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PHENOTYPIC BASIS FOR YIELD DIFFERENCES AMONG COWPEA CULTIVARS IN A SEMI-ARID REGION OF NORTH EAST NIGERIA

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ABSTRACT
Field trials were conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri, Maiduguri (11°47.840'N; 13 °12.021'E; elevation 319 m asl) in Borno State in a semi-arid region of north eastern Nigeria during the 2010 and 2011 rainy seasons. The objectives of the study were to evaluate the agronomic performances of some improved cowpea cultivars and to identify the phenotypic traits associated with high grain yield in a semi-arid region of North Eastern Nigeria. The trial consisted of eight treatments (cowpea cultivars), which included two local cultivars viz: *Kannanado White* and *Borno Brown* obtained from farmers in Maiduguri, Borno State and six improved cultivars viz: IT90K-277-2, IT97K-568-18, IT89KD-288, IT97K-499-35, IT98K-131-2 and IT89KD-391 obtained from IITA stations in Kano and Maiduguri, Nigeria. The treatments/cultivars were laid out in a randomized complete block design (RCBD) replicated three times. The gross plot size was 5.0 m x 4.0 m (20 m^2) while net plot size was 3.6 m x 3.0 m (10.8 m^2). The highest grain yields were produced by the cultivars IT90K-277-2, IT97K-499-35, IT98K-131-2 and IT89KD-288 in the combined data compared with the other cultivars. Cowpea grain yield per hectare was highly positively correlated with number of pods per plant, peduncle length, and number of peduncles per plant. However, the results showed highly significant negative correlation between cowpea grain yield per hectare and branch length.
Key words- Phenotypic basis, Cowpea cultivars, semi-arid region, Maiduguri, Nigeria

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, is of major importance in the livelihoods of millions of relatively poor people in less developed countries. From the production of this crop rural families derive food, animal feed and cash. Because of its high protein content (20-25%), cowpea has been referred as to as ''poor man's meat'' (Nielsen *et al.*, 1997). It is estimated that cowpea supplies 40% of the daily protein requirements to most people in Nigeria (Muleba *et al.*, 1997). Because of its superior nutritional attributes, versality, adaptability, and productivity cowpea was chosen by the US National Aeronautical and Space Administration as one of the few crops worthy of study for cultivation in space stations (Ehlers and Hall, 1997). However, cowpea, also popularly called 'beans' is produced extensively in the Sub-Saharan region of Africa where more than 70% of total world production is grown (Magloire, 2005) and in other semi-arid and arid regions of the world where drought stress is a major problem in cowpea production resulting in reduced cowpea quality and yield loss. Nigeria is the largest cowpea producer in the world and also has the highest level of consumption (FAO, 2000; Singh, 2007). Due to several constraints the average cowpea grain production in West Africa was reported to be as low as 358 kg/ha (FAO, 2000) whereas Singh *et al.* (1997) estimated 240 kg/ha cowpea grain yield as an average for northern Nigeria. In most parts of Borno State, rainfall is unreliable and frequently less and poorly distributed for a good cowpea crop. In the semi-arid region of north-eastern Nigeria, early season and terminal drought conditions are almost an annual event (Onyibe *et al.*, 2006). Improving the yield of cowpea in the State requires the use of drought-tolerant and drought-avoidance cultivars.

