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RESEARCH ARTICLE

OPTIMIZATION OF CORRELATION AND PATH COEFFICIENT ANALYSES AS SELECTION TECHNIQUES FOR YIELD IN LOCALLY GROWN COWPEA [*Vigna unguiculata* (L) Walp]

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ABSTRACT

This research paper was aimed at investigating the extent of relationship between yield and yield-contributing traits, which will facilitate selection of high performing genotype(s) of local cowpea. Seeds of three varieties of locally grown cowpea were sown in a randomized complete block design (RCBD) in ten replications. The field study was done at the University of Calabar Experimental Farm, University of Calabar, Nigeria, during the 2008-2009 growing season. Correlation coefficients and path coefficients were estimated on yield and yield-contributing traits. Results when averaged revealed that vein length^{-1} negatively correlated with the number of leaves^{-1} (-0.63*) and pod length^{-1} (-0.653*) while correlating positively with number of nodules^{-1} (0.605*). There was significant positive relationship between number of leaves^{-1} and pod length^{-1} (0.552*) and number of seeds^{-1} (0.641*) while correlating negatively with number of nodules^{-1} (-0.722*). Significant relationships were also observed between leaf area^{-1} and pod length^{-1} (0.587*) and number of pod^{-1} and 100-seed weight (0.683*). Other character had associations with one another though not significant. The genotypic correlation coefficient was partitioned into direct and indirect effects. It revealed that vein length^{-1} (-0.926), leaf area^{-1} (-0.619), pod length^{-1} (-0.621) and number of pods^{-1} (-0.116) had negative direct effects on yield while number of leaves^{-1} (0.788), number of flowers^{-1} (0.278), number of nodules^{-1} (0.551) and 100-seed weight (0.548) had positive direct effects on yield. However, number of leaves^{-1} had the highest direct effects followed by 100-seed weight, number of nodules^{-1} and number of flowers^{-1}. Explicitly, our results are indications that for the selection of superior genotypes of cowpea during any breeding programme, the genotype(s) with higher number of leaves, number of nodules, number of flowers, 100-seed weight should be considered in conjunction with those with broader leaf area and long pods.

INTRODUCTION

The high adaptability and nutritive values of pulses, especially the landraces should be incentives for exploration and exploitation of these extinct-threatened crops if future crisis in food security is anything to give attention to (Udensi *et al.,* 2011a; Udensi *et al .,* 2011b). Selection of superior genotypes using morphological, biochemical or molecular markers should be the aspiration of any crop breeder with the view of having optimal yield or productivity (Udensi *et al.,* 2010). It is obvious that these days molecular (DNA) or markers-assisted selection and improvement through Quantitative Trait Loci (QTLs) mapping has advanced successfully, the need to complement these approach should not be overemphasized as more often than not local farmers and breeders are deprived of high yielding genotypes (Udensi *et al.,* 2010). Parental selection of any crop for improvement requires knowledge of the likelihood of improving characters of interest based on the amount and type of genetic control is influential. This is because improvement of a character with very small genetic control relative to environmental influences will be difficult due to heritability (Ragsdale and Smith, 2003; Udensi *et al.,* 2011a). 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 (Udensi *et al.,* 2011a). Cowpea is widely grown in the semi-arid tropics and is 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). 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).While correlation measures the mutual association between two variables (traits), path coefficient analysis identifies the cause (genetic or environmental) and measures the relative importance of the association. This permits the partitioning of correlation into direct and indirect effects. Worthy of note is the fact that path coefficient is synonymous to standardized coefficient of regression after a multiple regression analysis using data which are independent of original units of

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measurement (Cramer and Wehner, 2000b). The technique of path coefficient analysis has been extensively used by Azeem and Azhar (2006), Afriah and Ghoneim (2000), (Cramer and Wehner, 2000b). and Akinyele and Osekita (2006). Additionally, Iqbal *et al.* (2003) has used this method in soybean while Yadev *et al.* (2001), Arshad e*t al*. (2003), Ghafoor *et al.* (2003) and Arshad *et al.* (2004) have mentioned the worth of this technique in other legumes. The pivotal issue in planting breeding programme is to evolve high yielding varieties (Salahuddin *et al.,* 2010). However, there are so many factors contributing integrally to optimal productivity, it is therefore desirable for plant breeders to know the extent of relationship between yield and yield-contributing traits, which will facilitate selection of high performing genotype(s). It is on this premise that this research paper finds relevance.

