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Genetic variability studies of some quantitative traits in cowpea (*Vigna unguiculata* l. [walp]) under water stress

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This research was conducted to study genetic variability of some quantitative traits in varieties of cowpea (*Vigna unguiculata* L. [Walp.]) under water stressed in Zaria Sudan Savannah, Nigeria. Seven varieties of cowpea (Sampea 1, Sampea 2, IAR1074, Sampea 7, Sampea 8, Sampea 10 and Sampea 12) collected from Institute for Agricultural Research, Samaru, Zaria, were screened for tolerance to water stress. The seeds were sown in poly bags containing sandy-loam arranged in Completely Randomized Design with three replications for quantitative traits evaluation. The result obtained revealed highly significant difference (P≤0.01) in the effects of water stress on the number of wilted and dead plants at 40 days after sowing. However, variety sampea-10 has the highest mean performance in terms of number of wilted plants at 34, while sampea 2 and IAR 1074 have the lowest mean performance. However, sampea 7 was found to have the highest mean performance for the number of wilted plants at 40 days and sampea 2 is the lowest. The result for quantitative traits study indicated highly significant difference (P≤0.01) in the plant height, number of days to 50% flowering, number of days to maturity, number of pods per plant, pod length, number of seeds per plant and 100 seed weight, and significant (P≤ 0.05) at seedling height and number of branches per plant. Similarly, IAR1074 was found to have high performance in terms of most of the quantitative traits under study. However, sampea 8 has the highest mean performance at nutritional level. It was therefore concluded that, all the seven cowpea genotypes were water stress tolerant and produced considerable yield that contained significant nutrients. It was recommended that IAR1074 should be grown for yield, while sampea 8 should be grown for protein supplements.

Key words: Quantitative traits, water stress, genetic variability, carbohydrate, protein, cowpea.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) belongs to the Leguminosea family. It is widely grown and distributed in many tropical regions of the world. Cowpea cultivation in West Africa is the most common in the dried part of the sub-region. Nigeria is one of the leading cowpea producers in the sub-region. It provides most of the needed source of protein for people. It also accounts for about 60% of the daily dietary poultry intake of most

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Nigerians. In addition, the cowpea plant enriches the soil through nitrogen fixation process (the major food legume cultivated in Nigeria is Cowpea (*V. unguiculata* L. Walp) (Nielson et al., 1997).

One of the major challenges facing the world is food security as well as how to address the phenomenon of malnutrition among the teeming and ever rising population of poor rural dwellers of the third world countries. In the wake of climate changes, fluctuating global economy and intensification of low-input agricultural production has led to a rapid increase in soil degradation and nutrient depletion in many parts of sub-Saharan Africa. This has constituted serious threats to food production and food security, there is need to promote crops that could fix into global nutrient requirements and one of such crop is cowpea.

Production of cowpea has been found with a number of problems or constraints, which includes the biotic and abiotic constrains that resulted into low grain and fodder yield. In most West African countries, development and release of improved varieties that adapts well and yield better have been slow in getting to the farmers (FAO, 2000). Development of cultivars with early maturity, acceptable grain quality, resistance to diseases and pests is necessary to overcome the ever-growing food shortage (Ehlers and Hall, 1997). Hence, there is need to generate more information on variability among the existing germplasm and cultivars and also broadening the gene pool of the crop for selection and development of more improved varieties not just in yield but with better nutritional values.

As a legume grain, cowpea is an important source of human dietary protein and calories. The grains contain about 25% proteins and 64% carbohydrate, while young leaves, pods and peas contain vitamins and minerals (Nielson et al., 1997). Its high protein and lysine content makes it natural supplement for high carbohydrates tubers and cereals, which are common staple foods among the sub-Saharan people. Malnutrition among the children in developing countries is mainly due to the consumption of cereal-based meal, which is bulky, high energy and anti-nutrients. Therefore, cowpea provides protein constituent of the daily diet of the economically depressed rural class, due to its potential to reduce malnutrition; it is sometimes being referred to as “poor man’s meat” (Geissler et al., 1998). Its utilization is majorly as grain crop, vegetables and fodder for livestock (Hall et al., 2003).

