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Correlation Study of Cowpea Agronomic Traits with Grain Yield in The Guinea Savanna Agro-Ecological Zone of Nigeria

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Abstract

The study was conducted in 2019, 2020 and 2021 cropping seasons in three locations; Makurdi, Abuja and Zaria within the Guinea Savanna Agro-ecological zone of Nigeria, considered as non-traditional cowpea growing region. Six improved cowpea varieties (IT99K-573-1-1, IT99K-573-2-1, IT89KD-288, UAM09-1055-6, UAM09-1046-6-1, and UAM09- 1051-1.) were planted across the three locations for correlation study. Pearson's correlation coefficient between grain yield and the other traits; days to first flowering, days to 50% flower, days to 95% maturity, leaf area index, plant height, total dry matter, harvest index, 100 grain weight, peduncle per m^2, branches per m^2, number of seeds per m^2, number of pods per m^2 and pod length was computed using PROC CORR of SAS. The result in Abuja showed that significant and positive correlation was observed between grain yield and total dry matter (g/m^{-2}), peduncles/m^{-2}, branches/m^{-2}, number of grains (m^{-2}), number of pod /m^{-2} and pod length. Significant and positive correlations were obtained between grains per pod and harvest index and number of grains/m^{-2}. The results in Makurdi showed highly significant and positive correlation were observed between number of grains per pod, number of grains (m^{-2}) and pod length. The result in Zaria revealed the same trend with highly significant and positive correlation were observed between grains per pod and leaf area index. From the present study, it can be concluded and recommended that, since number of peduncles, number of branches/m^2, number of pods per plant, pod length and number of grains/m^2 were consistently positively correlated with grain yield across locations; therefore, these traits could serve as good characteristics to use for improvement of yield.

Keywords: Cowpea; Agronomic traits; yield; correlation

Introduction

Cowpea (*Vigna unguiculata* (L.) Walpers) is an annual herbaceous legume of the family Fabaceae. It is characterized by its great morphological and ecological diversity that makes it proficient as a good cover crop and soil fertility enhancer (Oyewale and Bamaiyi 2013; Harrison et al. 2006; Udealor 2002). It is widely grown in the tropics and sub-tropics where it has strong adaptation across a wide range of agro-farming systems. The varieties of cowpea come in a number of forms depending on the morphology of the plant such as semi-erect, erect or climbing, derived from the stem structure while the pods could be coiled, round, crescent or linear (Pasquet 1999). According to Fatokun et al. (2012) and Fageria et al. (1997), most cowpea cultivars are indeterminate in nature, producing flowers and seed over a long period although some are determinate and produce flowers and seed within a season.

Studies by Agbogidi (2012), Awe (2008) and Ogbonnaya et al. (2003) identified cowpea as one of the most economically important legume crops adapted to the savannah agro-ecologies, where it matures as grain under residual moisture and serves as a major contributor to the overall protein intake of most families in sub-Sahara Africa. The seed contains about 24% protein, 63.6% carbohydrate, 1.9% fat, 6.3% fiber, 0.00074% thiamine, 0.00042% riboflavin and 0.00281% niacin (Davis et al. 1991). Studies have shown that Nigeria and Niger Republic account for about 87% of the world's cowpea production (Adaji et al. 2007; FAO 2003; Ortiz 1998).

Correlation analysis gives a picture of association pattern of different yield related characters with grain yield among themselves. Grain yield is a complex quantitative character governed by a large number of genes. For the rational approach towards the improvement of the yield, selection has to be made for the components of the yield. The correlation pattern is expected to differ with the material that is studied, since it is a reflection of the genetic makeup of the population (Withanage, 2005). The present study is to determine the correlation pattern of cowpea agronomic traits with grain yield in three different locations.

Materials and Methods

The study was conducted at three locations; Makurdi, Abuja and Zaria in 2019, 2020 and 2021 cropping seasons. The three locations are within the Guinea Savanna agro-ecological zone of Nigeria, considered as non-traditional cowpea growing region. At Makurdi, the experimental field was located at the Teaching and Research Farm of the College of Agronomy (7.41°N, 8.37°E, 97m above sea level), IITA/IAR Teaching and Research Farm, Samaru, Zaria (11.086° N, 7.719° E, 675 m above sea level) and IITA Teaching and Research Farm, Kubwa, Abuja (9.076° N, 7.399° E, 476m above sea level).

