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Relationship Studies in Cowpea (*Vigna unguiculata* L. Walp) Landraces Grown under Humid Lowland Condition

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ABSTRACT

Establishing the extent of relationship, identifying the cause and measuring the relative importance of such associations to yield is very crucial for varietal selection, breeding and subsequent improvement of crops, especially cowpea landraces. This research x-rays correlation coefficients and path coefficients of yield and yield-influencing traits in cowpea landraces. Seeds of four varieties of locally grown cowpea were sown in a Randomized Complete Block Design (RCBD) in ten replications. The field study was carried out at the University of Calabar Experimental Farm, University of Calabar, Nigeria, during the 2010-2011 growing season. Correlation coefficients and path coefficients were computed on yield and yield-contributing traits. Results obtained revealed that significant relationships between yield and yield-contributing traits existed which could be indices for selection. Genotypic correlations coefficients were high and more significant than the phenotypic and environmental correlation coefficients. Path coefficient analysis shows that number of pod per plant had the highest direct effects to cowpea yield (0.588). This was followed by number of flowers (0.454), number of seeds per pod (0.366), leaf area at 5 weeks (0.366) and pod length and 100 seed weight (0.316), respectively. Other morphological traits had negative direct effects on seed yield such as vein length at 10 weeks (-0.627), number of leaves at 5 weeks (-0.215), number of leaves at 10 weeks (-0.033), leaf area at 10 weeks -1.124, days to 50% flowering (-0.083) and days to 50% maturity (-0.066). Succinctly, it therefore implies that number of pods per plant, number of leaves per plant, leaf area, number of flowers per plant, pod length and number of seeds per pod are good selection indices for a high yielding variety of cowpea, especially the landraces. This then can be exploited in hybridization programmes involving cowpea.

Key words: Cowpea landraces, correlation analyses, path coefficients, selection, breeding, improvement

INTRODUCTION

The fact that pulses have high adaptability potentials and high nutritive values especially the landraces, should be enough incentives for their exploration and exploitation if food security is anything to accord priority in Nigeria (Udensi *et al.*, 2011a, b). Cowpea (*Vigna unguiculata* L. Walp) is one of the sixth major cultivated crop species of the family *Leguminosae* distributed throughout the tropics (Pasquet, 2001). The leaves, stems and seeds have been reported to have antimicrobial properties.

For two decades now, scientists in the field of genetic transformation of cowpea have made great strides with little success to develop reliable transformation systems for this crop that is very important as a good source of protein and energy for people in developing countries of Africa and Asia (Obembe, 2009). Grain legumes generally have been regarded as recalcitrant to transformation because of poor regeneration ability (especially via callus) and *in vitro* regeneration being genotypic-specific. Worst still, most cowpea cultivars are infrequently amenable to regeneration. There is also the problem of compatible gene delivery system (Somers *et al*., 2003; Chandra and Pental, 2003; Popelka *et al*., 2004). Other researchers in this field such as Sahoo *et al*. (2000) and Ikea *et al*. (2003) were however, not able to provide molecular evidence of stable transformation with Mendelian transmission of the transgenes to progeny. According to Popelka *et al*. (2006), Chaudhury *et al*. (2007), Ivo *et al*. (2008) and Solleti *et al*. (2008a, b) there are seeming roads at the end of the tunnel as regarding cowpea transformation and improvement though with little percentage transformation efficiency. These recent successes in cowpea genetic transformation have therefore paved way for the introduction of more agronomic traits to cowpea, thereby enhancing the genetic diversity of the crop and consequently complementing existing breeding programmes (Obembe, 2009). Additionally, molecular (DNA) or markers-assisted selection and improvement through Quantitative Trait Loci (QTLs) mapping has advanced successfully, the need to complement these approaches should not be overemphasized as more often than not local farmers and breeders are deprived of these high yielding genotypes (Udensi *et al*., 2010). Regrettably, since the Sub-Saharan Africa, indeed Nigeria is bedeviled with institutional and infrastructural problems coupled with the whooping sums of money involved in biotechnological processes, resting all our shoulders on these modern techniques might spell doom to future food security which is topical in vision 2020 agenda of the government in all tiers.