MATERIALS AND METHODS

Seeds of four locally grown (landraces) of cowpea were purchased from dealers in Enugu State, Nigeria. A plot of land measuring 10x10 meters was manually cleared in the University of Calabar Experimental Farm, Calabar during the 2008-2009 growing season. Five beds were made with a spacing of 2 meters between beds. Three seeds were sown in a hole of 4cm deep per variety (Center for New Crops and Plants Products, 2002). The 3 varieties were randomized on each bed with 10 replications per variety using randomized complete block design (RCBD). Spacing of varieties was 50 x 75cm. After seedling emergence, each stand of individual variety was thinned down to 2 stands. Weeding was done 3 and 5 weeks after planting. Data were collected every two months on plant height per plant, number of leaves per plant, leaf area per plant, number of flowers per plant; pod lengths, number of nodules, number of seeds per plant, number of pods per plant and 100-seed weight, respectively.

Data analysis

Data obtained were subjected to correlation and path coefficient analysis using statistical software PASW 18. Path coefficient was taken as the standardized coefficient of regression (direct effect) while the indirect effect was computed by multiplying the path coefficient of individual traits with their corresponding correlation coefficients (Cramer and Wehner, 2000a). The residual effect was estimated using the formula according to Singh and Chaudhary (1985):

RESULTS

Results when averaged revealed that vein length^{-1} negatively correlated with the number of leaves^{-1} (-0.63*) and pod length^{1} (-0.653*) while correlating positively with number of nodules^{1} (0.605*). There was however significant positive relationship between number of leaves^{-1} and pod length^{-1} (0.552*) and number of seeds^{-1} (0.641*) while correlating negatively with number of nodules^{-1} (-0.722*). Significant relationships were also observed between leaf area^{-1} and pod length^{-1} (0.587*) and number of pod^{-1} and 100-seed weight (0.683*). Other character had associations with one another though not significant (Table 1). The genotypic correlation coefficient was partitioned into direct and indirect effects (Table 2). It revealed that vein length^{-1} (-0.926), leaf area^{-1}(-0.619), pod length^{-1} (-0.621) and number of pods^{-1} (-0.116) had negative direct effects on yield while number of leaves^{-1} (0.788), number of flowers^{-1} (0.278), number of nodules^{-1} (0.551) and 100-seed weight (0.548) had positive direct effects on yield. However, number of leaves^{-1} had the highest direct effects followed by 100-seed weight, number of nodules^{-1} and number of flowers^{-1} (i.e. number of leaves^{-1} > 100 seed weight > number of nodules^{-1} > number of flowers^{-1}) (Fig. 1)

DISCUSSION

The knowledge of certain genetic parameters is essential for proper understanding and their subsequent manipulation in any crop improvement programme (Arshad *et al.,* 2006).

Table 1: Correlation of yield and yield related traits in cowpea [*Vigna unguiculata* (L.) Walp]

Traits	Plant height^{-1}	No. of leaves^{-1}	Leaf area^{-1}	No. of flowers^{-1}	No. of pod^{-1}	Pod length^{-1}	No. of seeds^{-1}	No. of nodules^{-1}	100-seed weight
Plant height^{-1}	1	-0.630*	-0.482	0.287	-0.044	-0.653*	-0.319	0.605*	-0.013
No. of leaves^{-1}		1	0.032	0.123	-0.065	0.552*	0.641*	-0.722*	-0.037
Leaf area^{-1}			1	-0.509	0.200	0.587*	-0.454	-0.077	0.471
No. of flowers^{-1}				1	-0.066	-0.012	0.322	0.166	-0.373
No. of pod^{-1}					1	-0.007	0.133	-0.182	0.683*
Pod length^{-1}						1	-0.106	-0.482	0.181
No. of seeds^{-1}							1	-0.302	-0.182
No. of nodules^{-1}								1	-0.235
100-seed weight									1