The soil type in the locations is Alfisols on Argillaceous sediments (Kwari et al., 1999). Field trials were conducted during the growing seasons of 2016, 2017 and 2018 at Abuja, Makurdi and Zaria, under the rainfed condition. Six improved cowpea varieties (IT99K-573-1-1, IT99K-573-2-1, IT89KD-288, UAM09-1055-6, UAM09-1046-6-1, and UAM09- 1051-1.) were planted across the three locations for correlation study. The experiment was laid in Randomized Complete Block Design (RCBD) with three replications per treatment. The plot size for each treatment comprised of four rows of 5m length, spaced 0.75m row apart to give a gross plot size of $15m^2$. Three seeds were planted per hill at 25 cm spacing between plants and thinned to two, 2 weeks after seedling emergence (WAE), providing a uniform plant population of about 106,667 plants ha^{-1}. Recommended fertilizer rate of 30 kg/ha P2O5 in the form of single super phosphate was applied by banding at planting.

The six improved cowpea varieties used for the study were selected on the basis of growth habit. They were obtained from the International Institute for Tropical Agriculture (IITA) Kano Station and the Breeding Unit of the Molecular Biology Laboratory, Joseph Sarwuan Tarka University, Makurdi, Nigeria. The experimental fields at each location were ploughed, harrowed with a tractor twice to a fine tilth and thereafter, ridges were also made.

The soil of the experimental sites was sampled randomly with soil auger, borings in four places to a depth of 0-15 cm. The soil samples were bulked, air-dried and sieved through 2mm sieve before physical and chemical analysis was carried out in the Soil Science Laboratory of the Department of Soil Science, Joseph Sarwuan Tarka University, Makurdi, Nigeria. The particle size analysis was carried out using the Hydrometer Methods described by Black (1965). The textural class of the soil was obtained using Marshall's textural class triangle (Palmer and Troeh, 1977). The pH was determined by using glass electrode pH meter as described by Page et al. (1982). The regular Macro-Kjeldahl Method was used to determine the total nitrogen (N) in the soil sample as described by Black (1965). The organic carbon content of the soil was determined using the Dichromate Wet Oxidation Method described by Walkley and Black (1934) as modified by Nelson and Sommers (1982). The available phosphorus in the soil sample was determined using the Bicarbonate Methods as described by Olsen et al. (1954). The concentration of K^+ was determined using the flame photometer as described by Page et al. (1982). Seeds of the cowpea varieties were treated with Apron Star 42 WS containing Metalaxyl-M 20% w/w, Difenoconazole 2% w/w and Thiamethoxam 20% w/w at the rate of one sachet (10g) to 8kg of seeds for protection against soil and seed-borne pests and diseases. Sowing was done manually; three seeds were sown per hole and later thinned to two seedlings per

hill at fourteen (14) days after sowing (DAS). Weeds were controlled with Pendilin (500g pendimethalin per litre as an emulsifiable concentrate) at the rate of 100 mls in 20 litres of water Knapsack sprayer (2L/Ha) and applied immediately after planting. Also at 3 weeks after sowing (WAS) and subsequently as needed to maintain a weed free field, the plots were weeded manually using hand hoes.

The experimental plots received basal application of fertilizer- Muriate of potash 60% ai and SSP 20% ai was applied at the rate of 40kg/ha P_20_5, and 40kg/h K_20, respectively using drilling method of fertilizer application. The cowpea plants were protected against insect attack with a broad-spectrum insecticide formulation, Cypermethrin + Dimethoate (Best Action) 30 +250g active ingredient/L, three times viz; at flower initiation, full flowering and pod development stages using a pressurized Knapsack sprayer at the rate of 100mls/20 litre of water.

Data were collected from the net plot (two central rows leaving the two outer rows and first plants at the beginning and the last plant at the end of each row to serve as borders. Field observations were made on the following: Number of branches was obtained by counting at physiological maturity from five plants in each plot. The total value was divided by five to obtain the average number of branches per plant. The branches of five selected plants from net plot were measured with a graduated meter rule at physiological maturity and the average value was recorded. Leaf area index was calculated as half the area of all leaves per unit area of ground. It was measured as the leaf area (m^2) per ground area (m^{-2}). Number of peduncles was counted at physiological maturity from 5 selected plants in the net plot. The average number of peduncles per plant was then recorded. Five plants from net plot were sampled and the lengths of all peduncles were measured with a meter rule and their average calculated and recorded.

