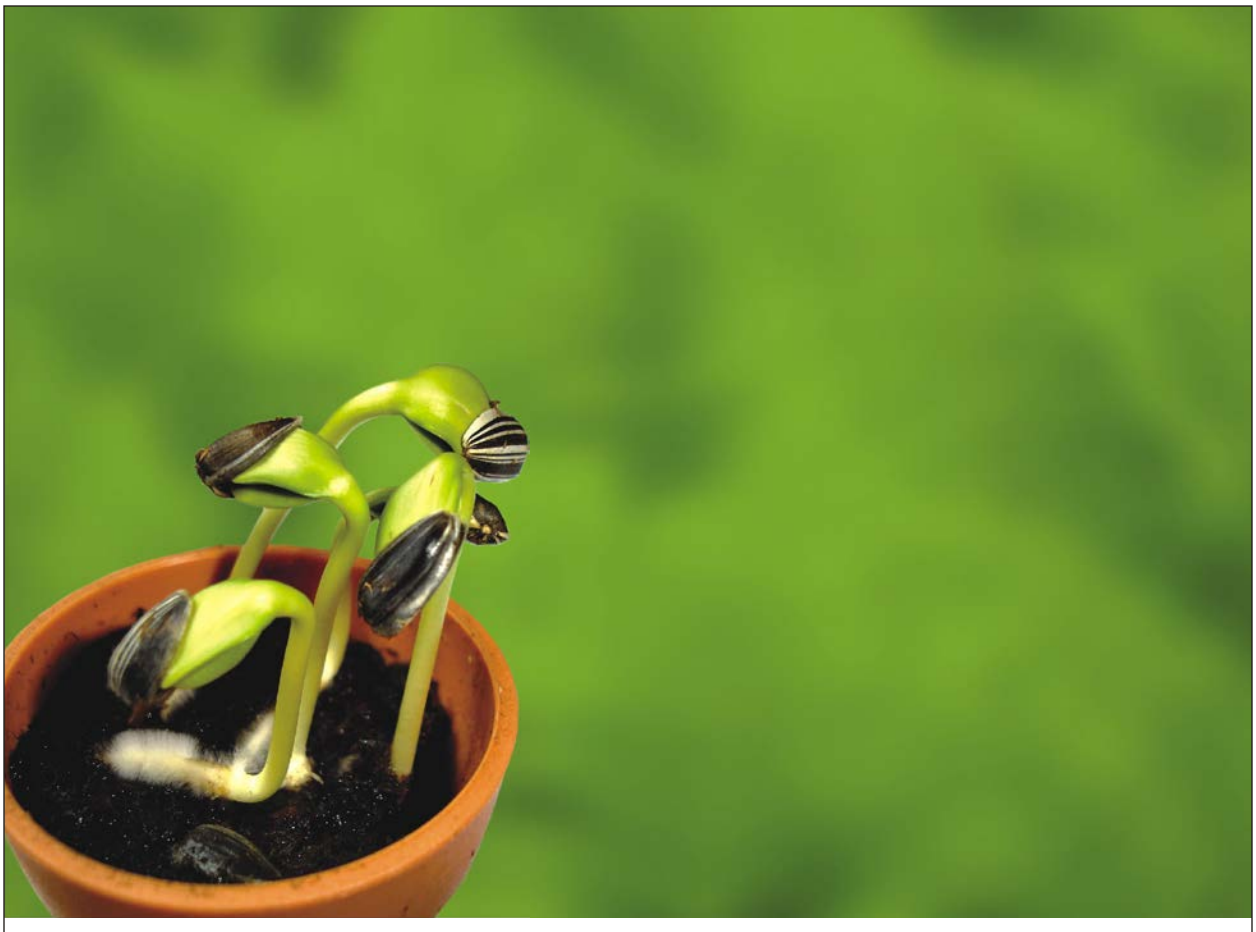

International Journal of Plant Breeding and Genetics

ISSN 1819-3595

Academic Journals Inc.

www.academicjournals.com

International Journal of Plant Breeding and Genetics 8 (1): 13-24, 2014
ISSN 1819-3595 / DOI: 10.3923/ijpbg.2014.13.24

Diversity in 118 Cowpea [*Vigna unguiculate* (L.) Walp] Accessions Assessed with 16 Morphological Traits

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ABSTRACT

The aim of the experiment was to assess the relatedness of 118 cowpea genotypes based on 16 morphological traits and to identify genotypes with unique traits for breeding purposes. The genotypes were from different parts of Ghana as well as International Institute of Tropical Agriculture in Nigeria and University of California Riverside in the United States of America. The phenotyping was done in the experimental farm of West Africa Centre for Crop Improvement, University of Ghana in April to June, 2011. Some of the traits included: terminal leaflet shape, number of seeds per pod, 100 seed weight, growth habit, days to flowering, plant pigmentation and number of pods per peduncle, based on key access and utilization descriptors for cowpea. Variability was observed in all of the 16 traits and was used to calculate dissimilarity between the genotypes with the method of Sokal and Sneath. The dissimilarity ranged from 7-100% with a mean of 43%. Factorial plot clustered the improved varieties together indicating that they have been selected based on similar traits pointing the importance of conservation in safeguarding genetic erosion. Diversity observed in the collection based on the 16 traits would be of use in selecting parents for genetic studies and breeding.