** Correlation significant at the 0.01 probability level; * Correlation significant at the 0.05 probability level

Table 2: Direct effect (underlined), indirect effect and genotypic correlation of yield-related traits with yield of cowpea [*Vigna unguiculata* (L.) Walp]

Traits	Plant height^{-1}	No. of leaves^{-1}	Leaf area^{-1}	No. of flowers^{-1}	No. of pod^{-1}	Pod length^{-1}	No. of nodules^{-1}	100-seed weight	Genotypic correlation with yield
Plant height^{-1}	-0.926	-0.496	0.298	0.080	0.007	0.406	0.309	-0.007	-0.339
No. of leaves^{-1}	0.590	0.788	-0.020	0.034	0.008	-0.343	-0.398	-0.020	0.639
Leaf area^{-1}	0.451	0.025	-0.619	-0.142	-0.023	-0.365	0.042	0.258	-0.373
No. of flowers^{-1}	-0.269	0.097	0.315	0.278	0.008	0.007	0.091	-0.204	0.323
No. of pod^{-1}	0.041	-0.051	-0.124	-0.018	-0.116	0.004	-0.100	0.374	0.010
Pod length^{-1}	0.611	0.435	-0.363	-0.003	0.001	-0.621	-0.266	0.099	-0.107
No. of nodules^{-1}	-0.566	-0.569	0.048	0.046	0.021	0.299	0.551	-0.129	-0.299
100-seed weight	0.012	-0.029	-0.292	-0.104	-0.079	-0.112	-0.129	0.548	-0.185

*values underlined are the direct effect to yield (path coefficients); *other values are indirect effects via different pathways except the genotypic correlation with yield.

The results on correlation analysis revealed that the vein length^{-1} significantly (P <0.05) correlated with negatively with the number of leaves^{-1} and pod length^{-1} but positively correlated with number of nodules^{-1} (Table1). It thus suggests

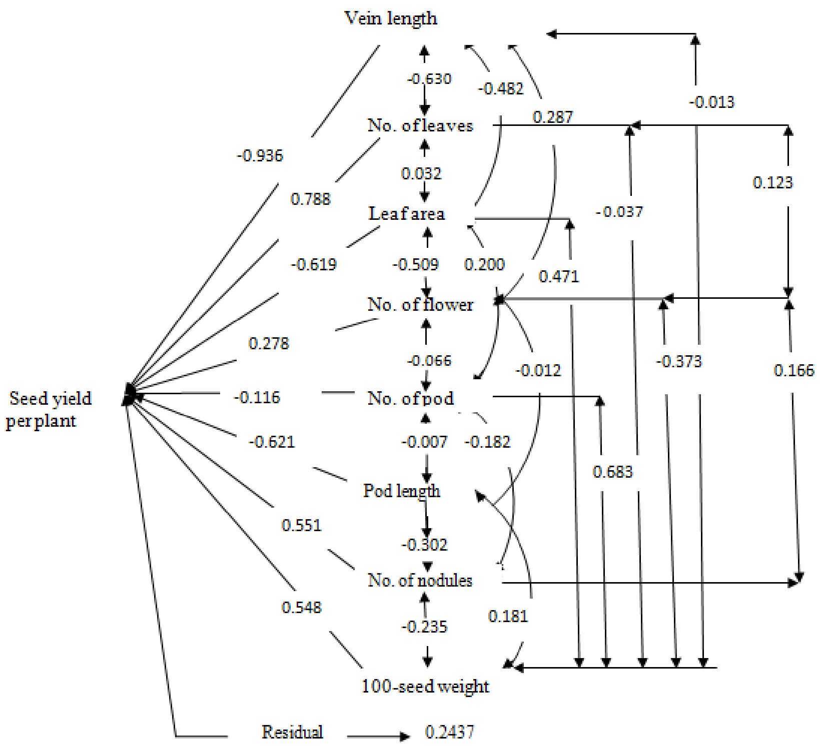

Fig., 1: Path diagram showing the path coefficients and correlation coefficients of yield and yield-related traits in locally grown cowpea varieties [*Vigna unguiculata* (L.) Walp]