Number of pods: This was done by counting the number of pods at harvest from the net plot summing them up and dividing by the number of plants from the net plot. Number of grains per pod: This was obtained by counting the number of grains from each pod harvested in the net plot, then summed up and divided by the number of pods to obtain the average number of grains per pod. Pod length: 5 matured pods were randomly selected from each net plot harvested and were measured individually with a ruler and their average length taken as pod length per plot. Plant height was assessed at 8 weeks after planting by measuring from the ground level to the last formed leaf using meter rule and was expressed in centimeters. Number of days to first flowering was done by visual observation, the number of days from planting to the day when first flower was observed at the net plot. Then the number of days to first flowering was calculated from the date of sowing. Number of days to 50% flowering: Number of days from sowing to the time when half of the plants in a plot had flowered was noted and recorded for each plot. Number of days to maturity: This was taken as the number of days from planting to the day when 95 percent of the pods had dried, which is when cowpea seeds were harvested (Pandey and Ngarm, 1985) in each plot was taken. One hundred (100) seed weight (g) was obtained by randomly counting 100 grains from the yield of each plot. The 100-seed was oven-dried at 650C for 48 hours to a constant weight and then weighed on a top loading MP10001 electronic balance (Max: 1000g e: 1g d: 0.1g No: SHP0100910069 2005-12, Shanghai Scientific Instrument Co. Ltd) to get the 100-seed weight. Harvest index (HI): The total above ground dry matter (TDM) was weighed on a top loading MP2000 electronic balance (Max: 2000g e: 10g d: 1g No: SHP0102410072 2005-12, Shanghai Scientific Instrument Co. Ltd) and recorded and the ratio of the grain yield to TDM (HI) was computed and expressed in percent.

$$\text{Harvest index} = \frac{weight\,of\,grains}{Total\ biomass} x100 \quad \text{(Obasi, 1989)}$$

Grain yield per plant (g): All the dried pods on the plants from the net plots were harvested and threshed and the seed was weighed on a top loading MP2000 electronic balance (Max: 2000g e: 10g d: 1g No: SHP0102410072 2005-12, Shanghai Scientific Instrument Co. Ltd). The total grain yield was divided by the number of plants in the plot to get the grain yield per plant. Grain yield (kg ha^{-1}): All the pods from the plants in each plot was harvested and threshed separately. The grains were weighed on a top loading MP2000 electronic balance (Max: 2000g e: 10g d: 1g No: SHP0102410072 2005-12, Shanghai Scientific Instrument Co. Ltd).

Fodder yields; All the plants in each plot after picking the pods was harvested separately and allowed to dry to a constant weight and then weighed on a top loading MP2000 electronic balance (Max: 2000g e: 10g d: 1g No: SHP0102410072 2005-12, Shanghai Scientific Instrument Co. Ltd).

Data Analysis

Pearson's correlation coefficient between grain yield and the other traits was computed using PROC CORR of SAS (SAS Institute, 2003).

Results

Soil Analysis

Table 1 presented the result of the soil analysis prior to planting collected from the three locations for the three years of study. The result showed that the soil in Makurdi study area was sandy loam, that of Abuja location was loamy soil and that of Zaria was clay loam. This implies that Zaria soil has the higher water holding capacity followed by that of Abuja and least was Makurdi soil.

Soil Composition	***Locations***		
Physical Properties	***Makurdi***	***Abuja***	***Zaria***
Sand (%)	77.6	70	70
Silt (%)	13.2	7	12
Clay (%)	9.2	13	18
Textural class	Sandy loamy	Loamy	Clay loam
Chemical Properties			
pH (H_2O) 1:2.5	5.90	5.28	5.50
pH (0.01M $CaCl_2$) 1:2.5	4.60	4.40	5.80
Organic carbon (g kg^{-1})	10.7	10.7	7.70
Nitrogen (%)	0.05	0.015	0.04
Bray P (mg kg^{-1})	7.61	15.74	4.48
Exchangeable bases (cmol kg-1 soil)			
Calcium (Ca^{2+})	3.20	0.44	5.80
Magnesium (Mg^{2+})	1.96	0.06	0.95
Potassium (K^{+})	0.37	0.01	0.39
Sodium (Na^{2+})	0.66	0.10	0.36
$ECEC^{+}$	6.00	1.07	6.67

ECEC=Effective cation exchange capacity.

