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Full Length Research Paper

Variability in yield of some selected *Vigna unguiculata* (L.) Walp. lines under varying shade conditions

Abubakar A. Zainab[1]* and Ajeigbe H. A.[2]

[1]Biological Science Department, Faculty of Science, Gombe State University, P. M. B. 0027, Tudun Wada, Gombe, Ngeria.
[2]IITA, Sabo Bakin Zuwo Road, P. M. B. 3112, Kano, Nigeria.

*Corresponding author. E-mail: zeepha22@yahoo.com, r02za11@abdn.ac.uk

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Cowpea (*Vigna unguiculata* (L.) Walp.) is an important legume in the tropics providing an inexpensive source of vegetable protein for both human beings and livestock. It is well adapted to relatively dry environments, and contributes to the sustainability of cropping systems in marginal lands of semi-arid areas by virtue of its high levels of nitrogen fixation, effective ground cover and soil improvement from plant residues. Given that light is an important limiting factor especially in intercropped cowpea, the shade adaptability of the selected cowpea varieties were analyzed in a pot experiment. The study was conducted to elucidate the effect of varying shade conditions of some selected cowpea lines in relation to their vegetative growth and yield which has proven to be of particular value in intercropping systems. The experiment was conducted in the screen house at International Institute of Tropical Agriculture (IITA) Kano, Nigeria with cultivars exposed to three levels of shading. Vegetative growth parameters measured revealed positive phenotypic correlation coefficients of higher magnitudes for varieties grown under the single and double shading conditions.

Key words: Cowpea, shade, intercropping.

INTRODUCTION

Cowpea, commonly known as ‘beans’ in Nigeria and ‘niebe’ in the Francophone countries, is a nutritious leguminous crop, grown for its high protein content of about 25% and also rich in several vitamins and minerals. It is grown as an intercrop with cereal crops like maize, sorghum and millet, as a green manure in rice fallows (Ishiyaku et al., 2010), or as a sole crop (Yusuf et al., 2006). Cowpea is a food and animal feed crop grown in the semi-arid tropics covering Africa, Asia, Europe, United States, and Central and South America. It originated and was domesticated in Southern Africa and was later moved to East and West Africa and Asia. The plant tolerates drought, performs well in a wide variety of soils, and being a legume replenishes low fertility soils when the roots are left to decay. It is grown mainly by small-scale farmers in developing regions where it is often cultivated with other crops as it tolerates shade. It also grows and covers the ground quickly, thereby preventing erosion.

The name "cowpea" probably derives from when it was an important livestock feed for cows in the United States. The area of peak production is in the moist Savannahs of Sub-Saharan Africa. Nigeria at present remains the largest producer and consumer of cowpea in the world, with 61% of production in Africa and 58% worldwide on an average per annum.

Grain legumes are an important constituent of traditional cropping systems in the tropics (Singh et al., 2003; Yusuf et al., 2006). International Institute for Tropical Agriculture (IITA) and other agricultural organisations in Nigeria embarked upon breeding programmes that led to development of high yielding, early maturing cowpea and soybean genotypes to substitute the farmers’ selections (Osunde et al., 2003; Bala et al., 2003; Yusuf et al., 2006; Singh et al., 1997). Cowpea is a diverse species in terms of plant form, seed size and colour, and maturity. This same variation exists in many crop species, and is not unique to cowpea.

Ecological studies in Northern Nigeria in millet/cowpea intercropping showed that cowpea receive from <30% to >70% of incident light inside the intercropped canopy. In these light limited conditions, cowpea varieties with a spreading growth habit can intercept more light than those with an erect growth habit by producing more leaves, as well as expanding their leaf area. However, the local spreading type has a low yield potential because of its low harvest index and inadequate root system (compared to the shoot system) (N'tare and Williams, 1992). Improvement of these two points especially in the local spreading variety without reducing its adaptability to shade will produce a variety that is better adapted to intercropping.

The aim of this study is to evaluate selected cowpea varieties for shade tolerance in order to assess the influence of shading on the vegetative growth and yield of the selected cowpea varieties.

MATERIALS AND METHODS

Study site

The experiment was conducted in the screen house at the International Institute of Tropical Agriculture (IITA) Kano, Kano Station, Nigeria; located at 12° 3'N, 8° 32'E and 476 m above sea level.

