Journal of Plant Breeding and Crop Science Vol. 1(7). pp. 273-280, September, 2009
Available online http://www.academicjournals.org/jpbcs

Full Length Research Paper

Morphological distinctiveness and metroglyph analysis of fifty accessions of West African okra (*Abelmoschus caillei*) (*A.* Chev.) *S*tevels

Sunday E. Aladele

National Centre for Genetic Resources and Biotechnology (NACGRAB), P. M. B. 5382, Moor Plantation, Ibadan, Nigeria. E-mail: sundayaladele@yahoo.com.

Accepted 4 August, 2009

The morphological uniqueness and metroglyph analysis of 50 accessions of West African okra (Abelmoschus caillei (A Chev.) Stevels) were assessed under three agro-ecological environments at Abeokuta, Ibadan and Mokwa in Nigeria. They were grown in a Randomized Complete Block Design with three replications; data were collected on 5 randomly selected plants from each plot. Data on twenty-one agronomic characters were collected; eleven traits were subjected to metroglyph analysis to investigate the extent of distinctiveness among the 50 accessions. The eleven agronomic characters representing the most commonly used in distinguishing between okra genotypes were used to construct a metroglyph chart. All accessions were grouped into seven distinct groups. The index scores ranged from 19.0 to 42.3 with groups I and VII showing the two extremes among the 50 accessions evaluated. The fruit surface of Akure-2-2 and Akure-1-1 were smooth while Akure-2-9 and Akure-2-4 showed slightly prickly fruits. This suggests that accessions from Akure town in Ondo state of Nigeria were domesticated to large extent and possibly are more related. The metroglyph showed that accessions with very poor yield had short plant height, an indication that for West African genotype okra to produce substantial yield, it must possess a strong stem, hence early planting is encouraged.

Key words: *Abelmoschus caillei*, accessions, genotype, index score, metroglyph.

INTRODUCTION

The value of a germplasm collection depends not only on the number of accessions it contains, but also upon the diversity present in those accessions (Ren et al., 1995). Knowledge of genetic diversity and relationships among okra (*Abelmoschus caillei*) germplasm may play significant role in breeding programmes for biotic and abiotic stress of okra. Within species variation among 30 West African genotypes were found to be considerably large based on phenotypic assessment (Ariyo, 1993). Nigeria, being the second largest producer of okra may have considerable level of genetic diversity as in many other important crop species (Gulsen et al., 2007). Understanding the genetic structure and germplasm diversity of okra being kept in the gene banks all over the world will bring valuable information for okra breeding programmes. *A. caillei* is commonly grown in the high rainfall zone of West Africa and mainly in subsistence systems (Schipper, 1998). High degree of morphological variation has been reported in the previous studies on West African okra (Omonhinmin and Osawaru, 2005). Many local cultivars occur in Africa and Asia, they differ from each other in growth habit (branching or non-branching, large or dwarf, late or early, hairy or glaborous, light green, dark green or red) and fruit characteristics (upright or pendulous, slender or wide, with 5 to 10 ridges). Pod shapes range from round to ridged and short to long. The plant and pods may have small spines on them that create allergies in some people (Splittstoessor, 1990).

Characterization and quantification of genetic diversity has long been a major goal in evolutionary biology. Information on the genetic diversity within and among closely related crop varieties is essential for a rational use of plant genetic resources. Bisht et al., (1995) reported that pigmentation and pubescence of stem, leaf, pods and seeds were important components of variability in okra germplasm. From the results he obtained from Principal

Component Analysis, it was clear that; days to flowering, plant height and various pod characteristics were important components of variability among genotypes. Plant breeders cannot develop a new variety without the use of genetic material with some levels of variation. The role of genetic resources in the improvement and development of cultivated plants has been well recognized (Tigerstedt, 1994). This is why collection, evaluation and storage of germplasm become the most important steps in a plant breeding. Characterization of the collected germplasm is indispensable in a plant breeding programme. It helps breeders in selecting suitable parents for crossing experiments to develop new varieties (Hartwig, 1972; Frankel, 1976).

The objectives of this study are to assess the distinctiveness of 50 accessions of West African Okra (*A. caillei*) using morphological data and to establish the level of uniformity among the similar accessions on the basis of metroglyph analysis.

