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Estimation of Genetic Variability in Locally Grown Pulses (*Cajans cajan* (L.) Millsp and *Vigna unguiculata* (L.) Walp): A Panacea for Sourcing Superior Genotypes

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Abstract: The negligence of breeders and farmers to explore and exploit landraces of pulses is worrisome and urgent measures needed to be set in motion to forestall major future crisis, taking into cognizance the high adaptability and nutritive values accredited to them. This study focused on the estimation of genetic variability and heritability of desirable morphological characters in Fiofio (*Cajans cajan*) and Olaudi and Akidi (*Vigna unguiculata*) with the aim of conservation. Three landraces of pulses were sown using randomized complete block design. The field experiment was carried out at the University of Calabar Experimental Farm, University of Calabar, Calabar, during 2008-2010 growing season. Phenotypic and genotypic variances and coefficients of variation and genetic advance were estimated on yield and yield-related traits. The results showed that there were considerable variations among the pulses for the traits studied. The result revealed high genetic variability in the number of leaf per plant, leaf area, number of flowers per plant, number of pods per plant and number of seeds per plant. It also showed that genetic variability in pod length and 100-seed weight was low. Heritability estimates obtained in the result were very high though the magnitude of genetic variability in the yield and yield-related traits was not proportional to the heritability estimates. The traits studied also show high genetic advance. These explicitly showed that there are sufficient genetic variations to warrant conservation and improvement in these extinction-threatened pulses studied.

Key words: Pulses, landraces, genetic variability, heritability, selection, conservation

INTRODUCTION

The world population is growing geometrically and it is projected to be over 7 billion by 2020. It is however, pathetic to note that the developing world which is under pressure with the challenge of food insecurity, is contributing most to this increase (Pardey and Wright, 2002). This scenario obviously paints a bleak picture of the future's food security, especially in the developing countries, with Nigeria as a case study. The economic growth in sub-Saharan Africa estimated at 5.7% in 2006 and the quality of life depends on the agricultural sector which accounts for about 30% of Gross Domestic Product (GDP), 70-80% of employment and is the major source of food, income and raw materials for industries (Commission for Africa, 2005; Economic Commssion for Africa, 2007).

Pulses such as pigeon pea (*Cajanus cajan* (L.) Millsp) and cowpea (*Vigna unguiculata* (L) Walp) are members of the tribe Phaseoleae which comprises other genera including *Phaseolus* and *Lablab* containing important grain legumes (Van der Maesen, 1990). Pigeon pea and cowpea are widely grown in the semi-arid tropics and are highly tolerant to drought, particularly in the Indian subcontinent where it accounts for over 70% of the world's production and coverage (http://faostat.fao.org). Southern and eastern Africa, particularly Kenya, Malawi, Mozambique, Tanzania and Uganda, constitute the second largest pigeon pea growing areas. Other growing regions include Southeast Asia, Central and West Africa and America. In many countries, pigeon pea is grown in small areas and as a backyard crop (Nene and Sheila, 1990). Interestingly, the centre of maximum diversity of cultivated cowpea is found in West Africa, in an area encompassing the Savannah region of Nigeria, Southern Niger, Burkina Faso, Northern Benin, Togo and the North Western part of Cameroon (Ng and Marechal, 1985).

Pigeon peas and cowpeas are largely self-pollinated crops but some out-crossing occurs through insect pollination. The flower type, the abundance of insect pollinators and weather conditions during flowering can influence the degree of cross-pollination (Bramel *et al*., 2004). Besides being high in protein, high adaptability and drought-tolerant, pigeon pea and cowpeas provide many benefits to resource poor farmers including fuel, fodder, improved soil fertility and control of soil erosion (Siambi *et al*., 1992). Despite this, pigeon peas and cowpeas landraces are neglected crops in terms of research.

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This negligence of farmers and breeders to explore and exploit these indigenous pulses germplasm which could be a promising gene and nutrient resources, is worrisome and urgent measures therefore needed to be taken in order to prevent a major future crisis. The promotion of these pulses as high value crops and the introduction and adoption of improved varieties is slowly reducing the genetic diversity of landraces.

