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Original Article

Effect of Water Stress on Some Growth Aspects of Two Varieties of Cowpea, *Vigna unguiculata* (L.) Walp Fabaceae.

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ABSTRACT
Experiments were carried out to examine the effects of water stress on some growth aspects of two varieties of Vigna unguiculata (Cowpea). Each polythene bag measuring 18 X 24 cm was well perforated to enhance drainage. Sterile sandy loam soil was packed in each polythene bag to a 20 cm height. Viable seeds of each variety of cowpea (white and brown variety) were sown. Cowpea seedlings were thinned to five per polythene bag. The watering regimes of 12, 24 and 48 hours in three replicates each were investigated. The seedlings were allowed to grow in the green-house for 30-days. The growth parameters studied were seedling height, leaf length, leaf width and leaf area. Results of this study showed that the two varieties of cowpea were significantly (P<0.05) affected by water stress. The highest growth performance was observed in the control (12 hours) and water stressed seedlings at 24 and 48 hours had more adverse effect on brown variety than white variety. Water stress is therefore an important factor to be considered during the growing stage of Vigna unguiculata as depicted by the morphological parameters in this study.
Keywords: *Vigna unguiculata*, water stress, varieties, seedlings, growth parameters.

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INTRODUCTION

Plants experience water stress either when the water supply to their roots becomes limiting or when the transpiration rate becomes intense. Water stress is primarily caused by the water deficit, i.e. drought or high soil salinity. In case of high soil salinity and also in other conditions like flooding and low soil temperature, water exists in soil solution but plants cannot absorb it – a situation commonly known as 'physiological drought'. Drought occurs in many parts of the world every year, frequently experienced in the field grown plants under arid and semi-arid climates [8].

Cowpea, *Vigna unguiculata* (L.) Walp. a dicotyledonous plant belonging to the family Fabaceae, genus *Vigna* is of major importance to the livelihood of millions of people in the tropics. It is an annual herb with varying growth forms. It may be erect, trailing, climbing or bushy, usually indeterminate under favourable conditions. The genus *Vigna* currently includes around 80 species distributed throughout the tropics [12]. It comprises seven domesticated species, five of which are Asiatic and two are of African origin [7]. The number of seeds per pod in *Vigna* vary from 8 to 20 and are relatively large (2 to 12 mm long) and weigh 5 to 30 g/100 seeds. The testa may be smooth or wrinkled; white, green, buff, red, brown, black, speckled, blotched, eyed (hilum white, surrounded by a dark ring) or mottled in colour. The plant may be erect, crescent-shaped or coiled. Usually yellow when ripe, but may also be brown or purple in colour [14].

Nutritionally, *V. unguiculata* is a good source of protein, vitamin A, thiamin, riboflavin, iron, phosphorus, and potassium, and a very good source for vitamin C, folate, magnesium, and manganese. In a serving size of 100 grammes yardlong beans there are 47 calories, 0 grams of total fat, 0 mg cholesterol, 4 mg sodium (0% daily value), 8 grams of total carbohydrates (2% daily value), and 3 grams of protein (5% daily value). There is also 17% DV vitamin A, 2% DV iron, 31% DV vitamin C, and 5% DV calcium. Percent daily values are based on a 2000 calorie diet. Individual daily values may be higher or lower depending on individual calorie needs [13]. Sixty two percent of the

common bean grown suffers from water stress at some stage of their growth [16]. Studies also show that in 93% of common bean growing areas, the physiological water requirements are not fulfilled and this affects yields especially when water stress occurs during the flowering stage [6]. Midseason droughts have been identified as one of the limiting factors to bean production in the smallholder sector where production is mainly rain fed [10]. In Niger delta region of Nigeria there is paucity of information on the effect of water stress on the commonly cultivated varieties of *Vigna*, therefore the aim of this study is to evaluate the effects of water stress on the growth performance of two varieties of *V. unguiculata*.

MATERIALS AND METHODS

Mature dry seeds of two varieties of *Vigna unguiculata* (cowpea): (white and brown) were obtained from Urua Akpan Andem in Uyo Local Government Area, Akwa Ibom State.

Collection of soil sample and polythene bags.