MATERIALS AND METHODS

All the collections made were planted on a single row-plot per pod to determine the photosensitivity and phenotypic similarities and differences. Planting was done in June 2004 at National Centre for Genetic Resources and Biotechnology (NACGRAB) research field, Ibadan, Nigeria. Visual field assessment was done before, during and after flowering to choose the test entries for the diversity studies. Entries that flowers before September were rejected while those with diverse traits were selected among the photosensitive and late maturity types. Characters considered include stem colour, leaf colour, stem and fruit pubescence, branching habits and fruit shape. Some entries that showed segregation were rejected on the assumption that they might have been crossed with *Abelmoschus esculentus*. During flowering, waterproof paper covering was employed to cover the flower at the point of bloom to avoid cross-pollination among accessions. Rouging was carried out on all suspected off types on each row. The trials were located at three environments to assess the performance of the 50 genotypes at different ecological zones. These locations were:

1. Ibadan – Oyo state - NACGRAB Research field
2. Abeokuta – Ogun state- University of Agriculture Research field.
3. Mokwa – Niger state –National Cereals Research Institute satellite research station.

The experiment was designed as Randomized Complete Block Design (RCBD). Three locations, 3 replications of 2 rows per plot at 4.2 m long and with between rows interval of 1.0 m and within row interval of 0.6 m was followed. The experiment was conducted for two years during 2005 and 2006 rainy season. All the necessary cultural practices such as thinning, weeding, fertilizer applications and spraying of insecticides were applied as at when due. Thinning was done to reduce the trial to one plant per stand at the three locations. Compound fertilizer of NPK was applied in two doses at the rate of 60 kg N/ha. Morphological data were collected on 5 randomly selected plants based on International Board for Plant Genetic Resources (IBPGR) recommended descriptor procedures for okra (Palve et al., 1986).

Morphological data collected

1. Stem pubescence (1- glabrous, 2-slightly prickly, 3-conspicous)
2. Stem colour (1-green, 2-green with red, 3-yellowish-green, 4-purple)
3. Fruit pubescence (1-downy, 2-slightly prickly, 3-pricky)
4. Fruit colour (1-green, 2-dark green, 3-yellowish green)
5. Leave length (cm)
6. Leave width (cm)
7. Days to 50% flowering
8. Number of fruits per plant
9. Number of seed per fruit
10. 100 seed weight (g)
11. Fruit yield per plant
12. Stem diseases (1- Resistant, 2- Moderately Resistant, 3-Suscepible)
13. Fruit diseases (1- Resistant, 2- Moderately Resistant, 3-Suscepible)
14. Leaf diseases (1- Resistant, 2- Moderately Resistant, 3-Suscepible)
15. Peduncles length (cm)
16. Plant height (From the base of the plant to the tip of the last leaf)
17. Fruit positioning (3-Erect, 5 Horizontal, 7-pendulous.)
18. Internodes length (cm)
19. Stem diameter (cm)
20. Fruit length (cm)
21. Fruit width (cm)

Morphological variation among 50 accessions were studied using metroglyph and index score was used to determine the distinctiveness of each accession using the mean values of nine agronomic characters (Ariyo, 1988). Class intervals were used to divide all the 50 accessions into 5 groups. The symbol "@" was used as the baseline to represent score-1 for all the nine characters considered. Shading progressively was used to differentiate score interval for days to 50% flowering, while the direction of rays was made unique for individual character for the rest traits. Pod yield per plant and height at maturity, which were the two most variable characters, were employed in locating the glyph for individual accession. The X coordinate, being pod yield per plant and Y coordinate, the plant height. Other agronomic characters were represented on the glyph by shading or by rays at different positions depending on the glyph. The rays may be long or short depending on the value of the index score.

RESULTS

The morphological evaluation of the 50 accessions of West African okra (*A. caillei)* is presented in Table 1. It shows that twenty-eight accessions had their fruits in horizontal position while only 6 accessions had their fruits positioned in erect form. There were 15 accessions with fruit positioning that fall between erect and horizontal; these are called semi-erect and only Akure 2-9 had a pendulum fruit position. The stem colour ranged from light purple to dark red and from green with some traces of purple to deep green. There were more purple stems within the 50 accessions than green stem colours. The fruit colours of the majority of the accessions were green but with some yellow and red colour patches. The greenish colour ranged from light green to very dark green. In some few cases the green colour was almost suppressed by yellow colour as in CEN 007, ABC-1, NCRI-5, CEN05, OJAOBA-1, Ojaoba-2 and Ado Ekiti-2. Most of the 50 accessions had glaborous stems. Those with slightly pric-

Table 1. Morphological characteristics of 50 accessions of West Africa okra.