Key words: Characterization, cowpea, dissimilarity, morphological

INTRODUCTION

Diversity in a given germplasm forms the raw material for the improvement of that crop. Cowpea is one of the crops with several number of accessions conserved in genebanks all over the world (Fatokun *et al*., 2000). The high number of cowpea accessions may be due to the presence of high morphological diversity within the species and the importance of the crop among others. There are instances that even closely related genotypes of cowpea have conspicuous differences (Omoigui *et al*., 2006) and this could lead to assigning them different accession numbers. There are about three hundred accessions of cowpea collected mainly from different parts of Ghana in conservation at the CSIR-PGRRI, Bunso. Bennett-Lartey and Ofori (1999) studied the variability of some qualitative traits of some of the accessions. Recently, Cobbinah *et al*. (2011) also published their work on morphological characterization of some of the Bunso cowpea collection. Oppong-Konadu *et al*. (2005) characterized the cowpea germplasm based on seed protein while Asare *et al*. (2010) used SSRs. All of these authors used cowpea accessions being conserved at

CSIR-PGRRI. Cowpea germplasm have very wide diversity depicting the geographic location and the planting system from which they were collected (Menendez *et al*., 1997). Therefore, to increase the gene pool, elite genotypes from different sources were included in the current diversity study to identify materials for future breeding programmes.

Despite the effectiveness of the use of molecular markers in diversity studies (Tan *et al*., 2012; Tanhuanpaa and Manninen, 2012), morphological and agronomic traits remain imperative to plant breeders (Krichen *et al*., 2012). Morphological characterization is used routinely by plant breeders for the initial description and classification of germplasm in order to select genotypes for cultivation by farmers or in breeding programmes (Krichen *et al*., 2012). In addition the desired traits must express in the target environment and this makes morphological characterization crucial in plant breeding.

Knowledge on the key traits of the germplasm helps in making decision of parent selection for breeding purposes and reduces the number of germplasm that a researcher would have selected for initial screening. The objective of the study therefore, was to assess the relatedness of 118 cowpea genotypes assembled based on 16 morphological traits and to identify genotypes with unique traits for breeding purposes.

MATERIALS AND METHODS

Plant materials and cultural practices: A total of 118 genotypes listed in Table 1 with their passport information were characterized. The bulk of the germplasm was assembled from CSIR-PGRRI, Bunso, Ghana. The genotypes consisted primarily of landraces; However, some of

Table 1: Passport information of the cowpea genotypes characterized

GH No.	Local name	Collection date	Region	Location	Lat	Long	Seed colour
GH1622	Ayi-dze	21-12-82	Volta	Djolo	06°35'N	00°27'E	Black
GH1630	Asedua	01-12-83	Volta	Anum	06°29'N	00°10'E	Black
GH1665	Asedua	26-11-82	Eastern	Nkawkaw			Red
GH1667	AduaNsawa	30-11-82	Eastern	Kan No. 2	06°40'N	01°20'W	Brown
GH2272	Banga	13-10-87	BrongAhafo	Tuobodom	07°43'N	01°69'W	
GH2279	Sanji	14-10-87	North	Tianjeni	09°15'N	00°37'W	Red
GH2280	Sanji	14-10-87	North	Labaraga	09°15'N	02°10'W	Brown
GH2281	Sanji	14-10-87	North	Boterly			Dark
GH2282	Sanji	14-10-87	North	Tua	09°55"N	00°07'W	Black
GH2284	Sanji	14-10-87	North	Sang	09°18'N	02°25'W	Red
GH2288	Isagi	14-10-87	North	Tuwuwa	09°26'N	02°00'W	Black
GH2291	Sanji	15-10-87	North	Ziong	09°13'N	01°02'W	Red
GH2293	Sanji	15-10-87	North	Limoh	09°29'N	01°13'W	Red seeds
GH2294		15-10-87	North	Limoh	09°29'N	01°13'W	Mottled
GH2296	Sanji	15-10-87	North	Duobunantor	10°21'N	00°35'W	Red
GH2306	Bonda	16-10-87	Upper West	Tumu	10°40'N	02°01'W	Black
GH2307	Bondawa	16-10-87	Upper West	Buoti	10°53'N	02°07'W	Black
GH2312	Dapiala	17-10-87	Upper West	Sombo	10°15'N	02°27'W	Red
GH2314	Bengah	17-10-87	Upper West	Kampala	10°0'N	02°24'W	Mottled
GH2317	Achibe	17-10-87	North	Tuna	09°32'N	02°36'W	Mottled
GH2325	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Cream/Mixed
GH2326	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	White
GH2329	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	White