Parental selection for pigeon pea and cowpea improvement requires knowledge of the likelihood of improving characters of interest based on the amount and type of genetic control is influential because improvement of a character with very small genetic control relative to environmental influences will be difficult due to heritability (Ragsdale and Smith, 2003). Interestingly, selection of superior genotypes in any crop is undoubtedly 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 suggests the degree to which improvement can be made possible through selection. Rohman *et al.* (2003) reported high heritability estimates coupled with high genetic advance for seed yield/plant, 100 grain weight, plant height, seed/pod and days to flowering in mungbean. Makeen *et al.* (2007) in a related study reported high genotypic and phenotypic coefficient of variation for seed yield and number of pod per plant in *Vigna radiate* L. (Wilezek). Farshader and Farshader (2008) observed high variation in number of branches and pod number in chickpea (*Cicer arientinum* L.) landraces.

This study is thus hinged on estimating the genetic variability in selected indigenous pulses in Nigeria as a panacea for selecting superior genotypes for subsequent conservation and improvement.

MATERIALS AND METHODS

Three landraces of pulses-Akidi, Fiofio and Olaudi were purchased from dealers in Enugu State, Nigeria. A plot of land measuring 10×10 m 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 Productsm, 2002). The 3 varieties were randomized on each bed with 6 replications per variety using Randomized Complete Block Design (RCBD). Spacing of Akidi and Olaudi was 50×75 cm (spread types) while Fiofio was 20×75 cm (erect type). 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 and leaf area were collected 5 and 10 weeks after planting. Days to 50% flowering were also recorded while number of flowers per plant; pod lengths, number of seeds per pod, number of pods per plant and 100-seed weight were obtained at maturity.

Statistical analysis: Phenotypic and genotypic coefficients of variation (PCV and GCV) were estimated according to methods of Singh and Chaudhury (1985):

- Genotypic variance (δ^2g) was calculated as means difference between genotypic mean square and error mean square (Uguru, 1998)
- Genetic Advance (GA) of the genotypic selected pressure was computed using the formula according to Singh and Chaudhury (1985)
- Estimates of broad sense heritability were determined as suggested by Singh and Chaudhury (1985)

RESULTS

The mean morphological and yield performance showed that there were significant differences ($p<0.05$) in the parameters studied. The results show that Olaud had the highest number of leaves per plant and leaf area. However, the mean leaf area significantly differed ($p<0.05$) from those of Fiofio. Surprisingly, Fiofio at maturity had more number of flowers and pods per plant when compared with Olaudi and Akidi. On the other hand, Olaudi had longer pods followed by Akidi. Though Fiofio had the shortest pod length comparatively, surprisingly, it had more number of seeds per pod. Additionally, the 100-seed weight for Fiofio significantly differed ($p<0.05$) from those of Olaudi and Akidi, respectively. Days to seedling emergence in the three pulses was not significantly different after planting while days to 50% flowering differed significantly ($p<0.05$) (Table 1).

Table 1: Mean yield and yield related traits of indigenous pulses

Morphological attributes	Week	Pulses' landraces		
		Fiofio	Olaudi	Akidi
Days to seedling emergence		4.00 ± 0.24^a	3.9 ± 0.21^a	4.1 ± 0.43^a
Days to 50% flowering		100.00 ± 2.34^b	20.0 ± 1.21^a	20.0 ± 0.89^a
Number of leaves per plant	5	28.40 ± 2.2^a	42.8 ± 2.5^b	26.8 ± 1.5^a
	10	77.20 ± 5.8^b	111.8 ± 4.2^c	28.6 ± 4.3^a
Leaf area per plant	5	29.90 ± 0.8^a	41.5 ± 1.0^c	36.6 ± 0.8^b
	10	37.10 ± 1.7^a	70.8 ± 0.3^c	47.3 ± 2.7^b
Number of flowers per plant	10	140.80 ± 2.5^b	5.6 ± 0.4^a	6.2 ± 1.0^a
Number of pods per plant	10	136.40 ± 3.5^b	11.8 ± 0.7^a	8.0 ± 0.8^a
Pod length per plant	10	7.82 ± 0.2^a	17.3 ± 0.3^c	15.0 ± 0.4^b
Number of seeds per pod	10	86.20 ± 4.2^b	14.0 ± 1.4^a	14.6 ± 0.7^a
100-seed weight	10	13.70 ± 0.2^c	9.2 ± 0.1^a	10.4 ± 0.1^b

Mean followed with same case letter in a given horizontal array as superscript indicates no significant difference at $p>0.05$