The objectives of the study are to evaluate the agronomic performances and to identify phenotypic traits associated with high grain yield of some improved cowpea cultivars in semi-arid region of north east Nigeria. The local cowpea cultivars are late maturing, low yielding and photosensitive and very susceptible to drought and heat. Even in the average year, the cowpea cultivars have to rely on moisture stored in the soil after the rains have stopped for grain filling. The crop performs poorly if the rains end early (Raheja, 1986). The improved cultivars have acceptable seed quality for various regions, and are resistant to major diseases and pests. They also have synchronous flowering and maturity (Singh, 1994). The improved cultivars are therefore early maturing, photoinsensitive and have high yield potential even with less rainfall. In the same vein the improved cowpea cultivars have varying degree of yield potentials which could be due to differences in their phenotypic traits in the dry ecologies of Borno State. Therefore, the need to try these promising cowpea cultivars for their adaptability in the semi-arid region of north east Nigeria is obvious as one of the strategies for improving the productivity of the crop in this region since scanty information is available on the performance of these cultivars in this region. Information on phenotypic differences of the different cowpea cultivars will be valuable for future strategies in the development of high yielding cowpeas for the semi-arid region of north east Nigeria.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri, ($11^{o}47.840'$N; $13^{o}12.021'$E; elevation 319 m asl) in Borno State in the semi-arid region of north east Nigeria during the 2010 and 2011 rainy seasons, August to November each year. The gross plot size was 5.0 m x 4.0 m (20 m^2) and the net plot size was 3.6m x 3.0 m (10.8 m^2). Each plot contained eight (8) rows of 4.0 m long with spacing of 0.75 m between rows and 0.2 m between plants. The trial consisted of 8 treatments (cultivars of cowpea). The treatments included two local cultivars viz: *Kannanado White* and *Borno Brown* and 6 improved cultivars viz: IT90K-277-2, IT97K-568-18, IT89KD-288, IT97K-499-35, IT98K-131-2 and IT89KD-391. The treatments/cultivars were laid out in a randomized complete block design (RCBD) replicated 3 times. Phenotypic parameters measured were number of branches per plant, branch length (cm), number of peduncles per plant, peduncle length (cm), number of pods per plant, number of seeds per pod, pod length (cm), number of matured seeds from 100 grains and grain yields (kg ha^{-1}). Data were presented as a combined analysis of both years. All data were subjected to analysis of variance (ANOVA) using Statistix 8.0 version. Treatment means were compared where F-values were significant using Duncan's Multiple Range Test (DMRT) at 5% level of probability (Duncan, 1955). Linear correlation coefficient (r) among combined means of two years of cowpea cultivar and phenotypic traits were calculated at 5%.

Table 1: Physico-chemical characteristics of the soil at the experimental site

S/No	Soil Characteristics	Physico-chemical properties
	Chemical Analysis	
1	pH in H_2O	6.71
2	Organic carbon (g/kg)	4.40
3	Organic matter (g/kg)	7.59
4	Total N (g/kg)	0.05
5	Available potassium (me/100g)	0.29
6	Available phosphorus (g/kg)	5.30
	Mechanical Analysis (0-15 cm depth)	
1	Clay (%)	15.0
2	Sand (%)	70.0
3	Silt (%)	15.0
4	Field Texture	Sandy loam

RESULTS AND DISCUSSION

The soil was sandy loam having organic matter of 7.59 g/kg. The pH of the soil was almost neutral while available phosphorus was 5.50 g/kg (Table 1). Based on the soil properties of the site it was ideal for cowpea growth. Table 2 showed the phenotypic parameters associated with yield differences among cowpea cultivars in a semi-arid region of north east Nigeria. The IT89KD-288 cultivar significantly produced the highest number of branches compared with the other cultivars, except cultivars *Kannanado White*, and IT98K-131-2 (Table 2). This could be due to the fact that the cultivar IT89KD-288 may be tolerant to *Striga gesnerioides* and has an indeterminate growth thus has the tendency to produce more number of branches because according to Kamara *et al.* (2008) *Striga* cause cowpea to have limited stem growth. The effect of cowpea cultivar on branch length per plant for the combined analysis showed that *Kannanado White* and *Borno Brown* cultivars had significantly the longest branches and significantly the lowest grain yields compared with the rest of the cultivars. These findings were contrary to those of Erkskine and Khan (1975) who reported that the ten highest yielding cultivars had on average longer main stems and longer lateral branches. However, it has been suggested that this type of growth habit is inefficient in grain yield production because of its low pod to stem ratio, its tendency to perenniality and its uneven pod ripening (Haizel, 1972; Ezedinma (1965). Also the cultivars, IT90K-277-2, IT89KD-391 and IT98K-131-2 produced significantly the highest number of peduncles per plant in the combined analysis compared to the rest of the cultivars. The cultivars IT90K-277-2 and IT98K-131-2 produced significantly the highest number of peduncles per plant and are among the cultivars with significantly the highest grain yields. This is an indication that grain yield is a function of different yield attributing characters. These could be the major grain determinants that contributed positively to the superior grain yield of these cultivars evaluated in this trial.