AAS: Atomic Absorption Spectrophotometer.

Table 1: Physical and chemical properties of soil collected across experimental fields prior to planting.

Correlation of Cowpea Agronomic Trait with Grain Yield in Abuja

The correlation values of cowpea agronomic traits with seed yield in Abuja location are presented in Table 2. The result revealed that there was significant and positive correlation between days to 50% flowering and days to first flowering (0.24288**). There was highly significant and positive correlation between days to 95 % maturity and days to first flowering (0.31453**), days to 50 % flowering (0.25861**). Highly significant and positive correlation was observed between leaf area index and days to first flowering (0.25705**), days to 50 % flowering (0.24338**) and days to 95 % maturity (0.25043**).

Significant and positive correlations were also observed between plant height and days to first flowering (0.31575**) and days to 95 % maturity (0.17798*). Highly significant and positive association was observed between total dry matter (kg/ha) and days to 50 % flowering (0.23985**), days to 95 % maturity (0.2651**) and leaf area index (0.3088**) also, a significant and positive correlation was observed between total dry matter and days to first flowering (0.20939*). Highly significant and negative correlation was observed between harvest index and days to first flowering (-0.23771**), days to 50 % flowering (-0.35923**), days to 95 % maturity (-0.34454**) and total dry matter (g/ m^{-2}) (-0.57547**) while significant and negative correlation was observed between harvest index and leaf area index (-0.16727*). Also, a significant and negative correlation were obtained between 100 grain weight and days to 50 % flowering (-0.17245*) and total dry matter (kg/ha) (-0.14078*).

Highly significant and positive association were observed between Peduncles/m^{-2} and days to first flowering (0.22476**) and total dry matter (g/ m^{-2}) (0.39995**) also, highly significant but negative correlation was observed between Peduncles /m^{-2} and harvest index (-0.19306**) and 100 grain weight (-0.20837**). Highly Significant and positive correlation were observed between Branches/m^{-2} and days to first flowering (0.32988**), days to 95 % maturity (0.42268**), leaf area index (0.23193**), total dry matter (g/ m^{-2}) (0.45741**) and Peduncles/m^{-2} (0.39639**) whereas a significant and positive correlation was observed between Branches/m^{-2} and days to 50 % flowering (0.1365*) while harvest index had highly significant but negatively correlated (-0.30825**).

Significant and positive correlations were obtained between grains number (m^{-2}) and total dry matter (g/ m^{-2}) (0.15084*) and Peduncles/m^{-2} (0.16397*) whereas highly significant and negative correlation was observed between grains number (m^{-2}) (-0.28097**). Highly significant and positive correlation was observed between Pod number/m^{-2} and days to first flowering (0.25898**), Peduncles/m^{-2} (0.53439**), Branches/m^{-2} (0.32399**) and grains number (m^{-2}) (0.19443**). Whereas, significant and negative correlation was observed between Pod number/m^{-2} and days to 50 % flowering (-0.16297*).

Highly significant and positive correlations were also obtained between pod length and 100 grain weight (0.2637**), grains number (m^{-2}) (0.33431**) whereas a significant and positive correlation was observed on harvest index (0.17386*). Also, significant and negative correlation were observed between pod length and days to 50 % flowering (-0.17099*), days to 50 % flowering (-0.58584**) and Branches/m^{-2} (-0.24663**). Highly significant and positive correlation was observed between grain yield and total dry matter (g/ m^{-2}) (0.17901**), Peduncles /m^{-2} (0.24298**), Branches/m^{-2} (0.20119**), grains number (m^{-2}) (0.52077**), Pod number/m^{-2} (0.35618**) and pod length (0.23646**) while highly significant and positive correlation was observed between grain yield and days to 95 % maturity (-0.21761**).

Significant and positive correlations were obtained between number of grains per pod and harvest index (0.13379*) and number of grains/m^{-2} (0.13594*). Also, significant and negative correlation were observed between grains per pod and pods number (m^{-2}) (-0.22863**) and grain yield (-0.1647*) (Table 2).

