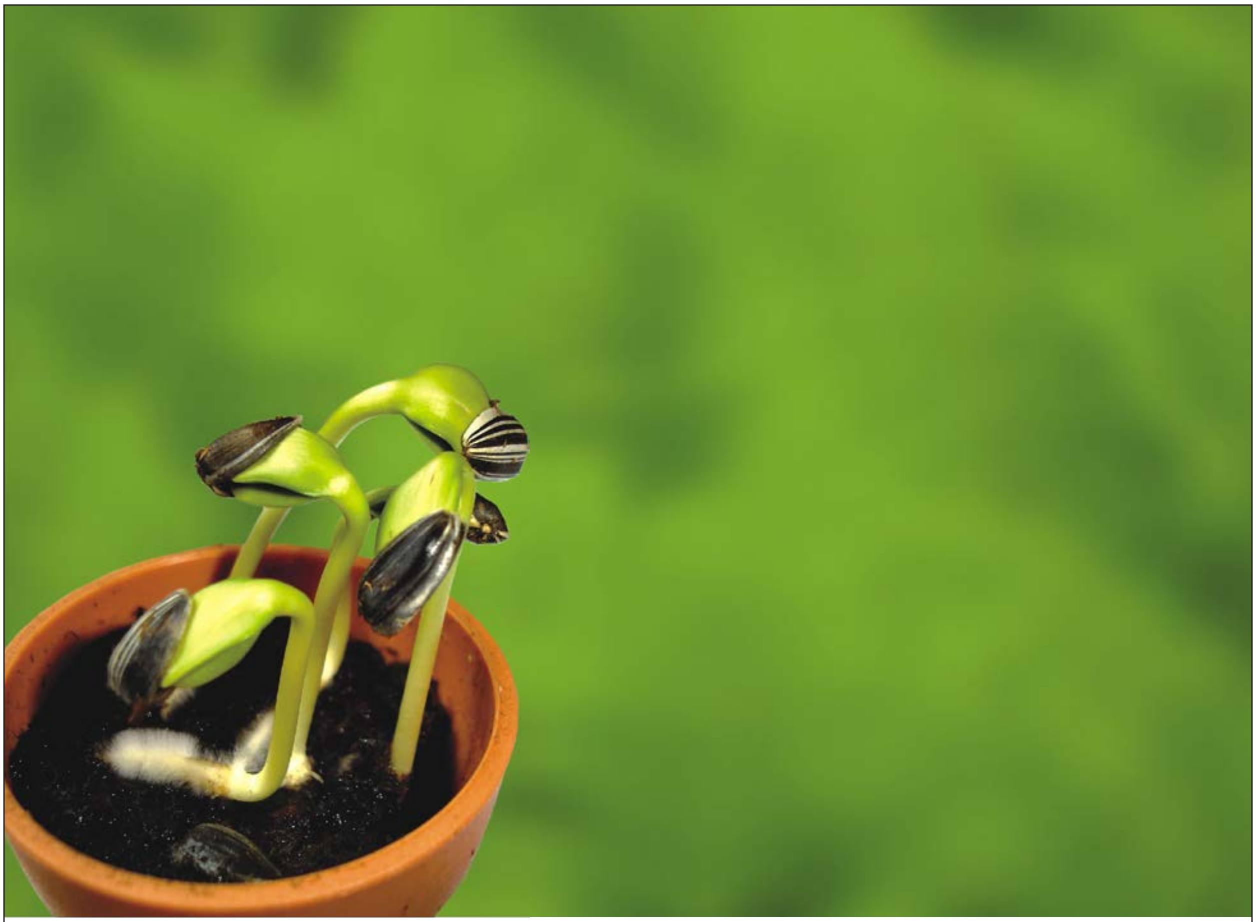

International Journal of

Plant Breeding and Genetics

ISSN 1819-3595

Academic Journals Inc.

www.academicjournals.com

International Journal of Plant Breeding and Genetics 6 (1): 47-53, 2012
ISSN 1819-3595 / DOI: 10.3923/ijpbg.2012.47.53

Biometrical Evaluation and Yield Performance Assessment of Cowpea [*Vigna unguiculata* (L.) Walp] Landraces Grown under Lowland Tropical Conditions