The peduncle length of cowpea cultivars for the combined analysis presented in Table 2 showed that the longest peduncles were produced by the cultivars IT90K-277-2, IT89KD-391, IT97K-568-18 and IT98K-131-2 in the combined data. Hall (2004) reported that cowpea cultivars having canopies with pods displayed above the leaves (long peduncles) have advantages with respect to providing fewer oviposition sites for pod borer (*Maruca testulalis,* Geyer). Pod borer is a major pest of cowpea in tropical zones such as the savannas of West Africa (Hall *et al*., 1997) which reduces yield drastically. The data in Table 2 showed the significant differences among the cowpea cultivars on mean number of pods per plant. Significantly higher number of pods per plant was recorded with cultivars IT90K-277-2 and IT97K-499-35 though they had comparable significant values with IT89KD-391 and IT98K-131-2 in the combined analysis only (Table 2). The non significant effect of cowpea cultivar on number of seeds per pod, pod length and number of matured seeds from 100 grains in the combined analysis are summarized in Table 2. Generally, though with no statistical differences over 92 seeds out of the 100 are matured. The highest grain yields were produced by the cultivars IT90K-277-2, IT97K-499-35, IT98K-131-2 and IT89KD-288 in the combined data compared with the other cultivars evaluated (Table 3).

Interrelationships among phenotypic traits

Correlation coefficient (r) among the various parameters taken combined across the two years is presented in Tables 3. The correlation among the variables showed many significant values. Cowpea grain yield per hectare was highly positively correlated with number of pods per plant, peduncle length, and number of peduncles per plant (Table 3). The highly and significant positive correlation coefficient ($r = 0.54$) between cowpea grain yield per hectare with peduncle length in this study is similar to the results of Hall (2004). This is advantageous because cowpea cultivars with long peduncles (pods displayed above the canopy) are easier to harvest by hand than pods retained within the canopy (Hall, 2004). Consequently there is merit in having cultivars with pods displayed above the canopy for rain fed production in wetter areas of Africa where the crop is manually harvested. However, there was no significant correlation between grain yield and number of branches per plant and number of seeds per pod in this study. This is contrary to the findings of Jakai (1995) who reported that the highest contributors to seed yield appear to be branch number and seeds per pod. However, the results showed highly significant negative correlation between cowpea grain yield per hectare and branch length (Table 3). Furthermore, the results showed that significant positive correlations existed between branch length and number of branches per plant,

Table 2: Effect of cowpea variety on phenotypic parameters at Maiduguri in 2010 and 2011 combined analysis