The study of variability and diversity in accessions of cultivated crops could provide vital information for the establishment of breeding programme, especially when intraspecific hybridization is necessary for the incorporation of new features or for mapping purposes. Assessment of genetic diversity and variability in cowpea would enhance development of cultivars for adaptation to specific production constrain. Therefore, sufficient information is necessary on genetic variability among the available germplasm to formulate and accelerate breeding programme. Previous workers have reported on genetic variability among different varieties of cowpea (Omoigui et al., 2006; Nwosu et al., 2013) and crop nutritional value (Henshaw, 2008; Mamiro et al., 2011; Odedeji and Oyeleke, 2011). However, only few of these reports compared nutrient composition of different varieties and in particular the early maturing varieties.

In order to achieve a successful breeding programme to improve the yield potentials of the crop, the quality of the grains in term of its nutritional values should also be a pivot concern. This enables the breeder to operate selection efficiently and subsequently developed appropriate breeding strategies to solve the problems of poor yield as well as improve the nutritive quality of the crop. Effort was made to examine the genetic differences among the studied cultivars to group them into relatively homogenous groups of baseline parents for breeding purposes.

Despite the increasing importance of cowpea in the diet of many Nigerians, yield per hectare remains low. Although yields of 2500 kg/ha are achievable, several constraints have kept farmers’ yields constantly low at levels between 350 and 700 kg/ha. To overcome the yield barrier, a new strategy to improve the genetic potential of cowpea plants by introducing new genes is required. For this to be achievable, genotypes with a potential for better quality traits are needed as parent stocks to develop improved varieties (Adeigbe et al., 2011). The aim of the research is to assess the genetic variability among screened water stressed tolerant varieties of cowpea for improved quantitative traits in northern Guinea savannah zone of Nigeria.

MATERIALS AND METHODS

Study area

The experiment was conducted under screen house in the Department of Biological Sciences, Ahmadu Bello University, Zaria (lat: 11°, 21^{1}N and long: 7°, 37^1 E, Alt: 550 to 700 m above sea level).

Sources of materials

The experimental seeds were obtained from the cowpea unit of Institute of Agricultural Research (IAR), Samaru, Ahmadu Bello University, Zaria.

Screening for water stress

The screening for water stress was conducted using box screening method in a completely randomized design (CRD) with three replications in a screen house. The box was half-filled with a soil in a ratio of 1:1 of top soil and humus; it was watered to sufficiently moist it for planting and two seeds were sown per hole. The watering continued regularly up to three weeks after sowing where a complete withdrawal of the water was applied. The data collected at 28 days after sowing, 34 days after sowing and 40 days after

Table 1. Mean square for water stress tolerance screening of seven different cowpea genotype.

Sources of variation	Df	Number of wilted plants	Number of dead plants	Number of wilted	Number of dead plants	Number of wilted plants	Number of dead plants	Number of healthy plants
Variety	6	0.00^{ns}	0.00^{ns}	0.21^{ns}	0.02^{ns}	1.22*	0.21^{ns}	1.52^{ns}
Water level	1	0.00^{ns}	0.00^{ns}	6.72*	0.00^{ns}	10.89**	6.72**	72.00**
Variety and water level	2	0.00^{ns}	0.00^{ns}	0.06^{ns}	0.00^{ns}	0.06^{ns}	0.06^{ns}	0.17^{ns}
Error	32	0.00	0.00	0.92	0.03	1.09	0.92	7.34

ns= No significant difference; *Significantly different (P=0.05), **Highly significant difference (P=0.01).

sowing were for the number of wilted plants, number of dead plants and the number of healthy plants, respectively.

Pot experiment for growth and yield

Polythene bags were used in place of pot and were filled with soil in a ratio of 1:1 humus and top soil. They were watered sufficiently to moist it for planting, and were arranged in completely randomized design with three replications. Four seeds were planted in each polythene pot and watered regularly until harvest. The data collected include germination percent, seedling height (cm), plant height at maturity (cm), number of branches per plant, number of leaves per plant, leaf area, number of days to fifty percent flowering, number of days to maturity, number of pods per plant, pod length, number of seeds per pod, 100 seed weight, and dry weight of the plant.