The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits on genetic gain for the primary traits under consideration (Umar *et al*., 2010). While correlation measures the mutual association between two variables (traits), path coefficient analysis on the other hand, identifies the cause and measures the relative importance of the association. Additionally, path coefficient analysis provides an effective means of partitioning correlation coefficients into unidirectional pathways and alternate pathways thus permitting a critical examination of specific factors that produce a given correlation which can be successfully employed in formulating an effective selection programme (Salahuddin *et al*., 2010). Importantly, path coefficient is synonymous to standardized coefficient of regression after a multiple regression analysis using data which are independent of original units of measurement (Cramer and Wehner, 2000b). The technique of path coefficient analysis has been extensively used by Azeem and Azhar (2006), Afiah and Ghoneim (2000), Cramer and Wehner (2000b) and Akinyele and Osekita (2006). Additionally, Iqbal *et al*. (2003) has used this method in soybean; Yadev *et al*. (2001), Arshad *et al*. (2003), Ghafoor *et al*. (2003) and Arshad *et al*. (2004) have used the technique in other legumes.

This presented study however, is aimed at selecting superior genotype(s) of cowpea landraces through correlation studies which could be exploited in hybridization programmes to develop and select hybrids with superior traits.

MATERIALS AND METHODS

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 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 Products, 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: 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 while genotypic, phenotypic and environmental correlations were computed according the method of Singh and Chaudhury (1985).

RESULTS

Simple pearson correlation: Our result in Table 1 presents the Pearson correlation coefficients. It shows that there were significant positive correlations between days to seedling emergence and number of leaves at 10 weeks (0.684*), vein length at 5 weeks and days to 50% flowering (0.684*) and pod length per plant and seed yield per plant (0.93***). Conversely, there were also negative significant correlation between leaf area at 5 weeks and pod length (-0.651*) and seed yield per plant (-0.725*); days to 50% flowering and number of seed per plant (-0.918***). However, other morphological traits studied had high correlations but were not significant.

Phenotypic correlation: Phenotypic correlation results revealed that there were positive significant association between number of leaves at 5 weeks and inter-node length (0.665*); leaf area at 5 weeks and number of pods per plant (0.665*); number of flowers and pod length (0.905***); inter-node length and seed yield (0.6300*) while negative significant relationship existed between days to seedling emergence and number of seeds per pod (-0.8473**) (Table 2).

Genotypic correlation: Furthermore, the genotypic correlation of yield and yield-related traits showed that there were generally high significant associations among most of the characters studied. The result shows that days to seedling emergence significantly correlated positively with vein length at 10 weeks (0.896**), leaf area at 5 weeks (0.84**), leaf area at 10 weeks (0.62*) and negatively with inter- node length (-0.858**), days to 50% flowering (-0.835**) and number of seeds per pod (-0.919***). It was also observed that vein length at 10 weeks significantly correlated positively with number of pods per plant (0.801**); leaf area at 5 and 10 weeks and days to 50% maturity with number of pods per plant (0.633*, 0.764**, 0.688*), respectively. There were positive significant association between number of leaves at 10 weeks, number of flowers with number of seeds per pod (0.739**, 0.979***). Days to seedling emergence, vein length at 5 weeks correlated negatively with number of seeds per pod (-0.919***, -0.646*) (Table 3).

Table 1: Pearson correlation on yield and yield-related traits in landraces of cowpea (*Vigna unguiculata* L. Walp)

