f}$ | 16.00±0.82$^{h}$ | 1.41±0.13e | 90.00±2.00$^{e}$ |
| NS-YEL-06 | 228.45±8.16$^{c}$ | 10.67±0.56$^{c}$ | 10.50±0.50$^{bc}$ | 1.07±0.05a | 84.00±2.00$^{cd}$ |
| NS-YEL-07 | 276.20±9.30$^{defg}$ | 13.10±0.27$^{d}$ | 13.40±0.40$^{e}$ | 1.12±0.03$^{ab}$ | 87.67±0.33$^{de}$ |
| NS-GAN-04 | 279.90±2.26$^{efg}$ | 11.67±0.33$^{cd}$ | 12.00±0.58$^{cd}$ | 1.15±0.04$^{ab}$ | 78.33±1.33$^{bc}$ |
| NS-GAN-05 | 280.30±6.92$^{efg}$ | 15.11±0.56$^{f}$ | 15.33±0.55$^{g}$ | 1.45±0.07$^{ef}$ | 78.00±2.31$^{bc}$ |
| NS-GIN-03 | 269.36±7.50$^{defg}$ | 14.83±0.79$^{ef}$ | 15.67±0.88$^{gh}$ | 1.58±0.06$^{f}$ | 77.67±0.33$^{bc}$ |
| KN-AA-01 | 271.44±6.85$^{defg}$ | 13.50±0.34$^{de}$ | 14.00±0.49$^{f}$ | 1.33±0.05$^{bc}$ | 106.00±4.16$^{f}$ |
| KN-AB-02 | 279.63±10.56$^{efg}$ | 14.70±0.54$^{ef}$ | 13.80±0.57$^{ef}$ | 1.28±0.03$^{bc}$ | 77.67±0.33$^{bc}$ |
| JIG-DU-01 | 283.27±4.08$^{efg}$ | 13.30±0.52$^{de}$ | 13.80±0.33$^{ef}$ | 1.24±0.04$^{b}$ | 125.67±3.76$^{gh}$ |
| JIG-BIR-01 | 283.55±12.92$^{efg}$ | 14.13±0.52$^{e}$ | 14.50±0.38$^{fg}$ | 1.26±0.06$^{bc}$ | 79.50±2.50$^{c}$ |
| NS-JIL-01 | 252.89±10.54$^{de}$ | 13.10±0.18$^{d}$ | 13.00±0.21$^{de}$ | 1.16±0.04$^{ab}$ | 87.33±0.66$^{de}$ |
| ZF-AA-01 | 168.54±5.43$^{a}$ | 10.00±0.55$^{bc}$ | 9.60±0.40$^{b}$ | 1.40±0.02$^{de}$ | 76.33±2b.91$^{b}$ |

**Correlation Analysis of Morphological Traits**

The result of correlation of the agro-morphological parameters is presented below (Table 4.4). With the exception of panicle diameter ($r = -0.25$, $p < 0.01$) and weight of panicle per plant ($r = -0.18$, $p < 0.05$) that are negatively and significantly correlated to days to anthesis, there was not significant correlation between day to anthesis and all other agro-morphological parameters. Weight of panicle per plant the trait was positively and significantly correlated with stem diameter ($r = 0.14$, $p < 0.05$) and all other parameters at $r < 0.01$. Similar, plant height is positively and significantly correlated ($r < 0.01$) to all other parameters. Stem diameter (-0.04), day to anthesis (-0.03) and panicle length (0.12) are not significantly correlated to weight of 1000 seeds per plant but significantly correlated to all other parameters.

**Table 5 Pearson Correlation of Morphological Traits in Pearl Millet Germplasm Accessions.**

| S/N | Traits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Plant Height** | 1.00 | | | | | | | | |
| 2 | **Number of Leaves** | 0.58** | 1.00 | | | | | | | |
| 3 | **Number of Internodes** | 0.59** | 0.93** | 1.00 | | | | | | |
| 4 | **Stem Diameter** | 0.19** | 0.16** | 0.16* | 1.00 | | | | | |
| 5 | **Days to Anthesis** | 0.02 ns | -0.07 ns | 0.01 ns | -0.06 ns | 1.00 | | | | |
| 6 | **Panicle length** | 0.16** | -0.14* | -0.12* | -0.10 ns | 0.16 ns | 1.00 | | | |
| 7 | **Panicle Diameter** | 0.32** | 0.43** | 0.38** | 0.23** | -0.25** | -0.112* | 1.00 | | |
| 8 | **Weight Per Panicle** | 0.42** | 0.27** | 0.23** | 0.14* | -0.18* | 0.17** | 0.45** | 1.00 | |
| 9 | **Weight of 1000 Seeds** | 0.38** | 0.35** | 0.29** | -0.04 ns | -0.03 ns | 0.12 ns | 0.40** | 0.51** | 1.00 |

** = Significant at P<0.01, * = Significant at P<0.05, ns-Non significant

**Principal Component Analysis**

Principal component analysis of 9 quantitative morphological characters was group into 9 components, which accounted for the entire (100%) variability among the studied accessions (Table 6). Significant eigen value were recorded for the first six components with the value of 2458.89, 487.62, 250.74, 91.89, 5.35 and 1.64 for PC 1, 2, 3, 4, 5, and 6 respectively. The first two (2) principal components contributed 89.39% of the variability and 100% variability was recorded at the first seven (7) components among the evaluated pearl millet accessions. The variability in PC1 (74.59%) was mainly due to the contribution of plant height, while days to anthesis and panicle weight are traits that contributed to PC2 (14.79%). In addition to days to anthesis which contributed to PC3 both panicle length and panicle weight affected the PC3 and PC4. PC5 and PC6 were influenced by number of leaves and internodes and weight of 1000 seeds.