Treatment /Cowpea variety	Number of branches per plant	Branch length (cm)	Number of peduncles per plant	Peduncle length (cm)	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Number of matured seeds from 100 grains	Grain yield (kg ha^2)
IT90K-277-2	2.57cd	61.53cd	6.57a	34.83ab	12.67a	8.97	13.18	96.00	998.2a
Kannanado White	3.17a-c	135.84a	2.97b	15.71d	5.23c	8.07	13.35	95.33	378.3c
IT97K-499-35	2.27^{d}	37.31^{d}	7.97^{a}	30.78^{bc}	12.10^{a}	8.63	13.39	97.00	990.8^{a}
Borno Brown	3.00^{bc}	135.47^{a}	3.37^{b}	20.78^{d}	4.93^{c}	7.73	13.89	95.67	373.9^{c}
IT89KD-391	2.67^{b-d}	47.33^{cd}	7.57^{a}	37.26^{a}	10.90^{ab}	8.70	14.22	96.00	745.6^{b}
IT97K-568-18	3.00^{bc}	72.57^{bc}	5.83^{a}	32.37^{a-c}	7.63b^{c}	9.45	14.31	94.83	750.4^{b}
IT98K-131-2	3.20^{ab}	69.84^{b-d}	6.87^{a}	35.78^{ab}	11.10^{ab}	9.05	15.17	92.50	938.0^{ab}
IT89KD-288	3.67^{a}	95.75^{b}	6.73^{a}	28.33^{c}	7.73b^{c}	8.51	13.86	95.67	784.8^{ab}
SE(±)	0.208	11.659	0.740	2.082	1.348	0.461	0.341	1.185	75.18

1=Means within a column and treatment followed by similar letter(s) are not significantly different (P≤0.05) according to Duncan's Multiple Range Test (DMRT).

Table 33: Correlation coefficient (r) between cowpea cultivars, grain yield and other parameters tested in 2010 and 2011 at Maiduguri

	GY	BL	BPP	PDL	PDPP	PL	PPP	MSHG	SPP
GY	1.00								
BL	-0.56**	1.00							
BPP	-0.22	0..36*	1.00						
PDL	0.11	0.04	0.36*	1.00					
PDPP	0.64**	-0.49**	-0.15	0.22	1.00				
PL	0.54**	-0.65**	-0.18	0.25	0.50**	1.00			
PPP	0.51**	-0.51**	-0.41**	-0.25	0.41**	0.49**	1.00		
MSHG	0.12	0.04	-0.09	0.26	0.13	-0.03	-0.16	1.00	
SPP	0.25	-0.07	0.20	0.63**	0.27	0.28	-0.04	0.07	1.00

GY= Grain yield, BPP= branches per plant, BL= Branch length, PPP= peduncles per plant, PL= Peduncle length, MSHG= matured seeds from 100 grains, PDPP= pods per plant, PDL= Pod length, SPP= seeds per pod, **= highly significant at 1% probability level, *= Significant at 5% probability level.

(Table 3). However, there were highly and significant negative correlation between number of pods per plant, peduncle length, and number of peduncles per plant (Table 3). Number of branches per plant had a significant positive correlation with pod length and a significant negative correlation with number of peduncles per pod (Table 3). Pod length had a highly and significant positive correlation number of seeds per plant. The results also indicated that the number of pods per plant had a highly and significant positive correlation with peduncle length and number of peduncles per plant, (Table 3). Also, peduncle length had a highly significant positive correlation with number of peduncles per plant.

CONCLUSIONS

In our work the highest grain yields were produced by the cultivars IT90K-277-2, IT97K-499-35, IT98K-131-2 and IT89KD-288 in the combined data compared with the other cultivars. Cowpea grain yield per hectare was highly positively correlated with number of pods per plant, peduncle length, and number of peduncles per plant and highly significantly negative correlation with branch length.

REFERENCES

Duncan, O.B. (1955). Multiple Range and Multiple F-tests. *Biometrics* **11**: 1-42.

Ehlers, J. D. and Hall, A. E. (1997). Cowpea (*Vigna unguiculata* L. Walp.). *Field Crops Research* **53**:187-204.

Erkskine, W. and Khan, T. N. (1975). Evaluation of cowpea germplasm for grain yield potential in Papua New Guinea.*Sabrao Journal* **7** (2): 189-196.

Ezedinma, F. O. C. (1965). Some studies on the vegetative and reproductive patterns in cowpeas (*Vigna unguiculata* (L.) Walp) in Southern Nigeria. *Niger. Agric. J.* **2**:32-4.

FAO, (2000). Site internet : http / www . FAO.org./statistics.