	Days to seedling emergence	Vein length at 5 wks	Vein length at 10 wks	No. of leaves at 5 wks	No. of leaves at 10 wks	Leaf area at 5 wks	Leaf area at 10 wks	Internode length	Days to 50% flowering	No. of flowers per plant	Days to 50% maturity	No. of pod per plant	No. of seeds per pod	Pod length	Seed yield	100 seed weight
Days to seedling emergence	1	-0.402	0.292	-0.092	0.684*	-0.014	0.375	-0.254	-0.397	0.235	0.127	0.191	0.341	0.16	0.239	-0.439
Vein length at 5 wks		1	0.528	-0.093	-0.496	0.12	0.309	-0.118	0.684*	0.092	-0.449	-0.565	-0.486	-0.26	-0.388	-0.291
Vein length at 10 wks			1	0.026	0.029	0.183	0.602	0.08	-0.085	-0.215	0.02	-0.396	0.187	-0.24	-0.425	-0.202
Number of leaves at 5 wks				1	0.406	0.421	-0.263	0.551	-0.15	-0.221	-0.036	-0.329	0.374	-0.328	-0.471	0.186
Number of leaves at 10 wks					1	0.022	-0.278	0.341	-0.311	-0.077	-0.059	0.198	0.281	0.099	0.168	-0.258
Leaf area at 5 wks						1	0.039	-0.206	0.231	-0.381	0.301	-0.20	-0.124	-0.651*	-0.725*	-0.228
Leaf area at 10 wks							1	-0.412	-0.099	0.301	-0.029	-0.365	0.157	-0.088	-0.19	-0.238
Internode length								1	-0.274	-0.483	-0.127	-0.214	0.245	0.149	-0.017	0.539
Days to 50% flowering									1	0.203	-0.541	-0.412	-0.918***	0.065	-0.068	-0.412
Number of flowers per plant										1	-0.217	-0.158	-0.123	0.384	0.444	-0.205
Days to 50% maturity											1	0.29	0.401	-0.05	-0.099	0.455
Number of pod plant^{-1}												1	0.273	-0.176	0.143	-0.18
Number of seeds pod^{-1}													1	-0.12	-0.141	0.298
Pod length														1	0.93***	0.414
Seed yield															1	0.209
100-seed weight																1

*p = 0.05, **p = 0.01, ***p = 0.001

Table 2: Phenotypic correlation of yield and yield-contributing traits in cowpea (*Vigna unguiculata* L. Walp) landraces

	Days to seedling emergence	Vein length at 5 wks	Vein length at 10 wks	No. of leaves at 5 wks	No. of leaves at 10 wks	Leaf area at 5 wks	Leaf area at 10 wks	Internode length	Days to 50% flowering	No. of flowers per plant	Days to 50% maturity	No. of pod per plant	No. of seeds per pod	Pod length	Seed yield	100 seed weight
Days to seedling emergence	1	0.091	0.095	-0.098	-0.13	0.071	-0.043	-0.065	-0.065	-0.274	-0.049	-0.111	-0.847**	-0.013	-0.001	-0.066
Vein length at 5 wks		1	-0.074	-0.275	-0.116	0.070	0.004	-0.071	-0.03	-0.027	-0.03	0.064	0.056	0.0003	-0.005	-0.026
Vein length at 10 wks			1	-0.144	-0.18	0.092	0.085	-0.073	-0.094	-0.052	-0.094	0.218	-0.288	-0.03	0.086	-0.029
Number of leaves at 5 wks				1	0.099	-0.069	-0.045	0.665*	0.071	0.038	0.029	-0.030	-0.064	-0.017	0.081	-0.0002
Number of leaves at 10 wks					1	-0.046	-0.030	-0.205	0.293	0.043	0.008	0.174	-0.086	0.094	0.103	0.013
Leaf area at 5 wks						1	0.096	-0.099	-0.039	-0.024	-0.078	0.665*	-0.024	0.012	0.104	-0.057
Leaf area at 10 wks							1	-0.097	-0.223	0.021	-0.07	0.258	0.001	0.026	0.081	0.026
Internode length								1	-0.129	0.019	0.057	-0.232	0.024	-0.016	0.63*	-0.238
Days to 50% flowering									1	-0.137	-0.099	0.06	-0.0267	-0.096	0.046	-0.087
Number of flowers per plant										1	0.060	-0.112	0.1184	0.905***	0.024	-0.098
Days to 50% maturity											1	-0.301	0.031	0.302	0.068	0.079
Number of pod plant^{-1}												1	-0.3880	0.0110	0.022	-0.065
Number of seeds pod^{-1}													1	0.0186	0.067	0.062
Pod length														1	0.106	-0.108
Seed yield															1	0.025
100-seed weight																1