that the number of leaves and pod length might pose some difficulties during selection contrary to the report of Udensi *et al.,* 2010). The vein length correlating positively with the number of nodules implies that as the vein length increases, the nodules number will simultaneously increase. Dashti et al. (1997), Raverkar and Konde (1988), Egamberdiyeva *et al.* (2004), Udensi et al., 2010) reported the effect of nodulation on soybean yield. Succinctly, selecting cowpea genotypes with long vein leading to greater nodule number could be beneficial to breeder. One would have expected that increase in vein length will lead to increase in the number of leaves, which did not follow. It is obvious that increase in the number of leaves should lead to increase photosynthetic activities, which probably could reflect on the crop's productivity. Table 1 also showed that number of leaves correlated positively with the pod length and number of seeds (seed yield) but negatively with number of nodules. The implication is that selecting cowpea genotypes based on the number of leaves might be a index for selecting superior genotypes for breeding programme. This is however in line with the results of Akinyele and Osekita (2006). (Cramer and Wehner, 2000b). Additionally, although some of these traits that had negative correlations with one another will be difficult to select for in characterization of desirable traits, those with positive relationship but non-significant correlation coefficients will be disregarded in selection for crop improvement. (Henry and Krishna, 1990; Akinyele and Osekita (2006). The direct positive effects of especially number of leaves^{-1} and number of nodules^{-1} (Table 2) to yield are a direct confirmation of the correlation results. However, number of flowers^{-1} and 100-seed weight had also positive direct effects on yield. These corroborate the reports of Singh and Yadava (2000); Shrivastava *et al.* (2001) and (Arshad *et al.,* 2006) in soybean. Yadev *et al.* (2001), Arshraf *et al.* (2002), (Arshad *et al.,* 2006) reported positive direct effect of 100-seed weight on the yield of wheat, urdbean and soybean, respectively. It then becomes substantial to select cowpea genotypes or lines (landraces) based on the number of leaves produced by each line, number of nodules produced in the roots, number of flowers, though to a lesser extent. The effect of 100-seed weight on yield is not very clear. Understandably, these seeds are not sold based on their weight and as such its influence is yet to be elucidated. However, it is probably that the effect could be traceable to the quantum of food reservoir that will enhance the germination capacity of this crop. Possibly, the higher the weight, the better the germination and subsequent growth and development. Accordingly to (Cramer and Wehner, 2000b), a large path coefficient indicates that the change will result in a proportional or inverselt proportional change in another correlated trait, whereas a weak coefficient indicates that the change will have little effect on the second trait. However, based on (Cramer and Wehner, 2000b). statistical test for the importance of path coefficient, only the number of leaves^{-1} had a strong coefficient, indicating that this trait will exert significant effect on cowpea seed yield. Other reporters in this field came out with coefficients lesser than (Cramer and Wehner, 2000b). hypothesis but claiming their strong effects on yield (Vange and Moses, 2009, Akinyele and Osekita (2006)., (Arshad *et al.,* 2006). It therefore will mean that number of flowers^{-1}, number of nodules^{-1} and 100-seed weight will have proportional effect on the yield while those traits with negative coefficients will have inversely proportional effect on yield. Interestingly, these traits that posses negative direct effects on yield could be compensated for taking cognizance of their indirect pathways to yield. For instance, selecting the vein length via the leaf area, pod length and number of nodules could nullify the effect of the direct selection of genotypes or lines with long vein length.

Additionally, instead of selecting directly the cowpea genotypes with long pod length, it will be more beneficial to indirectly select lines with long vein and increased number of leaves. It becomes explicit to assert that when selecting cowpea genotypes for breeding, the traits that will be markers for superior genotypes in terms of yield are number of leaves, number of nodules, number of flowers, 100-seed weight, the leaf area and pod length.

Conclusion

Explicitly, our results are indications that for the selection of superior genotypes of cowpea during any breeding programme, the genotype(s) with higher number of leaves, number of nodules, number of flowers, 100-seed weight should be considered in conjunction with those with broader leaf area and long pods.

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