VOL. 6, NO. 7, JULY 2011 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

CHARACTERIZATION, EVALUATION AND SELECTION OF COWPEA (*Vigna unguiculata* (L.) Walp) ACCESSIONS WITH DESIRABLE TRAITS FROM EIGHT REGIONS OF GHANA

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ABSTRACT

One hundred and thirty four accessions of cowpea from eight geographical origins of Ghana were planted at two locations, Bunso (semi-deciduous forest) and Pokuase (coastal savannah) to evaluate their performance and select those with desirable qualitative and quantitative characters for improvement. Qualitative characters evaluated included raceme position, pod colour, flower colour, growth habit and twining tendency. Quantitative characters included days to 50% germination, days to 50% flowering, days to 50% podding, number of branches on main stem, peduncle length, number of pods per plant, pod length, 100 seed weight and seed yield. Forty five accessions with promising characters based on the above characteristics were selected and further analyzed using a dendrogram out of which eleven accessions were selected. All the accessions analyzed showed three raceme positions, six growth habits and four types of flower colour. The hierarchical analysis grouped the selected accessions into three clusters with clustering of accessions not occurring along regional basis. High levels of similarity were revealed among the accessions.

Keywords: cowpea, accessions, characterization, clusters, peduncle length, flowering, number of pods, yield, Ghana.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important legume crops in Ghana (Aryeetey, 1971; Bennett-Lartey and Ofori, 1999). Despite its numerous benefits breeding of the crop poses a lot of challenges hence its production is not adequate to satisfy domestic demand for the commodity (MOFA, 2000). Although cowpea is a single crop species the varietal requirements in terms of plant type, seed colour or type, maturity and use pattern are extremely diverse from region to region, making breeding programmes for the crop more complex than for other crops (Singh *et al*., 1997).

Working on a world collection of cowpeas at the International Institute of Tropical Agriculture (IITA), Porter *et al*. (1974) reported of variability in several characters including growth habit, twining tendency, eye colour and pattern, days to flowering and maturity, and susceptibility to pests and diseases. Doku (1970) also reported of many different grain colours of cowpea in the Ghanaian market. Ofori *et al.*, (2006) stated that, due to the absence of improved seeds in Ghana, farmers continue to grow their own landraces and are the major custodians of germplasms. As a result landraces that do not appeal to them are likely to be lost.

Considerable progress has been made during the past decade in cowpea breeding, and a range of varieties has been developed, combining diverse plant type and maturity with resistance to several diseases, insect pests and parasitic weeds (Singh *et al*., 1997). This excellent progress in improving cowpeas in recent years, and the rapidly increasing worldwide interest in this crop, bode well for the future. However, other characteristics, including number of pods per plant, number of days to flowering and podding, growth habit and flower colour have been less researched. The lack of any serious researched activities or statistical analysis in these characteristics limits not only knowledge of the crop evolution but also relevant information usable for new and outstanding genetic improvement of the crop (Singh and Rachie, 1985; Ofori *et al*., 2006). This study was therefore conducted to evaluate the performance of cowpea accessions at two locations and select those with desirable qualitative and quantitative characters for improvement.

MATERIALS AND METHODS

Experimental materials

One hundred and ninety eight (198) cowpea accessions were planted out of which one hundred and thirty four (134) were used for the study. These were collections from eight regions of Ghana obtained from the Plant Genetic Resources Research Institute at Bunso, Ghana and hence no exploration work for the source of the planting materials was done.

Table-1 shows the number and origin of the accessions used for the study.

Table-1. Origin and number of accessions used for the study.

Region	Number of accessions planted	Number of accessions studied
Upper west	30	23
Upper east	22	14
Northern	30	20
Volta	24	16
Ashanti	19	11
Eastern	40	31
Brong Ahafo	16	8
Greater Accra	17	11
Total	**198**	**134**

Site description

The experiment was conducted at two locations, namely, the Crops Research Institute Station at Pokuase in the Greater Accra Region and the research farm of the Plant Genetic Resources Research Institute, Bunso in the Eastern Region from September 2005 to March 2006. The experimental area at Pokuase is within the coastal savannah ecological zone which is characterized by double maxima rainfall and dry season regimes. The major rainy season occurs between March and July while the minor season starts from September to November with the dry season occurring from December to March. The average annual temperature is 26^0C and the annual rainfall is 750 mm (Ofori *et al*., 2006).

Bunso is located in the semi-deciduous forest ecological zone with total annual rainfall of 1450 mm, a monthly mean temperatures ranging from 14.8^0C to 35.5^0C and a distinct dry period (with some occasional rains) observed between November and March (Bennet-Lartey and Ofori, 1999). The soils at Pokuase belong to the Ferric Acrisols (Ofori *et al*., 2006). Those of Bunso on the other hand range from red clay loams of elevated ground to heavier alluvial soils near the Birim River (Bennet-Lartey and Ofori, 1999).

Experimental design

Augmented block design was used. The experimental field were ploughed and harrowed with a tractor. The field was lined and pegged and divided into blocks made up of six rows per block. Each accession was planted in a single row of ten seeding holes (ten plants in a row) in a block. Two seeds per hill were planted using intra row spacing of 100cm and 100cm between rows. The experiment was carried out in the minor season (September 2005 to March 2006). Planting of seeds at Bunso was done on September 20, 2005 and that of Pokuase on September 29, 2005. Two manual weeding were done on each site. The first weeding was done in the third week after planting and the second weeding in the sixth week after planting. No fertilizer was applied since the objective of the study was to assess the performance of the accessions under farmer's field conditions. However, 480g of Chloropyrifos-ethyl EC per liter was applied twice at establishment and canopy closure to control aphids.

