Variability in some quantitative characters of cowpea (*Vigna unguiculata* (L.) Walp) landraces in Ghana

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ABSTRACT

Forty-five cowpea accessions randomly selected from cowpea germplasm from four major cowpea-producing regions of Ghana, namely Upper East, Upper West, Northern and Eastern regions, were evaluated to study variability in some quantitative characters. Variability within regions were not significant, but there were significant differences among the regions for all the characters studied. The accessions from Northern Region were the first to flower and mature, while those from Upper East Region were the last to flower and mature. The number of pods per plant and seed yield per plant had rather large and similar ranges. A large proportion of the observed variability in pod and seed character was due to genetic differences, especially for 100-seed weight. However, the lowest variability among accessions, except for the 100-seed weight, was recorded for the Eastern Region. Accessions from Upper East Region had the largest variability for most of the characters. This identifies the Upper East Region as a potential source of material for cowpea improvement.

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RÉSUMÉ

BENNETT-LARTEY, S. O. & OFORI, K.: *Variabilité en quelques caractères quantitatifs des variétés des dolique* (Vigna unguiculata *(L.) Walp) au Ghana.* Quarante-cinq accessions de dolique sélectionnées au hasard de germeplasme de dolique de quatre principales régions productrices de dolique au Ghana, à savoir, les regions d'Upper East, Upper West, Northern et Eastern étaient évaluées pour étudier la variabilité en quelques caractères quantitatifs. La variabilité à l'intérieur des régions n'était pas considérable, mais il y avait des différences considérables parmi les régions pour tous les caractères étudiés. Les accesions de Northern Region étaient les premières à fleurir et mûrir, alors que celles d'Upper East Region étaient les dernières à fleurir et mûrir. Le nombre de cosse par plante et le rendement de graine par plante avaient plutôt des variations grandes et semblables. Une grande partie de la variabilité observée dans les caractères de cosse et de graine était provoquée par des différences génétiques surtout pour le poids de 100-graine. Toutefois, la plus basse variabilité parmi les accessions, à l'exception du poids de 100-graine, était enregistrée pour Eastern Region. Les accessions d'Upper East Region avaient la plus grande variabilité pour la plupart des caractères. Ceci identifie Upper East Region comme une source potentielle de matériel pour l'amélioration de dolique.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is an important grain legume for the lowland and semi-arid tropics. Most of the world's cowpea production is in Africa, with Nigeria, Kenya, Niger, Burkina Faso, Ghana, and Uganda being major producers (Rachie, 1985).

In recent years, cowpea improvement has been intensified in Ghana by various research institutions with the results that improved varieties are being produced rapidly. This trend has been possible largely through the use of diverse cowpea germplasm, local and exotic, in improvement programmes. The chances of

germplasm being used in crop improvement is enhanced by the availability of reliable information from characterization and evaluation of such germplasm. Characterization and evaluation of germplasm are part of the responsibilities of gene banks and germplasm scientists (Chapman, 1989).

Characterization and evaluation of cowpea germplasm have been carried out for over 35 years now in Africa. Wild and cultivated cowpea germplasm have been characterized by morphological traits (Faris, 1963). At the International Institute of Tropical Agriculture (IITA) in Nigeria, cowpea germplasm collected from all over the world has been characterized and catalogued (Porter *et al.*, 1974). A similar catalogue was produced from data on Botswana cowpea germplasm (de Mooy, 1985).

Variability has been observed in several characters in cowpea germplasm. Most of these characters are qualitative rather than quantitative. Significant in recent times has been the identification of germplasm useful in improving resistance to insect pests such as aphids, thrips, pod borers, and storage weevils (Jackai & Singh, 1991; Jackai & Adalla, 1997). Quantitative characters are used during characterization and further evaluation of germplasm, when planting materials are in sufficient quantities to allow for replication. Germplasm, which has been characterized by quantitative and qualitative traits, provides a sound basis for a more active gene bank-plant breeder interaction than with only qualitative morphological characterization. The Plant Genetic Resources Centre (PGRC) of the Council for Scientific and Industrial Research (CSIR), Ghana, continues to collect, characterize and evaluate cowpea accessions which are provided to breeders to help in cowpea improvement programmes.

