Studies on Correlation Coefficients among Agronomic Traits of Cowpea (*Vigna unguiculata* L. Walp) Genotypes in Mubi Northern Guinea Savannah, Nigeria

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Abstract: Field experiments were conducted during the rainy seasons of 2022 and 2023 at the teaching and Research Farm of the Faculty of Agricutlure; Department of Crop Science, Adamawa State University, Mubi. The experiment studied the nature and extent of correlation coefficients of yield attributing characters with grain yield related traits. The 26 genotypes cowpea were evaluated in a Randomized Complete Block Design replicated three times and data were collected on 16 agronomic traits. Results from the individual years (2020, 2023) and the combined years (2022 and 2023) analyses revealed highly significant and positive coefficients between grain yield with pods/plant and also kernel/plant both at genotypic and phenotypic levels, including pod length of cowpea at phenotypic correlation level.

Keywords: Cowpea, grain yield and yield components, genotypic correlations and phenotypic correlations.

1.0 INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most ancient crop known to man and a highly valued crop (Kaloo and Bergh, 2012; Adewale *et al.,* 2021). The crop is a versatile annual and warm season legume belonging to the family, *Fabaceae;* subtribe *Phaseolinae*; genus, *Vigna* and section catjang (Padulosi and Ng 1997; Pasquet *et al*., 2001; and Vegetables, 2023). The name was most likely acquired due to their use as a fodder crop for cowpea. Cowpea is a crop with wide global distribution, especially in tropical regions. It is an important grain legume crop in sub Saharan Africa with significant production in Nigeria, Burkina faso, Niger, Cameroon and United Republic of Tanzania (Fatokun *et al*., 2012; FAOSTAT, 2017; Odireleng *et al.* 2020).

Studies suggest that most southern region of Africa could be the center of origin for *V. unguiculata* while domestication might have occurred in West Africa (Padulosi and Ng, 1997). Cowpea is produced throughout the world including Europe, Asia, United States of America and many parts of Africa, which accounts for about 60% of global production (IITA, 2015). The crop is cultivated on about 14.5 million hectares on the world arable land, with an annual production of 6.2 million metric tons and out of this, Africa accounts for 83.4% (Boukar *et al*., 2018; Kebede, 2020). West Africa produces over 80% of the quantity produced in Africa.

Correlation analysis provides vital information on interrelationship between important agronomic traits (Ajayi and Gbadamosi, 2020; Mofokeng *et al.,* 2020) and it is very important in plant breeding because of their reflection in dependence degree between two or more characters. If there is a genetic correlation between traits in the case of direct selection of one traits, this can cause a change in another trait. Correlation studies between traits have been of great value in determination of the effective procedures for selection of superior genotypes (Adebisi *et al.,* 2004). Correlation establishes the extent of association between yield and its related components and also brings out relative importance of its direct and indirect effects. Thus, giving an understand of the association between the traits with grain yield. Grain yield been the major yield is usually influenced by various yield contributing characters. Therefore, for the improvement grain yield of cowpea, the knowledge on the association between grain yield and its

components characters will tremendously be helpful. This study was therefore designed to identify the agronomic traits that influences grain yield of cowpea using the genotypic and phenotypic correlation coefficients.

MATERIALS AND METHODS

Experimental site

The two years (2022 and 2023) field trials were conducted at the teaching and Research Farm of Faculty of Agriculture, Department of Crop Science, Adamawa State University Mubi. Geographically, Mubi is located on latitude (10^{o} 06' – 10^{o} 29' N) longitude (13^{o} 07' – 10^{o} 30' E) and also found on alatitude 696 m above sea level, with annual rainfall between 700 mm - 1050 mm (Adebayo *et al.,* 2021).

Treatments and Experimental Design

The experimental trial field measured 32 m by 21.5 m (688 m^2) and the twenty-six genotypes were sown in a Randomized Completely Block Design (RCBD) with three replications. For each genotype of cowpea, two to three seeds were sown on a plot size of 3 m x 2 m (i.e. 6 m^2) with inter row spacing of 0.60 m and intra row spacing of 0.40 m. The gross plot size was 6 m^2 and net plot size of 1.2 m (0.60 m x 2 m) was also used. At two weeks after sowing (WAS), thinning was done to one plant per stand to obtain 16 plants population per plot.

Germplasm Source

Twenty-six genotypes of cowpea were sourced: Three from Institute for Agriculture Research Zaria, eleven from International Institute of Tropical Agriculture Ibadan, four genotypes from University of Agriculture Makurdi and seven genotype each from Adamawa State and one from Samaru Market respectively.