Table 1: Continue

GH No.	Local name	Collection date	Region	Location	Lat	Long	Seed colour
GH2330	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Red
GH2331	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Mottled
GH2332	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	White
GH2333	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Mottled
GH2334	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Cream
GH2335	Asedua	30-11-87	Eastern	Akoradarko	06°22'N	00°24'W	Red
GH2336	Asedua	30-11-87	Eastern	Ahomahomaso	06°27'N	00°29'W	Mottled
GH2338	AduaNsawa	12/1/1987	Eastern	Bepongkwahu	06°42'N	00°47'W	Red
GH2340	AduaNsawa	12/1/1987	Eastern	Asakraka	06°34'N	00°35'W	Black
GH2341	AduaNsawa	12/1/1987	Eastern	Abene	06°38'N	00°34'W	White
GH2342	AduaNsawa	12/1/1987	Eastern	Abene	06°38'N	00°34'W	Red
GH2347	Yor	18-12-87	Eastern	Nkurakan			Black
GH3108							Black
GH3666	Ayi	23-10-93	Volta	Juapong			Red
GH3667	Ayi	23-10-93	Volta	Juapong	06°18'E	0°11'N	Dark
GH3668	Ayi	23-10-93	Volta	Juapong	06°18'E	0°11'N	Black
GH3669	Ayi	23-10-93	Volta	Juapong	06°18'E	0°11'N	Black
GH3670	Ayi	23-10-93	Volta	Tedefenu	06°35N	0°06E	Brown
GH3673	Ayi	24-10-93	Volta	Awudome	06°41N	0°17E	Black
GH3674	Eveyi	24-10-93	Volta	Anyirawase	06°34N	0°18	Black
GH3675	Ase fita	25-10-93	Eastern	Senchi Ferry	06°13N	0°5E	Black
GH3677	Yor	26-10-93	Eastern	Aberewankor	06°06N	0°12W	Brown
GH3679	Yor	26-10-93	Eastern	Takunya	06°06N	0°11W	Other
GH3684	Asedua	29-10-93	Eastern	Tanoso	06°54N	0°43W	Brown
GH3685	Asedua	30-10-93	Eastern	Fukuokrom	07°16N	02°19W	Black
GH3689	Sanji	1-11-93	Eastern	Defaa	08°54N	0°39N	Brown
GH3701	Sanji	11-2-93	Eastern	Kpong	06°10'w	0°03'N	Brown
GH3703	Tua	11-2-93	North	Loagri			Red
GH3706	Benga	4-11-93	North	Tanina	09°50N	0°29W	Brown
GH3710	Tua	11-5-93	North	Nabori			Dark
GH4028	Adua nsawa	19-5-96	North	Owusukrom			Red
GH4524B	Yor	29-7-96	Accra	Prampram			Black
GH4524e	Yor	29-7-96	Accra	Prampram			Cream
GH452M	Yor	29-7-96	Accra	Prampram			Mottle
GH4524E	Yor	29-7-96	Accra	Prampram			Cream
GH4537	Ayi	08-1-96	Volta	Ziope			Brown
GH4529	Tolonye	30-7-96	Accra	Kasseh			Mottled
GH4530	Yor	30-7-96	Accra	Kasseh			Brown
GH4532	Ayiyibor	31-7-96	Volta	Dabala			Red
GH4533	Ayi	31-7-96	Volta	Dabala			Cream
GH4537	Ayi	1-8-96	Volta	Ziope			Brown
GH4546	Ayi	08-3-96	Volta	Ziope			Dark
GH4771	Bianga	22-10-96	Upper West	Wa			Black
GH4778	Gonja	27-10-96	North	Yipala			Red
GH5038	Vakli	11-4-96	Volta	Akuni No. 2			Cream
GH5039	åkye	11-4-96	Eastern	Abonse			Red
GH5040	Yor	11-5-96	Eastern	AhabasoGyaesu			Red
GH5043	Asedua	11-6-96	Eastern	New Tafo			Brown
GH5044	Yor	11-6-96	Eastern	Sutapong			Red