	DFF	*D50F*	*D95*	*LAI*	*PLTHT*	*TDMM2*	*HI*	*SD100*	*PED_M2*	*BRCH_M2*	*SDNO_M2*	*PODNOM2*	*POD_LT*	*YIELD*	*Grains /Pod*
DFF	1														
D50F	0.24288**														
D95	0.31453**	0.25861**													
LAI	0.25705**	0.24338**	0.25043**												
CANTHT	0.31575**	0.09204	0.17798*	0.05978											
TDMM2	0.20939*	0.23985**	0.2651**	0.3088**	-0.0176										
HI	-0.23771**	-0.35923**	-0.34454**	-0.16727*	-0.08384	-0.57547**									
SD100	0.03151	-0.17245*	0.00389	-0.0434	0.04747	-0.14078*	-0.0787								
PED_M2	0.22476**	0.00769	0.06649	0.03076	-0.05159	0.39995**	-0.19306**	-0.20837**							

BRCH_M2	0.32988**	0.1365*	0.42268**	0.23193**	-0.03692	0.45741**	-0.30825**	0.02454	0.39639**						
SDNO_M2	0.13077	0.1163	-0.28097**	0.11258	-0.00189	0.15084*	0.07419	-0.00209	0.16397*	0.08294					
PODNOM2	0.25898**	-0.16297*	0.02987	-0.02085	0.04326	0.11984	0.08044	0.05962	0.53439**	0.32399**	0.19443**				
POD_LT	-0.01829	-0.17099*	-0.58584**	-0.0426	0.11589	-0.20104	0.17386*	0.2637**	-0.12917	-0.24663**	0.33431**	0.03536			
YIELD	0.08191	-0.11508	-0.21761**	-0.04565	-0.0941	0.17901**	0.0601	0.07122	0.24298**	0.20119**	0.52077**	0.35618**	0.23646**		
GRAIN/ POD	0.04806	0.08596	0.04448	0.13379*	-0.02327	0.06211	-0.00567	-0.1127	-0.06979	0.03711	0.13594*	-0.22863**	0.01951	-0.1647*	1

Key: DFF: Days to first flowering, D50F: Days to 50% Flower, D95: Days to 95% Maturity, LAI: Leaf Area Index, PLTHT: Plant height, TDMM2: Total dry matter (kg/ha), HI: Harvest Index, SD100: 100 grain weight, PED_M2: Peduncles /m^{-2}, BRCH_M2: Branches/m^{-2}, SDNO_M^{-2}: Number of seeds/m^2, Number of grain/m^{-2}, PODNOM2: Pod number/m^{-2}, POD_LT: Pod length (cm), YIELD: Grain Yield (kg/ha).

Table 2: Correlation of Cowpea Agronomic Traits with Grain Yield in Abuja.

Correlation of Cowpea Agronomic Trait with Grain Yield in Makurdi

The correlation values of cowpea agronomic traits with seed yield in Makurdi location are presented in Table 3. The results showed highly significant and positive correlation between days to 50% flowering and days to first flowering (0.57603**), there were highly significant and positive correlation between days to 95 % maturity and days to first flowering (0.5401**), days to 50 % flowering (0.60702**). A significant positive and correlation was observed between leaf area index and days to 50 % flowering (0.17966*).

Highly significant and positive correlation were observed between plant height and days to first flowering (0.47934**), days to 50 % flowering (0.5406**) and days to 95 % maturity (0.48522**). Highly significant and positive association was observed between total dry matter (kg/ha) and days to first flowering (0.21552**), days to 50 % flowering (0.24523**), days to 95 % maturity (0.46204**) and plant height (0.1749**).

Highly significant and negative correlation was observed between harvest index and days to first flowering (-0.21904**), days to 50 % flowering (-0.23069**), days to 95 % maturity (-0.46795**), plant height (-0.30937**) and total dry matter (g/m^{-2}) (-0.58746**). Also, a significant and positive correlation was observed between 100 grain weight and plant height (0.14145*).

Highly significant and positive association were observed between Peduncles /m^{-2} and harvest index (0.20748**) also, significant but negative correlation was observed between Peduncles/m^{-2} and days to first flowering (-0.14193*) and days to 50 % flowering (-0.1579*). Highly significant and positive correlation were observed between Branches/m^{-2} and days to first flowering (0.37984**), days to 50 % flowering (0.3839**), days to 95 % maturity (0.4681**), plant height (0.20673**), total dry matter (g/m^{-2}) (0.41071**) and Peduncles/m^{-2} (0.62962**) whereas a significant and positive correlation was observed between Branches/m^{-2} and 100 grain weight (0.16269*).