Accession name	Stem colour	Stem pubescence	Fruit colour	Fruit pubescence	Fruit position
CEN 010	LP	Glabrous	DG	Downy	Erect
NGAE – 96-002	Purple	Glabrous	DG	SP	Horizontal
NGAE – 96-012 – 1	LP	Glabrous	Green	Downy	Horizontal
NGAE – 96-012 – 2	Purple	Conspicous	L G	Pricky	SE
NGAE – 96-012 – 3	Green	Glabrous	G w R	Downy	SE
CEN 016	Purple	SP	DG	Pricky	SE
CEN 012	Purple	Conspicous	Green	Pricky	Horizontal
CEN 007	Green	Glabrous	Y w G	Downy	SE
NGAE – 96-04	Green	Glabrous	Green	SP	SE
CEN 015	LP	Glabrous	D G	Downy	SE
OAA 96/175-5328	Green	SP	D G	Pricky	Horizontal
AGA97/066-5780	Purple	Glabrous	D G	Downy	Horizontal
ADO-EKITI-1	Green	Glabrous	D G	Pricky	Horizontal
CEN 001	Purple	Glabrous	G w Y	Pricky	Horizontal
CEN 009	LP	Glabrous	Green	Downy	Horizontal
NGAE – 96-0062 -1	LP	SP	G w R	Pricky	Erect
NGAE – 96-0062 – 2	Purple	Glabrous	DG	SP	SE
NGAE – 96-0066	Purple	Glabrous	Green	SP	Horizontal
NGAE – 96-0061	LP	Glabrous	G w R	SP	SE
NGAE – 96-0060	Purple	Glabrous	Green	Downy	Horizontal
NGAE – 96-0067	G w P	Glabrous	G w R	SP	Horizontal
NGAE – 96-0064	P w G	SP	G w R	Pricky	Horizontal
CEN 006A	Purple	Glabrous	Green	SP	Horizontal
NGAE – 96-0063	DR	SP	Green	Pricky	Erect
NGAE – 96-011	G w P	Glabrous	DG	SP	Horizontal
CEN 005	G w P	Glabrous	Y G	SP	Horizontal
NGAE – 96-0068	G w P	Glabrous	Green	Pricky	Horizontal
NGAE – 96-0065	P w G	Glabrous	Green	Downy	Horizontal
ABC -1	Green	Glabrous	Y G	Downy	SE
NCRI – 02	Purple	Glabrous	G w R	Downy	SE
NCRI -05	Purple	Glabrous	Y G	SP	SE
NGAE – 96-0069	Purple	Glabrous	G w R	SP	Horizontal
OJAOBA – 1	Green	Glabrous	Y G	SP	Horizontal
OJAOBA-2	Green	Glabrous	Y G	SP	Horizontal
OJAOBA-3	Green	Glabrous	Green	SP	Erect
OJAOBA-4	P w G	Glabrous	Green	Downy	Erect
ADO-EKITI-2	Green	Glabrous	Y G	Pricky	Horizontal
ADO-EKITI -3	Purple	Glabrous	Green	Downy	SE
ADO-EKITI -5	Purple	Glabrous	DG w R	Downy	Horizontal
IFE -1	Green	Glabrous	G w R	SP	SE
IFE -2	Purple	Glabrous	G w R	Downy	Horizontal
AKURE -2-2	Purple	Glabrous	G w R	Downy	Horizontal
AKURE -2 -9	Purple	Glabrous	G w R	SP	Pendulum
AKURE -1 -1	Green	Glabrous	LG	Downy	Erect
AKURE -2-4	Purple	Glabrous	G w R	SP	SE
OWODE-1	Green	Glabrous	LG	Pricky	Horizontal
OWODE-2	Purple	Glabrous	G w R	Pricky	Horizontal

Table 1. Contd.

OWODE-3	Purple	Glabrous	Green	Downy	Horizontal
OWODE-4	P w G	SP	Green	Pricky	SE
OWODE-5	Purple	SP	DG w R	Pricky	Horizontal

LP - Light Purple, GwP- Green with Purple, PwG - Purple with Green DG- Dark Green, LG- Light Green, GwR-Green with Red, YG- Yellowish Green, GwY-Green with Yellow, DGwR- Dark Green with Red, SP- Slightly Pricky, SE- Semi-Erect.

Table 2. Class intervals and index Score and Sign for 9 characters.

