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EFFECT OF DROUGHT AT DIFFERENT REPRODUCTIVE STAGES ON YIELD AND YIELD COMPONENTS OF SOME COWPEA (*VIGNA UNGUICULATA L. WALP*) VARIETIES IN LAPAI, NIGER STATE, NIGERIA

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ABSTRACT

Drought is one of the most unfavorable abiotic factors that can affect the growth and yield of cowpea. Drought at different reproductive stages can interfere with the morphological processes of plants. Therefore this research aim to determine the effect of drought at different reproductive stages on yield and yield components of some cowpea varieties. A screen house experiment was conducted at the Botanical Garden of Biological Science Department, Ibrahim Badamasi Babangida, University during the 2022 cropping season The three cowpea varieties used were; FUAMPEA 1, FUAMPEA 2 and ITK89KD-288 which were planted and subjected to water stress at three different reproductive stages which included; early flowering stage, early pod set stage, early seed filling stage and a well-watered treatment to serve as control. The treatments were arranged in a Complete Randomized Design (CRD) in three replications. Cowpea yield attributes evaluated were; number of pods per plant, pod length, pod weight per pot, number of seeds per pod, 100 seed weight, total grain yield per pot and estimated grain yield per hectare. Results revealed that variety was highly significant ($p \leq 0.01$) for pod length, total grain yield per pot and estimated grain yield per hectare. On the other hand, drought was significant ($p \leq 0.05$) for pod weight per pot. Variety however was not significant for number of pods per plant, number of seeds per pod and 100 seed weight. Drought showed a highly significant effect ($p \leq 0.01$) on number of pods per plant, pod length, pod weight per pot, number of seeds per pod, 100 seed weight, total grain yield per pot and estimated grain yield per hectare. Water stress at early seed filling stage significantly reduced total grain yield per plot and total grain yield per hectare. Drought at different reproductive stages affects the morphological and physiological processes of cowpea as a crop. This is an indication that water is very crucial during the growth and yield of cowpea.

Keywords: Drought, Grain Yield, Reproductive Stages, Seed Weight, Pod Length.

INTRODUCTION

Cowpea (*Vigna unguiculata L. Walp*.) is an annual herbaceous legume belonging to the family Fabaceae and it is grown predominantly in Africa and is an important staple crop providing an affordable source of protein (Muranaka, 2016). It has a number of common names, including black-eye pea, black-eye bean, Southern pea and China bean. Cowpea is an annual herbaceous legume cultivated for its edible seeds or for fodder. Cultivated cowpeas are herbaceous annuals that are either erect, prostrate or climbing annuals with a tap root and virtually all are glabrous. They are mostly grown for grain but a small proportion (about 10%) are grown as green leafy vegetables and fodder in Africa or as fresh pods in Eastern Asia (Boukar *et al*., 2017). The plants are thought to be native to West Africa and are widely cultivated in warm regions around the world. In addition to their use as a protein-rich food crop, cowpeas are extensively grown as a hay crop and as a green manure or cover crop. Cowpea is grown across the world on an estimated 14.5 million hectares of land planted each year and the total annual production is 6.2 million metric tons (FAOSTAT, 2019). Nigeria is Africa's biggest producer and consumer of cowpea with an estimated grain production of 3.4 million tons in 2017 (FAOSTAT, 2019). Most of the production in Sub-Saharan Africa is by smallholder farmers in marginal conditions, often as an intercrop with maize, sorghum and millet (Horn & Shimelis, 2020). The crop is a healthy food for legume that is considered as an important complement to soybean or groundnut that is high in oil content but lower in fiber (Timko & Singh, 2008).

Generally, plant productivity is adversely affected by various biotic and abiotic stress factors of the environment which are the most important yield reducing factors in the world (Franklin *et al*., 2010). Despite the enormous economic and nutritional importance of cowpea, most farmers in the country are largely dependent on rain fed cropping system hence; the productivity of the crop is repressed by environmental (abiotic) stress factors. Drought, (water deficit) stands out as one of the major abiotic stresses which adversely affects cowpea yield (Franklin *et al*., 2010). The occurrence of drought stress at different reproductive stages limits the yield potential and thus quality of cowpea (Casteel, 2012). Therefore, it is expedient to investigate the effect of drought on the yield and yield components of cowpea.

MATERIALS AND METHODS

Source of seeds

Three cowpea varieties used for this experiment (FUAMPEA 1, FUAMPEA 2 and ITK89KD-288) were obtained from the Seed Centre of the Joseph Sarwuan Tarka University, Makurdi during the 2022 cropping season.