Parameters measured

Data were collected from accessions that survived till maturity and harvest. Qualitative and quantitative variables were scored on individual plant basis, using six randomly selected plants per plot. Qualitative characters scored included immature pod pigmentation pattern, raceme position, pod colour, flower colour, growth habit and twining tendency. The quantitative characters evaluated were, terminal leaflet length, terminal leaflet width, peduncle length, number of branches per plant, number of pods per plant, pod length, pod width, 100 seed weight, and seed yield per plant.

The various traits were compared using the mean, range, standard deviation and co-efficient of variation between the two sites. Cowpea descriptor from the International Plant Genetic Resources Institute (IPGRI) (1982) was also used as a guide in the selection of parameters and procedures for characterization. Hierarchical clustering analysis (dendrogram) was then used to study selected accessions with some promising characters out of which those with high performing traits were selected.

RESULTS AND DISCUSSIONS

Qualitative characters

Raceme position

Figure-1 shows that 59.7% of the accessions studied had their raceme positions above the canopy while 29.8% had the raceme positions at the same level as the canopy. Only 10.4% of the accessions produced racemes within the canopy.

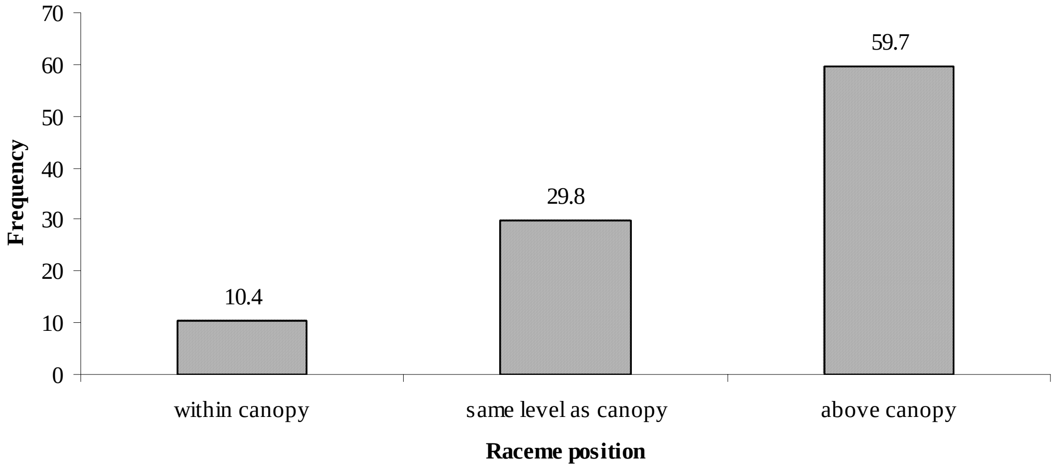

Figure-1. Frequency distribution of raceme position of cowpea accession.

Raceme position is a good attribute since it facilitates easy visibility of pods for harvesting. It was observed that when the racemes are held at the same level or within the canopy the pods become hidden within the canopy making harvesting more difficult and strenuous. According to Pandey and Ngarm (1985) and Bennett-Lartey and Ofori (1999) varieties with their racemes above the canopy are easier and cheaper to harvest than those with racemes below the canopy. Such accessions will also enhance the use of mechanical harvesters since they will not require the pulling up of the whole plant during harvesting. Pandey and Ngarm (1985) stated that for mechanical harvesting to be possible the plant habit must be upright and compact.

Twining tendency

Figure-2 shows the twinning tendency of the accessions studied. Out of the accessions studied 35.1% showed slight twinning tendency, 32.1% showed intermediate twinning tendency, 30.6% showed no twining tendency while 3.7% were observed to have pronounced twining tendency. The entire twining tendency documented in the IBPGR (1982) descriptor list for cowpea was observed for the accessions studied. The results obtained from the study suggest that most of the accessions need no staking since majority of them did not show trailing tendency. The associated cost and labour involved in providing stakes to prevent rotting would not be necessary and this can reduce the cost of production.

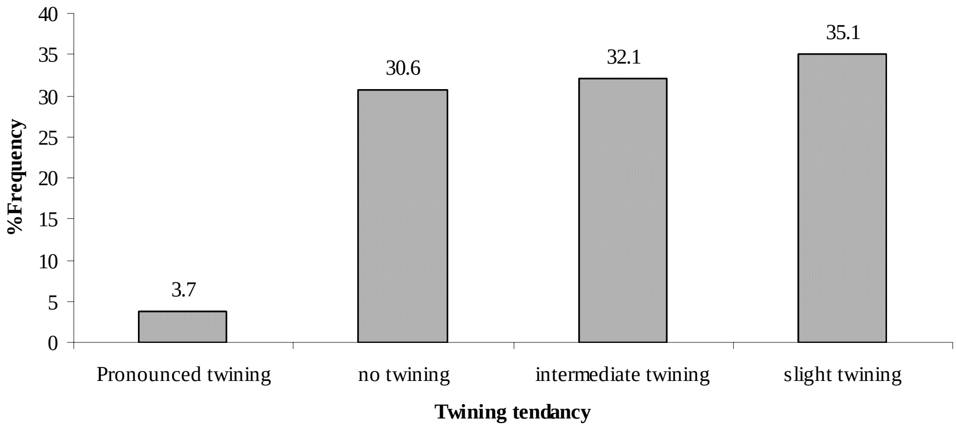

Figure-2. Frequency distribution of twining tendency of cowpea accessions.