Proximate analysis

Proximate analysis was performed to determine the relationship between Protein, Arsh, Crude Fibre, Fat and Moisture contents by extraction and using standard method by AOAC (2000). Carbohydrate content was determined using the formula:

% Carbohydrate = 100 - (% Moisture + % Ash + % Crude protein + % Crude fat + % Crude fibre)

Data analysis

All the data collected were subjected to analysis of variance (ANOVA) with Duncan's Multiple Range Test (DMRT) used to separate the means. All tests of relationships were done using Pearson's Product Moment Correlation Co-efficient.

RESULTS

The result for the ANOVA obtained due to the exposure of seven different cowpea varieties to water stress is shown in Table 1. The result indicated a highly significant difference ($P \leq 0.01$) in the effects of water stress on the number of wilted and dead plants at 40 days after sowing (DAS). Similar result was obtained in the number of healthy plants. However, a significant difference ($P \leq 0.05$) was found in the number of wilted plants at 34 DAS. While no significant difference was found in the effects of water stress from 28 DAS to 34 DAS in the remaining parameters. Furthermore, no significant difference was found in the interaction of the varieties to water level.

However, Table 2 shows the results of the mean performance of the seven cowpea varieties to water stress. The result shows that sampea 10 has the highest mean performance in terms of number of wilted plants at 34 DAS, while sampea 2 and IAR 1074 have the lowest mean performance. However, sampea 7 was found to have the highest mean performance for the number of wilted plants at 40 DAS and sampea 2 is lowest. Meanwhile the number of dead plants at 40 DAS, sampea 7 and sampea 10 have the highest mean performance, while the lowest was found in sampea 2, 12 and IAR1074. Nevertheless, in the number of healthy plants sampea 1 shows high mean performance, while sampea 7 has the lowest mean performance. At 34 DAS, sampea 12 was found to be the highest.

The combine ANOVA of the mean performance for seven cowpea genotypes to water stress is shown in Table 3. High mean performance was found in the water stressed plants for the number of wilted plants at 40 DAS, while the lowest mean performance was found in the number of wilted plants at 34 DAS. A high mean performance was found for the number of dead plants at 40 DAS. However, in the unstressed plants, the high mean performance was found in the number of wilted plants at 40 DAS and the lowest was obtained in the number of dead plants at 34 DAS. Similarly, a high mean performance was found in the water stressed healthy plants, while the lowest was found in the unstressed healthy plants.

Table 4 shows the results for the relationships between the seven cowpea varieties to water stress, which indicated that positive relationship ($P \leq 0.05$) exists between the number of wilted plants at 40 DAS and number of wilted plants at 34 DAS. Also, positive relationships exist between the number of dead plants at 40 DAS and the number of wilted plants at 40 DAS. Nevertheless, negative relationship was found in the number of healthy plants and number of wilted plants at 34 DAS; also, between number of wilted plants at 40 DAS and number of dead plants at 40 DAS. However, no significant difference was found in the others.

Table 2. Mean performance of seven cowpea varieties under water stress.

Variety	No. of wilted plants (28DAS)	No. of dead plants (28 DAS)	No. of Wilted plants (34 DAS)	No. of dead plants (34 DAS)	No. of wilted plants (40 DAS)	No. of dead plants (40 DAS)	No. of healthy plants
Sampea1	0.00[a]	0.00[a]	0.50[b]	0.00[a]	0.83[d]	0.50[d]	10.17[a]
Sampea2	0.00[a]	0.00[a]	0.67[c]	0.00[a]	0.67	0.67[c]	10.00[a]
IAR1074	0.00[a]	0.00[a]	0.67[c]	0.00[a]	0.83[d]	0.67[c]	9.83[b]
Sampea7	0.00[a]	0.00[a]	1.00[a]	0.00[a]	1.67[a]	1.00[a]	8.83[d]
Sampea8	0.00[a]	0.00[a]	0.83[b]	0.00[a]	1.00[b]	0.83[b]	9.33[c]
Sampea10	0.00[a]	0.00[a]	1.00[a]	0.00[a]	1.00[b]	1.00[a]	9.00[c]
Sampea12	0.00[a]	0.00[a]	0.67[c]	0.17[a]	1.00[b]	0.67[c]	9.50[b]
Means	0.00	0.00	0.76	0.02	0.93	0.76	9.52
SE(+-)	0.00	0.00	0.36	0.06	0.39	0.36	1.02

a=Higher mean; b, c, d=lowest mean.

