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Evaluation of Advanced Lines of Cowpea (*Vigna unguiculata* (L.) Walp) for Agronomic Traits and Grain Yield in the Transition Zone of Nigeria

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Abstract: A field experiment was conducted at the Teaching and Research Farm of the University of Agriculture, Abeokuta in 2001 and 2002 cropping seasons to evaluate 25 advanced medium erect cowpea lines for agronomic traits and grain yield using a Randomized Complete Block Design with three replicates. Significant difference was recorded on most of the parameters measured. The average number of days to 50% flowering ranged from 52 DAP TO 56 DAP in IT98K-131-2 and IT95K-207-22, respectively. Most of the lines attained physiological maturity about the same time. IT98K-131-2 recorded the highest average number of pods per plant and also recorded the highest grain yield of 1392 kg ha^{-1}. It is concluded that most farmers should be encouraged to adopt some of the breeding lines that recorded grain yield of over 1000 kg ha^{-1}.

Key words: Cowpea, advanced lines, evaluation, grain yield, forest savannah-transition zone

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an important food crop in many parts of the semi arid tropics (Jackai *et al*., 1985). Despite its importance, cowpea low yield of 500 kg ha^{-1}(Adipala *et al*., 1997) is prevalent on farmers' fields. A diverse and destructive pest complex is a major cause of low yield and sometimes total crop failure in the field and considerable losses in storage (Sabiti *et al*., 1994; Adipala *et al*., 1997; Omongo *et al*., 1997; Omongo *et al*., 1998). Cowpea yield can be as low as 110 kg ha^{-1} on farmers' fields in northern guinea savannah of Nigeria which is the heart of cowpea growing region in West and Central Africa (Mortimore *et al*., 1997). In the humid south western part of Nigeria the grain yield of cowpea is about 200-400 kg ha^{-1} in spite of the introduction of improved varieties (Okeleye *et al*., 1999). The use of host plant resistance to control the disease and pest problems in cowpea production is considered as the most appropriate approach for the resource-poor, small-scale farmers who can not afford to purchase insecticides (Adipala *et al*., 2003). Efforts aimed at increasing cowpea yield include breeding for disease resistance, drought tolerance or avoidance and early maturing varieties that are adapted to different agro-ecological environments. Such varieties would be particularly suitable in areas with unreliable total amount, distribution and duration of rainfall where crop failure is often attributed to early cessation of rains (Okeleye *et al*., 1999). Vegetative growth terminates at different days before flower opening. Thus number of days to 50% flowering and number of days to 95% maturity are critical factors in cowpea yield.

Agronomic traits of cowpea that contribute to cowpea growth, development and yield include number of peduncles per plant, number of pods per plant, pod length, number of seeds per pod, 100 seed weight and grain yield (Babalola, 1980). A wide range of genetic variability exist in cowpea that could provide the basis for genetic improvement for yield. Number of pods per plant and seeds per pod were positively correlated with yield (Doku, 1970; Ebong, 1971; Ojomo, 1974). High genotypic coefficient of variability has been observed for number of pods per plant and yield (Pandita *et al*., 1982), seeds per pod and yield (Singh and Mehndirata, 1969).

Component traits that are vital in indirect selection for yield should have high heritabilities and expressiveness. Crop improvement involves developing progeny lines through many generations up to F6. By the 5th and 6th generation of selfing, the resultant lines are regarded as advanced lines. Such lines need to be evaluated in different agro-ecologies while promising lines are advanced to multi-location national yield trials before they are eventually released as varieties for on-farm yield trials. The objective of this study therefore was to evaluate these advanced lines of cowpea for agronomic traits and grain yield in the transition zone of Nigeria.

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MATERIALS AND METHODS

This study was conducted at the Teaching and Research Farm of the University of Agriculture, Abeokuta, Nigeria (7°N, 3° 23'E) located in the forest-savannah transition zone of south west Nigeria. Twenty five advanced medium erect cowpea lines from the International Institute of Tropical Agriculture, Ibadan, Nigeria were evaluated during the late cropping seasons of 2001 and 2002 using a Randomized Complete Block Design with three replicates. Ife Brown was used as local check. Ife brown is a widely cultivated variety in savannah and rain forest ecologies of Nigeria. The experimental field was ploughed twice. After the second ploughing and subsequent harrowing, 20 kg N, 20 kg P and 20 kg K were applied as basal fertilizer one week before planting.