The objective of this study was to determine variability in some quantitative characters among cowpea accessions collected from major cowpea-producing regions of Ghana, and to assess the usefulness of these cowpea landraces to cowpea improvement programmes.

Materials and methods

Forty-five accessions, randomly selected from 72 accessions collected from four cowpea-growing regions of Ghana, were evaluated at the PGRC, Bunso, in the Eastern Region, under rain-fed conditions during the major seasons of 1989 and 1990. The accessions were collected from the Northern, Upper East, Upper West, and Eastern Regions, and were characterized at Bunso (Bennett-Lartey & Ofori, 1999). The distribution of the 45 accessions among the regions were 16, 6, 8 and 15 for the Northern, Upper East, Upper West, and Eastern Regions, respectively.

Each of the 45 accessions was represented by one row of 10 plants per replicate during the characterization phase in 1988. The rows were spaced at 90 cm apart and the plants within a row were also 90 cm apart. Three seeds were sown per hill and thinned out to two plants per hill at 2 weeks after planting. During the further characterization and evaluation phase in 1989, one-row plots were used with rows 60 cm apart, and plants within a row being 30 cm apart. In 1990, three-row plots were used with each plot measuring 1.8 m × 2.1m. There were 10 plants per row and rows were 60 cm apart. Three seeds were sown per hill and thinned out to two plants per hill at 10 days after emergence. A randomized complete block design with three replicates was used in both years of evaluation.

Phosphate fertilizer was applied as single superphosphate to provide 40 kg P ha^{-1} 3 days before planting. Two manual weedings were carried out at 2 weeks after emergence and 3 weeks later. Insects were controlled with Cymbush (cypermethrine) and Roxion (dimethoate) at 3 $ml\ l^{-1}$.

The following data were collected from five plants from the middle of each plot:

1. Days to flowering: number of days from sowing to time of 50 per cent flowering in a plot.
2. Days to maturity: number of days from sowing to time when the first pod on a plant turned colour completely.

3. Number of pods per plant: total number of pods harvested from a plant.
4. Number of seeds per pod: obtained from the average of five pods randomly picked from a plant.
5. 100-seed weight (g): two samples of 100 seeds each were weighed and averaged for each plot value.
6. Pod length (cm): obtained as the average length of five matured pods randomly picked from a plant. Same pods were used to determine seeds per pod.
7. Seed yield per plant (g): obtained from the weight of sun-dried seeds from a plant.

Pods were harvested as soon as they turned colour completely and began to dry. They were then sun-dried until completely dry.

Analysis of variance (ANOVA) was applied to data to determine differences among accessions within a region, and also differences among regions for the various characters. A random effects model was used to derive variance components from the mean squares from the ANOVA, by using the GENSTAT statistical programme (GENSTAT, 1995).

Results and discussion

Number of days to flowering and maturity

Six of the accessions which did not flower within the period of study were from Upper East (2), Upper West (1), and Eastern (3) Regions. Thus, the remaining accessions were 16, 4, 7, and 12 respectively, for Northern, Upper East, Upper West and Eastern Regions. Table 1 shows variability in days to flowering and maturity. The number of days to flowering for the 39 accessions ranged from 33 to 49 days, with a mean of 41 days. Accessions from Northern and Upper West Regions flowered in an average of 38 days, and were significantly ($P<0.05$) earlier than the accessions from Upper East and Eastern Regions. Differences in days to flowering and maturity among accessions within a region were not significant. The six accessions that did not flower within the period must be very late types. Since farmers grow them also for their seeds, earliness may not be an important feature to these farmers. Farmers' preference for indeterminate types for intercropping may be irrelevant of time of flowering. Variation in time of flowering could also be explained as due to photoperiod during period of growth. Wien & Summerfield (1980) and Steele & Mehra (1980) observed that onset of flowering in local cowpea may be ascribed to photoperiodic control, which also depends on the latitude of origin of the germplasm and the variation in day and night temperatures.