Characters	Range	Score 1	Sign	Score 2	Sign	Score 3	Sign	Score 4	Sign	Score 5	Sign
Days to 50% flowering	132 - 150	< 135	@	135 - 138	@	139 - 141	@	142 - 145	@	> 145	@
100 – Seed weight	2.37 - 6.01	< 4.0	@	4.0 - 4.4	@	4.5 - 4.8	@	4.9 - 5.0	@	> 5.0	@
Fruit length (cm)	6.3 - 11.1	< 8.0	@	8.0 - 8.9	@	9.0 - 9.5	@	9.6 - 10.0	@	> 10.0	@
Fruit width (cm)	2.7 - 5.23	< 3.50	@	3.51-3.70	@	3.71 - 3.90	@	3.91-4.10	@	> 4.10	@
Fruit / plant	3 - 26.3	< 10	@	10.1-13.0	@	13.1 - 15	@	15.1-17.0	@	> 17.0	@
Leaf length	10.3 -28.3	< 14.0	@	14.1 - 16	@	16.1 - 18.0	@	18.1 - 20	@	> 20.0	@
Seed/ pod	40.0 - 100	< 60	@	60 - 70	@	71 - 80	@	81 - 90	@	> 90	@
Stem diameter	1.5 - 3.2	< 1.80	@	1.80-2.00	@	2.01 - 2.20	@	2.21-2.40	@	> 2.40	@
Number of internode	3.1 – 6.98	< 3.5	@	3.5 – 4.4	@	4.5 - 5.4	@	5.5 - 6.5	@	> 6.5	@

@ = Days to 50% flowering; @ = 100-seed weight (g); @ = Fruit length (cm); @ = Fruit width (cm); @ = Fruits / plant; @ = Leaf length (cm); @ = Seeds / pod, @ = Stem diameter (cm); @ = Number of internodes.

kly stems include: CEN 016, OAA 96/175-5328, NGAE-96-0062-1, NGAE-96-0064, NGAE-96-0063, Owode-4 and Owode-5. Eighteen accessions have downy fruits while 14 accessions have prickly fruits. The rest 17 accessions are slightly prickly with varying degree of roughness compared with the prickly type. All the 4 accessions from Akure had glabrous stem with purple stem except Akure-1-1 which has green stem. All accessions were evaluated except three were tolerant to major diseases affecting leaves, stem and fruits. The three accessions that were slightly susceptible to stem borer and cotton stainers attack based on field assessment include AGA97/066-5780, CEN009 and OJAOBA-3.

The grouping of the variability of the eleven characters into 5 classes on the basis of their class intervals as well as their index scores and signs is presented in Table 2. The eleven characters that were used for the metroglyph include the main agronomic characters such as fruit length, fruit width, leaf length, days to 50% flowering, plant height, number of internodes, hundred seed weight, stem diameter and pod yield per plant. These were the most commonly used traits in distinguishing between okra genotypes (Ariyo, 1988). The mean values of the eleven traits considered for the metroglyph as well as the index score for each accession are presented in Tables 3 and 4. The metroglyph of the 50 accessions showed variation pattern in the eleven agronomic traits (Figure 1). The metroglyph chart grouped all the accessions into seven distinct groups with specific differences from other group. The index scores ranged from 19.0 to 42.3 with groups I and VII showing two extremes among the 50 accessions evaluated.

DISCUSSION

The scatter diagram can be distinguished into seven broad groups which reflect the uniqueness of each group based on the means of the different morphological traits measured.

Group I: short plants and low pod yielding genotypes.

Table 3. Mean values and index score (in brackets) for 11 characters.