Highly significant and positive correlation were observed between number of grains (m^{-2}) and leaf area index (0.17443**) and harvest index (0.42214**) also, highly significant and negative correlation was observed between leaf area index and days to 95 % maturity (-0.32585**), plant height (-0.195**) and total dry matter (g/m^{-2}) (-0.24717**). Highly significant and positive correlation was observed between pod number/m^{-2} and harvest index (0.30971**), Peduncles/m^{-2} (0.24255**) and Branches/m^{-2} (0.2009**). Whereas, highly significant and negative correlation was observed between Pod number/m^{-2} and days to 50 % flowering (-0.22907**), days to 95 % maturity (-0.20205**) and plant height (-0.17303**).

Highly significant and positive correlation were observed between pod length and harvest index (0.32541**), 100 grain weight (0.21108**) and Pod number/m^{-2} (0.31726**). Also, highly significant and negative correlation were observed between pod length and days to first flowering (-0.2607**), days to 50 % flowering (-0.29135**), days to 95 % maturity (-0.61531**), plant height (-0.20015**) and total dry matter (-0.26852**). Highly significant and positive correlation was observed between grain yield and harvest index (0.41122**), Peduncles/m^{-2} (0.42754**), Branches/m^{-2} (0.20798**), grains number (m^{-2}) (0.39696**), Pod number/m^{-2} (0.44399**)

while a significant and positive correlation was observed between grain yield and pod length (0.16628*).

The result also showed highly significant and positive correlation between number of grains per pod and grains number (m^{-2}) (0.2061**) and pod length (0.20943**). Also, highly significant and negative correlation were observed between grains per pod and days to 95 % maturity (-0.23315**), plant height (-0.19783**), 100 grain weight (-0.37499**) and number of grains (m^{-2}) (-0.28545**) while a significant and negative correlation was observed between number of grains per pod and days to first flowering (-0.13474*) (Table 3).

	DFF	D50F	D95	LAI	CANTHT	TDMM2	HI	SD100	PED_M2	BRCH_M2	SDNO_M2	PODNOM2	POD_LT	YIELD	Grains/Pod
DFF	1														
D50F	0.57603**														
D95	0.5401**	0.60702**													
LAI	0.04491	0.17966*	0.08455												
CANTHT	0.47934**	0.5406**	0.48522**	0.08862											
TDMM2	0.21552**	0.24523**	0.46204**	0.00864	0.1749**										
HI	-0.21904**	-0.23069**	-0.46795**	0.04097	-0.30937**	-0.58746**									
SD100	-0.00457	0.08174	0.05728	0.01391	0.14145*	0.0531	-0.07565								
PED_M2	-0.14193*	-0.1579*	-0.12742	0.19139	-0.32387	0.11484	0.20748**	0.09515							
BRCH_M2	0.37984**	0.3839**	0.4681**	0.07735	0.20673**	0.41071**	-0.11238	0.16269*	0.62962**						
SDNO_M2	-0.09852	-0.08106	-0.32585**	0.17443**	-0.195**	-0.24717**	0.42214**	0.03129	0.13476	-0.09572					
PODNOM2	0.03415	-0.22807**	-0.20205**	0.0477	-0.17303**	0.08769	0.30971**	-0.00626	0.24255**	0.2009**	-0.06606				
POD_LT	-0.2607**	-0.29135**	-0.61531**	0.04564	-0.20015**	-0.26852**	0.32541**	0.21108**	0.00377	-0.03942	-0.10436	0.31726**			
YIELD	-0.17831	-0.18845**	-0.38939**	0.13272	-0.25336**	-0.04232	0.41122**	0.09855	0.42754**	0.20798**	0.39696**	0.44399**	0.16628*		
Grains/Pod	-0.13474*	-0.12646	-0.23315**	-0.07007	-0.19783**	-0.03886	0.05316	-0.37499**	0.10485	0.10311	-0.28545**	0.2061**	0.20943**	-0.00818	1

Key: DFF: Days to first flowering, D50F: Days to 50% Flower, D95: Days to 95% Maturity, LAI: Leaf Area Index, PLTHT: Plant height, TDMM2: Total dry matter (kg/ha), HI: Harvest Index, SD100: 100 grain weight, PED_M2: Peduncles /m^{-2}, BRCH_M2: Branches/m^{-2}, SDNO_M^{-2}: Number of seeds/m^2, Number of grain/m^{-2}, PODNOM2: Pod number/m^{-2}, POD_LT: Pod length (cm), YIELD: Grain Yield (kg/ha).