Growth habit

It was observed that 30.6% of the accessions studied produced an acute erect growth habit, 22.4% had intermediate growth habit and 19.4% were semi prostrate with 17.2% showing prostrate growth habit. Only 0.8% of the accessions studied showed erect growth habit while 9.7% also showed semi erect growth habit (Figure-3).

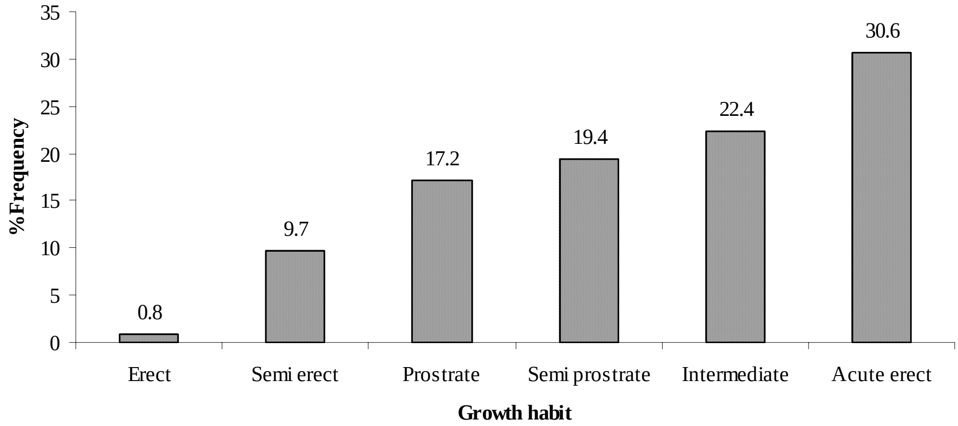

Figure-3. Frequency distribution of growth habit of cowpea accessions.

The International Board for Plant Genetic Resources IBPGR (1982) descriptor describes seven main growth habits in cowpea. These are climbing, prostrate, semi prostrate and intermediate. The others are semi-erect, erect and acute erect. However, in this study only three of these growth habits were found as was also observed by Bennett-Lartey and Ofori (1999). This may be attributed to the fact that the IBPGR report was based on assessment of large number of cowpea accessions collected from the world as compared to this study where the assessment was based on only a small number of cowpea accessions from eight regions of Ghana.

Growth habit is very important in the cropping system of cowpea in Ghana and an influential character in harvesting of cowpea (Fery, 1985; Bennett-Lartey and Ofori, 1999). The prostrate types are used by peasant farmers in mixed cropping (Doku, 1970; Rachie and Rawal, 1976) while the erect types have good returns for high intercrop adaptability (Singh and Emechebe, 1997). It was observed during harvesting that the prostrate types had protracted periods of pod maturation resulting in an uneven periods of harvesting and also required bending very low to pick the pods. Aryeetey (1971) also reported of a similar observation. Furthermore, accessions with erect or semi-erect growth habit had no lodging associated problems and also did not need staking to keep pods from touching the ground to prevent rotting of pods, which normally occurred when pods come into contact with the soil. According to Ezedinma (1965) the erect cultivars of cowpeas have high reproductive efficiency while the semi-erect ones have higher total pod yield than the spreading types. This attribute was also observed in this study.

Flower colour

The observed flower colours of the accessions used in this study are presented in Figure-4. About 13.4% of the accessions produced white flowers, 6% produced violet-pink flowers and 80.6% produced violet colour. In contrast, in a similar study by Ezueh and Nwoffiah (1984) and Bennett-Lartey and Ofori (1999), accessions

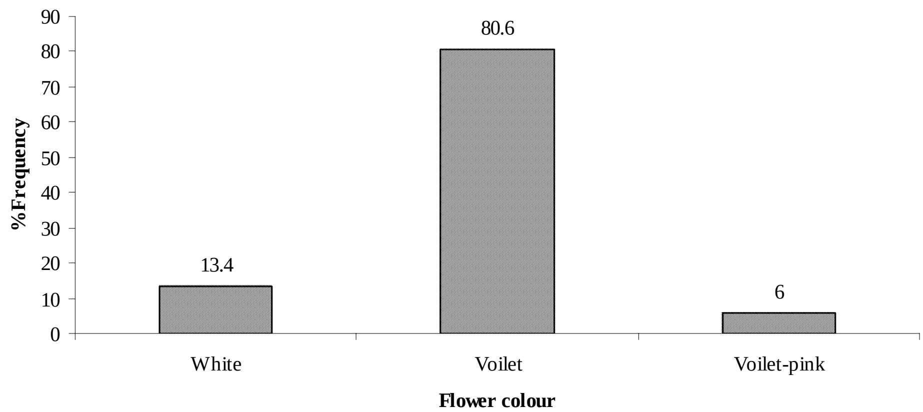

Figure-4. Frequency distribution of flower colour of cowpea accessions.

with purple flowers ranked the highest. Waters (1987) reported that the open display of flowers above the foliage and the presence of floral nectaries contribute to the attraction of insects. Although the results of the present study showed all three flower colours documented by IBPGR (1982), studies done by Gibbon and Pain (1985) reported of additional flower colours such as pale blue, yellow and pink, which were not observed in this study. This may be attributed to the relatively large number of accessions studied in their work as compared to the smaller number used in the present study. According to Purse glove (1984) flower colours that are mostly encountered on the field are yellow, white and purple. Flowers show monogenic inheritance (Rawal *et al*., 1976).