The experiment consisted of 5-row plots with a plot size of 5×2 m (10 m^2). Spacing was 0.75×0.25 m with 2 plants per stand (106, 666 plants per hectare).

The soil of the experimental site was sandy loam (sand 80%; silt 6.4%; clay 5.6%; CEC 6.2 meq $100g^{-1}$ and pH 5.98). Weed control was done manually at three and six Weeks After Planting (WAP). Spraying against insect pests was done three times commencing from five WAP at 10 days intervals. Cypermethrin+dimethoate (Sherpa-Plus) was applied at the manufacturers recommended rate of 50 mL 10 L of water (30+250 g a.i. ha^{-1}) for the first, second and third sprays.

Data were collected on days to 50% flowering, number of days to 95% maturity, maturity period, number of pods per plant, pod length, 100 seed weight and grain yield kg ha^{-1}. Data obtained were subjected to Analysis of Variance (ANOVA) and the treatment means were compared using the Duncan Multiple Range Test (DMRT) method. The association of different characters with yield was determined by multiple correlation.

RESULTS

Phenology: In general, high significant difference was recorded on days to flowering, days to 95% maturity and maturity period among the 25 cowpea lines. In 2001, IT97K-499-38 flowered at 49 DAP which was 10 and 2 days earlier than IT97K-1025-6 and Ife brown, respectively (Table 1). However, in 2002, IT95K-1090-12 flowered first at 48 DAP while IT47K-1025-18 flowered last at 59 DAP.

Most of the lines in 2001 and 2002 attained 95% maturity between 81-91 DAP and 80-92 DAP, respectively. In 2001 and 2002, the lines matured between 23-40 DAF and 25-39 DAF, respectively.

Table 1: Number of days to 50% flowering, number of days to 95% maturity and maturity period of advanced medium erect cowpea lines in 2001 and 2002 seasons

	No. of days to 50% flowering			No. of days to 95% maturity			Maturity period (Days)		
Lines	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
IT95k-207-15	50c	54ab	52ab	81c	87a	84ab	31bc	33ab	32a
IT95k-207-22	58a	54ab	56a	84c	92a	88a	26c	38a	32a
IT98k-128-4	51c	57a	54a	88a	84c	86a	37a	27bc	32a
IT98k-205-10	54ab	56a	55a	91a	85ab	88a	37a	29bc	33a
IT98k-205-15	58a	51c	55a	87a	89a	88a	29c	38a	33a
IT98k-205-9	50c	54ab	52ab	89a	85ab	87a	39a	31ab	35a
IT98K-962	51c	55ab	53ab	84c	86ab	85ab	33ab	31ab	32a
IT98K-506-1	56ab	52c	54a	87a	83c	85ab	31bc	31ab	31ab
IT98K-131-2	53 bc	51c	52ab	88a	84c	86a	35ab	33ab	34a
IT97K-1021-24	56ab	50c	53ab	85ab	83c	84ab	32bc	33c	31ab
IT97K-1021-9	52b	54ab	53ab	86ab	80c	83c	34ab	26ab	30ab
IT97K-1034-94	51c	54ab	53ab	87a	83c	85ab	32bc	32ab	32a
IT97K-499-38	49d	57a	53ab	89a	85ab	87a	40a	28bc	34a
IT95K-1090-12	56ab	48c	52ab	85ab	81c	83c	29c	33ab	31ab
IT97K-1025-18	51c	59a	55a	87a	83bc	85ab	36a	24c	30ab
IT97K-1025-6	59a	53bc	56a	89a	83bc	86a	30bc	30ab	30ab
IT97K-1034-5	52bc	56a	54a	88a	84bc	86a	36a	28bc	32a
IT97K-1034-89	52bc	54ab	53ab	84c	86ab	85ab	32bc	32ab	32a
IT97K-1034-92	56ab	50c	53ab	85ab	83bc	84c	29c	33ab	31ab
IT97K-1035-17	53bc	55ab	54a	86ab	80c	83c	33ab	25bc	29c
IT97K-1035-9	58a	50c	54a	81c	89a	85ab	23d	39a	31ab
IT97K-564-1	52bc	56a	54a	83c	87a	85ab	31bc	31ab	31ab
IT98K-5O3-1	54ab	50c	52ab	86ab	82c	84c	32bc	32ab	32a
IT90K-277-2	53bc	55ab	54a	86ab	80c	83c	33ab	25bc	29c
Ife Brown (Check)	55ab	49c	52ab	87a	85ab	86a	32bc	36a	34a
F-test	**	**	**	**	**	**	**	**	**
Mean	53.6	53.4	54.0	86.12	84.36	85.0	32.48	31.12	31.72
SE(+)	0.57	0.57	0.24	0.49	0.59	0.31	0.770	85	0.31
CV %	5.35	5.35	2.27	2.83	3.49	1.83	11.85	13.01	4.85