**Table 6 Principal Component Analysis of Morphological Traits in Pearl Millet Accessions.**

| | PC 1 | PC 2 | PC 3 | PC 4 | PC 5 | PC 6 | PC 7 | PC 8 | PC 9 |
|---|---|---|---|---|---|---|---|---|---|
| Plant Height | 0.97 | 0.10 | -0.20 | 0.02 | -0.05 | 0.02 | 0.00 | 0.00 | 0.00 |
| Number of Leaves | 0.03 | 0.01 | -0.04 | -0.09 | 0.59 | -0.38 | -0.52 | 0.48 | 0.05 |
| Number of Internodes | 0.03 | 0.01 | -0.04 | -0.09 | 0.61 | -0.34 | 0.53 | -0.46 | -0.08 |
| Stem Diameter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.04 | 0.09 | -0.03 | 0.99 |
| Days to Anthesis | -0.03 | 0.95 | 0.30 | -0.10 | -0.01 | -0.01 | 0.00 | 0.01 | 0.00 |
| Panicle length | 0.07 | -0.02 | 0.38 | 0.91 | 0.11 | -0.07 | 0.02 | 0.02 | 0.00 |
| Panicle Diameter | 0.01 | -0.01 | 0.01 | -0.03 | -0.01 | 0.03 | 0.66 | 0.75 | -0.03 |
| Panicle Weight | 0.21 | -0.31 | 0.85 | -0.37 | -0.04 | -0.06 | -0.01 | -0.02 | 0.00 |
| Weight of 1000 Seeds | 0.03 | -0.01 | 0.06 | -0.02 | 0.51 | 0.85 | -0.03 | 0.00 | 0.04 |
| Eigen value | 2458.89 | 487.62 | 250.74 | 91.89 | 5.35 | 1.64 | 0.11 | 0.10 | 0.01 |
| Individual % | 74.59 | 14.79 | 7.61 | 2.79 | 0.16 | 0.05 | 0.00 | 0.00 | 0.00 |
| Cumulative % | 74.59 | 89.39 | 96.99 | 99.78 | 99.94 | 99.99 | 100.00 | 100.00 | 100.00 |

**Cluster Analysis**

The variation among the pearl millet accessions was assessed in terms of the quantitative traits using cluster analysis (Figure 1). On the basis of morphological similarity, the accessions were clustered into three major groups, with cluster I consisting 68.57% of the genotypes, 5.72% in cluster II and 25.71% in cluster III. Accessions KD-CK-01 and NGB-501 were strongly associated with one another and distinctly cluster in cluster II. Similarly, In cluster I, Accessions NS-YEL-02 and NS-YEL-07 showed strong association among the rest of the accessions while NGB 575 and NGB 578 in cluster III were closely similar among the other accessions.