Table 1: Continue

GH No.	Local name	Collection date	Region	Location	Lat	Long	Seed colour
GH5045	Yor	11-6-96	Eastern	Sutapong			Red
GH5048	AduaNsadua	11-6-96	Eastern	Suminakese			Red
GH5050	Asådua	11-8-96	Ashanti	Kokoben			Red
GH5344	Asedua	11-6-96	Ashanti	Juaben			Red
GH5346	Atedua	9-11-96	Ashanti	Ayakomaso			Brown
GH6045	Soronko		Ashanti	Fumesua			Redish-Brown
GH6060	Ayiyi	28-8-98	Eastern	Nsawam			White
GH7174	Tse	18-2-03	Upper East	Bolga			White
GH7178	Benga	19-2-03	Upper East	Zebila			Red
GH7185	Sona	19-2-03	Upper East	Navrongo			Black
GH7218	Sona	1-4-03	Upper East	Babison			Other
GH7222	Bondabene	04-1-03	Upper West	Kong			Brown
GH7223	Sombene	04-1-03	Upper West	Kong			Dark
GH7224	Sompla	04-1-03	Upper West	Kong			Dark
GH7228	Bene	04-2-03	Upper West	Kalsegra			Dark
GH7229	Bene	04-2-03	Upper West	Kalsegra			Dark
GH7231	Bene	04-2-03	Upper West	Kalsegra			Dark
GH7235	Bene	04-2-03	Upper West	Kalsegra			Dark
GH7243		04-2-03	Upper West	Kaleo			Dark
GH7245	Sonorni	1-4-03	Upper West	Kunchogu			Other
GH7875	Asådua	15-3-06	Eastern	Anyinam			Red
GH7888	Asetenapa	16-8-06	Ashanti	C.R.I Fumesua			White
Agrimat				Market (Accra)			White
Market				Market (Ho)			White
Asontem				CSIR-CRI			Red
Nhyira				CSIR-CRI			Cream
Tona				CSIR-CRI			Brown
Bawuta				CSIR-SARI			White
Paddy tuya				CSIR-SARI			White
Songotra				CSIR-SARI			White
Zaayura				CSIR-SARI			White
IT97K-556-6				IITA			Brown
IT82E-18				IITA			Brown
IT93K-63-1				IITA			Brown
IT845				IITA			Red
Mouride				UCR			White
TVU1467				UCR			Black
TVU7778				UCR			Other
2425B				UCR			White
UCR 779				UCR			Brown
Bambey2				UCR			White
524B				UCR			White
Blackeye				UCR			White
CB 27				UCR			White
Danila				UCR			White
Yacine				UCR			Brown

CRI: Crop research institute, CSIR: Council for scientific and industrial research, IITA: International institute of tropical agriculture, SARI:Savanna agricultural research institut, UCR: University of California Riverside

them were commercial varieties in cultivation in Ghana. The rest of the germplasm came from different sources but were all obtained through the University of California Riverside, California, USA. Planting was done in the WACCI farm, University of Ghana using augmented design with three commercial varieties as checks in April, 2011. Plants were rainfed, no chemical fertilizer was applied. Insecticide (cymethoate) was applied at 1.5 L ha^{-1} in the 5th and 7th weeks of planting to reduce insect damage. Harvesting was done as soon as pods were ripe and sun dried before seed removal.

Data collection and analysis: Scoring for the various traits were done based on "Key access and utilization descriptors for cowpea genetic resources (Mahalakshmi *et al*., 2007)". Data was collected on plant vigour, growth habit, flower colour, plant pigmentation, mature and immature pod pigmentation, seed coat and eye colour, pod attachment, terminal leaflet shape and seed shape as the qualitative traits. Darwin software was used in the data analysis. The quantitative traits included number of days to flowering, number of pods per peduncle, pod length, seeds per pod and 100 seed weight. Both the qualitative as well as the quantitative data were scored as modalities and Sokal and Sneath dissimilarity calculated used for factorial display (Perrier *et al*., 2003; Perrier and Jacquemoud-Collet, 2006).

RESULTS

Plant vigour: The cowpea genotypes showed different degrees of vigour. Most vigorous plants observed were the spreading types such as Gh7218 and Gh7174. Accessions Gh7178 and Gh2336 were among few of the genotypes that were vigorous and erect.

Growth habit: Diverse growth habits were exhibited by the various cowpea lines in the collection. Climbing, prostrate and erect cowpea types were all observed in the collection as shown in Fig. 1.

Days to flowering: Flowering was recorded for first appearance of opened flowers on each cowpea accession. The earliest flowering was 31 days after sowing recorded for CB27. There were some local accessions that were also very early such as Gh3710 and Gh2293 which had opened flowers within 32 days of sowing. Accessions such as Gh3675 flowered 69 days after sowing and few others flowered after 75 days.

Fig. 1(a-c): (a) Erect, (b) Climbing and (c) Prostrate types of cowpea observed in the collection

Flower colour: There was much variability in flower colour, however, they were put into two categories; either violet or white.

Plant pigmentation: Varying degree of plant pigmentation was shown in the germplasm collection. It was observed that the local accessions generally showed more intense anthocyanin pigmentation than the exotic ones. Yacine and TVU14676 for instance did not show any pigmentation.