Flower pigmentation

Figure-5 shows the frequency distribution of flower pigmentation pattern. The results indicated that 6.7% of the flowers were not pigmented (white). Another 6.7% were observed to have the wings pigmented at the standard with light V-shape pattern of pigment at top centre. About 8.2% had pigmented margins on the wing and standard while 26.9% had the wings pigmented and standard lightly pigmented. It was observed that 51.5% of the accessions also had the flowers completely pigmented.

Colour we see in flowers is actually the result of reflected light from various plant pigments. A group of compounds called "anthocyanidins" are the basic ingredients (Perry, 2001). The pigments which occur in flowers are very useful to plants and have been reported to be a key component of pollination and subsequent fruit production (Perry, 2001).

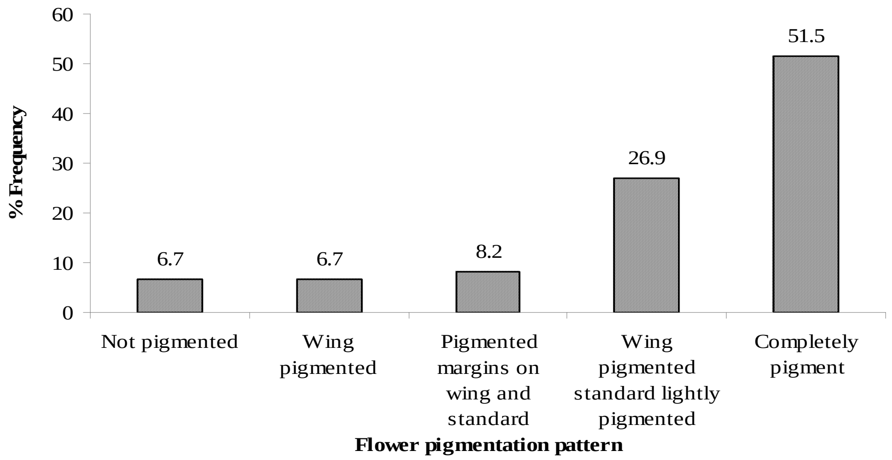

Figure-5. Frequency distribution of flower pigmentation of accessions.

Immature and mature pod pigmentation

The pigmentation pattern of the immature and mature pods of the accessions is shown in Figures 6 and 7 respectively. The general trend is that 2.2% of the accessions had splashes of pigment on the immature pods while 9% of the accessions were uniformly pigmented. Pods that were pigmented at the valves as well as those with pigmented sutures were both 11.9%. It was observed that 14.2% of the immature pods were pigmented at the tips and 50.7% showed no pigmentation. For the matured pod pigmentation pattern 55.2% of the mature pods were purple, 26.7% were dark purple with both pale tan and dark tan each being 9%.

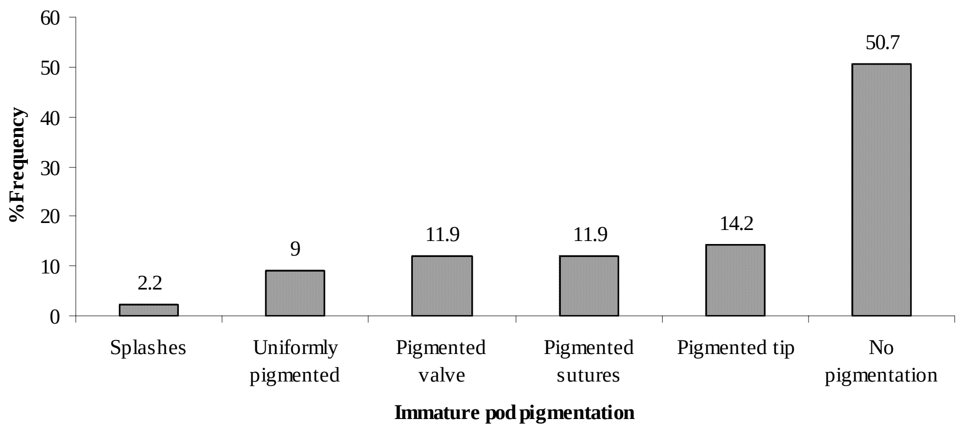

Figure-6. Frequency distribution of immature pod pigmentation of cowpea accessions.

The study revealed that the pattern of pigment distribution of full grown immature pods varied. The pods of most of the immature accessions were not pigmented even though Porter *et al*., (1974) had reported of six different patterns of pod pigmentation. According to Singh and Rachie (1985), Fery (1985) and Bennet-Lartey and Ofori (1999) the pods of many cowpea cultivars contain anthocyanin which is either partially or wholly purple. The results obtained in the present study could be attributed to the fact that the accessions studied lack or have low concentration of anthocyanins pigment in the pods at the immature state.