Table 3. Mean performance (Combine ANOVA) of the seven cowpea genotype.

Water level	NWP 28 DAS	NDP28 DAS	NWP 34 DAS	NDP34 DAS	NWP 40 DAS	NDP 40 DAS	NHP
Water stressed	0.00[a]	0.00[a]	1.22[a]	0.03[a]	1.56[a]	1.22[a]	9.94[a]
Control	0.00[a]	0.00[a]	0.64[a]	0.00[a]	0.76[b]	0.64[b]	8.00[b]
Means	0.00	0.00	0.93	0.02	1.94	0.93	8.97
S E (+)	0.00	0.00	0.89	0.00	0.41	0.71	0.89

a= Highest mean; b= lowest mean.

Table 4. Relationships among the wilted and dead plants at different time of water stress of the seven cowpea.

Genotype	No. of wilted plants (28DAS)	No. of dead plants (28 DAS)	No. of Wilted plants (34 DAS)	No. of dead plants (34 DAS)	No. of wilted plants (40 DAS)	No. of dead plants (40 DAS)	No. of healthy plants
NWP 28	1.00						
NDP 28	0.00	1.00					
NWP 34	0.00	0.00	1.00				
NDP 34	0.00	0.00	0.20[ns]	1.00			
NWP 40	0.00	0.00	0.65*	0.31[ns]	1.00		
NDP 40	0.00	0.00	1.00[ns]	0.20[ns]	0.65*	1.00	
NHP	0.00	0.00	-0.95*	-0.31[ns]	-0.85*	-0.95*	1.00

ns= No significant difference; *Significantly different (P≤0.05), **Highly significant difference (P≤0.01).

Table 5 shows the results of ANOVA for genetic variability for growth and yield of seven cowpea varieties. The result shows that a highly significant difference (P≤0.01) was found in the plant height, number of days to 50% flowering, number of days to maturity, number of pods per plant, pod length, number of seeds per plant and 100 seed weight, while significant difference (P≤0.05) was found in seedling height and number of branches per plant. No significant difference was found on the other growth and yield parameters.

The mean performance of seven cowpea varieties is shown in Table 6, which shows that IAR1074 and sampea 2 has the highest mean performance in terms of germination percentage and the lowest mean performance was found in sampea 8. Similarly, IAR1074 was found to have the highest mean performance in the seedling height and least was found in sampea 10. However, sampea 1 has the higher mean performance in

Table 5. Mean square for the geneticvariability studies among seven cowpea variety.

Source of variation	Df	G7	SH (cm)	PH (cm)	B/p	L/p	LA	D 50% F	DM	P/ p	Pl (cm)	S/p	SW	DW (g)
Variety	6	1.49^{ns}	13.43*	749.34**	2.74*	27.11^{ns}	154.59 ^{ns}	3679.56**	6727.89**	15.75**	82.15**	47.60**	144.96**	52.44**
Error	14	2.00	-	-	0.95	14.57	89.38	3.09	2.24	1.95	1.63	0.95	0.19	1.24

ns= No significant difference; *Significantly different (P≤0.05), **Highly significant difference (P≤0.01).

Table 6. Mean performance of the seven cowpea genotypes for growth and yield.