Table 2: Variance estimates, genetic advance and heritability of morphological attributes of pulses' landraces

Morphological attributes per plant	Genotypic variance	Phenotypic variance	PVC (%)	GVC (%)	GA	$H_{(bs)}$
No. of leaves (5 weeks)	72.62	97.80	30.27	26.09	13.03	0.74
No. of leaves (10 weeks)	3308.64	3424.36	80.68	79.30	114.49	0.97
Leaf area (5 weeks)	33.09	36.55	16.78	15.97	10.03	0.91
Leaf area (10 weeks)	296.38	311.17	34.11	33.29	33.78	0.95
No. of flowers	5931.63	6603.93	159.75	151.40	142.50	0.90
No. of pods	5171.83	6001.13	148.77	138.11	127.67	0.86
Pod length	24.44	25.05	37.39	36.93	9.93	0.98
No. of seeds	3270.51	3380.56	151.94	149.45	113.97	o.97
100 seed weight	5.51	5.52	21.15	21.13	4.83	1.00

Variance estimates, genetic advance and heritability of morphological attributes obtained after 5 and 10 weeks after planting show that there were wide genotypic, phenotypic variances among the pulses screened (Table 2). Broad sense heritability for leaf area was higher (0.91) than number of leaves per plant. After 10 weeks of planting, the trend was not the same as the genotypic and phenotypic variances, phenotypic and genotypic coefficient of variation, including the genetic advance for number of leaves per plant were higher than leaf area per plant. The result obtained showed that there is a high genetic variability in the number of flowers per plant, number of pods per plant and number of seeds per pod. Conversely, there is low genetic variability in the pod length and 100-seed weight. The magnitude of the genetic variances in the yield and yield-related traits was not proportional to the heritability estimates. It was observed that the higher and wider the genetic variances, the smaller their heritability. Number of leaves per plant, number of flowers per plant, number of pod per plant and number of seed per pod showed high genetic advance (Table 2).

DISCUSSION

Worthy of note is the fact that creation of genetic variability and selection for important traits is undoubtedly crucial activities that any plant breeder should apply to achieve better yield and other desirable traits. Our results show that there were significant ($p<0.05$) mean differences in all the traits evaluated. It was observed that Fiofio performed better than Olaudi and Akidi in their yield traits the time to reach 50% flowering, notwithstanding. This observation corroborates the position of Memon *et al.* (2005), suggesting Fiofio probably to have superior genes resulting to better yield performance.

Present results also show that there were high and wide variability among the landraces. This corroborates with the earlier reports of Siddique and Gupta (1991), Sharma and Singhania (1992), Tyagi *et al.* (2000) and Idahosa *et al.* (2010) in cowpea and Sarsamkar *et al.* (2008) in pigeon pea. High phenotypic and genotypic coefficient of variation, including heritability indicates the presence of more additive gene effect for possible conservation and improvement. Additionally, the differences between phenotypic and genotypic coefficient of variation for all the corresponding traits was small which suggests that these characters were less influenced by environmental factors. Suffice it to say that the phenotypic coefficient of variation was greater than the genotypic coefficient of variation in all traits, implying that there is a good scope for yield improvement through phenotypic selection.

According to Dabholkar (1992), heritability was stratified as 5-10% (low); 10-30% (medium) and >30% (high). Going by this classification therefore, all the broad sense heritability estimates obtained in this study is very high, suggesting high breeding value. This means that there is more additive genetic effect which is paramount for crop improvement. This high heritability estimates may have been caused by adequate rainfall and other environmental conditions, including the adaptability of these landraces.

Present results show that the magnitude of genetic variances in the yield and yield-related traits was not proportional to the heritability estimates. Amin *et al.* (1992) opined that for better genetic gain through selection, high heritability will not always be associated with high genetic advance. Though our result generally show high genetic advance, there is a high genetic gain which could inform selection of these crops for conservation, especially Fiofio.

These indigenous pulses such as Fiofio, Olaudi and Akidi if not explored and exploited could lead to further extinction of these rich genetic resources. Since heritability estimate is the measure of phenotypic variance attributable to genetic causes which has a good predictive function of breeding crops, present results show high potential for effective conservation, improvement and further manipulation of the genetic resources (landraces) through breeding as these are good sources of genes for many desirable characters.

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