No	Flower (day)	Fruit/Plant (cm)	Fruit Length (cm)	Fruit width (cm)	Height (cm)	No. of Internode (cm)	Leaf Length (cm)	Peduncle length (cm)	Seed 100 Wt (g)	Seed Fruit	Stem Diameter (cm)	Yield Plant (g)
1	136(2)	12.2(2)	8.9(2)	4.20(5)	96(3)	4.70(3)	15.3(2)	16.0	4.06(2)	74(3)	2.03(3)	79.1(5)
2	138(2)	7.9(1)	8.6(2)	3.77(3)	77(2)	4.87(3)	15.4(2)	19.1	4.03(2)	84(4)	2.30(4)	42.8(2)
3	138(2)	10.8(2)	9.4(3)	3.87(3)	99(3)	3.30(1)	16.3(3)	23.0	4.37(2)	89(4)	2.63(5)	68.3(4)
4	137(2)	8.3(1)	9.2(3)	3.61(2)	94(3)	3.87(2)	16.1(3)	22.8	4.48(3)	73(3)	2.27(4)	42.6(2)
5	140(3)	9.4(1)	9.2(3)	3.77(3)	90(3)	4.97(3)	15.9(2)	21.1	4.52(3)	80(3)	2.40(4)	49.1(2)
6	142(3)	4.7(1)	9.6(3)	3.90(2)	69(1)	4.50(3)	14.9(2)	16.0	4.35(2)	54(1)	1.93(2)	24.7(1)
7	140(3)	15.9(4)	10.1(4)	3.67(2)	119(5)	4.93(3)	16.3(3)	23.2	4.93(4)	75(3)	2.57(5)	40.0(2)
8	140(3)	7.0(1)	9.5(3)	3.57(2)	89(3)	3.13(1)	16.6(3)	20.0	3.83(1)	87(4)	2.27(4)	42.2(2)
9	136(2)	15.2(4)	8.5(2)	4.03(4)	104(4)	4.37(2)	16.2(3)	18.0	4.28(2)	73(3)	2.47(5)	70.2(5)
10	142(4)	10.1(2)	9.6(4)	3.80(3)	118(5)	3.50(2)	15.9(2)	20.0	3.44(1)	67(2)	2.17(3)	45.4(2)
11	136(2)	17.0(5)	10.6(5)	3.47(1)	111(4)	5.27(4)	17.7(3)	24.6	4.16(2)	82(3)	2.80(5)	61.3(4)
12	139(3)	10.9(2)	8.5(2)	3.53(2)	82(2)	4.30(2)	15.2(2)	16.9	4.23(2)	71(3)	2.00(2)	44.5(2)
13	133(1)	13.6(3)	7.7(1)	3.98(4)	113(4)	6.47(4)	17.3(3)	20.3	4.53(3)	87(4)	2.20(3)	89.0(5)
14	136(2)	13.2(3)	9.2(3)	4.34(5)	113(4)	4.97(3)	16.5(3)	22.2	4.59(3)	87(4)	2.53(5)	107.2(5)
15	140(3)	13.8(3)	9.0(3)	3.97(4)	118(5)	4.57(3)	16.1(3)	21.2	4.42(2)	67(2)	2.20(3)	82.8(5)
16	135(2)	17.7(5)	8.4(2)	3.76(3)	130(5)	6.37(4)	17.1(3)	23.4	4.73(3)	91(5)	2.53(5)	111.2(5)
17	139(3)	23.1(5)	10.0(4)	3.96(4)	118(5)	6.93(5)	19.0(4)	21.9	4.62(3)	86(4)	2.60(5)	146.1(5)
18	136(2)	13.6(3)	10.2(5)	3.80(3)	112(4)	4.70(3)	19.4(4)	21.6	4.78(3)	83(4)	2.47(5)	100.7(5)
19	136(2)	14.4(3)	10.4(5)	4.05(4)	136(5)	6.57(5)	19.9(4)	21.0	4.82(3)	91(5)	2.40(4)	100.2(5)
20	136(2)	17.1(5)	9.2(3)	4.17(5)	117(5)	5.60(4)	24.3(5)	27.2	4.95(4)	94(5)	2.60(5)	120.3(5)
21	133(1)	12.7(5)	9.8(4)	3.78(3)	101(4)	5.00(3)	17.1(3)	19.3	4.94(4)	74(3)	2.00(2)	91.0(5)
22	138(2)	10.6(2)	10.2(5)	3.78(3)	111(4)	5.40(3)	15.8(2)	22.4	4.97(4)	93(5)	2.13(3)	61.6(4)
23	145(4)	5.9(1)	7.3(1)	3.61(2)	80(2)	4.57(3)	14.3(2)	18.2	4.76(3)	78(3)	1.80(2)	48.0(2)
24	138(2)	5.3(1)	8.0(2)	3.73(3)	76(2)	3.90(2)	12.8(1)	15.8	4.91(4)	71(3)	1.67(1)	34.7(1)
25	136(2)	15.2(4)	8.2(2)	3.72(3)	145(5)	5.63(4)	17.6(3)	21.8	4.34(2)	64(2)	2.53(5)	110.0(5)
26	136(2)	9.1(1)	8.3(2)	3.59(2)	89(3)	4.23(2)	13.2(1)	17.8	4.68(3)	62(2)	2.03(3)	32.9(1)
27	142(3)	12.1(2)	9.1(3)	3.13(1)	97(3)	5.20(3)	15.4(2)	20.4	4.42(2)	79(3)	2.07(3)	58.1(3)
28	134(1)	14.7(3)	10.3(5)	3.53(2)	107(4)	5.23(3)	16.6(3)	22.6	4.24(2)	74(3)	2.33(4)	93.9(5)
29	154(5)	6.5(1)	8.7(2)	3.42(1)	100(3)	4.87(3)	16.0(2)	21.3	4.38(2)	65(2)	1.97(2)	41.6(2)
30	148(5)	7.2(1)	8.3(2)	3.60(2)	87(3)	3.37(1)	15.0(2)	13.9	5.61(5)	66(2)	1.90(2)	26.9(1)
31	140(3)	8.9(1)	8.9(2)	3.98(4)	96(3)	4.63(3)	15.3(2)	18.7	5.13(5)	81(4)	2.07(3)	60.9(4)
32	137(2)	7.3(1)	9.7(4)	3.88(3)	102(4)	3.77(2)	15.8(2)	20.0	4.94(4)	83(4)	2.07(3)	58.1(3)
33	141(3)	6.3(1)	7.8(1)	3.48(1)	78(2)	3.57(2)	13.8(1)	17.5	4.15(2)	66(2)	2.13(3)	34.4(1)
34	145(4)	4.9(1)	8.6(2)	3.05(1)	77(1)	4.20(2)	12.5(1)	15.1	4.20(2)	72(3)	1.73(1)	35.7(1)