TABLE 1

Ranges, Means, Standard Errors, and Coefficients of Variation for Number of Days to Flowering and Maturity of Cowpea Germplasm from Four Regions of Ghana

Region	*Days to flowering*		*Days to maturity*	
	Range	*Mean ± SE*	*Range*	*Mean ± SE*
Northern	33 - 45	38 ± 2.0	57 - 80	60 ± 2.1
Upper East	43 - 49	46 ± 3.8	73 - 78	76 ± 3.5
Upper West	35 - 44	38 ± 2.7	62 - 69	64 ± 2.8
Eastern	41 - 49	45 ± 1.2	64 - 72	68 ± 1.3
Mean		41		68
LSD (P=0.05)		4.2		4.5
Range		33 - 49		57 - 80
PCV (%)		62.3		66.6
GCV (%)		16.8		10.4

The number of days to maturity ranged from 57 to 80 days after planting, with a mean of 68 days for all 39 accessions. Variability in number of days to maturity followed a similar pattern as flowering date. The earliest plants to mature were from Northern Region and the latest were from Upper West Region. Accessions from Northern and Upper West Regions matured earlier than the average of the population, but accessions from Upper East Region matured later than the average of the population. Selection from Northern and Upper West Regions may produce plants that will mature earlier than randomly selected plants from the population.

Though there were large differences among

accessions for these two characters, as indicated by the large phenotypic coefficients of variation (PCV), very little of these differences could be ascribed to genetic differences. The low values of genotypic coefficient of variation (GCV) also indicated that variability available for selection by breeders is low.

Number of pods per plant and pod length

Table 2 shows the means and variability in the number of pods per plant and pod length in the 39 accessions. The number of pods per plant ranged from 5.0 to 38.3, with a mean of 16.7. Accessions from Upper East Region produced only 5.0 to 8.7 pods per plant, while those from Eastern Region produced 14 to 38.3 pods per plant. There were no significant differences among accessions within a region. However, differences between some regions were highly significant ($P<0.01$) except the Northern and Upper West Regions. The mean number of pods from the Eastern Region was significantly ($P<0.01$) higher than the means from the other regions. A large proportion (88 %) of observed variability in this character was due to genetic differences. There was also a high GVC, indicating a large amount of variability for selection or for exploitation through hybridization.

TABLE 2

Ranges, Means, Standard Errors and Coefficients of Variation for Pod Length and Pods per Plant of Cowpea Germplasm from Four Regions of Ghana

Region	*Pods per plant*		*Pod length (cm)*	
	Range	*Mean ± SE*	*Range*	*Mean ± SE*
Northern	4.3 - 29.3	16.2 ± 4.4	10.6 - 14.8	12.3 ± 0.6
Upper East	5.0 - 8.7	6.3 ± 3.4	11.1 - 13.7	12.3 ± 1.2
Upper West	10.3 - 26.0	17.0 ± 4.3	11.7 - 13.9	12.9 ± 0.8
Eastern	14.0 - 38.3	27.2 ± 3.3	12.3 - 15.9	14.3 ± 0.4
Mean		16.7		13.1
LSD (P=0.05)		7.7		1.3
Range		5.0 - 38.3		10.6 - 15.9
PCV (%)	65.3		16.1	
GCV (%)	57.7		13.4	

Pod length of the cowpea germplasm ranged from 10.6 to 15.9 cm (Table 2). The mean for the germplasm was 13.1. Pod length in the Eastern Region accessions averaged 14.3 cm and was the highest among the germplasm. There was a significant ($P<0.05$) difference between the mean of Eastern Region and those of the other three regions. Differences among the other three regions were not significant. Variability of this character in the germplasm was rather low, being only 16.1 per cent. Though this character was genetically controlled to a large extent, potential genetic variability for selection was low and hence may lead to very little change. Verdcourt (1970) also reported that pod length was an important diagnostic feature for wild and cultivated cowpea.