Variety	G %	SH (cm)	PH (cm)	B/P	L/P	LA	D50% F	DM	P/P	P L	S/p	100 SW	DW
Sampea1	11.33^{a}	32.40^{bc}	91.00^{a}	6.00^{bc}	19.33^{a}	34.47^{b}	0.00^{d}	0.00^{e}	0.00^{c}	0.00^{d}	0.00^{e}	0.00^{f}	16.90^{a}
Sampea2	11.00^{a}	36.23^{ba}	67.33^{b}	5.33^{bc}	12.33^{ba}	44.50^{ba}	94.33^{a}	125.67^{b}	5.00^{ba}	12.83^{ba}	10.00^{bc}	15.23^{e}	10.33^{b}
IAR1074	11.67^{a}	36.63^{a}	71.67^{b}	5.67^{bc}	16.67^{ba}	47.63^{ba}	96.67^{a}	132.00^{a}	5.67^{ba}	14.00^{ba}	9.33^{bcd}	19.30^{b}	14.87^{a}
Sampea7	11.33^{a}	36.17^{ba}	70.67^{b}	4.67^{c}	11.33^{b}	54.00^{a}	96.33^{a}	128.33^{b}	7.33^{a}	13.67^{ba}	10.67^{ba}	16.23^{d}	10.73^{b}
Sampea8	09.67^{a}	32.30^{bc}	49.00^{cd}	7.00^{ba}	17.00^{ba}	39.57^{ba}	91.00^{b}	126.33^{b}	5.67^{ba}	12.33^{b}	8.67^{cd}	16.93^{dc}	15.83^{a}
Sampea10	10.67^{a}	31.73^{c}	43.67^{d}	7.33^{a}	12.33^{ba}	39.57^{ba}	86.67^{b}	121.67^{c}	4.33^{b}	15.17^{a}	12.33^{a}	17.10^{c}	6.57^{c}
Sampea12	11.67^{a}	34.43^{bc}	59.50^{bc}	5.33^{bc}	13.67^{ba}	52.23^{ba}	73.33^{c}	105.67^{d}	5.33^{ba}	8.83^{c}	7.67^{d}	21.07^{a}	7.17^{c}
Mean	11.05	34.27	64.69	5.90	14.67	44.57	77.33	105.67	4.76	10.98	8.38	15.12	11.76
S E (+)	0.51	1.03	6.28	0.46	1.62	3.94	12.55	1.69	0.93	1.92	1.46	2.49	1.54

a = High mean; b a, b, b c, c, b c d, c d, and d = lowest mean.

terms of plant height and sampea 10 is having the lowest mean performance. Meanwhile the highest mean performance for the number of branches per plant was obtained in sampea 10, while the least was found in sampea 7. In terms of the number of leaves per plant, the highest mean was found in sampea 1, while sampea 7 has the lowest. The highest mean performance in the leaf area was found in the sampea 7 while sampea1 has the lowest mean performance. However, IAR1074 has the highest mean in the number of days to 50% flowering and the number of days to maturity, while sampea 7 has the higher mean performance in terms of number of pod per plant and in the pod length, the high mean was found in sampea 10 similarly in the number of seeds per plants. However, sampea 12 was found to have the highest mean performance in 100 seed weight and sampea 1 is found to be the lowest in all yield parameters. Meanwhile, sampea 1 was found to be the highest interms of dry weight and sampea 10 was having the lowest mean performance.

On the other hand, Table 7 shows the relationships between different parameters of the seven cowpea varieties. The result indicated a positive relationship between the number of days to 50% flowering and the number of days to maturity. Similar relationship exists between the number of days to maturity and number of pod per plant; between the number of days to 50% flowering and number of pod per plant; pod length and number of days to 50% flowering; seed per pod and number of days to 50% flowering; seed per pod and number of days to maturity; pod per plant and pod length. Similarly, the result indicated that positive relationship exists between 100 seed weight and number of days to flowering, days to maturity, pod per plant, pod length and seed per pod. A positive relationship was also found between leaf area and seedling height, pod per plant and 100 seed weight. While no relationship was found on germination percentage and other parameters. Similarly, no relationship was found between leaf area and days to 50% flowering days to maturity. However, negative relationship was found between plant and other parameters; while no relationship was in the remaining parameters.