Land Preparation

The site for the trial was cleared of shrubs, stubbles and volunteer crops. Thereafter, a disc plough tractor will be used to plough the soil and later the soil was harrowed to enable the easy germination of cowpea seeds and seedlings emergence. Hand hoe was used to level the soil properly to reduce pockets of water on the field; that could cause seed rot and seedling growth stagnation.

Seed Treatment and Sowing

Healthy and robust cowpea seeds without holes and damages were selected for sowing. The selected cowpea seeds was dressed prior to sowing using Apron plus (fungicide) Momtaz 45 WS. This provided protection from fungal and other diseases related organisms; thereby enhancing good seedling emergence. The cowpea genotypes for the research was sown on 30th July 2022 and 2023 respectively. For each genotype of cowpea, two to three seeds were sown. At two weeks after sowing (WAS), thinning will be done to one plant per stand.

Cultural Practices

Weed Control

Hand hoe was used to control weeds on the plots. The first weeding was done at 2 WAS after sowing and second weeding at 6 WAS. The weeding helped to minimize weed competition for space and nutrients with the cowpea plants.

Pest and Diseases Control

Pesticides such as cypermethrine 12 EC was applied to control pests and diseases, particularly prior to and during flowering stages.

Data Collection

Quantitative Parameters collected are as follows:

Growth Parameters: primary vein length (cm), number of branches/plants, number of clusters/plants, fresh pod weight and dry pod weight (gm).

Phenological Parameters: days to first and 50% flowering**.**

Yield Attributing Parameters: pods/plant, pod length (cm), seeds/pod and 100 seed weight (g).

Yield Parameters: fresh plant weight (cm), haulm yield, kernel yield/plant and grain yield (kg/ha).

Statistical Analysis

Data obtained were analyzed using SAS statistical package SAS (1999) and genotypic and phenotypic correlation coefficients were calculated as described by Miller *et al.* (1958).

RESULTS

Genotypic and Phenotypic Correlation Coefficients of 16 Cowpea Traits during 2022 Cropping Season

The genotypic and phenotypic coefficients of 16 cowpea traits during 2022 cropping season is presented in Table 1. Significant and positive genotypic and phenotypic correlation coefficients was recorded in the association between days to first and 50% flowering ($r = 0.992^{**}$ and 0.908^{**} respectively), 100 seed weight ($r = 0.753^{**}$ and 0.694^{**} respectively) and branches/plant ($r = 0.495^{*}$ and 0.335^{**} respectively). Although days to first flowering had a significant but negative correlation with clusters/plant ($r = -0.483^{*}$ and -0.411^{**} respectively), pod length ($r = -0.394^{*}$ and -0.331^{**} respectively) and kernel yield/plant ($r = -0.601^{**}$ and -0.473^{**} respectively). Similarly, days to 50 % flowering had a positive and significant genotypic and phenotypic correlation coefficients with number of branches ($r = 0.588^{**}$ and 0.397^{**} respectively), but a significant and negative genotypic and phenotypic correlation coefficients with pods/plant ($r = -0.532^{**}$ and -0.421^{**} respectively), clusters/plant ($r = -0.410^{*}$ and -0.347^{**} respectively), pod length ($r = -0.414^{*}$ and -0.373^{**} respectively), kernel yield ($r = -0.533^{**}$ and -0.428^{**} respectively) and grain yield ($r = -0.509^{**}$ and -0.402^{**} respectively). Day to 50 % flowering had a positive and significant genotypic correlation coefficient with 100 seed weight ($r = 0.823^{**}$) but a significant and negative phenotypic correlation ($r = -0.770^{**}$). Fresh weight of shoots recorded a significant and positive genotypic and phenotypic correlation with fresh weight of roots ($r = 0.631^{**}$ and 0.642^{**} respectively) and dry weight of roots ($r = 0.670^{**}$ and 0.574^{**} respectively). Although, fresh weight of shoots had a significant and positive genotypic correlation with pods/plant ($r = 0.486^{*}$), clusters/plant ($r = 0.529^{**}$) and pod length ($r = 0.396^{*}$). Dry weight of roots recorded a significant and positive correlation with fresh weight of roots ($r = 0.627^{**}$ and 0.503^{**} respectively). Furthermore, fresh weight of roots had a significant and positive genotypic correlation with pods/plant ($r = 0.415^{*}$), kernel and grain yield having ($r = 0.456^{*}$ and 0.436^{*} respectively). Pod length of cowpea, fresh pod weight and primary vein length recorded a significant and positive correlation with dry weight of roots ($r = 0.480^{*}$ and 0.333^{**}, 0.449^{*} and 0.400^{**} and 0.458^{*} and 0.483^{**} respectively). Primary vein length recorded significant and positive correlation coefficients with fresh pod weight ($r = 0.665^{**}$ and 0.593^{**} respectively) and pod length ($r = 0.447^{**}$ and 0.396^{**} respectively). Although, it recorded a significant and negative correlation with 100 seed weight ($r = 0.292^{**}$). Branches/plant recorded a significant and positive correlation with 100 seed weight ($r = 0.508^{**}$ and 0.370^{**}) at both genotypic and phenotypic levels. Pods/plant recorded a significant and positive genotypic and phenotypic correlation with clusters/plant ($r = 0.504^{**}$ and 0.378^{**} respectively) and grain yield ($r = 0.439^{*}$ and 0.277^{*}). Furthermore, number of clusters had a positive and significant correlation coefficient with kernel yield/plant and grain yield ($r = 0.584^{**}$ and 0.418^{**} and 0.594^{**} and 0.415^{**} respectively). 100 seed weight and pod length had a positive and significant genotypic and phenotypic correlation with fresh pod weight ($r = 0.462^{*}$ and 0.426^{**}, 0.476^{*} and 0.418^{**} respectively). Pod length recorded a significant and positive genotypic correlation with haulm yield ($r = 0.505^{**}$) and a phenotypic significant and positive correlation with kernel yield ($r = 0.303^{**}$) and grain yield ($r = 0.278^{*}$). Number of seeds/plants had a significant and positive phenotypic correlation with kernel yield ($r = 0.259^{*}$) and grain yield ($r = 0.273^{*}$). Similarly, 100 seed weight had a significant but negative correlation phenotypically with