Sandy loam soil (garden soil) used in this study was collected from Botany Postgraduate Farm, University of Uyo, Uyo, Akwa Ibom State. The soil was sterilized using electric oven kept at 120^0C and allowed to cool for about 24 hours. Eighteen (18) well perforated polythene bags 18-24cm used in this study were obtained from Ministry of Environment and Mineral Resources, Department of Forestry, Uyo, Akwa Ibom State.

Determination of growth parameters

The growth parameters were taken at two different phases i.e. 15 and 30 days after germination. Meter rule was used to measure seedling height and the leaves. Growth parameters studied include: Seedling height, Leaf length, Leaf width and Leaf area.

Seedling height

Seedling height was measured and calculated for five seedlings per replicate thus:

$$\frac{n_1 + n_2 + n_3 + n_4 + n_5}{n}$$

Where:

n = number of seedling

Determination of leaf area

Leaf area (LA) was determined by multiplying leaf length by leaf width with the correction co-efficient (r) 0.72 as proposed by Hoyt and Brafield [9, 5].

LA = L X W X r

Where: L = Leaf length

W = Leaf width

r = Correction co-efficient (0.72)

Statistical analysis

Results were expressed as a mean Standard Deviation (M.S.D.) and statistical significance between the different groups were determined using one-way Analysis of Variance (ANOVA). The levels of statistical significance ($P<0.05$) were expressed using SPSS and PAST.

RESULTS

Effect of water stress (WS) on some growth parameters at 15 days after germination

The effects of WS conditions on seedling height, leaf length and leaf width were measured to determine the tolerance of each cowpea variety to WS. Out of the two cowpea varieties (white and brown) tested; some morphological features were reduced as the WS increased in potted plants. Seedling height was relatively affected as WS increased. Seedling height was affected more in brown variety than in white variety. Leaf area was also affected as the stress increased and white variety had better improvement than in brown variety (Figure I and II).

Effect of water stress (WS) on some growth parameters at 30 days after germination

The results of 30 days after germination showed that seedling height of white variety of cowpea in W_1 increased to 159 ± 20.07 followed by W_2 with 82.6 ± 3.3 and W_3 had 66.0 ± 8.5. Following the same trend, brown variety in W_1 had 104 ± 1.9 followed by W_2 with 69.3 ± 5.0 and 66.0 ± 8.6 were recorded in W_3 (Figure III and IV). Like seedling height, leaf length and leaf area of white variety were more sensitive to WS than brown variety that is, Leaf area in white variety, W_1, W_2 and W_3 recorded

133.1±3.2, 75.9±0.9 and 60.1±5.3 respectively while brown variety was more better thus W_1, W_2 and W_3 had 136.2±1.2, 82.1±3.3 and 75.1±2.2 respectively (Figure III and IV).

DISCUSSION

From the results, it was evident that values of all the growth parameters decreased with the period of growth as the water stress (WS) increased. However, there was variation in the rate of decrease of growth parameters among the different varieties (in different fortnight) with respect to corresponding variation in water stresses. Under drought conditions, there was a sharp decline in the values obtained

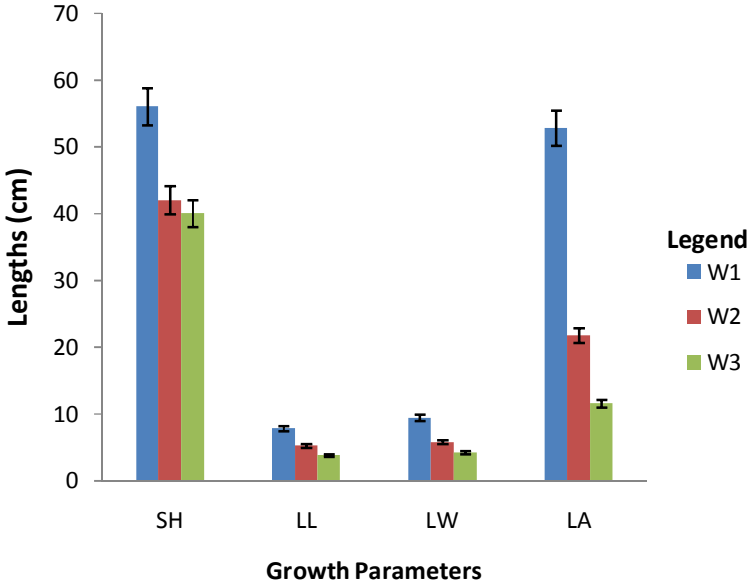

Figure I: Some growth parameters of white variety of cowpea at 15 days after germination (DAG). SH: Seedling height, LL: Leaf length, LW: Leaf width and LA: Leaf area. W_1 = watering once everyday, W_2 = watering at 1 day interval, W_3 = watering at 2 days interval.