Table 3. contd.

35	140(3)	9.7(1)	7.5(1)	3.81(3)	91(3)	4.67(3)	14.3(2)	15.8	4.08(2)	64(2)	2.03(3)	31.0(1)
36	134(1)	13.9(3)	8.8(2)	3.43(1)	98(3)	4.33(2)	13.9(1)	17.0	3.93(1)	72(3)	2.03(3)	69.5(4)
37	146(5)	9.8(1)	6.8(1)	3.35(1)	85(2)	4.13(2)	13.7(1)	18.7	4.43(2)	61(2)	1.80(2)	47.4(2)
38	143(4)	8.5(1)	7.8(1)	3.65(2)	80(2)	5.40(3)	13.6(1)	18.2	4.09(2)	60(2)	1.80(2)	35.8(1)
39	144(4)	3.5(1)	7.9(1)	3.11(1)	64(1)	4.63(3)	11.4(1)	12.6	3.98(1)	41(1)	1.57(1)	21.4(1)
40	142(4)	10.7(2)	8.1(2)	3.70(2)	72(1)	3.83(2)	12.7(1)	15.7	4.42(2)	88(4)	1.67(1)	69.7(4)
41	137(2)	6.8(1)	10.2(5)	3.38(1)	92(3)	3.77(2)	15.2(2)	16.0	4.94(4)	71(3)	1.93(2)	34.3(1)
42	139(3)	5.5(1)	8.2(2)	3.41(1)	80(2)	4.43(3)	10.7(1)	18.5	4.79(4)	65(2)	1.77(1)	43.0(2)
43	140(3)	5.7(1)	9.5(3)	3.57(2)	99(3)	4.20(2)	13.0(1)	19.7	4.29(2)	72(3)	1.90(2)	37.1(1)
44	136(2)	5.3(1)	8.0(2)	3.78(3)	81(2)	3.87(2)	12.8(1)	16.3	4.94(4)	80(3)	1.67(1)	30.6(1)
45	141(3)	6.9(1)	7.8(1)	2.97(1)	112(4)	4.87(3)	15.7(2)	21.7	2.87(1)	63(2)	2.06(3)	29.5(1)
46	142(4)	7.4(1)	7.8(1)	3.53(2)	98(3)	5.83(4)	15.5(2)	19.9	4.95(4)	79(3)	1.90(2)	41.6(2)
47	137(2)	17.3(5)	10.1(5)	3.64(2)	123(5)	5.30(2)	19.1(4)	23.5	4.56(3)	73(3)	2.43(4)	91.5(5)
48	141(3)	14.2(3)	8.9(2)	3.24(1)	81(2)	4.47(3)	13.6(1)	18.3	4.40(2)	81(4)	2.00(3)	80.4(5)
49	138(2)	7.4(1)	9.9(4)	3.10(1)	89(3)	4.43(3)	14.3(2)	17.5	4.71(3)	68(2)	1.73(1)	36.0(1)
50	136(2)	13.0(3)	8.5(2)	3.75(2)	106(4)	3.77(2)	15.1(2)	20.6	4.61(3)	98(5)	2.23(3)	66.2(4)

Table 4. Frequency distribution of index score of the seven groups of *A. caillei*.