kernel yield (r = - 0.281*) and grain yield (r = - 0.281*). Haulm yield and grain yield recorded a significant positive genotypic and phenotypic correlation with kernel yield (r = 0.731** and 0.420** and r = 0.757** and 0.433** respectively). Grain yield recorded significant positive genotypic and phenotypic correlation coefficients with kernel yield (r = 0.992** and 0.993** respectively).

Genotypic and Phenotypic Correlation Coefficients of 16 Cowpea Traits during 2023 Cropping Season at Mubi.

The genotypic and phenotypic correlation among 16 traits of cowpea during 2023 cropping season is presented in Table 2. Days to first flowering recorded a significant and positive genotypic and phenotypic correlation coefficient with days to 50% flowering (r = 0.978** and 0.923** respectively), number of branches (r = 0.888** and 0.611** respectively), 100 seed weight (r = 0.681** and 0.558** respectively) and haulm yield (r = 0.466** and 0.518** respectively). On the other hand, days to first flowering had a significant but negative correlation with pods/plant (r = - 0.624** and - 0.478** respectively), kernel yield (r = - 0.647** and - 0.531** respectively) and grain yield (r = - 0.560** and - 0.487** respectively). Similarly, days to 50% flowering recorded significant and positive genotypic and phenotypic correlation with number of branches (r = 0.989** and 0.624**), 100 seed weight (r = 0.713** and 0.542**) and haulm yield (r = 0.457** and 0.512**), but a significant negative genotypic and phenotypic correlation with number of pods (r = - 0.582** and - 0.464**), kernel yield (r = - 0.692** and – 0.570**) and grain yield (r = - 0.612** and - 0.530** respectively). Furthermore, fresh weight of shoots had a significant and positive genotypic and phenotypic correlation with fresh weight of roots (r = 0.898** and 0.742** respectively), dry weight of roots (r = 0.731* and 0.759* respectively) and number of branches (r = 0.397** and 0.229* respectively), but fresh weight of shoots recorded a significant and negative genotypic coefficient with pods/plant (r = - 0.765**), kernel yield/plant (r = - 0.830**) and grain yield of cowpea (r = - 0.797**). Dry weight of roots recorded a positive and significant genotypic correlation with fresh pod weight (r = 0.472*) and pod length of cowpea (r = 0.414*), but a significant and negative genotypic correlation with number of pods (r = - 0.555**), number of clusters (r = - 0.660**), kernel yield (r = - 0.620**) and grain yield of cowpea (r = - 0.618**). Haulm yield/plant had positive and significant genotypic and phenotypic correlation coefficients with primary vein length (r = 0.774** and 0.320** respectively). Branches/plant recorded a positive significant genotypic and phenotypic coefficient with 100 seed weight (r = 0.682** and 0.324** respectively) and haulm yield (r = 0.602** and 0.415** respectively). Although branches/plant had negative and significant correlation with pods/plant (r = - 0.536** and - 0.346** respectively), pod length (r = - 0.536** and - 0.243**), kernel yield (r = - 0.808** and - 0.423**) and grain yield (r = - 0.765** and - 0.381**). Pods/plant trait recorded positive and significant genotypic and phenotypic correlation with clusters/plant (r = 0.533** and 0.428**), including kernel yield and grain yield (r = 0.709** and 0.462** and 0.720** and 0.450** respectively). Haulm yield had a negative and significant genotypic correlation with clusters/plant (r = - 0.472*), but a positive and significant phenotypic correlation with clusters/plant (r = 0.284*). Pod length had a positive significant genotypic and phenotypic coefficient with fresh pod weight (r = 0.845** and 0.633**). Pod length further had a positive and significant genotypic and phenotypic correlation with kernel yield (r = 0.443* and 0.277*), but a negative and significant correlation with haulm yield (r = - 0.663** and - 0.253* respectively). 100 seed weight recorded a positive and significant genotypic correlation with haulm yield (r = 0.883**) and a negative and significant phenotypic correlation with kernel yield (r = - 0.239*). Haulm yield recorded a significant and negative genotypic coefficient with kernel yield (r = - 0.358**) and grain yield (r = - 0.364**). Grain yield/ha had a positive and significant genotypic correlation with kernel yield (r = 0.959** and 0.960**).