Table 3: Correlation of Cowpea Agronomic Traits with Grain Yield in Makurdi.

Correlation of Cowpea Agronomic Trait with Grain Yield in Zaria

The correlation values of cowpea agronomic traits with seed yield in Zaria location are presented in Table 4. The result revealed highly significant and positive correlation between days to 50% flowering and days to first flowering (0.51991**), there were highly significant and positive correlation between days to 95 % maturity and days to first flowering (0.51757**), days to 50 % flowering (0.39748**). Highly significant and positive correlation was observed between leaf area index and days to first flowering (0.12238**), days to 50 % flowering (0.17641**) and days to 95 % maturity (0.1016**).

Highly significant and positive correlation were observed between plant height and days to first flowering (0.25425**), days to 50 % flowering (0.27916**) and days to 95 % maturity (0.16237**) whereas a significant and positive correlation was observed on leaf area index (0.08911*). Highly significant and positive correlation was observed between total dry matter (kg/ha) and days to 50 % flowering (0.24389**), leaf area index (0.14546**) and plant height (0.13783**). Highly significant and negative correlation was observed between harvest index and days to 50 % flowering (-0.10428**) and total dry matter (g/m^{-2}) (-0.31173**). Also, highly significant and positive correlation were observed between 100 grain weight and days to 95 % maturity (0.20023**) and harvest index (0.11988**). Also, significant and negative correlation was observed between 100 grain weight and days to 50 % flowering (-0.10471**), plant height (-0.08516*) and total dry matter (g/m^{-2}) (-0.2735**).

Highly significant and positive association were observed between Peduncles /m^{-2} and leaf area index (0.13789**) and total dry matter (g/ m^{-2}) (0.18735**) also, highly significant and negative correlation was observed between Peduncles/m^{-2} and plant height (-0.11322**). Highly Significant and positive correlation were observed between Branches/m^{-2} and days to 50 % flowering (0.17964**), days to 95 % maturity (0.318**), leaf area index (0.20825**), plant height (0.10573**), total dry matter (kg/ha) (0.21413**) and Peduncles /m^{-2} (0.41848**) whereas a significant and positive correlation was observed between Branches/m^{-2} and 100 grain weight (0.07898*).

Highly significant and positive correlation were observed between grains number (m^{-2}) and leaf area index (0.15001**), total dry matter (g/m^{-2}) (0.15525**) and Peduncles /m^{-2} (0.25863**) also, significant and negative correlation was observed between number of grains (m^{-2}) and days to 95 % maturity (-0.30418**), plant height (-0.09923**) and 100 grains weight (-0.17641**). Highly significant and positive correlation was observed between Pod number/m^{-2} and total dry matter (g/ m^{-2}) (0.16655**) and Peduncles /m^{-2} (0.46812**) Branches/m^{-2} (0.25524**) and grains number (m^{-2}) (0.25773**). Whereas, highly significant and negative correlation was observed between pod number/m^{-2} and days to 50 % flowering (-0.1432**) and days to 95 % maturity (-0.14763**).

Highly significant and positive correlation between pod length and number of grains (m^{-2}) (0.31009**) and number of pod (m^{-2}) (0.22489**). Also, highly significant and negative correlation were observed between pod length and days to first flowering (-0.17314**), days to 50 % flowering (-0.15487**), days to 95 % maturity (-0.5566**) and Branches/m^{-2} (-0.18458**). Highly significant and positive correlation was observed between grain yield and leaf area index (0.13075**), total dry matter (g/ m^{-2}) (0.09133**), harvest index (0.12279**), Peduncles/m^{-2} (0.4017**), Branches/m^{-2} (0.17151**), number of grains (m^{-2}) (0.5009**), number of pod /m^{-2} (0.48647**) and pod length (0.30068**) whereas highly significant and negative correlation was observed between grain yield and days to 50% flowering (-0.10632**).

Highly significant and positive correlation were observed between number of grains per pod and leaf area index (0.10545**). Also, highly significant and negative correlation were observed between grains per pod and pods number (m^{-2}) (-0.10434**) and grain yield (-0.10174**) while a significant and negative correlation was observed between grains per pod and Peduncles /m^{-2} (-0.0802*) (Table 4).