Group	No. in group	16	19	21	22	23	24	25	26	27	28	29	30	31	32	33	34	36	37	38	40	41	42	45	47	48	Total	Average score
I	02	1			1																						38	19.0
II	21		2	2	3	4	2	1	1	1	3	1	1														506	24.1
III	04							1				1						1		1							128	32.0
IV	03				1								1							1							90	30.0
V	09						1				1			1	3		2		1								284	31.5
VI	07										1					1	1	1			1	1			1		259	37.0
VII	04																			1			1	1		1	173	43.3
Total	50	1	2	2	5	4	3	2	1	1	5	2	2	1	3	1	3	2	1	3	1	1	1	1	1	1		

This group, though matured relatively late, their yield was relatively low. Accession CEN 016 and ADO - EKITI-5 belonged to this group.

Group II: Low yield but with relatively medium plant height. Twenty-one genotypes fall within this group and they are generally more closely related than other groups.

Group III: Short to medium plant height with moderate pod yield. CEN 010, NGAE-96-0067, IFE-1 and OWODE-3 belong to this group. They are also different from each other in terms of yield and height. OWODE-3 was relatively taller and yielded more than IFE-1.

Group IV: Moderately tall with low yield. Three genotypes belong to this group which includes CEN012, CEN015 and AKURE-2-4. They are generally late maturing with robust stem and relatively long pod size.

Group V: Average plant height and moderate pod yield. This group was generally in between the other groups and they are unique for their

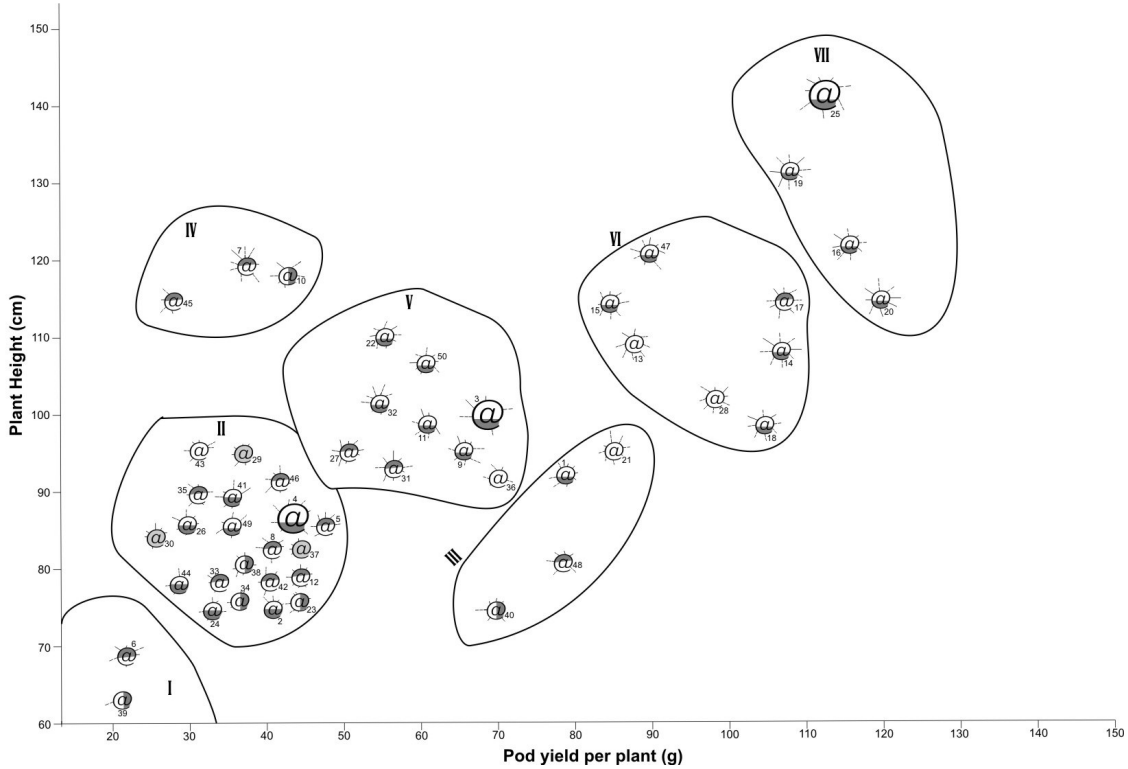

Figure 1. Scatter diagram of metroglyphs representing 50 accessions of *A. caillei* on eleven agronomic characters.

robust stem. They are more scattered and varied within the group in terms of height and yield unlike group II. Some were late while others were early. Eleven genotypes belong to this group as indicated by their code number on the glyph chart.