Genotypic and Phenotypic Correlation of 16 Cowpea Traits during 2022 and 2023 Cropping Season at Mubi, Combined.

The genotypic and phenotypic correlation among 16 traits of cowpea during 2022 and 2023 at Mubi combined is presented in Table 3. The Table revealed that days to first flowering recorded positive and significant genotypic and phenotypic correlation coefficients with days to 50% flowering (r = 0.1000** and 0.972** respectively), 100 seed weight (r = 0.748** and 0.701** respectively) and haulm yield (r = 0.821** and 0.321** respectively). Although, days to first flowering had a significant but negative genotypic and phenotypic correlation with pods/plant (r = - 0.674** and - 0.526** respectively), clusters/plant (r = - 0.423* and - 0.342** respectively), pod length (r = - 0.398* and - 0.288* respectively), kernel yield (r = - 0.687** and - 0.566** respectively) including grain yield (r = -0.640** and - 0.550** respectively). Similarly, days to 50% flowering had positive and significant genotypic and phenotypic correlation coefficients with branches/plant (r = 0.921** and 0.698** respectively), 100 seed weight (r = 0.784** and

0.723** respectively) and haulm yield (r = 0.835** and 0.335** respectively), but a significant and negative genotypic and phenotypic correlation coefficients with pods/plant (r = - 0.682** and - 0.545**), speeds/pod (r = - 0.977*), clusters/plant (r = - 0.402* and - 0.338**), pod length (r = - 0.418* and - 0.344**), kernel yield (r = - 0.663** and - 0.589** respectively), including grain yield (r = - 0.619** and - 0.556** respectively). Fresh weight of shoots recorded a significant and positive genotypic and phenotypic correlation with fresh weight of roots (r = 0.689** and 0.620**) and dry weight of roots (r = 0.534** and 0.578**), but a significant and negative genotypic correlation with pods/plant (r = - 0.710**), clusters/plant (r = - 0.575**), kernel yield (r = - 0.641**) and grain yield (r = - 0.662**). Fresh weight of roots had a positive and significant genotypic and phenotypic correlation with dry weight of roots (r = 0.637** and 0.519**) and fresh pod weight (r = 0.453* and 0.282*) but a significant and negative correlation with seeds/plant (r = - 0.453* and - 0.247*). Dry weight of roots had a positive and significant genotypic and phenotypic coefficient with primary vein length (r = 0.455** and 0.388**), fresh pod weight (r = 0.595** and 0.413**) and pod length (r = 0.466* and 0.286*). Primary vein length recorded a significant and positive genotypic and phenotypic coefficient with haulm yield (r = 0.122** and 0.539**), but a significant and negative correlation with pods/plant (r = - 0.443* and - 0.261* respectively). Branches/plant recorded a significant and positive genotypic and phenotypic correlation with 100 seed weight (r = 0.147** and 0.531**) and haulm yield (r = 0.708** and 0.300**). Although number of branches/plants recorded a significant and negative genotypic and phenotypic correlation coefficient with pods/plant, clusters/plant, pod length, kernel yield and grain yield. Number of pods/plants had a positive and significant genotypic and phenotypic correlation with clusters/plant (r = 0.596** and 0.440**), kernel yield (r = 0.678** and 0.517**) and grain yield (r = 0.666** and 0.500**), but a negative and significant correlation with 100 seed weight (r = - 0.561** and 0.401**). Clusters/plant recorded a positive and significant genotypic and phenotypic correlation with kernel yield (r = 0.410** and 0.364**) and grain yield (r = 0.408** and 0.369**). Pod length of cowpea had a positive and significant genotypic and phenotypic correlation coefficient with fresh pod weight (r = 0.709** and 0.612**) and kernel yield (r = 0.419* and 0.309**). Seeds/plant recorded a significant and positive genotypic and phenotypic correlation with kernel yield (r = 0.652** and 0.259*) and grain yield (r = 0.661** and 0. 300**). 100 seed weight had significant but negative genotypic and phenotypic correlation with kernel yield (r = - 0.446* and - 0.536** respectively) and grain yield (r = - 0.400* and - 0.333** respectively). Haulm yield trait recorded a significant and negative genotypic correlation with kernel yield and grain yield (r = - 0.707** and - 0.635** respectively). Grain yield had a positive and significant genotypic and phenotypic correlation coefficient with kernel yield (r = 0.998** and 0.983** respectively).