Pods per peduncle: The number of pods per peduncle was supposed to be recorded under total insect control condition. This experiment, however, was not under total insect control. The number of pods per peduncle recorded was the mode for each accession. An accession may have 2 as the number of pods per peduncle but some of the peduncles may have as much as 4 or even more pods.

Pod pigmentation: Both immature and mature pod pigmentations were examined. There were genotypes with no anthocyanin pigmentation of immature pods through to solid pigmentation. Mature and dried pods also showed variability in the collection. Figure 2 shows variability in pod shape colour and shattering ability.

Seed coat and eye colour: The variability in seed coat colour and eye was very high in the collection. There were some accessions with two or more different seed coat colours. This type was designated other. A mixture of cowpea seeds with different coat colours is presented in Fig. 3.

Fig. 2(a-c): (a) Dry pod curvature, (b) Shattering ability and (c) Colour observed in the collection

Fig. 3: Cowpea seeds with different coat colours

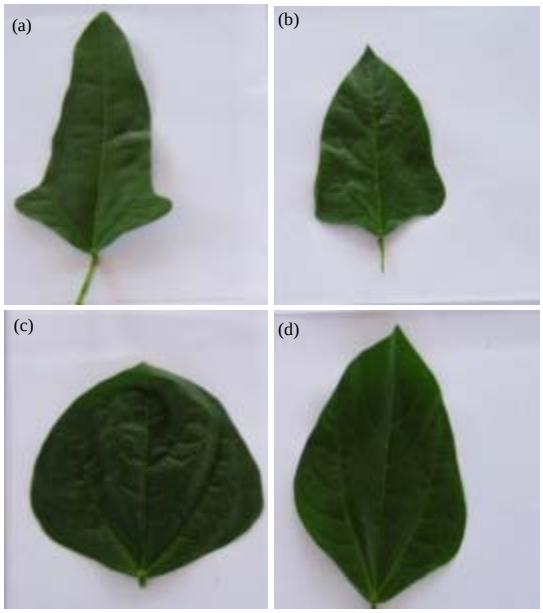

Fig. 4(a-d): Terminal leaflet shape, (a) Hastate, (b) Sub-hastate, (c) Globose and (d) Sub-globose

Pod attachment: All three types of pod attachment namely; pendant, 30-90° and erect were observed in the collection. There were some genotypes that were difficult to be assigned a group because of showing traits of two different groups or intermediate.

Terminal leaflet shape: Sub-hastate and sub-globose were the most occurring terminal leaflet types (Fig. 4) observed. Hastate and globose terminal leaflets are conspicuous; however, they are less frequent than sub-globose and sub-hastate types.

Seed shape, pod length, seeds per pod and 100 seed weight: Seed shapes observed were kidney, ovoid, globose and rhomboid. Seed weight was measured at about 14% moisture content. Number of seeds per pod ranged from 9 to 21 while 100 seed weight was from 6.69 to 20.84 g.

All the traits scored were used to calculate dissimilarity based on Sokal and Sneath modality (Perrier *et al*., 2003):

$$dij = \left\{ \frac{u}{2m+u} \right\}$$

where, dij is dissimilarity between two genotypes i and j, u is number of unmatching variables and m is number of matching variables (Perrier *et al*., 2003).

Bar-graph of the dissimilarity is shown in Fig. 5. Dissimilarity ranged from 0.07 to 1.0; however, most genotype pairs had values between 0.42 and 0.53. The dissimilarity is used for factorial display of the genotypes (Fig. 6).

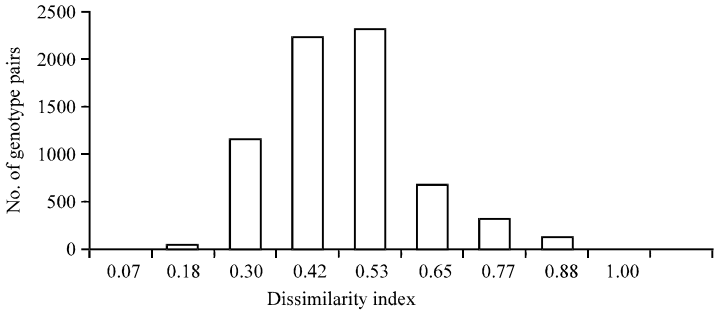

Fig. 5: Dissimilarity bar-graph based on sokal and sneath modality from the 16 morphological traits taken on the cowpea genotypes