*p = 0.05, **p = 0.01, ***p = 0.001

Table 3: Genotypic correlation of yield and yield-contributing traits in cowpea (*Vigna unguiculata* L. Walp) landraces

	Days to seedling emergence	Vein length at 5 wks	Vein length at 10 wks	No. of leaves at 5 wks	No. of leaves at 10 wks	Leaf area at 5 wks	Leaf area at 10 wks	Internode length	Days to 50% flowering	No. of flowers per plant	Days to 50% maturity	No. of pod per plant	No. of seeds per pod	Pod length	Seed yield	100 seed weight
Days to seedling emergence	1	0.057	0.896***	-0.152	-0.086	0.84**	0.621*	-0.858**	-0.835**	-0.524	-0.593	0.099	-0.919***	-0.453	-0.041	-0.222
Vein length at 5 wks		1	0.626*	-0.897**	-0.845**	0.403	0.444	-0.624*	-0.687*	-0.208	-0.357	0.2780	-0.646*	-0.258	-0.077	-0.108
Vein length at 10 wks			1	0.542	-0.532	0.974***	0.895**	-0.932***	-0.128	-0.595	-0.981***	0.801**	-0.579	-0.302	0.60	-0.192
Number of leaves at 5 wks				1	0.986***	-0.675*	-0.455	0.674*	0.876**	0.382	0.298	-0.363	0.076	0.186	0.142	0.074
Number of leaves at 10 wks					1	-0.559	-0.301	0.532	0.878**	0.436	0.208	0.058	0.739*	0.284	0.296	0.172
Leaf area at 5 wks						1	0.962***	-0.102	-0.374	-0.245	-0.762*	0.633*	-0.289	0.075	0.636*	0.174
Leaf area at 10 wks							1	-0.983***	-0.201	-0.081	-0.741*	0.764*	-0.001	0.274	0.809**	0.33
Internode length								1	-0.431	0.156	-0.734*	-0.47	0.208	-0.175	-0.627*	-0.238
Days to 50% flowering									1	-0.1167	-0.179	0.251	0.281	-0.191	0.3790	-0.290
Number of flowers per plant										1	0.688*	-0.287	0.976***	0.034	0.078	-0.181
Days to 50% maturity											1	0.688*	0.516	0.486	-0.707*	0.943***
Number of pod plant^{-1}												1	0.52	-0.534	0.297	-0.336
Number of seeds pod^{-1}													1	0.959***	0.279	0.961***
Pod length														1	0.297	0.106
Seed yield															1	0.247
100-seed weight																1

*p = 0.05, **p = 0.01, ***p = 0.001

Environmental correlation: Result obtained on environmental correlation revealed that there were positive significant associations between vein length at 10 weeks and days to 50% maturity (0.63*) and seed yield per plant (0.63*) but negatively with 100 seed weight (-0.998***). Positive significant relationship existed between number of leaves and leaf area at 5 weeks (0.859**) and pod length (0.681*) while correlating negatively with number of pod per plant (-0.648*) and 100 seed weight (-0.984***). It was also observed that number of pod per plant correlated positively with seed yield per plant (0.899**). However, other morphological traits had high correlation coefficients (Table 4).

Path coefficients: Direct (path coefficients) and indirect effects of yield-contributing traits to the yield of cowpea are as presented on Table 5. It shows that number of pod per plant had the highest direct effects to cowpea yield (0.588). This was followed by number of flowers (0.454), number of seeds per pod (0.366), leaf area at 5 weeks (0.366) and pod length and 100 seed weight (0.316), respectively. Other morphological traits had negative direct effects on seed yield such as vein length at 10 weeks (-0.627), number of leaves at 5 weeks (-0.215), number of leaves at 10 weeks (-0.033), leaf area at 10 weeks -1.124, days to 50% flowering (-0.083) and days to 50% maturity (-0.066). Some traits exhibited high total genotypic correlation coefficients.