VOL. 6, NO. 7, JULY 2011 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

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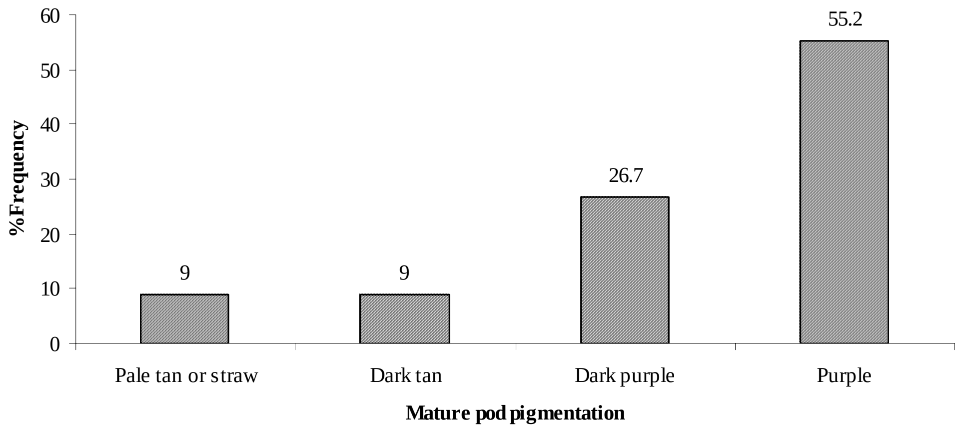

Figure-7. Frequency distribution of mature pod pigmentation pattern of cowpea accessions.

QUANTITATIVE CHARACTERS

Days to 50% flowering

The range and mean for the number of days to 50% flowering of the accessions studied are presented in the Table-4. Six accessions were the first to flower within a range of 31 to 38 days with a mean of approximately 37 days. Accession number 7233 flowered first in 31 days after emergence. The accessions numbered 2286, 3710, 4767, 2282 and 2279 all flowered in 38 days after emergence. Five accessions registered the longest days to flower within a range of 49 to 52 days and with a mean of 50 days. Among the five accessions that flowered late, accessions 1647 and 6230 recorded the longest time of flowering according to this study in 51 and 55 days respectively. The CV for the number of days to 50% flowering was 1.21%.

Table-4. Days to 50% flowering.

No. of accessions	Range	Mean
6	31-38	36.8 ± 0.22
17	39-40	39.9 ± 0.62
48	41-42	41.5 ± 1.74
46	43-44	43.2 ± 1.67
12	45-46	45.2 ± 0.44
10	47-48	47.9 ± 0.36
3	49-50	49.0 ± 0.11
2	51-52	51.5 ± 0.05

Mean = 39.5 days; CV = 1.21%

The mean value of 39.5 days to flowering recorded in this study compared to those reported in previous studies, suggests an element of early flowering by the accessions studied although the difference is not all that great. Some reports indicate that early maturity is dominant over late maturity (Mak and Yap, 1980). Both Erskine and Khan (1978) reported heterosis for earliness. The relatively low CVs are an indication that the accessions studied have relatively very little variability in their days to flowering and podding and thus have the potentials to flower, pod and mature early. According to Ojomo (1974) much of the genetic variation for days to flowering is due to dominance or epitasis.

The results showed that majority of the accessions studied flowered within 39 to 44 days. Similarly, when early maturing lines of cowpea in four different locations in Ghana were tested Mahama and Marfo (1988) reported that all the varieties evaluated took between 39 to 44 days after planting to attain 50% flowering. The broad-sense heritability estimate average 48.3% for days to flowering and 47.8% for days to pod maturity have been reported (Singh and Rachie, 1985). Several authors concluded that additive gene action is responsible for much of the genetic variation for earliness (Lal *et al*., 1976; Mak and Yap, 1980; Zaveri *et al*., 1980). Other reports, however, indicate that action by non-additive genes and interactions between genotype and environment are important in some instances (Singh and Rachie, 1985). A good seed yield will require varieties with short flowering periods to enable them divert energy into pod and seed development (Summerfield *et al*., 1985). Benee (1988) stated that the earlier a variety sets flowers, the earlier it matured. Indications are that the accessions used in the present study would be very useful in dry environments because of their ability to escape drought.

Days to 50% podding

Table-5 shows the mean and range of days to 50% podding of the accessions studied. It took between 39 to 60 days after emergence for all the accessions to attain 50% podding. The result indicated that one accession podded first in 40 days and was followed by nine other accessions that also podded within 41 to 42 days after emergence. Two accessions took the longest days (60 days), after emergence to pod, 40 accessions podded within 45 to 46 days after emergence. 32 other accessions also podded within 47 to 48 days after emergence. The CV was 1.97 % and the mean was 48.7 days.

Early maturity is a relatively important agronomic characteristic and is measured by such criteria as days to flowering or days to maturity (Singh and Rachie, 1985). All the accessions studied flowered within a range of 35 to 52 days with a mean of 39.5 days and

VOL. 6, NO. 7, JULY 2011 ISSN 1990-6145
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podded between 39 to 60 days with a mean of 48.7 days. Singh and Rachie (1985) also reported that some cultivars flower within 30 days from sowing and are ready for dry seed harvest 25 days later while others take more than 100 days to flower and take between 210 and 240 days to mature.