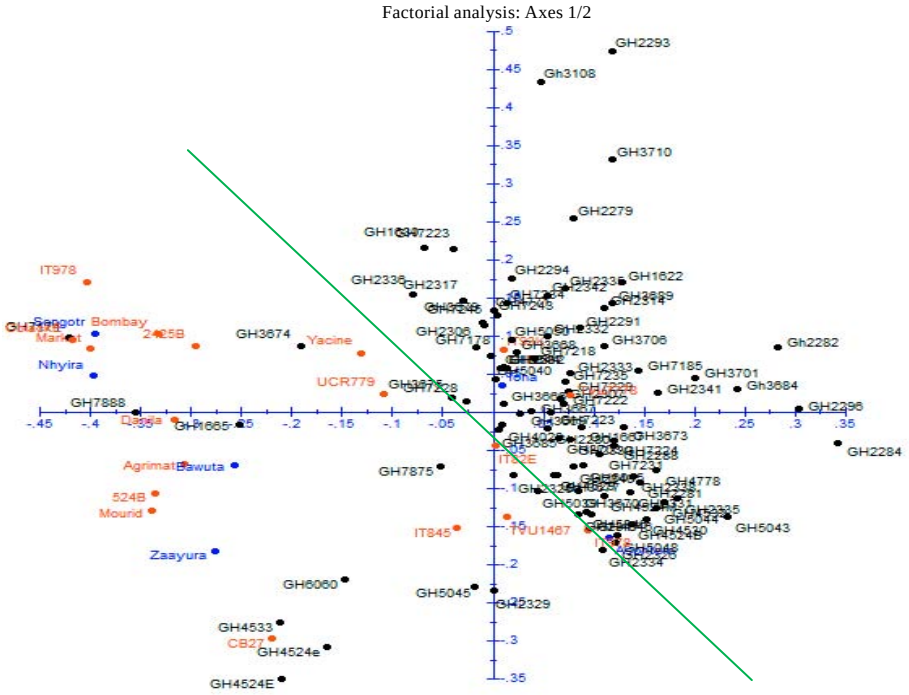

Fig. 6: Factorial display of the cowpea accessions based on 16 morphological traits with dissimilarity calculated using sokal and sneath modality

Factorial display of the cowpea genotypes: Factorial plot (Fig. 6) was drawn based on dissimilarities calculated with the traits scored with modalities. None of the 16 traits were shared with some of the genotypes resulting in 100% dissimilarity among those genotypes. Some genotypes on the other hand shared most of the traits which resulted in their dissimilarity indices less that 10%. The factorial plot generally divided the genotypes into two: genebank materials and foreign or improved varieties.

DISCUSSION

Although, cowpea is reported to have narrow genetic base (Li *et al*., 2001; Asare *et al*., 2010), variability was observed in all of the 16 morphological traits studied confirming the report of

Omoigui *et al.* (2006) that even closely related genotypes may have morphological differences. Variability was observed at early growth as some genotypes were more vigorous than others. Plant vigour is determined by growth in height and width. Vigorous plants have advantage in early establishment and dominance over weeds. Therefore vigorous plants are preferred over less vigorous ones. Early establishment may also be important in drought resistance. Most vigorous plants observed were the spreading types such as Gh7218 and Gh7174. These lines would be good candidates in developing varieties for cover cropping as objective. Accessions Gh7178 and Gh2336 were vigorous and erect which are two good traits. However, Gh7178 and Gh2336 have red and black seed coat respectively, which are less attractive to consumers in Ghana (Quaye *et al.*, 2011).

Diverse growth habits were exhibited by the various cowpea lines in the collection. Growth habit is important in choosing planting distance as erect lines such as California Black Eye would require closer planting. This is also important in deciding on the planting system to choose for the variety. The climbers, prostrate and erect cowpea types would definitely be used in different planting systems such as sole crop or intercropping described by Hall *et al.* (1997). Plant architecture determines how much sunlight the plant can capture. Although, closed canopy as in erect type is likely to be conducive for microbial infection, they are also likely to have higher harvest index.

Flowering was recorded for first appearance of opened flowers on each cowpea accession. The earliest flowering was 31 days after sowing recorded for CB27. There were some local accessions that were also very early such as Gh3710 and Gh2293 which had opened flowers within 32 days of sowing. Accessions such as Gh3675 flowered 69 days after sowing and still there were some accessions that did not flower after 75 days. It may however, not be appropriate to conclude on these late flowering accessions as they might be responding to photoperiod which is known to delay flowering in some cowpea genotypes (Ishiyaku *et al.*, 2005; Timko and Singh, 2008). However, it could be concluded with certainty that very early maturing cowpea genotypes are available in the collection.

There was much variability in flower colour, however, they were put into two categories; either violet or white. Several morphological traits in cowpea are linked (Kehinde *et al.*, 1997) and flower colour is not an exception. According to Omoigui *et al.* (2006) and Egbadzor *et al.* (2012), there is pleiotropic control of flower, pod pigmentation and seed coat pigmentation in cowpea. Makoi *et al.* (2010) reported relationship between seed coat pigmentation and insect pest resistance. The linkage of flower colour to other traits could help in using it in indirect selection for important/economic traits.