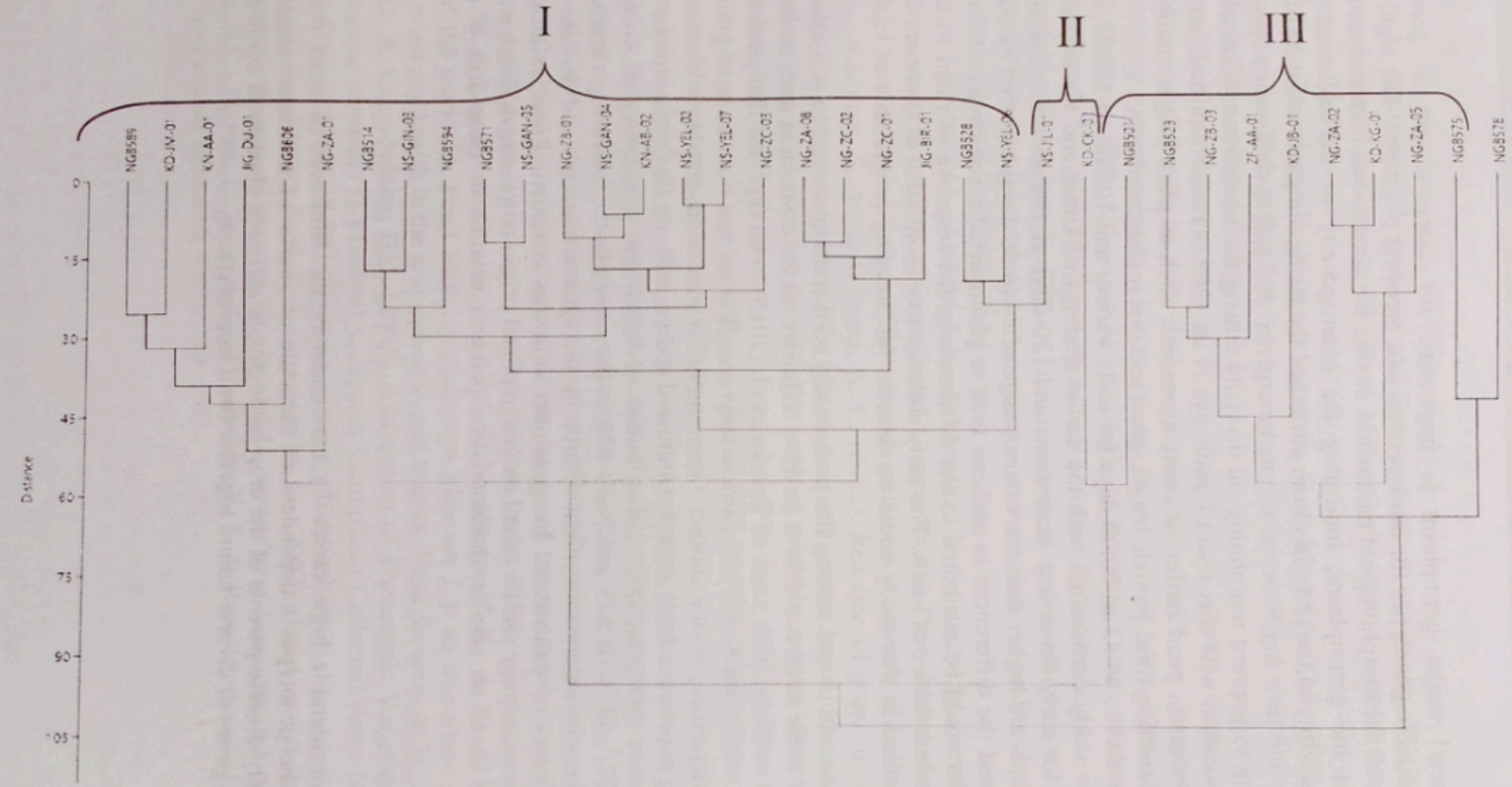


**Figure 1. Hierarchical Euclidean Clustering Dendrogram of Pearl Millet Accessions Based on Similarity Distance of Nine Morphological Traits**

## DISCUSSION

Characterization of pearl millet germplasm is imperative for categorization of germplasm and identification of the desirable genotypes for introgression into breeding programs. The highly significant differences recorded in all the morphological parameters among the accessions, demonstrate the adequate variability that exit in the gerrmplasm; indicating the heterogeneity of the collected pearl millet accessions. The high variabity in the plant has been attributed the Being allogamous nature of pearl millet couple with protogyny and time lag between stigma emergence and anther dehiscence favour complete cross pollination leading to greatest morphological diversity among the accessions (Bhattacharjee *et al.*, 2007)). Also, in corroboration with this result Upadhyaya *et al.* (2007) earlier reported that tremendous phenotypic variability exists in pearl millet for many agronomic such as plant height, number of tillers, weight of1000-seeds, flowering time, panicle length, grain and stover characteristics.
Variation in days to anthesis; 66.33 to 90.00 days for early variety and 106.00 to 129.33 days for late variety observed in this study corroborate with the earlier findings of Umar and Kwon-Ndung (2014), who reported 60 days for early flowering accessions and 120 days as late as flowering accessions in finger millet. These values are higher than the values (range of 44 to 56 days) reported by Animasaun *et al.* (2017), who attributed the differences in anthesis time to photoperiodic sensitivity of the plant. The variation in these results could be attributed to the difference in the response of plant to the different environment and the genetic nature of seeds. The early anthesis accessions such as Bambara-2, Bambara-3 and Bambara-12 obtained in this study could be selected for breeding programme of early maturing variety.
The positive associations within and among the panicle and seed traits observed in this study signified that selecting for any of these traits could have positive influence on the associated traits in improvement programme. This result conform with work of Ezeaku et al. (2015), who reported that panicle weight is significantly correlated with plant height and panicle length, indicating that both traits to grain yield and could be selected for independent of one another. Grouping of the accessions into three clusters with each cluster group containing accessions from different state and source, indicate that there was no association between pattern of clusters and geographical distribution of accessions. Clustering of Accessions NS-YEL-02 and NS-YEL-07; and NGB 575 and NGB 578 in the same cluster indicating closely similarity could be attributed to trans-boundary movement of crop by the agrarian farmers and become adapted to that environment after years of cultivation. In agreement with this statement Ercan *et al.* (2002) had earlier reported that accessions may cluster based on geographical origin or genetic difference and further small clusters could be based on similar characteristics, pedigree relation or close area of cultivation within the main group.

## CONCLUSION

It is established that considerable high variability exists among the landraces of pearl millet in the country. Clustering of the genotypes independent of the state or source of collection suggested that, hybridizing the genetically diverse parents of the crop belonging to different clusters of could provide an opportunity for bringing genes of diverse nature together for it improvement.

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