Result for the ANOVA of proximate analysis for seven cowpea genotypes is shown in Table 8. The result indicated a highly significant difference

Table 7. Relationship between the growth and yield parameters of the seven cowpea genotypes under study.

Correlation	*Germ%*	*SDH*	*PLH*	*BRP*	*LVP*	*LFA*	*DFL*	*DMT*	*PPP*	*SPP*	*PL*	*SW*	*DW*
Germ%	1.00												
SDH	0.18	1.00											
PLH	0.26	0.15	1.00										
BRPP	-0.42	-0.16	-0.51*	1.00									
LVPP	-0.27	-0.16	-0.45*	0.21	1.00								
LFA	0.21	0.53*	-0.13	-0.32	-0.44	1.00							
DFL	-0.09	0.31	-0.55*	-0.06	-0.45*	0.37	1.00						
DMT	-0.09	0.31	-0.61**	-0.03	-0.44	0.37	0.99**	1.00					
PPP	-0.18	0.40	-0.35	-0.24	-0.35	0.51*	0.88**	0.81**	1.00				
PL	-0.16	0.23	-0.60**	0.05	-0.40	0.21	0.95**	0.94**	0.69**	1.00			
SPP	-0.15	0.17	-0.66**	0.08	-0.51*	0.32	0.92**	0.92**	0.70**	0.94**	1.00		
100SW	0.01	0.27	-0.63**	-0.06	-0.39	0.44	0.89**	0.91**	0.76**	0.80**	0.81**	1.00	
DW	-0.14	-0.13	0.48*	-0.05	0.51*	-0.27	-0.41	-0.42	-0.33	-0.43	-0.58**	-o.54*	1.00

ns=No relationship; *=Relationship; **= strong relationship.

Table 8. Result for the mean squares of the seven cowpea genotypes.

Sources of variation	Df	Moisture	Ash	Fibre	Fat/oil	Protein	Carbohydrate
Variety	5	2.22^{ns}	1.54**	2.10*	0.21^{ns}	12.69**	21.70^{ns}
Error	12	2.43	0.11	0.83	0.43	3.76	16.94

ns= No significant difference; * =Significant difference (P≤0.05); **= Highly Significant difference (P0.01).

Table 9. Mean performance of the proximate analysis for the six cowpea genotypes under study.

Variety	Moisture	Ash	Fibre	Fat/oil	Protein	Carbohydrate
Sampea 2	6.67^{a}	2.17^{b}	3.00^{ab}	3.33^{a}	23.79^{ab}	62.29^{a}
IAR 1074	5.00^{a}	2.35^{b}	2.33^{b}	3.33^{a}	21.05^{b}	65.94^{a}
Sampea 7	6.67^{a}	3.97^{a}	4.00^{ab}	3.75^{a}	20.99^{b}	59.38^{a}
Sampea 8	5.83^{a}	2.22^{a}	4.33^{a}	3.32^{a}	26.40^{a}	58.72^{a}
Sampea 10	6.67^{a}	2.20^{b}	3.00^{ab}	3.33^{a}	24.10^{ab}	59.73^{a}
Sampea 12	7.50^{a}	2.16^{b}	2.33^{b}	2.92^{a}	22.70^{ab}	62.25^{a}
Mean	6.39	2.51	3.17	3.33	23.17	61.39
S E (+)	0.63	0.30	0.45	0.25	1.03	1.75

a = Higher mean; ab, b = lowest mean.

(P≤0.01) in the ash and protein content, while a significant difference (P≤0.05) was observed in the fiber content; whereas no significant difference was found in the remaining parameters. Table 9 shows the result of mean performance for the proximate analysis of seven different cowpea varieties that indicated that sampea 12 has the highest moisture content, while IAR1074 has the lowest. The highest ash content was found in sampea 7 and the lowest was found in sampea 12. In terms of amount of fibre, the highest mean performance was found in sampea 8 while IAR 1074 and sampea 12 has the least mean performance. However, for fat content, the highest mean was found in sampea 7 and the lowest was found in sampea12. Sampea 8 shows a high mean performance in terms of protein content while sampea 7 has the lowest. However, the carbohydrate content of cowpea varieties was found to have the highest mean performance in IAR1074 and the lowest was sampea 8.