Varying degree of plant pigmentation was shown in the 118 cowpea genotypes. It was observed that the local accessions generally showed more intense anthocyanin pigmentation than the exotic ones. Yacine and TVU14676 for instance did not show any pigmentation. Both immature and mature pod pigmentations were examined. A given immature pod pigment may result in different mature pod pigment while different types of immature pod pigments may also mature to similar pigments. Genotypes with darker mature pods were observed to shatter easily on maturity.

The number of pods per peduncle was supposed to be recorded under total insect control condition. This experiment, however, was not under total insect control. Total insect control would have resulted in higher number of pods per peduncle. The number of pods per peduncle recorded was the mode for each accession. An accession may have 2 as the number of pods per peduncle but some of the peduncles may have as much as 4 or even more pods.

Seed colour influences consumer preference in cowpea (Mustapha, 2008). It is known that higher grain yields and improved grain quality are the primary breeding objectives of nearly all

cowpea breeding programmes (Timko and Singh, 2008). Grain colour is one of the qualities that consumers look for in cowpea and this preference has cultural dimension. The variability in seed coat colour and eye was very high in the collection. There were some accessions with two or more different seed coat colours. This type was designated other. This is a sign of within accession variability in some of the genotypes and was observed only in the local genotypes.

All three types of pod attachment namely; pendant, 30-90° and erect were observed in the collection. There were some genotypes that were difficult to be assigned a group because of showing traits of two different groups or intermediate. Erect type pods were mostly above the canopy which are said to be easier to harvest (Bennett-Lartey and Ofori, 1999; Cobbinah *et al*., 2011) especially when borne on long peduncles. Pendant pods with short peduncles were within canopy. However, Pendant pods were generally long and had more seeds than erect types which would contribute to higher seed yields. Variety with pendant pods borne on relatively long peduncles would be desirable.

Sub-hastate and sub-globose were the most occurring terminal leaflet types. There is a thin difference between the sub-globose and sub-hastate leaves. Haste and globose terminal leaflets are conspicuous; however, they are less frequent than sub-globose and sub-hastate types.

Seed shapes observed were kidney, ovoid, globose and rhomboid. Critical observation revealed that genotypes with some seed shapes had fewer seed per pod. For instance, kidney shaped seeds are normally few per pod compared to rhomboid types of seeds which are usually many per given pod. Seed weight was measured at about 14% moisture content. Seed weight reduces as the number of seeds per pod increases. Number of seeds per pod ranged from 9 to 21. Pod length ranged from 10.33 to 22.00 cm while 100 seed weight was from 6.69 to 20.84 g. As expected, longer pods have more seeds.

The factorial display showed general diversity in the cowpea collection based on the 16 morphological traits. Two main clusters are recognizable in the display demarcated with a diagonal green line. The genotypes on the left side of the green line are mainly improved varieties in cultivation in Ghana with names written in blue and foreign genotypes written in red. Clustering of the improved genotypes together is an indication of being selected for similar traits. Most of the improved or foreign varieties share similar traits such as erect growth habit, early maturity and they bear multiple pods per peduncle among other traits. Consequently, this leads to the narrowing of the genetic base of crops. The clustering of genebank materials away from the improved varieties means that there are available genotypes for possible improvement in cowpea. Also, this shows importance of conservation in safeguarding genetic erosion. Few genebank materials clustering with improved types may also help in using local materials for cowpea improvement; nevertheless, the use of foreign materials has its own advantage.

CONCLUSION

Variability was observed in all of the 16 morphological traits used in characterizing the 118 cowpea genotypes. Despite the variability, some of the genotypes were similar for most of the traits resulting in low dissimilarity values. Some of the genotypes also did not have any trait in common resulting in 100% dissimilarity. Improved cowpea varieties clustered together away from genebank materials in a factorial plot. The experiments strengthened the proposition for conservation of plant genetic resources and in this case cowpea, to safeguard genetic erosion. In addition, it is clear that introduction of genotypes from other regions and breeding programmes increases the genetic diversity for breeder's use.

REFERENCES

Asare, A.T., B.S. Gowda, I.K.A. Galyuon, L.M. Aboagye, J.F. Takrama and M.P. Timko, 2010. Assessment of the genetic diversity in cowpea (*Vigna unguiculata* L. Walp.) germplasm from Ghana using simple sequence repeat markers. Plant Genet. Resour., 8: 142-150.

Bennett-Lartey, S.O. and I. Ofori, 1999. Variability studies in some qualitative characters of cowpea (*Vigna unguiculata*) (L.) Walp) accessions from four cowpea-growing regions of Ghana. Ghana J. Agric. Sci., 32: 3-9.