	DFF	D50F	D95	LAI	CANTHT	TDMM2	HI	SD100	PED_M2	BRCH_M2	SDNO_M2	PODNOM2	POD_LT	YIELD	Grains/ Pod
DFF	1														
D50F	0.51991**														
D95	0.51757**	0.39748**													
LAI	0.12238**	0.17641**	0.1016**												
CANTHT	0.25425**	0.27916**	0.16237**	0.08911*											
TDMM2	0.10229	0.24389**	0.00216	0.14546**	0.13783**										
HI	-0.03995	-0.10428**	0.01985	-0.00678	-0.06881	-0.31173**									
SD100	0.02194	-0.10471**	0.20023**	-0.02565	-0.08516*	-0.2735**	0.11988**								
PED_M2	0.03116	-0.01804	-0.05154	0.13789**	-0.11322**	0.18735**	0.0073	-0.05687							
BRCH_M2	0.21776	0.17964**	0.318**	0.20825**	0.10573**	0.21413**	-0.00946	0.07898*	0.41848**						
SDNO_M2	0.04066	0.07182	-0.30418**	0.15001**	-0.09923*	0.15525**	-0.06352	-0.17641**	0.25863**	-0.00612					
PODNOM2	0.02801	-0.1432**	-0.14763**	0.05144	-0.01633	0.16655**	0.01711	-0.05306	0.46812**	0.25524**	0.25773**				
POD_LT	-0.17314**	-0.15487**	-0.5566**	-0.00354	-0.00206	0.05732	-0.03317	-0.05153	0.02247	-0.18458**	0.31009**	0.22489**			
YIELD	-0.05672	-0.10632**	-0.26564**	0.13075**	-0.12429**	0.09133*	0.12279**	-0.01563	0.4017**	0.17151**	0.5009**	0.48647**	0.30068**		
Grains/ Pod	-0.01583	-0.00723	-0.0142	0.10545**	-0.06141	0.02674	0.04106	-0.03972	-0.0802*	-0.06326	-0.00859	-0.10434**	0.04016	-0.10174**	1

Key: DFF: Days to first flowering, D50F: Days to 50% Flower, D95: Days to 95% Maturity, LAI: Leaf Area Index, PLTHT: Plant height, TDMM2: Total dry matter (kg/ha), HI:

Harvest Index, SD100: 100 grain weight, PED_M2: Peduncles /m-2, BRCH_M2: Branches/m-2, SDNO_M2: Number of seeds/m^2, Number of grain number/m^{-2}, PODNOM2: Pod number/m^{-2}, POD_LT: Pod length (cm), YIELD: Grain Yield (kg/ha).

Table 4: Correlation of Cowpea Agronomic Trait with Grain Yield in Zaria.

Discussion

The report observed in the current study observed that number of peduncle, number of pods per plant, pod length and number of grains were consistently and positively correlated with grain yield which agrees with the report of Aryeetey and Laing (1973) which found positive correlation of grain yield per plant with number of pods per plant, number of seeds per pod and 100-seed weight, number of pods per plant was consistently positively correlated with grain yield, but negative with pod length. The observations in the current study collaborate with the findings of Kumar and Hirochika (2000), who reported significant and positive correlation between the number of pods per plant and seed yield.

Husain et al. (1988) reported that number of pods per plant was consistently and strongly correlated with yield and similar correlations were reported by other workers (Kambal, 1969; Ishag, 1973). The authors above also observed that number of seeds per pod was considerably variable than the number of pods per plant. According to Chung and Goulden (1970) and Yassim (1973), the correlation of pods per plant and yield had been determined to be positive and significant in seed legumes. Kuruvadi and Escobar (1987) observed a close association between yield and number of pods per plant in common bean. The authors concluded that selection for number of pods per plant, number of seeds per pod and seed weight individually or simultaneously should increase yielding ability of the varieties. Therefore, it would appear as a good characteristic to use for improvement of yield.

Harvest index was affected by season in a similar way it affected grain yield with early season favoring higher expression of both traits. Harvest index was directly related with some yield components. This finding is supported by Kwapata and Hall (1990) who noted that harvest index was positively correlated with yield and yield components in cowpea. This indicated that the yield potential of cowpea could be raised by selecting for high harvest index.

Conclusion and Recommendation

From the present study, it can be concluded and recommended that, since number of peduncles, number of Branches/m^2, number of pods per plant, pod length and number of grains/m^2 were consistently and positively correlated with grain yield across locations; therefore, these traits could appear as a good characteristic to use for improvement of yield.

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