Means followed by the same letter along the column for different lines are not significantly different at p = 0.05 according to Duncan's Multiple Range Test
* Significant ($p \leq 0.05$), ** Highly significant ($p \leq 0.01$)

Table 2: Number of pods per plant, pod length and hundred seed weight of advanced medium erect cowpea lines evaluated in 2001 and 2002 Seasons

	No. of pods per plant			Pod length (cm)			100 seed weight (g)		
Lines	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
IT95k-207-15	22ab	26ab	24ab	15.0ab	16.2ab	15.6ab	18.7a	19.7a	19.2a
IT95k-207-22	15d	13e	14c	13.2c	11.4d	12.3c	15.2bc	14.4c	14.8bc
IT98k-128-4	25ab	29a	27 a	16.1ab	18.3a	17.2 a	17.5ab	20.9a	19.2a
IT98k-205-10	24ab	26ab	25ab	14.2ab	16.0ab	15.1ab	16.2bc	15.4bc	15.8ab
IT98k-205-15	16 d	14d	15c	12.4c	13.8c	13.1c	15.5bc	15.1bc	15.3ab
IT98k-205-9	24ab	22ab	23abc	15.5ab	16.3ab	15.9ab	16.6ab	14.8c	15.7ab
IT98K-962	24ab	26ab	25ab	12.5c	14.3bc	13.4c	16.9ab	18.1ab	17.5ab
IT98K-506-1	20c	26ab	23abc	14.2ab	13.2c	13.7c	18.4a	16.4bc	17.4ab
IT98K-131-2	39a	31a	35 a	16.4ab	21.2a	18.8 a	19.3a	22.3a	20.8a
IT97K-1021-24	26ab	30a	28 a	17.2 a	13.6c	15.4ab	17.4ab	16.2bc	16.8ab
IT97K-1021-9	20 c	24ab	22ab	16.4ab	16.8ab	16.6ab	16.8ab	17.6ab	17.2ab
IT97K-1034-94	18c	16d	17c	16.3ab	14.5bc	5.4ab	18.2ab	20.6 a	19.4a
IT97K-499-38	11d	13d	12 d	13.3c	12.5c	12.9c	13.9c	15.3bc	14.6bc
IT95K-1090-12	22ab	20c	21bc	12.7c	14.5bc	13.6c	14.6c	16.4bc	15.5ab
IT97K-1025-18	21c	17d	19bc	15.3ab	12.9d	14.1bc	17.9ab	18.7ab	18.3 a
IT97K-1025-6	20c	16d	18bc	14.8ab	12.4d	13.6bc	13.1c	17.3ab	15.2ab
IT97K-1034-5	28a	30a	29 a	15.7ab	16.5ab	16.1ab	13.4c	15.4bc	14.4bc
IT97K-1034-89	13d	15	14c	13.8abc	10.4 d	12.1c	17.1ab	15.9ab	16.5ab
IT97K-1034-92	30a	26 ab	28 a	17.2a	15.4ab	16.3ab	18.6 a	17.8ab	18.2a
IT97K-1035-17	24ab	26 ab	25ab	12.7d	9.5d	11.1c	14.9c	15.9ab	15.4ab
IT97K-1035-9	34a	30a	32 a	22.5a	8.1d	20.3a	20.2a	17.6ab	18.9a
IT97K-564-1	28a	30a	29 a	18.1a	16.3ab	17.2a	14.2c	15.4bc	14.8bc
IT98K-5O3-1	27ab	21c	24ab	10.8d	13.6	12.2c	14.1c	16.3bc	15.2ab
IT90K-277-2	12d	16d	14c	14.5ab	11.9d	13.2c	19.6 a	17.6ab	18.6a
Ife Brown (Check)	15d	11e	13 d	13.1c	15.3ab	14.2bc	13.1d	15.3bc	14.2bc
F-test	**	**	*	**	*	**	**	**	**
Mean	22.32	22.16	22.00DD	15.0	14.6	14.7	16.46	17.05	16.8
SE(+)	1.35	1.30	1.27	0.48	0.53	0.44	0.43	0.41	0.37
CV %	30.2	29.33	28.59	15.93	18.08	14.96	13.06	1208	11.28