Experimental procedures

The plants were subjected to three levels of shading as follows

Design

There were three replications for each of the thirty-three selected cowpea lines at three levels of shading:

i. Full sunlight radiation.
ii. 75% sunlight radiation (Single layered canopy).
iii. 50% sunlight radiation (Double layered canopy).

Collection and planting of seeds

The following 27 selected cowpea varieties were obtained from IITA, Kano Station, Northern Nigeria, for the study: Aloka, Danila, IT00K-901-5, IT03K-338-1, IT03K-378-4, IT04K-227-2, IT04K-321-2, IT88D-867-11, IT89KD-391, IT90K-277-2, IT90K-372-1-2, IT90K-76, IT90K-82-2, IT93K-452-1, IT96D-610, IT97K-499-35, IT97K-499-38, IT97K-568-18, IT97K-819-118, IT98K-131-2, IT98K-205-8, IT98K-506-1, IT99K-1060, Tegina06BT, IT99K-1245, TN5-78, TVX3236.

Land preparation

Six seeds were sown in 5 L pots along a single row containing soil of sandy loam composition after been dressed to avoid damage from insects and seed-soil borne diseases. There were three replications for each of the thirty-three selected cowpea lines at all the levels of shading. N.P.K 15:15:15 compound fertilizer was incorporated to the soils before planting to mimic field planting conditions.

Data collection

Two plants were thinned from each variety at 24 and 48 days respectively after sowing leaving 2 stands per pot till maturity and harvest, where at vegetative stage, Plant height (cm), Hypocotyl length (cm) and Epicotyl length (cm) were measured.

At harvest, matured pods were removed from the stands, threshed and the seeds kept in seed envelopes. Parameters measured include; Number of pods/plant, Number of seeds/pod, Weight of pods/plant (g), Weight of seeds/plant (g), Number of seeds/plant and Root weight (g).

Statistical analysis

Data obtained was statistically analyzed using Complete Block Design (CBD) for analysis of variance using the R Statistical data Package (R Project for Statistical Computing, http://www.r-project.org/). Correlation and regression (determine the association between the different shade treatments and vegetative growth and yield.) between the variables using the mean values were also determined.

RESULTS AND DISCUSSION

Results obtained from all the varieties under the varying shade treatments showed significant differences ($P \leq 0.05$) during the growing period (3 - 12 weeks after planting). Several farmers reported on enough sunlight requirements in the early stage (3 - 5 weeks after planting) which produce vigorous branching, determining the extent of future growth, because it limit's the sizes of both sink and source. Intercropping also, affects soil fertility maintenance through nitrogen fixation and differential uptake of soil nutrients (Reddy et al., 1992), as well as by reducing drought stress in the early growth stage of the plants through mutual protection from direct

Table 1. Traits coefficients for growth and yield of the selected cowpea lines.

Traits	Mean	Range	%CV	Significance
HtPlt2 (cm)	61.9	34.3-91.2	59.55	*
MnHypo (cm)	2.27	3.47-22.54	75.4	**
MnEpi (cm)	10.77	1.89-3.00	79.8	**
Nopd/plt	5.33	2.67-7.67	66.8	**
Nosed/plt	5.24	3.22-8.62	52.3	**
Sedwt/plt (g)	5.43	3.21-9.35	75.5	**
PDWT/PLT (g)	6.92	3.93-11.75	77.9	**
WT/POD (g)	0.726	0.58-1.27	40.3	*
SEDWT/POD (g)	0.726	3.25-4.30	51.2	**
ROOTWT	0.985	0.483-2.189	83.8	**
DmPlt1 (cm)	61.9	3.13-15.16	74.3	**