Table-5. Days to 50% podding.

No. of accessions	Range	Mean
1	39-40	40.0±0.03
9	41-42	41.6 ± 0.03
36	43-44	43.6 ± 1.31
40	45-46	43.2 ± 1.46
32	47-48	47.8 ± 2.02
16	49-50	49.4 ± 0.58
5	51-52	49.0 ± 0.18
2	53-54	53.0 ± 0.73
2	55-56	55.5 ± 0.73
2	59-60	60.0 ± 0.73

Mean = 48.7; CV = 1.97 %

Terminal leaflet length, terminal leaflet width and number of branches per main stem

Table-6 shows the evaluation of the terminal leaflet length, terminal leaflet width and the number of branches per main stem. The mean terminal leaflet length was 100.4 mm at Pokuase and 99.94 mm at Bunso. The SD and the CV were higher at Pokuase than at Bunso but not significant. The terminal leaflet width was 69.71 mm at Pokuase and 64.21 mm at Bunso. The SD and the CV were, however similar at both sites. The mean number of branches at Pokuase and Bunso were the same even though there were differences in their SD and CVs.

It was observed from this study that in accessions where leaf shedding did not occur and most leaves remained on the plant, harvesting of the matured pods (when the pods were 85% to 90% dry) became strenuous because these mature pods were not exposed enough to facilitate easy harvesting. The situation even became compounded and time consuming in cases where there were no distinction of colours between the ripe pods and the unshed leaves.

Table-6. Terminal leaflet length, terminal leaflet width and number of branches per main stem.

	Terminal leaflet length (mm)		**Terminal leaflet width** (mm)		**No. of branches**	
	Pokuase	**Bunso**	**Pokuase**	**Bunso**	**Pokuase**	**Bunso**
Mean	100.4	99.94	69.71	64.21	4.09	4.40
Range	65.4-178.6	67.149.6	35-107.2	23-96.8	2.4-5.8	2.6-7.4
SD	18.50	16.37	15.99	14.83	0.66	0.84
CV	18.56	16.47	22.7	23.07	16.17	18.91

Peduncle length, pod length and pod width

The results of the evaluation of the peduncle length, pod length and pod width of the accessions evaluated are presented in Table-7. The mean peduncle length was longer at Pokuase (294.20mm) than at Bunso (250.11mm) although the differences were not statistically significant. The SD and the CV for the peduncle length were also greater at Pokuase. The pod length and width were, however, greater at Bunso than at Pokuase. The SDs and CVs for the pod length and pod width were nevertheless similar at both sites.

The peduncle lengths exhibited very little variability. Peduncle length determines the position of the pods on the plant and thus becomes an important character with respect to harvesting of cowpea. This is because mature pods are normally held on the peduncle, which reflects the position of pods on the plant. Pandey and Ngarm (1985) stated that for easy harvesting of cowpea, the peduncle length should be intermediate and above the canopy to hold the pods the above the canopy to enhance easy visibility. However, it was observed that accessions with extra long peduncles were easily lodged by strong winds casing other problems such as rotting and rodent attack.

It was observed from this study that accessions with longer pods were easily visible (especially with the erect types) and firmly held during harvesting. Attention should therefore be paid to such accessions since they enhance the rate of harvesting of cowpea. Also in situations where all the locules are filled up during pod development pod length could also play a significant role in the number of seeds per pod. Some accessions with longer pods however produced low seeds per plant as those with shorter pods even though according to Saviers es-hass (1973) seed yield is highly and positively correlated with pod length and number of seeds per pod. This may be attributed to differences existing among the accessions and wider spacing of seeds within the longer pods as compared to those with relatively shorter pod lengths. In a similar trial of cowpea accessions, Fery (1985) estimated the heritability for pod length to be 75.2%.

Table-7. Peduncle length, pod length and pod width.

	Peduncle length (mm		**Pod length** (mm)		**Pod width** (mm)	
	Pokuase	**Bunso**	**Pokuase**	**Bunso**	**Pokuase**	**Bunso**
Mean	294.20	250.11	153.70	157.72	7.84	8.66
Range	131-490	117-414	117-227.3	112.2-215.4	5.8-10.2	5.8-12.2
SD	74.90	57.49	18.56	19.95	1.02	1.10
CV	25.24	23.22	12.19	12.57	13.38	12.57

Hundred seed weight, number of pods per plant and yield per plant

Table-8 shows the 100 seed weight, number of pods per plant and seed yield per plant. Mean 100 seed weight was 11.44g at Pokuase and 14.32g at Bunso with the SDs being similar. The CV was on the other hand was higher at Pokuase than at Bunso. The number of pods per plant, SD and CV were all higher at Pokuase than at Bunso. The yield per plant was 20.04g at Pokuase and 23.53g at Bunso with similar SDs and CVs.

The better yield performance recorded at Bunso may be due to better climatic conditions in the semi-deciduous forest where Bunso is located compared to Pokuase, which is located in the coastal savannah. According to Padi and Marfo (2005) rate and time of specific developmental processes conditioned by location-specific conditions of temperature, rainfall and soil factors determine the final seed yield.

Table-8. Hundred seed weight, number of pods per plant and yield per plant.