Group VI: High yielding genotypes with moderate plant height and medium maturity. This group consisted of seven genotypes and they possess medium to high value for all the agronomic characters considered for this study. Some of the group members were more related to other group members than within the group. This might be linked to their point of collection, which means they might be having some genetic relationships.

Group VII: This group is as unique as group I because it combines tall plant height with high pod yield. The four genotypes in this group were also different from each other in height but with relatively the same pod yield and varied maturity period. The genotypes in this group are NGAE-96-062-1 (16), NGAE-96-0061 (19), NGAE-96-0060 (60) and NGAE-96-011 (25).

The metroglyph showed that accessions with very poor yield had short plant height, an indication that for West African genotype okra to produce substantial yield, it must possessed strong stem, hence early planting is encouraged. The average index score of group I was 19.0, while that of group VII with four accessions in the group had index score of 42.3. This suggest how wide the differences in both yield and height among the groups. The index score of groups V which was on the glyph chart was 32.5 and was almost the central point between the two extremes of groups I and VII. The index scores of groups III, IV and V with 32.0, 30 and 31.5 was a reflection on how close these groups might be. This suggests that breeders may contemplate using from any of these groups for crossing purposes and not all or two of them at the same time, though this still depends on the goal of the breeder.

It is interesting therefore to note the ability with which the metroplyph reduced the complex interrelationships among accessions to a simple pictorial scatter diagram which is easier to comprehend (Akoroda, 1983, Khan et al., 2007). The fruit surface of Akure-2-2 and Akure-1-1 were smooth while Akure-2-9 and Akure-2-4 showed slightly prickly fruits. This suggests that accessions from Akure town in Ondo state of Nigeria have been domesticated to large extent and possibly are more related. There is need for collec-tion and conservation of okra germplasm especially, West African genotypes to prevent total genetic erosion.

REFERENCES

Akoroda MO (1983). Principal Component Analysis and Metroglyph of Variation among Nigerian yellow yams Euphytica 32: 565 – 573.

Ariyo OJ (1993). Genetic diversity in West African Okra (*Abelmoschus caillei* (A. Chev.) Stevels) – Multivariate analysis of morphological and agronomic characteristics. Genet. Res. Crop Evol. 40: 25-32.

Ariyo OJ (1988). Metroglyph and index score analysis and variety distinctness in okra (*Abelmoschus esculentus)*. Niger. J. Agron. 3:42-46.

Bisht IS, Mahajan RK, Rana RS (1995). Genetic diversity in South Asian okra *(Abelmoschus esculentus)* germplasm collection. Ann. Appl. Biol. 126: 239-550.

Frankel OH (1976). Natural Variation and its Conservation in Proceedings of an International Symposium on Genetic Control of Diversity in Plants at Lahore, Pakistan

Gulsen OS, Karagul S, Abak K (2007). Diversity and relationships among Turkish germplasm by SRAP and Phenotypic marker polymorphism. Biologia, Bratislava 62(1): 41-45.

Hartwig EE (1972). Utilization of soybean germplasm strains in a soybean improvement programme. Crop Sci. 12: 856-859.

Khan MR, Samad A, Begun S, Khaleda S, Alam AKMS, Rahman MZ(not cited. Please provide or delete) (2007). Metroglyph Analysis in Cotton (*Gossypium spp*). Bangladesh J. Sci. Ind. Res. 42(4): 449-454.

Omonhinmin CA, Osawaru ME (2005). Morphological characterization of two species of Abelmoschus: *Abelmoschus esculentus and Abelmoschus caillei*. Genet. Res. Newslett. 144: 51-55.

Palve SS, Rajput JC, Jamdagni BM (1986). Genetic Variability and Correlation studies in okra (*Abelmoschus esculentus*). Indian J. Agric. Res., 19(1): 20-22.

Ren J, McFerson J, Kresovich RLS, Lamboy WF (1995). Identities and Relationships among Chinese Vegetable Brassicas as Determined by Random Amplified Polymorphic DNA Markers. J. Am. Soc. Hort. Sci., 120(3): 548 - 555.

Splittstoessor WE (1990). Vegetable growing handbook. New York: Van Nostrand Reinhold. Pp. 248-250.

Stevels JCM (1988). Une nouvelle combinaison dans *Abelmoschus. (Malvaceae)* un gombo d'Afrique de l'Ouest et centrale. Bull. Mus. Nat. Hist, Nat., Paris u-ser. Lo., Section B., *Adansonia* 2: 137-144.

Tigerstedt PMA (1994). Adaptation, variation and selection in marginal areas. Euphytica 77: 171-174.