DISCUSSION

It is undoubtedly obvious that genetic dissection and mapping of a Quantitative Traits Loci (QTLs) of any crop to decipher the exact locus of the chromosome where a particular trait could be found for onward improvement is a herculean task and thus needs preliminary work such as relationship studies which will guide selection. According to Umar *et al.* (2010), relationships study among quantitative traits is important for assessing the feasibility of joint selection of two or more traits. Yield (seed yield) as a complex polygenic trait influenced by many genes and factors working in synergy (Ezeaku and Mohammed, 2006) is the focal point in cowpea breeding and improvement.

According to Akinyele and Osekita (2006), mutual association of traits is often expressed by the phenotypic, genotypic and environmental correlations. Phenotypic correlation is directly proportional to the genotypic and environmental correlations. Present result shows that there were positive significant phenotypic correlation between number of leaves at 5 weeks and inter-node length; leaf area at 5 weeks and number of pod per plant; inter-node length and seed yield and number of flowers per plant and pod length. The broader the leaves, the more leaf surface that will be exposed to photosynthetic activity and the more pod that will be produced. This might be due to the higher photosynthetic efficiency of the varieties (Fagwalawa, 2000; Akinyele and Osekita, 2006). This however, might mean more flowers which might affect the pod lengths and ultimately seed yield. Their facilitatory role contributes significantly to the final yield and thus should be considered during selection to improve yield in cowpea breeding. Conversely, the negative significant phenotypic correlation observed between days to seedling emergence and number of seeds per pod indicates that the time taken for cowpea variety to germinate and emerge into seedling could affect the number of seeds produced per pod. It might suggest that selection of cowpea genotypes should take into cognizance early germination capacity which could lead to higher seed production.

Table 4: Environmental correlation of yield and yield-contributing traits in cowpea (*Vigna unguiculata* L. Walp) landraces

	Days to seedling emergence	Vein length at 5 wks	Vein length at 10 wks	No. of leaves at 5 wks	No. of leaves at 10 wks	Leaf area at 5 wks	Leaf area at 10 wks	Internode length	Days to 50% flowering	No. of flowers per plant	Days to 50% maturity	No. of pod per plant	No. of seeds per pod	Pod length	Seed yield	100 seed weight
Days to seedling emergence	1	0.132	-0.061	-0.08	-0.72*	0.001	-0.535	0.068	0.028	-0.132	0.001	0.118	-0.061	0.117	0.025	-0.617
Vein length at 5 wks		1	0.221	0.019	-0.299	0.444	0.162	-0.281	-0.405	0.306	-0.029	0.130	0.069	0.291	0.060	-0.63*
Vein length at 10 wks			1	-0.32	0.026	-0.050	-0.117	0.329	-0.033	0.069	0.630*	0.095	0.317	0.03	0.63*	-0.998***
Number of leaves at 5 wks				1	-0.191	-0.123	0.035	0.014	-0.882**	0.015	-0.0002	-0.149	-0.121	-0.11	-0.40	-0.572
Number of leaves at 10 wks					1	0.859**	0.169	-0.201	0.05	-0.088	0.356	-0.648*	0.263	0.681*	0.135	-0.984***
Leaf area at 5 wks						1	0.123	0.064	-0.135	0.0178	-0.229	0.267	-0.190	0.267	0.081	-0.386
Leaf area at 10 wks							1	-0.050	-0.378	0.80**	0.47	-0.174	0.18	0.033	0.236	-0.587
Internode length								1	-0.391	0.11	-0.437	-0.044	0.088	0.005	0.029	-0.217
Days to 50% flowering									1	-0.598	-0.699*	-0.611	-0.414	-0.93***	-0.33	-0.599
Number of flowers per plant										1	0.028	0.095	0.114	-0.07	0.004	0.167
Days to 50% maturity											1	-0.044	0.089	0.334	0.004	-0.457
Number of pod $plant^{-1}$												1	-0.336	0.082	0.891**	0.552
Number of seeds pod^{-1}													1	-0.09	0.106	0.944***
Pod length														1	-0.01	-0.401
Seed yield															1	-0.711*
100-seed weight																1