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ABSTRACT

The precarious and worsening climatic and weather conditions being experienced in the globe today poses a threat to food security. Thus, there is a need for an urgent search for crops with intrinsic capacity to withstand the stressors and still perform well productivity-wise. The present study focused on the estimation of genetic variability and heritability of morphological traits in four cowpea landraces-akidi, olaudi, ileje ajaka and ileje with the aim of improvement. Seeds of the landraces were obtained from dealers in Enugu and Kogi States, Nigeria, respectively and sown on a plot of land measuring 10x10 meters at the University of Calabar Experimental Farm, Calabar during 2010-2011 growing season. A randomized complete block design was adopted during the planting. Variance estimates, genetic advance and heritability of yield and yield-related traits were estimated. The mean morphological and yield performance showed that there were significant differences ($p<0.05$) in all the parameters studied except days to 50% seedling emergence with "olaudi" variety maturing fast and having the highest seed yield. The results present high and wide genetic variability in the vein length per plant, number of leaves per plant, leaf area, number of flowers per plant, days to 50% maturity and seed yield. Genetic advance were considerably low but with high heritability estimates in all the traits investigated. The results explicitly revealed that there are sufficient genetic variations to encourage the improvement of these orphan crops.

Key words: Cowpea, landraces, genetic variability, heritability, selection, breeding, improvement, conservation

INTRODUCTION

According to Damaris (2007), the increased threat to agricultural production in Africa due to global warming has been emphasized in the 2006 United Nations Conference on Climate Change in Nairobi, Kenya. This precarious and worsening climatic and weather conditions being experienced in the globe today are source of serious concerns especially, to food security. Worst still is the fact that the soils are already depleted (Drechsel *et al.*, 2001) and the situation is worsened by increasing effects of soil erosion (Lal, 2003). This precarious situations demand search for crops that will have the intrinsic capacity to withstand the stressors and still perform well productivity-wise. Unfortunately, some of these African's native drought-tolerant crops are the least researched worldwide, thus leading to their extinction (Naylor *et al.*, 2004). A pragmatic and proactive action becomes imperative towards bridging the gap between food production and population increase, especially in African countries that are plagued with poverty and political instability.

Interestingly, recent advances in biotechnology, molecular biology, genomics and proteomics have evolved techniques culminating to genetic mapping, dissection of crop plants; isolation, cloning and insertion of transgenes into desired crops. This transgenes insertion triggers the recipient crops for its expression. This is usually aimed at improving the crops for better performance, even in adverse conditions. This notwithstanding, conventional techniques involving the use of biometrical approaches has also proved indispensible as a complementary tool to the modern techniques (Udensi *et al*., 2010, 2011a).

Though cowpea [*Vigna unguiculata* (L.) Walp] has been reported to have high protein value, high variability, high adaptability and drought-tolerant capacity (Siambi *et al*., 1992; Udensi *et al*., 2011a, b), its landraces have been skimmed out in terms of research, which has caused serious losses of superior genes that could have been used during crop genetic manipulation. According to IITA (2002), it was estimated that 3.3 million tonnes of cowpea dry grains were produced worldwide. Of this, Nigeria produced 2.1 million tonnes which ranked her the world's largest producer. This followed by Niger and Mali with 650, 000 and 110,000 tonnes, respectively. It was also estimated that cowpea was grown on a total area of 9.8 million hectares, out of which about 9.3 million hectares is found in West Africa. Additionally, the world average yield was 337 kg per hectare while Nigeria and Niger had 417 kg per hectare and 171 kg per hectare as average yield, respectively. Though, it sounds thrilling, the unfortunate side of this reported statistics is that it is based on improved cowpea lines which has slowly reduced the genetic diversity of the landraces (Udensi *et al*., 2011a).

According to Ng and Marechal (1985) and Ogunkanmi *et al*. (2006), the center of diversity for cowpea in West Africa, is an area encompassing the savanna region of Nigeria, southern Niger, part of Burkina Faso, northern Benin, Togo and part of northern Cameroon. This even makes it an important indigenous crop that deserves much attention. Additionally, the high adaptability accredited to cowpea makes them a crop of choice even in the humid lowland tropical conditions of Calabar, Cross River State, Nigeria.

This study was therefore aimed at estimating genetic variability in the selected cowpea landraces from Nigeria, which could serve as breeding stock for future conservation and improvement.