*, significant; **, highly significant

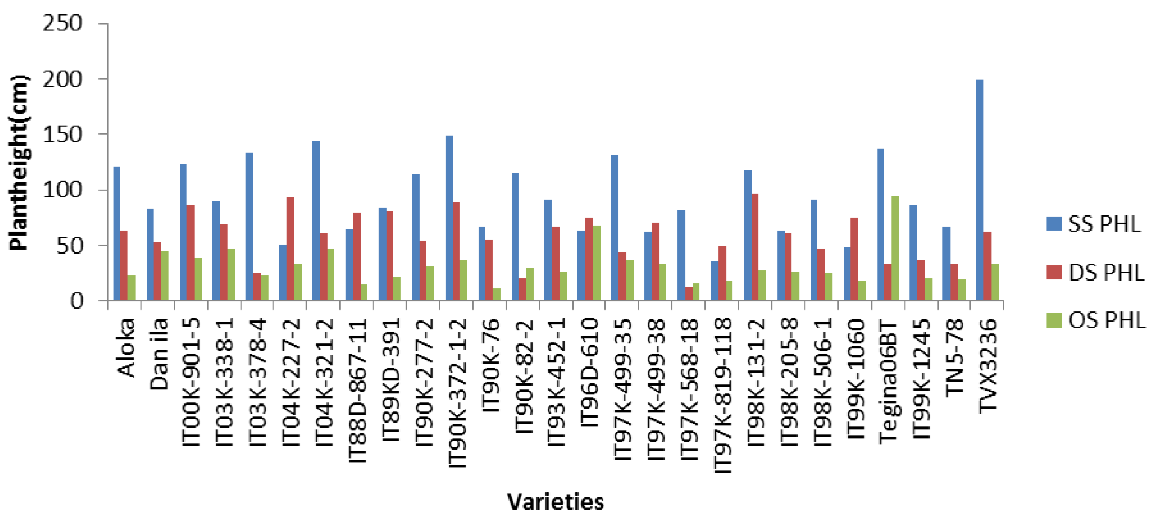

Figure 1. Plant heights (cm) of varieties under the single (SS), double (DS) and full sunlight (OS) conditions.

sunlight and shade.

It was observed that varieties IT00K 901-5 (under the single shade), IT90K-372-1-2 and IT98K-131-2 (under the double shade) and IT98K-499-35 (outside) produced the lengthiest plant height while IT97K-819-118 and IT99K-1060 (under the single shade), IT03K-378-4-1 and IT97K-568-18 (under the double shade), and IT97K-499-38 and IT90K-76 (outside) (Table 1) produced the shortest plant height. The variation was more pronounced between the seedling stages. The results showed no further increase in plant height beyond the second seedling stage except in some few varieties like Aloka, IT03K-378-4, IT04-227-2, IT04-321-2, IT90K-277-2, IT90K-372-1-2, IT90K-82-2, IT97K-499-35, IT98K-131-2, Tegina06BT, TVX3236 (Figure 1). In comparison, the plants generally grown under the single and double shades have heights ranging from 0.85 to 91.2 cm respectively (Table 1). Research on light has indicated that there is a benefit where resources are maximized when intercropping is done. Willey (1979) has suggested that the advantage may have not to do only with the amount of light intercepted during the entire growing season. The rapid establishment of a prostate cowpea will enable more light to be used than if only a dorminant crop, such as millet, is grown of course, this holds time when cowpea is planted with a slow developing tuber, such as cassava. Clark and Francis (1985) have observed that if a tall crop, especially a C4 plant, is combined with a shorter C3 crop, there can be enhanced use of total light. They also observed that maize-bean systems established total ground cover; one week prior to sole crop beans and three weeks prior to sole crop maize. Srinivasan et al. (1990) observed that shade tolerant cowpea performed well under *Casuarina*