	100 Seed weight (g)		**No. of pods/plant**		**Seed yield/plant** (g)	
	Pokuase	**Bunso**	**Pokuase**	**Bunso**	**Pokuase**	**Bunso**
Mean	11.44	14.32	22.74	26.37	20.04	23.53
Range	9.8-22.6	7.8-19.7	3-57	5-63	0.9-68.8	4.0-59.3
SD	2.33	2.57	11.40	9.04	10.35	12.34
CV	20.19	17.74	50.07	34.30	51.50	52.67

Cluster of selected accessions

Figure-8 shows a dendrogram of the 45 selected accessions. A preliminary examination of the dendrogram does not show perfect correspondence with the morphological classification of the accessions analyzed and also none of the selected accessions occurred as unique or alone but rather occurred as duplicates signifying that the accessions are genetically the same material. Again, all the three groups of clusters contain a mixture of accessions and that no particular cluster contains accessions from only one particular geographical region.

Distribution of the selected accessions into clusters

Table-9 shows a summary of the distribution for the selected accessions into clusters as presented in the dendrogram (Figure-8). All the accessions were grouped into three clusters. Cluster II was the smallest with four accessions and with representations from only two regions. Cluster III, which was the largest cluster had twenty-three accessions and was made up of accessions from six regions. This was followed by cluster I with eighteen accessions also made up of accessions from six regions.

In cluster I, Eastern Region produced the highest number of accessions (seven). This was followed by Upper West with five accessions and Northern Region with three accessions. Upper East, Ashanti and Volta Regions all produced one accession each. In cluster II, one accession was from the Ashanti Region while three were from the Eastern Region. The Eastern Region recorded the highest number of accessions (seven) in cluster III, which was followed by the Upper East with five accessions and Upper West (four accessions). The Northern and Volta Regions produced three accessions each. Ashanti Region registered only one accession.

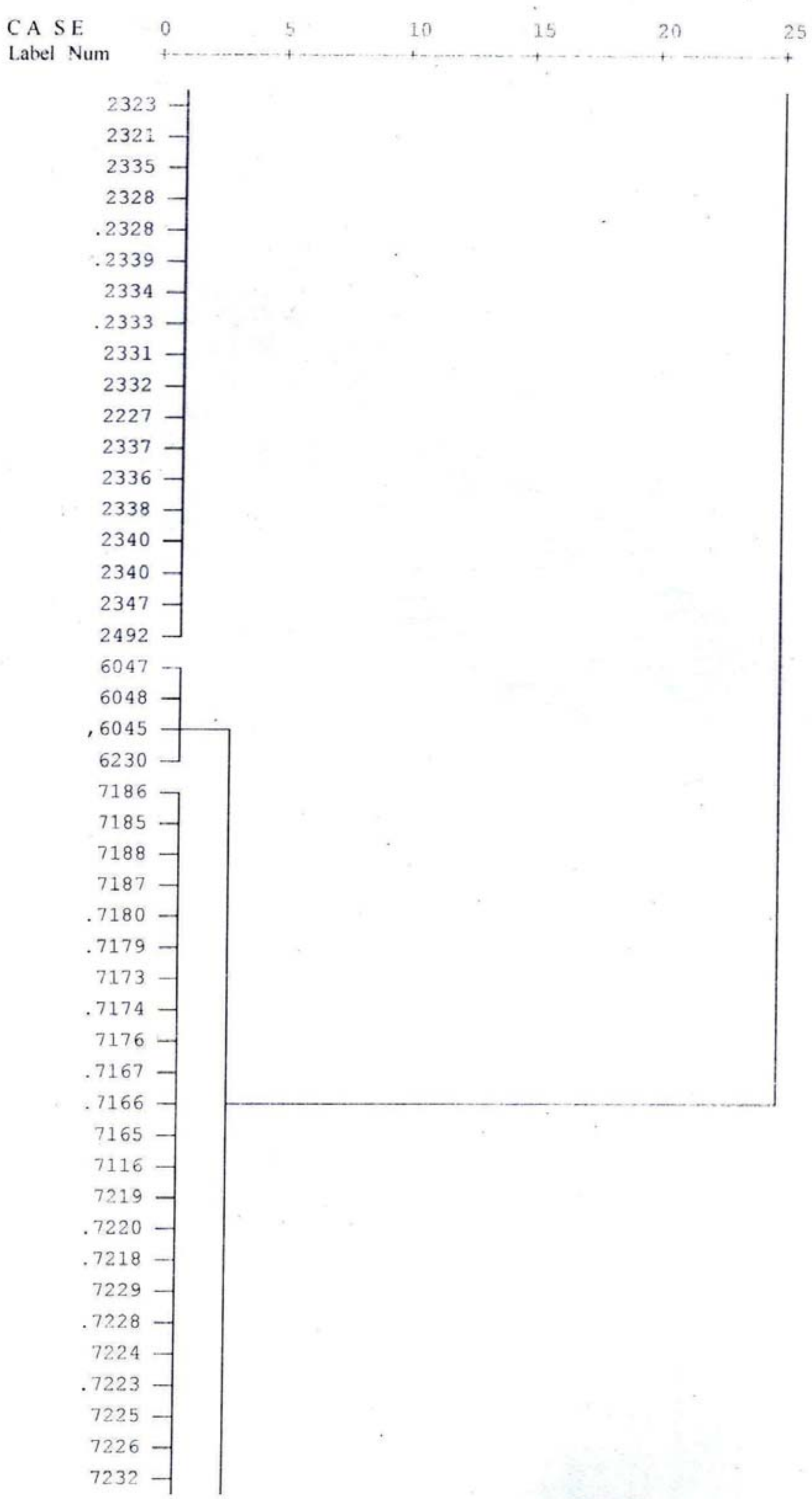

Figure-8. Dendrogram of selected cowpea accessions (average linkage between groups) based on quantitative characters.