MATERIALS AND METHODS

This experiment was mounted during the 2010-2011 farming season. Seeds of four landraces of cowpea-Akidi, Olaudi, Ileje ajaka and Ileje were obtained from dealers in Enugu and Kogi States, Nigeria, respectively. A plot of land measuring 10×10 meters was manually cleared in the University of Calabar Experimental Farm, Calabar. Five beds were made with a spacing of 2 m between beds. Three seeds were sown in a hole of 4 cm deep per variety (Center for New Crops and Plants Production, 2002). The 4 varieties were randomized on each bed with 8 replications per variety using Randomized Complete Block Design (RCBD). Spacing was 50×75 cm. After seedling emergence, each stand of individual variety was thinned down to 2 stands. Weeding was done 3 and 5 weeks after planting while staking was done 4 weeks after planting. Days to seedling emergence was noted while data on number of leaves, leaf area and vein length were collected 5 and 10 weeks after planting. Days to 50% flowering and days to 50% maturity were also recorded while number of flowers per plant; pod lengths, inter-node length per plant, number of seeds per pod, number of pods per plant, seed yield per plants and 100 seed weight were obtained at maturity.

Statistical analyses: Analysis of variance was computed using statistical software PASW 18 at probability level of 95% ($\alpha = 0.05$). Phenotypic and genotypic coefficients of variation (PCV and GCV), phenotypic, genotypic and environmental variations, genetic advance and broad sense heritability were estimated according to the methods of Singh and Chaudhary (1985) while genotypic variance was calculated as mean difference between genotypic mean square and error mean square (environmental variance) (Uguru, 1998).

RESULTS

Performance of morphological traits of the four cowpea landraces: The mean morphological and yield performance of four landraces of cowpea showed that there were significant differences ($p<0.05$) in all the parameters studied except days to 50% seedling emergence that showed no significant difference ($p>0.05$) among the varieties screened (Table 1). Result obtained showed that Ileje had the smallest leaf surface area at 5 and 10 weeks, while Olaudi had the highest leaf surface area. This trend however, was followed for the number of leaves per plant at 5 and 10 weeks. Importantly, it was observed that Olaudi produced the highest number of seeds per plant (seed yield) while no significant difference ($p>0.05$) on seed yield was observed in Akidi and Ileje varieties. There was no significant difference ($p>0.05$) on the number of seeds per pod between Akidi and Ileje ajaka but differed considerably with those of Olaudi and Ileje. Significant differences were observed in the number of pod per plant among the varieties with Olaudi having the highest number of pods. Pod length per plant almost showed the same trend as the number of seeds per pod. Days to 50% flowering showed that Akidi' variety flowers faster than other landraces screened. Present result revealed that there was no significant difference in the

Table 1: Mean yield and yield related morphological traits of four cowpea landraces

	Cowpea landraces			
Morphological traits	Akidi	Olaudi	Ileje ajaka	Ileje
Days to seedling emergence	4.29 ± 0.05^{a}	4.10 ± 0.19^{a}	3.97 ± 0.04^{a}	3.81 ± 0.15^{a}
Vein length plant^{-1} at 5 weeks	71.58 ± 3.96^{b}	62.75 ± 2.59^{b}	55.33 ± 2.08^{a}	50.58 ± 1.95^{a}
Vein length plant^{-1} at 10 weeks	176.58 ± 3.61^{b}	191.99 ± 3.18^{bc}	172.05 ± 1.76^{b}	139.18 ± 3.60^{a}
Number of leaves plant^{-1} at 5 weeks	25.60 ± 0.22^{a}	42.50 ± 0.35^{b}	56.83 ± 0.24^{c}	61.08 ± 0.38^{d}
Number of leaves plant^{-1} at 10 weeks	32.11 ± 0.35^{a}	111.52 ± 0.27^{b}	142.51 ± 0.46^{c}	159.27 ± 0.67^{d}
Leaf area plant^{-1} at 5 weeks	35.90 ± 0.38^{c}	41.47 ± 0.48^{d}	31.64 ± 0.48^{b}	26.86 ± 0.47^{a}
Leaf area plant^{-1} at 10 weeks	46.72 ± 0.39^{c}	70.43 ± 0.34^{d}	40.60 ± 0.20^{b}	33.64 ± 0.75^{a}
Inter-node length plant^{-1}	6.70 ± 0.16^{b}	5.43 ± 0.17^{a}	7.85 ± 0.14^{c}	8.46 ± 0.21^{c}
Days to 50% flowering	44.26 ± 0.56^{a}	48.02 ± 0.77^{b}	51.84 ± 0.85^{bc}	48.43 ± 0.58^{b}
Number of flowers plant^{-1}	54.60 ± 1.34^{a}	64.40 ± 2.15^{b}	49.50 ± 2.66^{a}	74.60 ± 2.20^{b}
Days to 50% maturity	62.91 ± 0.87^{b}	58.57 ± 0.10^{a}	59.63 ± 0.75^{a}	68.17 ± 0.56^{c}
Number of pod plant^{-1}	32.30 ± 1.07^{b}	46.70 ± 0.82^{d}	40.40 ± 0.62^{c}	27.50 ± 0.65^{a}
Number of seeds pod^{-1}	15.9 ± 0.52^{a}	19.50 ± 0.75^{ab}	17.00 ± 0.59^{a}	21.20 ± 0.74^{bc}
Pod length plant^{-1}	14.81 ± 0.36^{a}	16.34 ± 0.55^{ab}	13.91 ± 0.25^{a}	16.59 ± 0.41^{b}
Seed yield plant^{-1}	514.60 ± 27.16^{a}	911.00 ± 38.26^{c}	688.50 ± 24.56^{b}	582.90 ± 24.62^{a}
100-seed weight	9.64 ± 0.05^{b}	11.51 ± 0.04^{c}	8.15 ± 0.04^{a}	11.57 ± 0.09^{c}