Cobbinah, F.A., A.A. Addo-Quaye and I.K. Asante, 2011. Characterization, evaluation and selection of cowpea (*Vigna unguiculata* (L.) Walp) accessions with desirable traits from eight regions of Ghana. ARPN J. Agric. Biol. Sci., 6: 25-32.

Egbadzor, K.F., I. Amoako-Attah, E.Y. Danquah, S.K. Offei, K. Ofori and M.O. Opoku-Agyeman, 2012. Relationship between flower, immature pod pigmentation and seed testa of cowpea. Int. J. Biodiversity Conserv., 4: 411-415.

Fatokun, C.A., S.A. Tarawali, B.B. Sign, P.M. Korawa and M. Tumo, 2000. Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the 3rd World Cowpea Conference, September 4-8, 2000, International Institute of Tropical Agriculture IITA, Ibadan Nigeria..

Hall, A.E., B.B. Singh and J.D. Ehlers, 1997. Cowpea breeding. Plant Breed. Rev., 15: 215-274.

Ishiyaku, M.F., B.B. Singh and P.Q. Craufurd, 2005. Inheritance of time to flowering in Cowpea (*Vigna unguiculata* (L.) Walp.). Euphytica, 142: 291-300.

Kehinde, O.B., G.O. Myers and I. Fawole, 1997. Analysis of genetic linkage in cowpea *Vigna unguiculata*. Trop. Agric. Sci., 20: 75-82.

Krichen, L., J.M. Audergon and N. Trifi-Farah, 2012. Relative efficiency of morphological characters and molecular markers in the establishment of an apricot core collection. Hereditas, 149: 163-172.

Li, C.D., C.A. Fatokun, B. Ubi, B.B. Singh and G.J. Scoles, 2001. Determining genetic similarities and relationships among cowpea breeding lines and cultivars by microsatellite markers. Crop Sci., 41: 189-197.

Mahalakshmi, V., Q. Ng, M. Lawson and R. Ortiz, 2007. Cowpea [*Vigna unguiculata* (L.) Walp.] core collection defined by geographical, agronomical and botanical descriptors. Plant Genet. Resour., 5: 113-119.

Makoi, J.H.J.R., A.K. Belane, S.B.M. Chimphango and F.D. Dakora, 2010. Seed flavonoids and anthocyanins as markers of enhanced plant defence in nodulated cowpea (*Vigna unguiculata* L. Walp.). Field Crops Res., 118: 21-27.

Menendez, C.M., A.E. Hall and P. Gepts, 1997. A genetic linkage map of cowpea (*Vigna unguiculata*) developed from a cross between two inbred, domesticated lines. Theor. Applied Genet., 95: 1210-1217.

Mustapha, Y., 2008. Inheritance of seed colour in cowpea [*Vigna unguiculata* (L.) walp]. Int. J. Pure Applied Sci., 2: 1-9.

Omoigui, L.O., M.F. Ishiyaku, A.Y. Kamara, S.O. Alabi and S.G. Mahammed, 2006. Genetic variability and heritability studies of some reproductive traits in cowpea (*Vigna unguiculate* (L.) Walp.). Afr. J. Biotechnol., 5: 1191-1195.

Oppong-Konadu, E.Y.R., I.K. Akromah, Adu-Dapaah and E. Okai, 2005. Genetic diversity within ghanaian cowpea germplasm based on SDS-PAGE of seed proteins. Afr. Crop Sci. J., 13: 117-123.

Perrier, X., A. Flori and F. Bonnot, 2003. Data Analysis Methods. In: Genetic Diversity of Cultivated Tropical Plants. Seguin, X. Perrier and J.C. Glaszmann (Eds.). Enfield Science Publishers, Montpellier, France, pp: 43-76.

Perrier, X. and J.P. Jacquemoud-Collet, 2006. DARwin software: Version 5.0.158. http://darwin.cirad.fr/Home.php

Quaye, W., K. Adofo, E.S. Buckman, G. Frempong, J. Jongerden and G. Ruivenkamp, 2011. A socio-economic assessment of cowpea diversity on the Ghanaian market: Implications for breeding. Int. J. Consum. Stud., 35: 679-687.

Tan, H., M. Tie, Q. Luo, Y. Zhu, J. Lai and H. Li, 2012. A review of molecular makers applied in cowpea (*Vigna unguiculata* L. Walp.) breeding. J. Life Sci., 6: 1190-1199.

Tanhuanpaa, P. and O. Manninen, 2012. High SSR diversity but little differentiation between accessions of Nordic timothy (*Phleum pretense* L.). Hereditas, 149: 114-127.

Timko, M.P. and B.B. Singh, 2008. Cowpea: A Multifunctional Legume. In: Genomics of Tropical Crops Plants, More P.H. and R. Ming (Eds.). Springer-Verlag, Berlin, Germany, pp: 227-258.