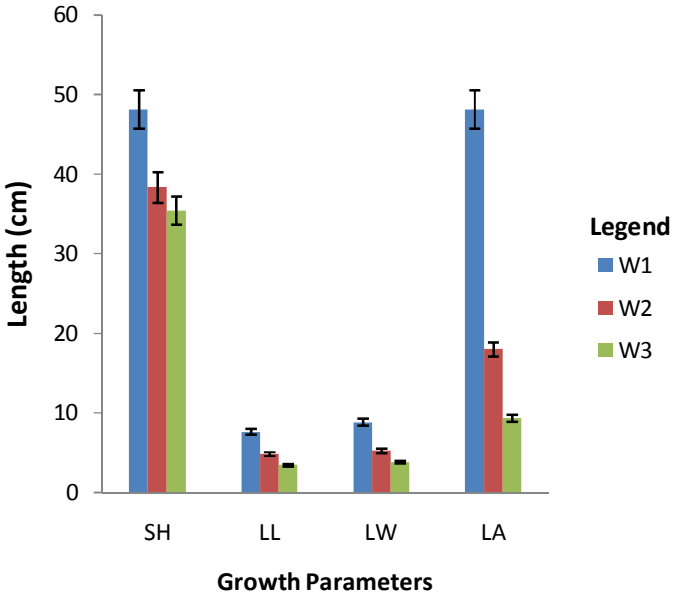

Figure II: Some growth parameters of brown variety of cowpea at 15 days after germination (DAG). SH: Seedling height, LL: Leaf length, LW: Leaf width and LA: Leaf area. W_1 = watering once everyday, W_2 = watering at 1 day interval, W_3 = watering at 2 days interval.

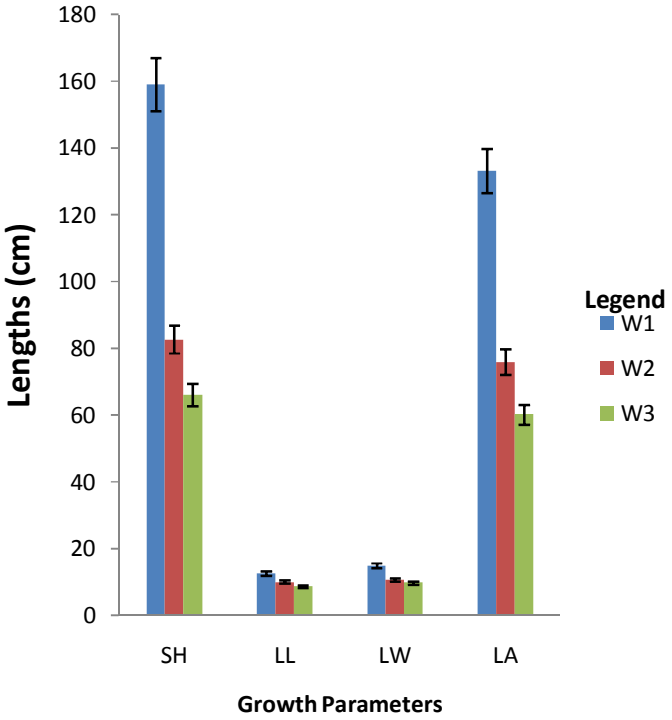

Figure III: Some growth parameters of white variety of cowpea at 30 days after germination (DAS). SH: Seedling height, LL: Leaf length, LW: Leaf width and LA: Leaf area. W_1 = watering once everyday, W_2 = watering at 1 day interval, W_3 = watering at 2 days interval.