DISCUSSION

Genotypic and Phenotypic Correlation Coefficients among Traits of Cowpea Genotypes

The results of the genotypic and phenotypic correlation coefficients for the individual years (2022, 2023) and the combined years (2022 and 2023) showed that highly significant and positive correlation between days to the first and 50% flowering with branches/plant and 100 seed weight corroborate with the findings of: Nkeki *et al.* (2014) and Zannou *et al.* (2015) in cowpea studies. Furthermore, Meena *et al.* (2015) also recorded positive and significant correlation for days to 50% flowering with number of branches and 100 seed weight at both genotypic and phonotypic levels. In contrast Udensi *et al.* (2012) and Kavyashree *et al.* (2023) recorded a negative but significant and correlation with 100 seed weight. Plant height (primary vein length) that recorded a significant and positive correlation with pod length during 2022 cropping session, is in line with the findings of Abe *et al.* (2015) and Datthi *et al.* (2022) in cowpea. Meena *et al.* (2015) also recorded significant and positive genotypic and phenotypic correlation for plant height and pod length. During 2023 cropping season and the combined years (2022 and 2023), primary vein length recorded negative and significant genotypic and phenotypic correlation with haulm yield as earlier reported by Mahesh *et al.* (2016).

The individual years (2022, 2023) and the combined years (2022 and 2023) revealed that pods/plant at both genotypic and phonotypic levels correlated positively and significantly with clusters/plant, kernel yield and grain yield. This result agreed with the earlier findings of Mahesh *et al.* (2016). Furthermore, Meena *et al.* (2015), Abiola and Alaba (2020); similarly recorded positive and significant correlation between pods/plant and kernel yield of cowpea. Other researchers that recorded positive and significant correlations between pods/plant with kernel yield and grain yields (Kwan-Ndung and Kwala 2017; Noma 2019; Nelia *et al.*, 2020 Chaudhary *et al.*, 2023 and Kavyashree *et al.*, 2023). For the year 2022 and the combined years (2022 and 2023) grain yield recorded a significant and positive genotypic and phenotypic correlation with haulm yield (biological yield), kernel yield, pods/plant,

clusters/plant and seeds/plant. The trials of Sheidu and Igyuve (2023), similarly reveals that grains yield with haulm yield and seeds/plant record significant positive genotypic and phenotypic correlations. In contrast, grain yield had significant but negative correlation coefficients with haulm yield and also days to first and 50% flowering (Souleymane; 2021). Although Noma (2019) had negative and non-significant correlation between grain yield and days to first flowering including haulm yield (biological yield).

Conclusion

From the individual years (2022, 2023) and the combined years (2022 and 2023) results revealed that significant and positively correlation coefficient exists between cowpea grain yield with pods/plant and also with kernel yield/plant at both genotypic and phenotypic levels; including pod length at phenotypic level.