In the first cluster (Cluster I) the grouping of the 18 accessions into the same cluster may be attributed to the fact that all these accessions may have the same or similar attributes such as morphological characteristics. Looking at the numbers from the Eastern and the Upper West Regions, it is likely that these accessions were either introduced from the Eastern or Upper West Region into the other regions i.e., Upper East, Ashanti and Volta

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Regions. In the second cluster (Cluster II) it is also possible that the accessions may have been introduced from the Eastern Region into the Ashanti Region due to the higher numbers found in the Eastern Region. The third cluster (Cluster III) had the highest number of accessions (23) among the three clusters. Both the Eastern and Upper East Regions may therefore be said to be the centre of introduction into the other regions. The large nature of the cluster gives an idea of the acceptance the accession has gained among the local farmers. It also signifies the spread of the accessions in the two regions. This may be due to their desirable attributes such as high yield, adaptation to the environment, colour, taste or easy marketability.

Clustering of accessions did not occur along regions of collection basis although growing conditions differed considerably among the various regions where they were collected. Also duplications encountered tended to be more within regions of collection than among regions. Repeated collections within regions without proper documentation could account for such situations. Extensive exchange of cowpea accessions that has taken place in the past without any proper documentation may also account for such duplication. Molecular analysis could be used to confirm these duplications (Massawe *et al.*, 2000; Amadou *et al.*, 2001).

Table-9. Distribution of selected accessions into clusters.

Cluster No.	Number of accessions	Accessions numbers	No. of accessions per region
I	18	2323 2340 2331 2347 2332 2338 2321 2335 2237 2334 2328 2337 2336 2342 2329 2333 2492 2327	Northern region (3) Eastern region (7) Upper East region (1) Upper West region (5) Ashanti region (1) Volta region (1)
II	4	6047 6048 6045 6230	Ashanti region (1) Eastern region (3)
III	23	7165 7228 7161 7218 7174 7187 7182 7176 7226 7166 7229 7232 7220 7173 7185 7179 7225 7224 7167 7186 7223 7219 7188	Northern region (3) Eastern region (7) Upper East region (5) Upper West region (4) Ashanti region (1) Volta region (3)
Total	45		

The relatively higher similarity between these clusters suggests that attempts could be made to transfer genes from accessions in cluster II to accessions in cluster I and from accessions in cluster III to accession in cluster II. This result, if confirmed by further studies, could make gene transfer in these cowpea accessions possible. In situations where direct conventional crosses pose problems such close accessions could be used as links to achieve the objective. Such transfers could be of great interest, since high levels of resistance to some cowpea insect pests have been observed in several accessions of cowpea (Ng, 1990). It should, however, be noted that the high similarities revealed among the accessions by the hierarchical clustering could also be because both quantitative and qualitative traits were used to generate the dendrogram. Table-10 shows a summary of the characteristics of eleven accessions selected out of the forty-five accessions, which exhibited very high desirable traits.

Table-10. Selected accessions with high desirable characters.

Code	UW22	NR4	VR1	AS2	GA6	GA9	BA5	UE9	UE10	UE12	ER5
Accession number	4541	2316	2284	2492	2332	5044	2331	5040	4028	4529	3669
Branches/main stem	4	5	5	5	5	5	6	4	5	5	5
Peduncle length (cm)	32.3	31.5	29.4	26.1	27.9	31	31	29.3	31.4	27.5	22.8
Days 50% germination	3	3	3	3	3	3	3	3	3	3	3
Days 50% flowering	43	40	41	41	41	43	48	43	43	41	41
Days 50% podding	50	44	44	45	45	48	53	48	47	45	47
Pod length (mm)	179	160.5	170.5	180.5	163.5	171	179	162	167	157.5	179.5
Pods/ plant	30	39	33	33	33	35	43	27	23	23	32

KEY: UW- Accessions from Upper East region; VR- Accessions from Volta region; NR- Accessions from Northern region; AS- Accessions from Ashanti region; GA- Accessions from Greater Accra region; BA- Accessions from Brong Ahafo region; UE- Accessions from Upper East region; ER- Accessions from Eastern region.

CONCLUSIONS

All the accessions studied showed three raceme positions. Four twinning tendency types were also observed with accessions with slight twinning tendency scoring the highest. Observations made on the growth habit revealed that the greatest percentage of the accessions have acute growth habit. Three types of flower colour; white, violet and violet-pink were also observed with accessions that produce violet flowers ranking the highest.

Clustering of accessions did not, however, occur along regional basis even though in some cases the same accession was given different names at different localities by farmers according to characteristics, which suited them. The results of this study demonstrated that out of all the 134 accessions studied 11 accessions had higher performing potentials that can form a baseline for further research even though 45 accessions were found to have shown high desirable characters.

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