Experimental design

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Ten seeds each of the three cowpea varieties consisting of FUAMPEA 1, FUAMPEA 2 and ITK89KD-288 were planted separately each in a pot packed with sterilized top soil. Watering of the plastic pots was done consistently at field capacity until the commencement of water stress treatment at early flowering stage when watering was stopped for the drought treatment except for the control. The varieties were subjected to water stress at three different growth stages - early flowering stage, early pod set stage and early seed filling stage. The drought period lasted for ten days for drought treatments after which watering resumed. Thinning to reduce the seedling population to six plants per pot was done two weeks after sowing. The experiment was carried out in the screen house at Botanical Garden of Biological Science Department, Ibrahim Badamasi Babangida University which lies between latitude of 71349.46ºN and longitude 32611.98⁰E.The treatments were arranged in a Completely Randomized Design (CRD) replicated three times.

Data Collection and Analysis

Data were taken on number of pods per plant, pod length, pod weight per pot, number of seeds per pod, 100 seed weight, total grain yield per pot and estimated grain yield per hectare. Data collected on all parameters were subjected to the Analysis of Variance (ANOVA) using the Minitab version 2017 package. Significant means were separated at 95% Probability level using Tukey Pairwise Comparisons

RESULTS

The mean squares from the analysis of variance for the effect of drought at different reproductive stages on yield of cowpea are presented in table 1. The table indicated that variety was highly significant (p≤0.01) for pod length, total grain yield per pot and estimated grain yield per hectare. On the other hand, drought was significant (p≤0.05) for pod weight per pot. Variety however was not significant for number of pods per plant, number of seeds per pod and 100 seed weight. Drought showed a highly significant effect (p≤0.01) on number of pods per plant, pod length, pod weight per pot, number of seeds per pod, 100 seed weight, total grain yield per pot and total grain yield per hectare. Similarly, Variety x Drought interaction was highly significant (p≤0.01) for pod length, pod weight per pot, total grain yield per pot and estimated grain yield per hectare.

Table 1: Mean Squares for Effect of Drought at different Reproductive stages on Yield of Cowpea

SOV	NOP/PLT	POD LGHT (cm)	POD WGT/POT (Kg)	NOS/POD	100SWT (g)	TGY/PLOT (Kg)	ETGY/ha (Kg)
Replication	23.12	45.32	62.12	34.45	56.11	38.45	27.34
Varieties	54.84NS	6.90**	91.34*	27.10NS	12.91NS	596.32**	367.10**
Drought	34.11**	34.52**	41.56**	14.31**	31.58**	2787**	871.90**
Variety x Drought	45.78NS	67.87**	12.79**	79.45NS	90.31NS	56.43**	567.44**
Error	24.24	43.76	76.23	7.32	5.47	121.01	431.46

NOP/PLT= Number of pods per plant
NOS/POD=Number of seeds per pod
100 SWT=One hundred seed weight
POD LGHT= Pod length
POD WGT/PLOT= Pod weight per plot
TGY/PLOT= Total grain yield per plot
ETGY/ha= Estimated grain per hectare
NS= Not significant
**= Highly significant at (p≤0.01)
*= Significant at (p≤0.05

The mean effect of variety on yield of cowpea is presented in table 2. The result showed that FUAMPEA 1 recorded significantly the longest pods compared to FUAMPEA 2 and ITK89KD-288 A similar trend was observed for pod weight per pot where FUAMPEA 1 was observed to have recorded the highest pod weight even though it was not significantly different from FUAMPEA 2 but was different from ITK89KD-288 (0.84). More so, number of seeds per pod was highest in FUAMPEA 1 and significantly lowest in ITK89KD-288.

Table 2: Mean Effect of Variety on Yield of Cowpea

VARIETY	NOP/PLT	POD LGHT (cm)	POD WGT/POT (Kg)	NOS/POD	100 SWT (g)	TGY/POT (Kg)	ETGY/ha (Kg)
FUAMPEA 1	20.35a	17.04a	2.55a	14.61a	45.56a	0.39a	392.34a
FUAMPEA 2	20.51a	15.79b	2.53a	12.45b	45.50a	0.34b	345.12b
ITK89KD-288	19.98a	13.45c	0.84b	8.43c	45.42a	0.27c	271.23c

*Means with the same letter(s) in a column are not significantly different

NOP/PLT= Number of pods per plant
NOS/POD=Number of seeds per pod
100 SWT=One hundred seed weight
POD LGHT= Pod length
POD WGT/PLOT= Pod weight per plot
TGY/PLOT= Estimated grain yield per plot
TGY/ha= Total grain per hectare

Mean effect of drought at different reproductive stages on yield of cowpea is shown in table 3. The result showed that the well-watered control recorded significantly highest number of pods per plant whereas drought during early flowering stage produced the least number of pods per plant Similarly, the well-watered control produced significantly longest pods though were not significantly different from when drought occurred at early flowering stage but were however different from drought at early seed fill stage and early pod set stage. Pod weight per pot also showed a similar trend. Number of seed per pod was observed to be highest in the control treatment and lowest when drought occurred at early pod fill stage. A similar trend was observed for 100 seed weight. Total grain yield per pot was observed to be significantly highest in the control and lowest when drought occurred at early seed filling stage. Estimated grain yield per hectare followed a similar trend.