Means followed with the same superscript along horizontal array indicates no significant difference ($p>0.05$)

Table 2: Variance estimates, genetic advance and heritability of morphological traits of cowpea landraces

Morphological traits	Phenotypic variance	Genotypic variance	Environmental variance	PCV (%)	GCV (%)	GA	h^2 (%)
Days to seedling emergence	0.42	0.03	0.15	16.10	4.14	0.09	65.73
Vein length plant^{-1} at 5 weeks	1099.24	103.23	66.89	1830.23	171.88	6.41	93.91
Vein length plant^{-1} at 10 weeks	4936.54	454.13	395.22	2904.53	267.19	13.32	91.99
Number of leaves at 5 weeks	2574.98	257.41	0.91	109.13	34.50	10.45	99.96
Number of leaves at 10 weeks	31820.93	3181.88	2.15	160.20	50.66	36.75	99.99
Leaf area at 5 weeks	397.09	39.47	2.42	58.92	18.58	4.08	99.39
Leaf area at 10 weeks	2552.06	254.98	2.30	105.58	33.37	10.40	99.91
Inter-node length plant^{-1}	17.73	1.73	0.48	249.38	24.26	0.84	97.29
Days to 50% flowering	96.19	9.00	6.16	199.85	18.71	1.89	93.59
Number of flowers plant^{-1}	1227.18	117.75	49.67	2019.05	193.73	6.72	95.95
Days to 50% maturity	186.13	17.74	6.72	298.66	28.79	2.71	96.39
Number of pod plant^{-1}	72.29	6.40	8.27	196.81	17.43	1.55	88.56
Number of seeds pod^{-1}	57.53	5.32	4.35	312.68	28.91	1.44	92.44
Pod length plant^{-1}	16.19	1.44	1.81	105.04	9.33	0.74	88.80
Seed yield plant^{-1}	09285.09	30101.49	8270.20	82.48	25.73	111.50	97.33
100-seed weight	27.03	2.69	0.04	264.53	26.32	1.07	99.85

PCV: Phenotypic coefficient of variation; GCV: Genotypic coefficient of variation; GA: Genetic advance; h^2: Broad sense heritability.

days to 50% flowering between Olaudi and Ileje varieties. Ileje ajaka slightly differed from Ileje in their time of flowering. Additionally, days to 50% maturity showed no significant difference ($p>0.05$) between Olaudi and Ileje ajaka but significantly differed from those of Akidi and Ileje. The result obtained revealed that Ileje variety matures late when compared to other landraces studied. Olaudi was observed to performed best in most morphological traits studied, most importantly, seed yield.