Means followed by the same letter along the column for different lines are not significantly different at p = 0.05 according to Duncan's Multiple Range Test
* Significant ($p \leq 0.05$), ** Highly significant ($p \leq 0.01$)

Table 3: Grain yield of advanced medium erect Cowpea lines evaluated in 2001and 2002 seasons

	Grain yield (kg ha^{-1})			
Lines	2001	2002	Mean	Yield advantage over local %
IT95k-207-15	900ab	702c	801abc	16
IT95k-207-22	502d	494d	498d	-
IT98k-128-4	1091a	1099a	1095a	59
IT98k-205-10	876ab	860ab	868ab	26
IT98k-205-15	275e	605c	590d	-
IT98k-205-9	815bc	829ab	822ab	19
IT98K-962	811ab	607c	709c	3
IT98K-506-1	865ab	715bc	790c	14
IT98K-131-2	1390a	1394a	1392a	102
IT97K-1021-24	804bc	814ab	809ab	17
IT97K-1021-9	839bc	827ab	833ab	21
IT97K-1034-94	705c	667c	686c	-
IT97K-499-38	481d	325e	403d	-
IT95K-1090-12	805bc	761abc	783c	13
IT97K-1025-18	715c	691c	703c	2
IT97K-1025-6	685c	753abc	719c	4
IT97K-1034-5	1080a	1098a	1089a	58
IT97K-1034-89	516d	392e	454d	-
IT97K-1034-92	918ab	906ab	912ab	32
IT97K-1035-17	816bc	810abc	813abc	18
IT97K-1035-9	1210a	1234a	1222a	77
IT97K-564-1	1060a	1044a	1052a	52
IT98K-5O3-1	591c	793a	692c	2
IT90K-277-2	607c	431abc	519d	-
Ife Brown (Check)	705c	675c	690c	-
F-test	**	**	**	
Mean	802.48	780.68	797.76	
SE(±)	9.14	50.73	4.76	
CV %	30.51	1.25	2.98	

Means followed by the same letter along the column for different lines are not significantly different at p = 0.05 according to Duncan's Multiple Range Test
* Significant ($p \leq 0.05$) ** Highly significant ($p \leq 0.01$)

Table 4: Correlation matrix of agronomic traits of advanced medium erect Cowpea lines evaluated in 2001 season

Parameters	No. of days to 50% flowering	No. of days to 90% maturity	Pod length (cm)	No. of pods per plant	100 Seed weight (g)
No. of days to 95% maturity	0.46**				
Pod length (cm)	0.20	0.05			
No. of pods per plant	0.41*	0.3	0.68**		
100 seed weight (g)	0.02	0.25	0.46**	0.50**	
Grain yield (kg ha^{-1})	0.32	0.23	0.68**	0.93**	0.52**

* Significant at $\alpha = 0.05$, ** Significant at $\alpha = 0.01$

Table 5: Correlation matrix of agronomic traits of advanced medium erect Cowpea lines evaluated in 2002 season

Parameters	No. of days to 50% flowering	No. of days to 90% maturity	Pod length (cm)	No. of pods per plant	100 Seed weight (g)
No. of days to 95% maturity	0.41*				
Pod length (cm)	-0.17	0.02			
No. of pods per plant	-0.19	-0.02	0.70**		
100 seed weight (g)	-0.02	-0.03	0.51**	0.38	
Grain yield (kg ha^{-1})	-0.14	-0.07	0.84**	0.91**	0.40**s

* Significant at $\alpha = 0.05$, ** Significant at $\alpha = 0.01$

Yield components: The lines evaluated were significantly different from each other in number of pods per plant (Table 2). Although, IT98K-131-2 which produced the highest number of pods per plant was not significantly different from IT97K-1034-5 and IT97K-564-1 which produced the lowest number of pods per plant. Similarly, in 2002, IT98K-131-2 also produced the highest number of pods while the least number of pods was produced by Ife brown.