The relationship among the seven cowpea varieties for the proximate analysis is shown in Table 10 which indicated that there is a negative relationship (P≤ 0.01) between moisture content and carbohydrate, fibre and

Table 10. Relationship among the nutritional content of cowpea.

Correlation	Moisture	Ash	Fibre	Fat/oil	Protein	Carbohydrate
Moisture	1.00					
Ash	0.09^{ns}	1.00				
Fibre	0.20^{ns}	0.28^{ns}	1.00			
Fat/oil	0.06^{ns}	0.39^{ns}	0.21^{ns}	1.00		
Protein	0.08^{ns}	-0.38^{ns}	0.24^{ns}	-0.11ns	1.00	
Carbohydrate	-0.63^{**}	-0.24^{ns}	-0.58ns	-0.21ns	-0.58^{*}	1.00

ns = No relationship; * = relationship; ** =strong relationship.

Table 11. Some of the qualitative traits found in the seven cowpea varieties under study.

Variety	Growth habit	Flower color	Seed coat color	Seed shape	Seed texture	Eye color
Sampea1	Spreading	-	-	-	-	-
Sampea2	Spreading	White	Brown	Kidney	Smooth	Brown
IAR1074	Spreading	White	Brown	Kidney	Smooth	Brown
Sampea7	Erect	White	Brown	Rhomboid	Smooth	Brown
Sampea8	Erect	White/Violet	White	Rhomboid	Rough	Black
Sampea10	Erect	White	White	Rhomboid	Rough	Black
Sampea12	Spreading	White	Brown	Kidney	Smooth	Brown

carbohydrate and also between protein and carbohydrate, while there are no relationships among other.

Also from Table 11 it shows some important qualitative traits found in the seven cowpea varieties that include Growth habit, Flower Color, Seed Coat Color, Seed Shape, Seed texture and Eye Color.

DISCUSSION

The screening for water stress tolerance in cowpea is a vital phenomenon that increases the potential of cowpea production in Nigeria especially in areas where drought is rampant. The significant difference and highly significant differences exhibited for number of wilted plants at 34 and 40 days. The number of dead plants at 40 days as well as number of healthy stands would be as an evidence that values of all the growth parameters decreased with the period of growth as the water stress increased. This is in conformity with the findings of Okon (2013). The different (highest and lowest) mean performances obtained in the different varieties under water stress based on the number of wilted, dead and healthy plants at different days interval could be as a result of variation that exist in the rate of decrease of growth parameters among the different varieties (in different fortnight) with respect to corresponding variation in water stresses. It was observed that, under intense water stress conditions, there was a sharp changes in the values obtained. Similar result was reported by Ba et al. (2004) in soya bean seedlings.

High differences in the mean performance were observed in the different cowpea varieties to water stress at different days based on the wilted, dead and healthy plants, with the highest mean performance (8.97) obtained in the number of healthy plants and lowest (0.02) obtained in the number of dead plants at 34 days. This indicates the existence of a high degree of genetic variability in the different cowpea varieties. However, certain factors such as height of the culms, size of the leaves, the distance between the veins and the stomata openings are all affected when the varieties are developing under water stress. This is in line with findings of Zia-ul-haq et al. (2010) who reported that water stress causes changes (significant difference) in the different varieties.

The positive relationships that exist between number of wilted plants at 40 days also between number of dead and wilted plants at 40 days showed that traits might not be independent in their action and are interlinked likely to bring simultaneous change for other characters. They can be effectively used as selection criteria for cowpea yields (varieties) under water stress conditions.

The negative relationships that exist between number of healthy plants and number of wilted plants at 34 days, number of wilted plants conditions can influence genetic interactions among the traits as well as genetic variance in the traits themselves. This is in line with the findings of Coulibaly et al. (2002) who suggested exposure to water stress conditions may induce positive relationships for among the traits and expression of new gene will break negative correlations. The highly significant difference (P≤0.01) and significant difference (P≤0.05) exhibited the characters (parameters) studied indicated the existence of sufficient genetic variability among the selected traits for improve yield in cowpea. While the non-significant difference (P≤0.05) exhibited for some few characters (parameters) is line with the report of Manggoel et al. (2012) who suggested that traits with such significant difference might be under genetic control rather than environmental influence.