Variance estimates, genetic advance and heritability of morphological traits investigated: The results presented in Table 2 showed variance estimates, genetic advance and heritability of morphological traits after planting. Results revealed that there were wide genotypic, phenotypic variances among cowpea landraces screened except for days to 50% seedling emergence with very low variance estimates as compared with other parameters. Leaf area per plant, number of leaves per plant, number of flower per plant, vein length at 5 and 10 weeks and seed yield showed very high phenotypic and genotypic variances. Phenotypic and genotypic coefficients of variations of the aforementioned traits were also correspondingly high. Other morphological attributes such as days to 50% flowering, number of pod per plant, days to 50% maturity and number of seed per pod showed high phenotypic variance, phenotypic coefficient of variation but rather low genotypic variance and genotypic coefficient of variation. Generally, our result also showed that all the cowpea landraces studied had low genetic advance while broad sense heritability were comparatively high. Conversely, the magnitude of the genetic variances in the yield and yield-related traits were not proportional to the heritability estimates. Seed yield per plant had the highest variance estimates, genetic advance and high heritability.

DISCUSSION

Creation of genetic variability and subsequent selection for important traits is undoubtedly crucial activities that any plant breeder should apply to achieve better yield and other desirable traits. Selection of superior genotypes in any crop is proportional to the amount of genetic variability present in the population and the degree to which the traits are inherited. The magnitude of these estimates obviously suggests the degree to which improvement can be made possible through selection (Ragsdale and Smith, 2003; Udensi *et al.*, 2011a).

Though all morphological traits studied in this research contribute either directly or indirectly to grain yield which is the focal point for selection and breeding of cowpea, it is our thinking that greater attention should be paid to days to flowering, days to maturity and most importantly grain yield. It might prove logical to think that since akidi reaches flowering time first, it would have matured first. This however, was not the case as olaudi and ileje ajaka matured faster than akidi variety. The mechanism underlying this is presently unknown though it might probably be assumed that the variety to reach anthesis first does not necessarily imply that the variety will mature first.

One would have expected that the more the number of leaves, the higher the seed yield courtesy of photosynthesis. This was not the case as olaudi having 111.52 leaves per plant at the 10th week produced 911.0 seeds. The broader the leaf area, the more surface exposed for photosynthetic activities, which could have been the underlying reason behind the seed yield of olaudi variety. This corroborates the earlier reports of Udensi *et al.* (2010, 2011a). Going by the outstanding performance of olaudi on days to flowering, days to maturity, pod length and seed yield obviously suggest that probably olaudi had superior genes (Udensi *et al.*, 2011a). Present result seems to suggest a direct proportional relationship between the lengths of pod and number of seeds therein. It implies therefore that the longer the pod, the higher will be the seed number. This succinctly, points out to the fact that selection and subsequent breeding of cowpea landraces should take cognizance of varieties with long pods.

The high and wide variability observed among the cowpea landraces screened in the study, especially on some traits (Table 2) agrees with earlier reports by Tyagi *et al.* (2000) and Sarsamkar *et al.* (2008) in pigeon pealy (Idahosa *et al.*, 2010; Udensi *et al.*, 2011a). There were high genotypic and phenotypic coefficients of variation for most of the parameters studied. This is in conformity to the reports of Makeen *et al.* (2007) and Farshader and Farshader (2008).

Variance estimates in our work, including the broad sense heritability suggest that additive gene effects played paramount role in influencing traits performance. Udensi *et al.* (2011a) opined that since phenotypic coefficient of variation was greater than genotypic coefficient of variation, so yield improvement through phenotypic selection becomes cardinal. This submission presents itself in our present study. Heritability estimates is the measure of phenotypic variance attributable to genetic causes which has a good predictive function of breeding crops. Present result on broad sense heritability suggest high breeding value, implying more additive genetic effect which is pivotal for crop improvement (Dabholkar, 1992; Rohman *et al.*, 2003; Udensi *et al.*, 2011a). Seed yield should be an important index during cowpea selection, breeding and improvement. This is the case with our present study as there was corresponding high heritability estimate for seed yield and genetic advance, although Amin *et al.* (1992) reported that for better genetic gain through selection, high heritability will not always be associated with high genetic advance.

CONCLUSION

Giving that these indigenous crops have high nutritive value, high productivity, high variability, high adaptive potential and reservoir for economic genes to withstand changing climatic conditions, they need intensive and holistic research, even in the humid lowland conditions of

Calabar, Nigeria. Present results explicitly suggest that these cowpea landraces should be improved, especially olaudi variety owing to their morphological attributes, high variance estimates and high heritability.

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