IT97K-103509 which had the longest pod (22.5 cm) in 2001 was not significantly different from IT97K-1021-24 and IT97K-564-1 which recorded 17.2 and 18.1 cm pod length, respectively. The longest pod of 21.2 cm was recorded by IT98K-131-2 in 2002 while IT97K-1039-9 had the shortest pod of 8.1 cm.

IT97K-1035-9 recorded the highest hundred seed weight (20.2 g) in 2001 while each of IT97K-1025-6 and Ife brown recorded 13.1 g. In 2002, IT98K-131-2 with 22.3 g one hundred seed weight was not significantly different from IT98K-128-4 and IT97K-1034-94 with 20.9 and 20.6 g, respectively.

Grain yield: Most of the lines produced higher grain yield than Ife brown in both 2001 and 2002 (Table 3). The average yield ranged from 403 kg ha^{-1} in IT97K-499-38 to 1392 kg ha^{-1} in IT98K-131-2 which out yielded Ife brown with the yield advantage of 102%. The highest yielder (IT98K-131-2) was however, not significantly different from IT97K-1034-5 and IT95K-564-1 which produced grain yield of 1222 and 1095 kg ha^{-1}, respectively.

Relationship between grain yield and yield components: In both 2001 and 2002, pod length was significantly correlated with number of pods per plant, 100 seed weight and grain yield. Number of pods per plant was significantly correlated with grain yield (r = 0.93 and r = 0.91, respectively) as shown in Table 4 and 5.

DISCUSSION

The advanced medium erect cowpea lines in both 2001 and 2002 flowered between 52 to 56 days after planting (DAP). High yielders like IT98K-131-2, IT98K-128-4 and IT97K-1043-5 flowered between 52 to 54 DAP while the check, Ife brown flowered at 52 DAP. The average number of days to maturity varied from 83 to 88 DAP in all the lines. There was no significant difference among the lines that attained 95% maturity at 88 DAP and those that attained 95% maturity at 86 DAP and 87 DAP. Most lines attained maturity about the same time after flowering. The maturity period ranged from 29 to 34 DAF for all lines. The range of 32 to 35 number of days to maturity could minimize cost of labour and drudgery associated with repeated and selective harvesting since harvesting could be done at once for all these varieties.

The average number of pods per plant ranged from 13 in Ife brown to 35 in IT98K-131-2 which also produced the highest average 100 seed weight (20.8 g IT97K-1035-9 produced the longest average pod length (20.3 cm) and also the highest 100 seed weight (20.2) in 2001. Eighteen of the breeding lines gave higher yield than the check (Ife brown). Though IT98K-131-2 out-yielded the check, Ife brown by 102%, six of the breeding lines gave lower grain yield than Ife brown where IT97K-499-38 recorded the lowest grain yield of 403 kg ha^{-1}. Thus, number of pods per plant was the most critical yield component that determined yield differences.

Based on the available literature (Okeleye *et al*., 1999) and the present results, the highly significant correlation between pod length, number of pods per plant, 100 seed weight and grain yield per hectare confirm that these characters are major components of yield in cowpea.

CONCLUSIONS

The experiment revealed that IT98K-131-2 performed best in terms of number of pods per plant (35), 100 seed weight (20.8 g) and grain yield per hectare (1392 kg ha^{-1}). The resource-poor local farmers in forest-savannah transition zone should be encouraged to adopt breeding lines that gave an average grain yield of over 1000 kg ha^{-1}. The possibility of reduction in the cost of harvesting of these lines would be of particular interest to the farmers since this operation could be done at once instead of repeated harvests.

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