*p= 0.05, **p= 0.01, ***p= 0.001

Table 5: Direct (bold) and indirect effects of yield-contributing traits in cowpea landraces (*Vigna unguiculata* L. Walp)

	Days to seedling emergence	Vein length at 5 wks	Vein length at 10 wks	No. of leaves at 5 wks	No. of leaves at 10 wks	Leaf area at 5 wks	Leaf area at 10 wks	Internode length	Days to 50% flowering	No. of flowers per plant	Days to 50% maturity	No. of pod per plant	No. of seeds per pod	Pod length	100 seed weight	Total genotypic correlation on yield
Days to seedling emergence	0.123	-0.122	-0.183	0.020	-0.023	-0.005	-0.422	-0.007	0.033	0.107	-0.008	0.588	0.125	0.050	-0.133	0.143
Vein length at 5 wks	-0.049	0.303	-0.331	0.020	0.016	0.040	-0.347	-0.003	-0.057	0.042	0.030	-0.332	-0.178	-0.082	-0.092	-1.021
Vein length at 10 wks	0.036	0.088	-0.627	-0.006	-0.001	0.006	-0.677	0.002	0.007	-0.098	-0.001	-0.233	0.068	-0.076	-0.064	-1.573
Number of leaves at 5 wks	-0.011	-0.028	-0.016	-0.215	-0.013	0.142	0.295	0.015	0.012	0.100	0.023	-0.193	0.137	-0.104	0.059	0.202
Number of leaves at 10 wks	0.084	-0.150	-0.018	0.087	-0.033	0.007	0.312	0.009	0.026	-0.035	0.004	0.116	0.103	0.031	-0.082	0.461
Leaf area at 5 wks	-0.002	0.036	-0.115	-0.091	-0.001	0.337	-0.044	-0.006	-0.019	-0.173	-0.020	-0.118	-0.045	-0.206	-0.072	-0.579
Leaf area at 10 wks	0.046	0.094	-0.378	0.057	0.009	0.013	-1.124	-0.011	-0.008	0.137	-0.002	-0.215	0.057	-0.028	-0.075	-1.428
Internode length	-0.031	-0.036	-0.050	-0.119	-0.011	-0.069	0.463	0.027	0.023	-0.219	0.008	-0.126	0.090	0.047	0.170	0.167
Days to 50% flowering	-0.049	0.207	0.053	0.032	0.010	0.079	0.111	-0.007	-0.083	0.092	0.036	-0.242	-0.336	-0.021	-0.130	-0.248
Number of flowers per plant	0.029	0.028	0.135	0.048	0.003	-0.128	-0.338	-0.013	-0.017	0.454	0.014	-0.093	-0.045	0.122	-0.065	0.134
Days to 50% maturity	0.016	0.136	-0.013	0.008	0.002	0.101	0.033	-0.003	0.045	-0.099	-0.066	0.171	0.147	-0.016	0.144	0.606
Number of pod per plant	0.023	-0.171	0.248	0.071	-0.007	-0.067	0.410	-0.006	0.034	-0.072	-0.019	0.588	0.100	-0.056	-0.057	1.019
Number of seeds per pod	0.042	-0.147	-0.117	-0.080	-0.009	-0.042	-0.177	0.007	0.076	-0.056	-0.027	0.152	0.366	-0.038	0.094	0.044
Pod length	0.020	-0.079	0.151	0.071	-0.003	-0.219	0.099	0.004	-0.005	0.174	0.003	-0.098	-0.104	0.316	0.131	0.461
100-seed weight	-0.054	-0.088	0.127	-0.040	0.009	-0.077	0.268	0.015	0.034	-0.093	-0.030	-0.106	0.109	0.131	0.316	0.521