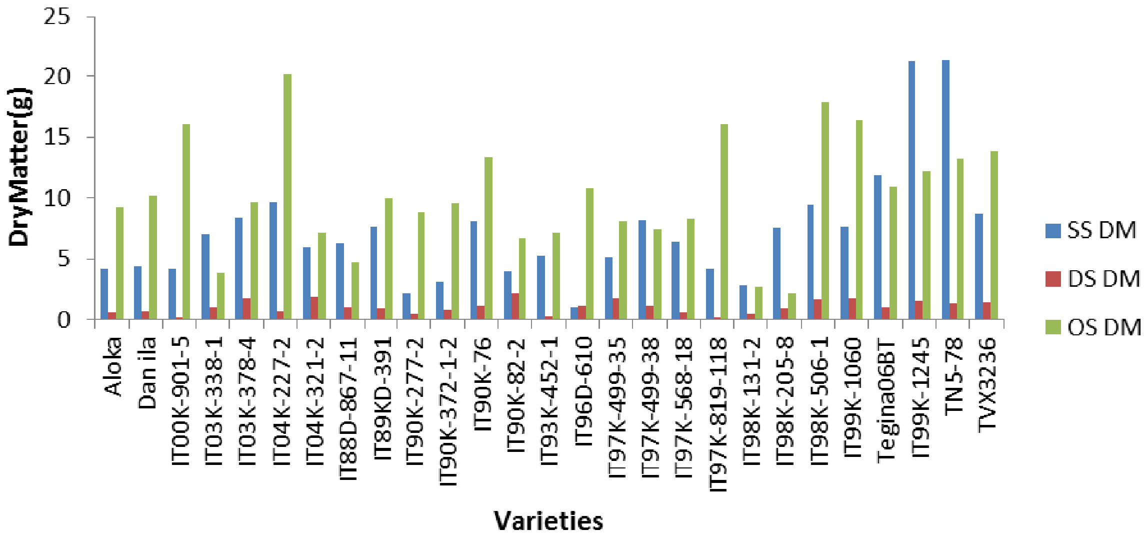

Figure 2. Dry matter weights of varieties under the single (SS), double (DS) and full sunlight (OS) conditions.

equisetofolia. Fawusi et al. (1982) reported that a maize cowpea system intercepted 52.3% of incoming light, which is less than the 76.4% interception in a maize-cowpea system reported by Blade et al. (1992). This difference was probably due to measurements taken 6 - 8 weeks after planting in the Fawusi study, so that the total canopy was not developed. Terao et al. (1997) reported that the amount of light reaching cowpea in cereal-based cropping systems varies (30 - 75% of ambient light). They noted that if the cereal canopy intercepts large amounts of light, cowpea growth is so limited that almost no foliage can intercept what light does pass through the cereal canopy. The local cowpea varieties are successful due to their flexibility in response to competition; light in the early branching patterns, which will in turn determine the source and sink of the plant.

Highly significant differences (P<=0.001) were observed for all the varieties planted under the double shade trailed by those planted under the single shade and then the least, those planted outside for epicotyl and hypocotyl measurements observed.

The result obtained for dry matter (fodder) (Figure 2) weight at harvest revealed highly significant differences between those varieties planted under the three levels of shading. The highest fodder mean was recorded for all those varieties planted outside while the least was recorded for those planted under the double shade. The same trend was observed for the entire yield data measured. Vegetative growth tends to be more pronounced for those varieties grown under the single and double shades; this might be attributed to the shading and low rainfall and sunlight radiation. The poor vegetative growth observed for those varieties planted outside was probably due to the effects of much sunlight radiation and heavy rainfall.

Plant height and epicotyls lengths for all the varieties indicated high range of growth under the single and double canopies while the hypocotyls length tend to be more obvious only for those varieties grown under the double shades followed by those planted under the single shades (Figures 3 and 4). Variation in the dry matter weights varies between the varieties in that those planted outside produced more fodder than those planted under the single and double shades. It can be suggested that there was a treatment effect on those varieties grown under the double layered canopy as they tend to produce lesser yield compared to those varieties grown under the single layered canopy (Table 1). However, the major weakness of intercropping is that the yields of cowpea are very low, just like for the local spreading type variety which has high adaptability in intercropping bringing about its flexibility of growth. This variety can spread twice more leaf area than the erect type variety under shade through increasing top/root ratio and expanding per leaf area weights. Also, the photosynthetic light curve of the local spreading type variety changed under shade to a more efficient form, as the plant adjusted to collect low intensity light better than the erect type variety did (N'tare and Williams, 1992).

Like in all organisms, growth and yield production in the cowpea plants are subjected to cross fertilization between the genetic make-up of an individual variety and the environmental factors. Genotypic correlation factor provides a measure of genetic association between the characters, and this helps to identify the more important characters to be considered in breeding programs. The magnitude of phenotypic traits correlation coefficients was in most cases higher than the genotypic correlation coefficients. This showed that there was a great effect of the varying shading treatments administered for most of