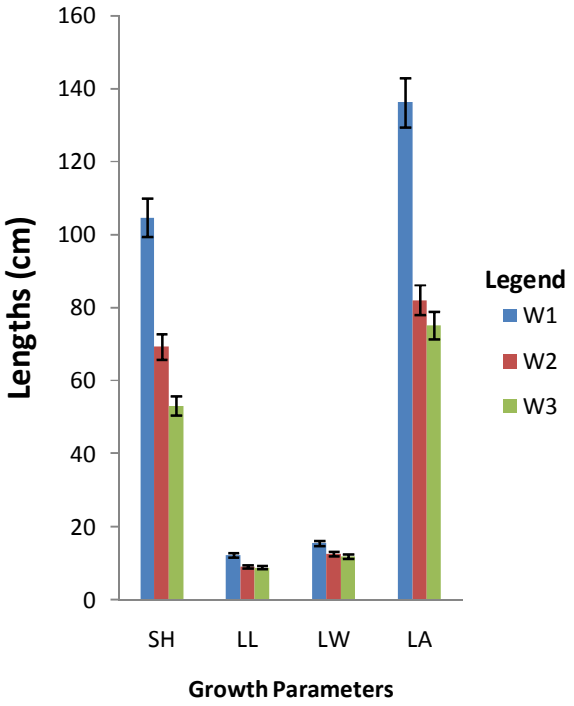

Figure IV: Some growth parameters of brown variety of cowpea at 30 days after germination (DAG). SH: Seedling height, LL: Leaf length, LW: Leaf width and LA: Leaf area. W_1 = watering once everyday, W_2 = watering at 1 day interval, W_3 = watering at 2 days interval.

DISCUSSION

From the results, it was evident that values of all the growth parameters decreased with the period of growth as the water stress (WS) increased. However, there was variation in the rate of decrease of growth parameters among the different varieties (in different fortnight) with respect to corresponding variation in water stresses. Under drought conditions, there was a sharp decline in the values obtained. There was a significant reduction ($P<0.05$) in seedling height in W_3 of both varieties in W_2 and W_3 when compared with their corresponding controls atfer 15 and 30 days of germination. Similar reduction in plant height in maize seedling due to drought was reported by Del Rosario *et al*. [4]. Creelman *et al*. [3] reported same in the growth of soyabean seedlings. The decrease in plant height under extreme water stress may have been due to reduced turgor, which affected cell division and expansion since growth involves both cell growth and development. Mwai [11] reported that cell growth and development is a process consisting of three stages; cell division, enlargement and differentiation. Morphologically, seedling height is perceived as an increase in plant size as indicated by parameters such as seedling height, moisture content and root length while development involves tissue and organ formation. Therefore reduced growth rate under water stress can be qualitatively related to reduced cell turgor or a reduction in the extensibility of the cell wall. Cell turgor reduces with any dehydration-induced decrease in cell water potential. Severe water stress has been known to delay stem elongation in *Panicum maximum* and also in the case of mango seedlings [2].

The water potential at which plants get stress varies with species and varieties. The production of leaves represents an increase in the photosynthetic surface for the plants. A significant ($P<0.05$) increase was observed in the leaf area in control seedlings watered once a day (12 hours) when compared to those under severe WS i.e. (W_2 and W_3) as was observed in white and brown varieties of cowpea. Severe WS have been known to decrease leaf area development in several crops [17]. The reduction in leaf area under extreme water stress may have been due to reduction in leaf formation and increased abscission of lower leaves eventually leading to wilting and chlorosis of the whole plant. Tezara *et al*. [15] reported that low water resulted in poor formation and biomass production of leaves in cereals and also caused low leaf initiation [1]. It is apparent from this research, as also observed by Tezara *et al*. [15] in cereals, that mild water stress does not inhibit the growth of *Vigna unguiculata* seedlings.

CONCLUSION AND RECOMMENDATIONS

Water stress reduced growth performance of both cowpea varieties but brown variety had more negative effects than the white variety, especially on plant height and leaf area. Water stress significantly reduced parameters of cowpea, the greatest reduction occurring when water stress was imposed after germination. The least reduction occurred when water stress was imposed during the first 15 days after germination. The results also showed that water stress at different growth phases of cowpea significantly affected its components. Water stress caused a reduction in shoot height. However, water stress also significantly ($P<0.05$) affected the leaf area. It is therefore recommended that cowpea growers should ensure that their crop does not suffer from water stress during growth stages.

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