Seeds per pod and 100-seed weight

Table 3 shows the number of seeds per pod and 100-seed weight of the germplasm. For both characters, within-region differences were not significant. The number of seeds per pod for accessions from the Upper East Region ranged from

TABLE 3

Ranges, Means, Standard Errors, and Coefficients of Variation for Number of Seeds Per Pod and 100-seed Weight of Cowpea Germplasm from Four Regions of Ghana

Region	*Seeds per pod*		*100-seed weight (g)*	
	Range	*Mean ± SE*	*Range*	*Mean ± SE*
Northern	9.3 - 11.7	10.6 ± 0.6	9.0 - 11.5	10.0 ± 0.30
Upper East	8.3 - 9.7	9.1 ± 0.5	14.3 - 15.8	14.9 ± 0.39
Upper West	10.0 - 12.7	11.5 ± 0.5	8.7 - 11.4	9.8 ± 0.48
Eastern	9.7 - 12.3	10.9 ± 0.4	7.9 - 11.7	9.4 ± 0.54
Mean		10.5		11.0
LSD (P=0.05)		1.1		1.1
Range		8.3 - 12.7		7.9 - 15.8
PCV (%)		15.8		16.3
GCV (%)		13.1		15.7

8.3 to 9.7. These means fell below the population mean of 10.5 and were significantly ($P<0.05$) lower than the accessions from the other regions. Upper West Region had the highest of 10.0 to 12.7 seeds per pod. Research efforts have been directed at producing long pods (Rachie & Rawal, 1976). Amoatey (1987) found a positive and significant ($P<0.05$) correlation between number of seeds per pod and pod length of local cowpea collection. Thus, selection for long pods could result in a high number of seeds per pod.

The 100-seed weight of the cowpea germplasm ranged from 7.0 to 15.8 g. All the accessions from Northern, Upper West, and Eastern Regions had 100-seed weights below 12 g, but accessions from the Upper East Region had significantly ($P<0.05$) larger seeds ranging in weight from 14.3 to 15.8 g. The largest variability in seed weight was found in the accessions from Eastern Region, although the coefficients of variation were rather low. However, the ratio of genotypic to phenotypic coefficients of variation was high, indicating a high genetic control of this character.

Seed yield per plant

Table 4 shows the seed yield per plant of the cowpea germplasm. The mean for the population was 18.4 g. The individual accession means ranged from 4.5 to 37.6 g, while the regional means ranged from 8.2 to 27.5 g. With the exception of the Northern and Upper West Regions, there were significant ($P<0.05$) differences between the regional means, but within-region differences were not significant.

TABLE 4

Ranges, Means, Standard Errors, and Coefficients of Variation for Seed Yield per Plant of Cowpea Germplasm from Four Regions of Ghana

Region	*Seed yield per plant*	
	Range	*Mean ± SE*
Northern	4.5 - 31.9	18.5 ± 4.0
Upper East	6.8 - 11.6	8.2 ± 4.4
Upper West	11.4 - 29.8	19.4 ± 4.8
Eastern	13.0 - 37.6	27.5 ± 2.9
Mean		18.4
LSD (P=0.05)		8.5
Range		4.5 - 37.6
PCV (%)		66.5
GCV (%)		58.8

The accessions from Eastern Region had the least variability as indicated by the standard errors. There will be the need for more extensive collections in this region to enhance variability for selection, compared to the other regions. It seems cowpea cultivation in the Eastern Region is more recent than the northerly regions, and hence a lot of selection has already been carried out in the materials. This possibly explains why the region had the lowest variability in most of the characters studied.

The coefficients of variation for seed yield per plant were large, being 66.5 and 58.8 per cent for potential phenotypic and genotypic differences, respectively. The large GCV indicates a large potential available for selection in this population. The ratio of genotypic to phenotypic variation for this character clearly indicates that selection for this character will be effective.

Conclusion

There was considerable variability in all the characters studied, especially for the accessions from Upper East. Eastern Region had the lowest variability, except for the 100-seed weight. Cowpea production in the latter region is more recent than the other regions, and hence the materials assembled have already undergone considerable selection. More extensive exploration will be required in the Eastern Region, but fewer will be required in the Upper East Region. The Upper East Region has a high potential variability that could be harnessed for cowpea improvement.

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