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Table 1: Genotypic (δ_g) and Phenotypic (δ_p) Correlation Coefficients of 16 Traits of 26 Cowpea Genotypes during 2022 Cropping Season

Traits		DFF	D50F	FWS	FWR	DWR	PVL	NOB	NOP	NOC	FPW	PLC	NOS	100SW	HYP	KYP	GYC
DFF	δ_g	1.000	0.992**	-0.538**	-0.410**	-0.158	0.218	0.495*	-0.453*	-0.483*	0.372	-0.394*	-0.071	0.753**	-0.597**	-0.601**	-0.575
	δ_P	1.000	0.908**	-0.217	10.189	-0.080	0.186	0.335**	-0.363**	-0.411**	0.331**	-0.351**	-0.078	0.694**	-0.220	-0.473**	-0.443**
D50F	δ_g		1.000	-0.455**	-0.274	-0.722	0.255	0.588**	-0.532**	-0.410*	0.365	-0.414*	-0.067	0.823**	-0.582**	-0.533**	-0.509**
	δ_P		1.000	-0.113	-0.117	-0.011	0.228*	0.397**	-0.421**	-0.347**	0.324**	-0.373**	-0.051	-0.770**	-0.174	-0.428**	-0.402**
FWS	δ_g			1.000	0.631**	0.670**	0.241	-0.208	0.486*	0.529**	0.222	0.396*	0.137	-0.082	0.224	0.239	0.211
	δ_P			1.000	0.642**	0.574**	0.228*	-0.005	0.140	0.118	0.155	0.178	0.029	-0.027	0.096	0.078	0.071
FWR	δ_g				1.000	0.627**	0.073	-0.323	0.415*	0.248	0.286	0.228	-0.208	0.292	0.054	0.456*	0.436*
	δ_P				1.000	0.503**	0.122	-0.124	0.216	0.097	0.224*	0.185	-0.159	0.151	0.050	0.108	0.085
DWR	δ_g					1.000	0.458*	-0.366	0.136	0.148	0.449*	0.480*	-0.007	0.052	-0.010	0.036	0.032
	δ_P					1.000	0.483**	-0.196	0.073	0.170	0.400**	0.333**	-0.017	0.033	-0.075	0.021	0.024
PVL	δ_g						1.000	-0.170	-0.191	-0.213	0.665**	0.447*	-0.022	0.350	-0.119	-0.180	-0.218
	δ_P						1.000	-0.058	-0.086	-0.218	0.593**	0.396**	-0.057	0.292**	-0.032	-0.008	-0.026
NOB	δ_g							1.000	-0.189	-0.143	-0.156	-0.400*	-0.032	0.508**	0.115	-0.314	-0.281
	δ_P							1.000	-0.086	-0.098	-0.073	-0.285*	-0.041	0.370**	0.210	-0.110	-0.071
NOP	δ_g								1.000	0.504**	-0.009	0.384	-0.117	-0.315	0.448*	0.439*	0.439*
	δ_P								1.000	0.378**	-0.039	0.32**	-0.146	-0.262*	0.031	0.286	0.277*
NOC	δ_g									1.000	-0.321	0.041	0.035	-0.278	0.585**	0.584**	0.594**
	δ_P									1.000	-0.310	0.067	0.042	-0.253*	0.188	0.418**	0.415**
FPW	δ_g										1.000	0.476*	-0.117	0.462*	-0.331	-0.034	-0.052
	δ_P										1.000	0.418**	-0.104	0.426**	-0.039	-0.004	-0.016
PLC	δ_g											1.000	-0.073	-0.261	0.505**	0.383	0.354
	δ_P											1.000	-0.044	-0.252*	0.158	0.303**	0.278*
NOS	δ_g												1.000	-0.245	-0.091	0.363	0.380
	δ_P												1.000	-0.201	-0.013	0.259*	0.273*
100SW	δ_g													1.000	-0.351	-0.347	-0.557
	δ_P													1.000	-0.144	-0.281*	-0.281*
HYP	δ_g														1.000	0.731**	0.757**
	δ_P														1.000	0.420**	0.433**
KYP	δ_g															1.000	0.992**
	δ_P															1.000	0.993**
GYP	δ_g																1.000
	δ_P																1.000

DFF = days to first flowering, D50F = days to 50% flowering, FWS = Fresh weight of shoots, FWR = Fresh weight of roots, DWR = Dry weight without root, PVL = Primary vein length, NOB = Number of branches, NOP = Number of pods, NOC = Number of clusters, FPW = Fresh pod weight, PLC = Pod length of cowpea, NOS = Number of seeds, 100SW = Hundred seed weight, HYP = Haulm yield of plant, KYP = Kernel yield/plant and GYC = Grain yield (kg/ha)

Table 2: Genotypic (δ_g) and Phenotypic (δ_p) Correlation Coefficient of 16 Traits of 26 Cowpea Genotypes in 2023 Cropping Season