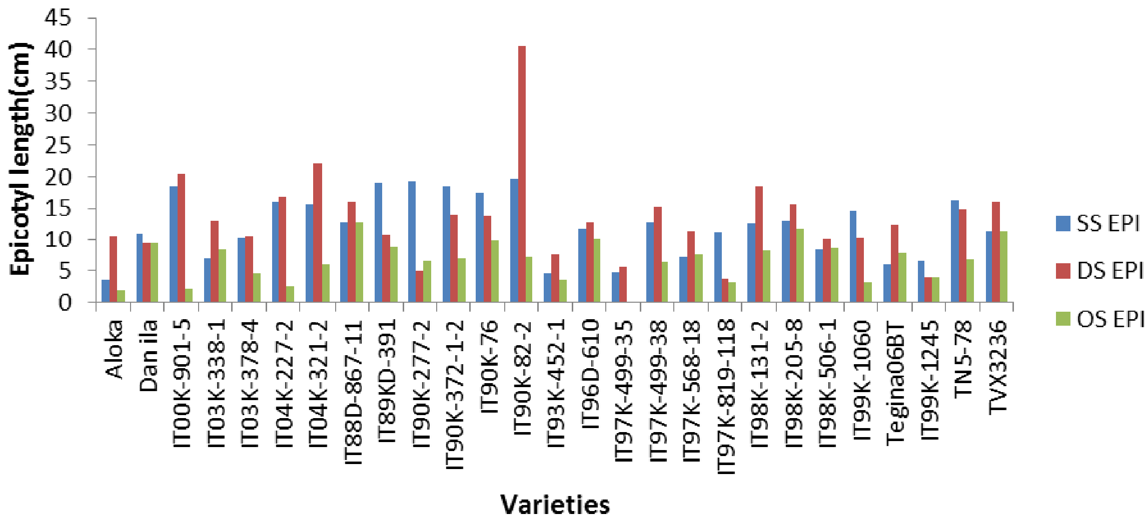

Figure 3. Epicotyl lengths (cm) of varieties under the single (SS), double (DS) and full sunlight (OS) conditions.

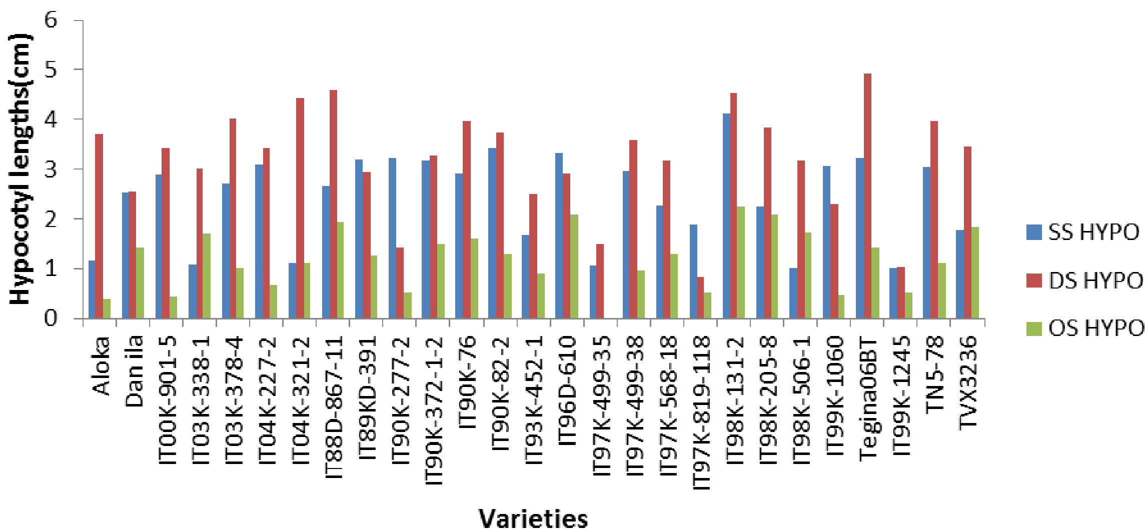

Figure 4. Hypocotyl lengths (cm) of varieties under the single (SS), double (DS) and full sunlight (OS) conditions.

the traits studied.

Conclusion

The results of the vegetative growth and yield of the selected cowpea varieties responded positively to all the varying shade treatments only that those planted under the single double shades indicated pronounced growth rate while those varieties planted outside produced the highest yield. Varieties; IT03K-378-4, 338-1, IT99K-1245 and TVX3236 showed to be real promising in terms of the shade tolerance as they performed relatively well under all treatments, clearly suggesting them of been worthy to be chosen by farmers for intercropping systems.

Yield potential was generally high to those planted outside and under the single shade compared to those varieties planted under the double shade, indicating the high effect of shading and low radiation under the double shade.

Though vegetative growth responded positively to those varieties planted under the double and single shades because of mediated sunlight radiation and rainfall, it can be deduced that the magnitude of phenotypic correlation coefficient were higher than the genotypic correlation of coefficient due to the effect of shading. Suggesting that growth characters observed tend to be more influenced than yield characters by the varying shade treatments; for that reason, for increased fodder yield, shading or intercropping practices provocatively could be adapted for cowpea farming.

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