The differences (highest and lowest) in mean performance of different cowpea varieties studies based on their different traits measured could be as a result of durations of the experiment which affects the differential changes that might occur in the morphological features of the varieties of the plants at a given time. The growth habits of different varieties studied also varied which result to differences in the mean performance, with highest mean performance in a particular trait such as maturity and lowest in another trait in a given variety. This observation is in line with the findings of Ekpo et al. (2012) who observed that there is variability in the growth habit of cowpea in different species.

The results from this research are similar to those found by Lobato and Costa (2011) where reduction in leaf relative to water content was reported. The study also recorded reduced vegetative growth due to water stress. This finding agrees with that of Nwofia et al (2012). Nwofia et al. (2012) reported similar results on decrease in growth and yield which can be attributed to the effects water has on the physiology of cowpea. The finding also agrees with that of Samson and Helmut (2007) on cowpea that reduction in leaf area in cowpea varieties (with sampea 1 had the lowest 34.47 cm^2) is a mechanism adapted to avoid higher rate of transpiration and reduced surfaces for radiation due to water deficit. The reduction in number of pods result of increase in with the lowest found in sampea 10, which is (4.33), could be because of increase in reduction of soil moisture, thereby reducing the number of seeds that may contribute to low yield in water, stressed cowpea. This is in line with the findings of who reported reduction in number of pods in different cowpea varieties Abayomi and Abidoye (2009).

The positive relationships that exist between yield traits or parameters could be as a result of the fact that cowpea varieties height studied contributed to yield as it leads to resulting increase in the number of days to maturity, days to flowering, number of pods and other yield traits. The result obtained is in line with the findings of Cursky et.al (2002) who reported that plant height contribute positively to different yield parameters or traits. In addition, yield improvement would be possibly achieved by selecting for the number of pods per plant, since the study revealed that, number of pods per plants increased significantly.

Correlations has used in indirect selection for breeding characters (Diouf, 2011). The highly significant difference (P≤0.01) and significant difference (P≤0.05) obtained in the ash, protein content and fibre contents showed that the range of values were within the recommended values, this range of values fall within the values reported for cowpea Longe (1980). In this study, the ash have 2 to 3%; protein, 20 to 27%; and fiber, 2 to 4%.

The best mean performance of the proximate analysis was found in carbohydrate in all the cowpea varieties (58.72-65.94%), while the least mean performances in all the varieties were found in Ash content (2-4%). The high and low mean performance of the studied varieties may not depend on genetic factor alone, but also on environmental influences. The result obtained is in line with the findings of Nwosu et al. (2013) who worked on the different cowpea varieties and discovered high and low in the mean performance of the proximate analysis contents. However, from the result obtained, high variability was found in the mean performances of the different varieties in terms of their yield traits (ash content, protein, moisture, fibre, fat and carbohydrates). The observed variability was in agreement with the work of Nwosu et al. (2013) and could serve as an important purpose in improving the crop as selected would be effective for population with broad genetic variability as opened by previous workers (Omoigai et al., 2006; Animasaun et al., 2015). The negative relationship that exist shows that moisture content had the highest relationship (0.63) and the least values or relationships were found in fibre and protein (0.58). The significance of the result would be better interpreted to mean that the cowpea varieties cultivated under wide cultural conditions such as soil compositions climate and agronomic practices vary widely in moisture and carbohydrate, contents, followed by the fibre and protein. These components are important in determining nutritive quality and processing quality of cowpea seeds. The content of fat was the least with no relationship. The non-relationship that exists between fat content and carbohydrate is an advantage during processing to flour; unlike other legumes such as soya bean, there is no need for a defatting stage in flour production. Similar finding was obtained by Henshaw (2008) who studied varietal differences in physical characteristics and proximate composition of cowpea (*V. unguiculata*).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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