A positive genetic correlation between two desirable traits makes selection easy for improving both traits simultaneously while the reverse is the case for negative correlation. Results obtained show that the genotypic correlation coefficients were very high as compared to the phenotypic and environmental effects. This indicates greater contribution of genotypic factor in the growth and development of these trait associations. It also show that vein length at 10 weeks significantly correlated positively with number of pods per plant leaf area at 5 and 10 weeks and days to 50% maturity with number of pods per plant, respectively. There were also positive significant associations between numbers of leaves at 10 weeks, number of flowers with number of seeds per pod. This corroborates the report of Cramer and Wehner (2000a, b). High and significant genotypic correlation coefficients are an indication that selection of cowpea landraces for future breeding programmes should be fundamentally based on the superiority of the genotypes alongside with their phenotypic expression. These according to Akinyele and Osekita (2006) are very important in determining the yield of the crop. This implies that these traits should be given high priority during selection. Traits with negative genotypic correlation imply that a lot of breeding programmes are needed to develop such traits. The significant relationship between days to 50% flowering and days to 50% maturity is suggestive that there is a strong relationship between the stage of plant growth at which flowering is initiated and the time taken to complete the crop's life cycle (Akinyele and Osekita, 2006).

The implication of significant positive relationship of environmental correlation is that environmental factors favour the performance of cowpea and thus should be selected for as a component of yield. Interestingly, our result revealed positive significant environmental correlations between number of leaves at 10 weeks and leaf area at 5 weeks; leaf area at 10 weeks and number of flowers per plant; number of leaves at 10 weeks and pod length; nein length at 10 weeks and seed yield; number of pod per plant and seed yield and number of seeds per pod and 100 seed weight. This means that environmental factors prevailing during the growing season of these cowpea genotypes favoured the production of longer vein, leaf production and broader leaf surface area which might have culminated to higher flower numbers, longer pods and most importantly the seed yield. However, other traits with negative but significant correlation coefficients imply that environmental factors could have exerted great impediments to the growth and development of the traits. This obviously will be detrimental to the crop productivity. Additionally, although some of these characters that exercise negative correlations with one another will be difficult to select for in characterization of desired traits, those with negative association but non-significant correlation will be disregarded in selection for crop or variety improvement (Henry and Krishna, 1990; Akinyele and Osekita, 2006).

Accordingly to Cramer and Wehner (2000a), a large path coefficient indicates that the change will result in a proportional or inversely proportional change in another correlated trait, whereas a weak coefficient indicates that the change will have little effect on the second trait. Using (Cramer and Wehner, 2000a) statistical test for the importance of path coefficient (strong = 0.7 to 1.0 or -0.7 to -1.0; weak = -0.69 to 0.69), our result fall below their mark. This notwithstanding, other authors in the field reported path coefficients lesser than Cramer and Wehner (2000a) hypothesis but asserting their strong effects on yield (Vange and Moses, 2009; Akinyele and Osekita, 2006). The trait-contributing the highest direct effect was number of pods per plant which also corroborates with the earlier reports of Khan *et al.* (2000), Singh and Yadava (2000) and Shrivastava *et al.* (2001) in soybean. The high positive direct effects of number of pod per plant, number of flowers, number of seeds per pod, pod length, days to seedling emergence, leaf area and 100 seed weight on seed yield suggests that with other variables held constant, an increase in the above-mentioned morphological traits might increase seed yield per plant. This was also the position of Akinyele and Osekita (2006) in their report on *Abelmoschus esculentus*. The positive direct effects of 100 seed weight on seed yield corroborates reports of Yadev *et al.* (2001) in wheat; Ashraf *et al.* (2002) in urdbean and Arshad *et al.* (2004) in chicken pea.

Furthermore, according to Singh and Chaudhury (1985), if the total genotypic correlation coefficient is positive with negative or negligible direct effect, the indirect effects might be the causal factor of correlation. Critically, the seed yield of cowpea landraces might not be attributed directly by the morphological traits investigated rather via their alternative pathways (indirect routes) (Table 5). This according to Salahuddin *et al.* (2010) should be considered simultaneously for during selection.

CONCLUSION

Succinctly, it therefore implies that number of pods per plant, number of leaves per plant, leaf area, number of flowers per plant, pod length and number of seeds per pod are good selection indices for a high yielding variety of cowpea, especially the landraces. This then can be exploited in hybridization programmes involving cowpea.

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