Traits		DFF	D50F	FWS	FWR	DWR	PVL	NOB	NOP	NOC	FPW	PLC	NOS	100SW	HYP	KYP	GYC
DFF	δ_g	1.000	0.978**	0.207	0.201	0.063	0.237	0.888**	-0.624**	-0.366	-0.181	-0.316	-0.036	0.681**	0.466**	-0.647**	-0.560**
	δ_p	1.000	0.923**	0.046	0.107	0.053	0.153	0.611**	-0.478**	-0.269**	-0.159	-0.138	-0.040	0.558**	0.518**	-0.531**	-0.487**
D50F	δ_g		1.000	0.412*	0.396*	0.206	0.176	0.989**	-0.582**	-0.276	-0.215	-0.380	-0.024	0.713**	0.457**	-0.692**	-0.612**
	δ_p		1.000	0.135	0.130	0.046	0.129	0.624**	-0.464**	-0.220	-0.208	-0.239	-0.045	0.542**	0.512**	-0.570**	-0.530**
FWS	δ_g			1.000	0.898**	0.731**	-0.214	0.397*	-0.765**	-0.328	0.012	-0.010	-0.269	0.136	0.227	-0.830**	-0.797**
	δ_p			1.000	0.742**	0.769**	0.092	0.229*	-0.101	-0.045	-0.014	0.015	-0.218	0.031	0.225*	-0.089	-0.141
FWR	δ_g				1.000	0.405**	-0.481*	0.094	-0.421*	-0.525**	0.671**	0.216	-0.097	-0.083	0.276	-0.708**	-0.623**
	δ_p				1.000	0.744**	0.202	0.068	-0.037	-0.090	0.162	0.078	-0.088	0.083	0.227*	-0.069	-0.118
DWR	δ_g					1.000	-0.022	0.221	-0.555**	-0.660**	0.472*	0.414*	-0.216	-0.258	0.193	-0.620**	-0.618**
	δ_p					1.000	0.196	0.172	-0.097	-0.025	0.214	0.130	-0.142	-0.117	0.396**	-0.106	-0.146
PVL	δ_g						1.000	-0.017	-0.303	-0.089	-0.029	-0.284	-0.094	-0.012	0.774**	-0.244	-0.164
	δ_p						1.000	0.066	-0.116	-0.005	0.023	-0.150	-0.048	-0.063	0.320**	-0.100	-0.099
NOB	δ_g							1.000	-0.536**	-0.235	-0.376	-0.536**	-0.003	0.682**	0.602**	-0.808**	-0.765**
	δ_p							1.000	-0.346**	-0.111	-0.232*	-0.243*	-0.021	0.324**	0.415**	-0.423**	-0.381**
NOP	δ_g								1.000	0.533**	0.078	0.036	-0.032	-0.525**	-0.996**	0.709**	0.720**
	δ_p								1.000	0.428**	0.096	0.004	0.075	-0.348**	-0.353**	0.462**	0.450**
NOC	δ_g									1.000	-0.361	-0.692	0.027	-0.241	-0.472*	0.215	0.211
	δ_p									1.000	-0.098	-0.163	-0.030	-0.149	0.006	0.280*	0.284*
FPW	δ_g										1.000	0.845**	-0.064	-0.129	-0.187	0.233	0.149
	δ_p										1.000	0.633**	0.033	-0.083	-0.048	0.169	0.147
PLC	δ_g											1.000	0.005	-0.203	-0.663**	0.443*	0.381
	δ_p											1.000	-0.008	-0.018	-0.253*	0.277*	0.266*
NOS	δ_g												-0.022	0.052	-0.137	0.140	0.221
	δ_p												1.000	0.058	-0.073	0.152	0.227
100SW	δ_g													1.000	0.883**	-0.376	-0.272
	δ_p													1.000	0.117	-0.239*	-0.219
HYP	δ_g														1.000	-0.358**	-0.364**
	δ_p														1.000	-0.382	-0.380
KYP	δ_g															1.000	0.959**
	δ_p															1.000	0.960**
GYP	δ_g																1.000
	δ_p																1.000

DFF = days to first flowering, D50F = days to 50% flowering, FWS = Fresh weight of shoots, FWR = Fresh weight of roots, DWR = Dry weight without root, PVL = Primary vein length, NOB = Number of branches, NOP = Number of pods, NOC = Number of clusters, FPW = Fresh pod weight, PLC = Pod length of cowpea, NOS = Number of seeds, 100SW = Hundred seed weight, HYP = Haulm yield of plant, KYP = Kernel yield/plant and GYC = Grain yield (kg/ha)

Table 3: Genotypic (δ_g) and Phenotypic (δ_p) Correlation Coefficients of 16 Traits of 26 Cowpea Genotypes in 2022 and 2023 Cropping Seasons Combined