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Table 3: Mean Effect of Drought at different Reproductive stages on Yield of Cowpea

DROUGHT	NOP/ PLT	POD LGHT (cm)	POD WGT/POT (Kg)	NOS/ POD	100 SWT (g)	TGY/ POT (Kg)	EGY/ha (Kg)
Early Flowering stage	5.21d	16.09a	2.22ab	12.12b	37.11b	0.39a	394.34b
Early Pod Set stage	12.47c	13.62c	1.97c	8.00c	28.42c	0.34b	342.57c
Early Seed Filling stage	17.32b	15.45b	0.57d	4.27d	21.33d	0.29c	292.11d
Control	20.56a	16.38a	2.86a	14.07a	40.21a	0.40a	407.45a

*Means with the same letter(s) in a column are not significantly different

NOP/PLT= Number of pods per plant
NOS/POD=Number of seeds per pod
100 SWT= One hundred seed weight
TGY/PLT= Total grain yield per plant
POD LGHT= Pod length
POD WGT/PLOT= Pod weight
TGY/ha= Estimated grain yield per hectare

Effect of variety x drought interaction on yield of cowpea is shown in table 4. The table indicated that FUAMPEA 1 performed better than FUAMPEA 2 and ITK89KD-288 at the different stages of drought occurrence.

Table 4: Effect of Variety x Drought Interaction on Yield of Cowpea

Variety x Drought	POD LGHT (cm)	POD WGT/POT (Kg)	TGY/ LOT (Kg)	EGY/ha (Kg)
Early Flowering stage	16.89a	2.54a	0.39a	390.11a
FUAMPEA 1 Early Pod Set stage	12.43b	1.71a	0.32a	324.23a
Early Seed Filling stage	15.34a	0.89a	0.21a	212.34a
Control	17.78a	2.78a	0.40a	408.22a
Early Flowering stage	14.56a	2.51a	0.37b	370.00b
FUAMPEA 2 Early Pod Set stage	13.43a	1.08b	0.29b	290.57b
Early Seed Filling stage	14.03b	0.54b	0.20a	202.45b
Control	16.69b	2.32a	0.38b	380.21b
Early Flowering stage	16.23b	2.16b	0.28c	280.31c
ITK89KD-288Early Pod Set stage	11.04c	1.00b	0.23c	233.08c
Early Seed Filling stage	12.56c	0.51b	0.19a	192.34c
Control	16.02b	2.29a	0.30c	301.87c

*Means with the same letter(s) in a column are not significantly different

NOP/PLT= Number of pods per plant
NOS/POD= Number of seeds per pod
100 SWT= One hundred seed weight
TGY/PLT= Total grain yield per plant
POD LGHT= Pod length
POD WGT/PLOT= Pod weight, **EGY/ha**= Estimated grain yield per hectare

DISCUSSION

The highly significant effect of drought at different reproductive stages on yield of cowpea is an indication that water is very essential during the reproductive stages in the cowpea growth. This is evident in the consistent reduction in the yield indices of the cowpea varieties as a result of water deficit from the beginning of the reproductive phase (early flowering stage) to early seed fill stage. This observation is similar to what was reported by (Damba *et al*., 2019) that drought during the flowering stage in cowpea resulted to abortions of flowers thereby leading to fewer number of pods per plant. It is also in line with the report of (Mike, 2018) that water stress during the bloom stage of soybean caused flower abortions which significantly reduced the number of pods. Similarly, (Dennis *et al*., 2021) reported a drastic reduction in yield of soybean when drought (water stress) occurred at the early seed filling stage.

Number of seeds per pod was significantly highest in FUAMPEA 1 compared to FUAMPEA 2 and ITK89KD-288 Similar trend was observed for total grain yield per plot and also estimated grain yield per hectare. This agrees with the findings of (Virmani & Kumar, 2004) who reported that, when plants are grown in a given ecology, growth and yield differences are observed due to the differences in their genotypes. This observation is also in line with the findings of (Dennis *et al*., 2021) who reported variations in yield among soybean genotypes as a result of drought during reproductive ontogeny indicating that the genotypes were genetically different from each other in their abilities to withstand drought.

The occurrence of drought especially at seed filling stage significantly reduced cowpea seed yield.(Dadson *et al*., 2005) reported a significant decline in cowpea seed yield when drought occurred during the reproductive stages but was more severe at seed filling stage. The declining seed weight as drought occurred from early flowering to seed filling stages further indicated that the importance of water at different reproductive stages of cowpea. This observation is similar to what was reported by (Canci & Toker, 2009). that water stress at seed filling stage reduced the general seed weight due to inadequate dry matter accumulation in the seed.

The least yield for all the varieties was observed when drought occurred at early seed filling stage. (Virmani & Kumar, 2004) reported that plants exhibits differences in their growth and yield potentials due the differences in their genetic makeup.

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