Haizel, K. A. (1972). The effects of plant density on the growth, development and grain yield of two varieties of cowpea, *Vigna unguiculata* (l.) Walp. *Ghana J. Agric. Sci.* **5**: 163-171.

Hall, A. E., Singh, B. B. and Ehlers, J. D. (1997). Cowpea Breeding. *Plant Breeding Review* **15**: 215-274.

Hall, A. E. (2004). Comparative ecophysiology of cowpea, common bean and peanut. P.271-325. In Nguyen, H. I. and Blum, A. (eds) *Physiology and Biotechnology Integration for Plant Breeding*, Marcel Dekker, Inc., New York.

Jackai, L. E. N. (1985). The legume pod borer *Maruca vitrata*, and its principal host plant *Vigna unguiculata* (L.) Walp. Use of selective insecticide sprays as an aid in the identificatioin of useful levels of resistance. *Crop Protection* **14**: 299-306.

Kamara, A. Y., Chikoye, D., Ekeleme, F., Omoigui, L. O. and Dugje, I. Y. (2008). Field performance of improved cowpea varieties under conditions of natural infestation by the parasitic weed *Striga gesneriodes*. *International Journal of Pest Management*. **54**:3, 189-195.

Magloire, N. (2005). The genetic, morphological and physiological evaluation of African cowpea genotypes. Thesis (unpublished).

Muleba, N. C., Dabire, J. B. S., Drabo, I. and Ouedraogo, J. T. (1997). Technologies for cowpea production based on genetic and environmental manipulations in the semi-arid tropics. Pages 192-206 in *Technologies options for sustainable agriculture in sub-Saharan Africa*, edited by Bezuneh, T.; Emechebe, A. M.; Sedgo, J. and Oeudrago, M. Publication of the Semi-Arid Food Grain Research and Development Agency (SAFGRAD) of the Scientific, Technical and Research Commission of OAU Ouagadougou, Burkino Faso.

Nielsen, S. S., Ohler, T. A. and Mitchell, C. A. (1997). Cowpea leaves for human consumption, utilization, and nutrient composition. Pages 326-332 in *Advances in cowpea research*, edited by Singh, B. B., Mohan Raj, D. R., Dashiel, K. E. and Jackai, L. E. N. Copublication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA,Ibadan, Nigeria.

Onyibe, J. E., Kamara, A. Y. and Omoigui, L. O. (2006). *Guide to cowpea production in Borno State, Nigeria*. Promoting Sustainable Agriculture in Borno State (PROSAB). Ibadan, Nigeria. 36pp.

Raheja, A. K. (1986). Problems and prospects of cowpea production in the Nigerian Savannas. Pages.13-15 in *Tropical grain legume bulletin*. World Cowpea Research Confernce, 5-7 November 1986, **32**, IITA, Special Issue.

Singh, B. B. (1994). Breeding suitable cowpea varieties for West and Central African Savanna. Pages 77-85 in *Progress in food grains research and production in Semi-Africa*, edited by Menyonga, J. M., Bezuneh, J. B., Yayock, J. Y. and Soumana, I. OAU / STRC-SAFGRAD, Ouagadougou, Burkino Faso.

Singh, B. B., Chamblis, O. L. and Sharma, B. (1997). Recent advances in cowpea breeding. Pages 30-49 in *Advances in cowpea research*, edited by Singh, B. B., Mohan Raj, D. R., Dashiel, K. E and Jackai, L. E. N. Copublication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA, Ibadan, Nigeria.

Singh, B. B. (2007). Potential and constraints of improved cowpea varieties in increasing the productivity of cowpea-cereal systems in the dry Savannas of West Africa. Pages 14-26 in Majiwa, P., Odera, M., Muchiri, N., Omanya, G. and Werehire, P. (eds). A plan to apply technology in the improvement of cowpea productivity and utilisation for the benefit of farmers and consumers in Africa*: Proceedings of cowpea stakeholders workshop*. Nairobi Kenya: African Agricultural Technology Foundation.