Traits		DFF	D50F	FWS	FWR	DWR	PVL	NOB	NOP	NOC	FPW	PLC	NOS	100SW	HYP	KYP	GYC
DFF	δ_g	1.000	1.001**	-0.098	-0.097	0.052	0.271	0.865**	-0.674**	-0.423*	0.183	-0.398*	-0.222	0.748**	0.821**	-0.687**	-0.640**
	δ_p	1.000	0.972**	-0.013	-0.003	0.069	0.236*	0.679	-0.526**	-0.342**	0.129*	-0.288*	-0.139	0.701**	0.321**	-0.566**	-0.550**
D50F	δ_g		1.000	-0.022	-0.044	0.035	0.22	0.921**	-0.682**	-0.402*	0.117	-0.418*	-0.275	0.784**	0.835**	-0.663**	-0.619**
	δ_p		1.000	0.022	-0.006	0.499	0.198	0.698**	-0.545**	-0.338**	0.096	-0.344**	-0.101	0.723**	0.335**	-0.589**	-0.556**
FWS	δ_g			1.000	0.689**	0.534**	0.270	-0.249	-0.710**	-0.575**	0.255	0.278	-0.977*	0.188	-0.061	-0.641**	-0.662**
	δ_p			1.000	0.620**	0.578**	0.150	0.150	-0.081	-0.100	0.118	0.072	-0.224*	0.020	0.392**	-0.163	-0.171
FWR	δ_g				1.000	0.637**	0.036	-0.331	-0.119	-0.222	0.453*	0.206	-0.453*	0.326	-0.055	0.013	0.016
	δ_p				1.000	0.519**	0.109	-0.053	0.026	-0.071	0.282*	0.182	-0.247*	0.156	0.314**	-0.024	-0.033
DWR	δ_g					1.000	0.455*	-0.243	-0.353	-0.446*	0.595**	0.466*	-0.371	0.042	0.202	-0.273	-0.298
	δ_p					1.000	0.388**	-0.049	-0.112	-0.154	0.413**	0.286*	-0.099	-0.017	0.507**	-0.116	-0.147
PVL	δ_g						1.000	0.003	-0.443*	-0.243	0.234	0.137	-0.194	0.141	1.122**	-0.340	-0.333
	δ_p						1.000	0.063	-0.261*	-0.124	0.181	0.106	-0.123	0.087	0.539**	-0.190	-0.200
NOB	δ_g							1.000	-0.654**	-0.454*	-0.189	-0.588**	-0.095	0.147**	0.708**	-0.728**	-0.687**
	δ_p							1.000	-0.431**	-0.235*	-0.167	-0.411**	-0.079	0.531**	0.300**	-0.437**	-0.395**
NOP	δ_g								1.000	0.596**	-0.160	0.157	0.404*	-0.516**	-0.802	0.678**	0.666*
	δ_p								1.000	0.440**	-0.097	0.094	0.047	-0.401**	-0.239*	0.517**	0.500**
NOC	δ_g									1.000	-0.412	-0.250	0.053	-0.238	-0.525	0.410*	0.408*
	δ_p									1.000	-0.257*	-0.122	-0.018	-0.202	-0.028	0.364**	0.369**
FPW	δ_g										1.000	0.709**	-0.264	0.140	0.293	0.052	0.028
	δ_p										1.000	0.612**	-0.115	0.111	0.192	0.044	0.029
PLC	δ_g											1.000	-0.118	-0.296	-0.310	0.419*	0.376
	δ_p											1.000	-0.118	-0.238*	-0.079	0.309**	0.266*
NOS	δ_g												1.000	-0.369	-0.540**	0.652**	0.661**
	δ_p												1.000	-0.182	-0.116	0.259*	0.300**
100SW	δ_g													1.000	0.813**	-0.446*	-0.400*
	δ_p													1.000	0.214	-0.356**	-0.333**
HYP	δ_g														1.000	-0.707**	-0.635**
	δ_p														1.000	-0.169	-0.158
KYP	δ_g															1.000	0.998**
	δ_p															1.000	0.983**
GYP	δ_g																1.000
	δ_p																1.000

DFF = days to first flowering, D50F = days to 50% flowering, FWS = Fresh weight of shoots, FWR = Fresh weight of roots, DWR = Dry weight without root, PVL = Primary vein length, NOB = Number of branches, NOP = Number of pods, NOC = Number of clusters, FPW = Fresh pod weight, PLC = Pod length of cowpea, NOS = Number of seeds, 100SW = Hundred seed weight, HYP = Haulm yield of plant, KYP = Kernel yield/plant and GYC = Grain yield (kg/ha)