GROWTH OF AN INDIGENOUS VEGETABLE CROP *(AMARANTHUS CRUENTUS L.)* IN RESPONSE TO DROUGHT

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Abstract

Amaranthus cruentus L. is an important leafy vegetable in Nigeria that has high dietary value. Experiments were conducted to investigate the effects of drought on growth of *Amaranthus cruentus* in Ekpoma, Edo State of Nigeria. Although the vegetable crop tolerates drought to some certain degree and adapted to drought, the most significant point is that drought had remarkable effects on growth of *Amaranthus cruentus.* The general effects were low dry weight yields, wilting and yellowing of leaves leading to senescence and eventual death of some of the plants. In drought, the water content in *A. cruentus* increased with the period of treatment. The results are discussed in relation to the morphological and physiological adaptations of the plants to water stress.

Introduction

Among the factors influencing prospects for food security, the inequitable distribution of rainfall is an unavoidable problem throughout Nigeria. It is the main cause of widespread food insecurity since agricultural production of food depends on it. In many instances, crop production especially vegetables must be done during the rainy season. Therefore, they are relatively scarce during the dry season. Poor storability of the vegetable has also compounded this problem. For this reason, off-season vegetable production has been of interest to many Scientists and farmers alike.

Amaranthus cruentus L. is an important vegetable crop in Nigeria and is extensively cultivated in the Southwest of Nigeria under rainfed cindition for its edible leaves which have dietary values (Omidiji et al., 1986). Members of the genus *Amaranthus* are widely distributed throughout in World's tropical, subtropical and temperate regions. A cruentus is useful both as leafy vegetable and as a grain. It has a protein content of 16 percent (Olufolaji and Tayo, 1980). Protein levels in other amaranth species have been reported at around 30 percent (Wesche-Ebeling et al., 1995). *A, cruentus* is also a useful crop for livestock, particularly ruminants and among the factors constraining its production, drought is the major problem. *Amaranthus cruentus* is frequently mentioned as leafy vegetable but research information on its performance under drought conditions found in West Africa in general and Nigeria in particular, and its notable therefore that current research efforts give priority^ to measures which ensure production strategy of nutrient rich crops especially vegetables in order to generate sufficient and sustainable income to overcome poverty. The objective of this paper, therefore, is to study the response of *Amaranthus cruentus* to water stress (drought) in order to develop strategies for the production and availability of the crops throughout the year aimed at achieving food security in Nigeria.

Materials And Methods

Seeds of *Amaranthus cruentus* were sown in generation trays at the Experimental Farm of Ambrose Alli University, Ekpoma, Edo State Nigeria (06° 42' N Latitude 06° 08'E Longitude) using garden loamy soil. Seedlings were transplanted into individual polyethylene bags measuring 25 cm x 15 cm and allowed to harden prior to lying out in the field. The vegetable crop was tested during the dry season in 1987. The treatments were (1) drought treatment (imposed by applying water to seedlings once a week) and (2) control treatment (adequate watering was done three times a week). The experiments were laid out in the field in a Completely Randomized design with 30 cm x 30 cm spacing between and within rows respectively.

Sampling commenced 6 weeks after treatment to enable them acclimatize to the weather. The sampling was done weekly over a period of 8 weeks. For every sampling week five plants of the species per replicate were selected randomly and harvested from each treatment for growth analysis. The sampled plants in the potting bags were soaked in a bucket of water for 15 minutes prior to harvesting and were carefully pulled out from the polyethylene bags without losing any of the roots. The sampled plants were separated into roots, stems and leaves and the fresh weights of different parts were taken. Growth of species was determined using the method of Hunt (1978). The plant parts were dried in an oven at 65° C until constant weights were achieved and they were re-weighed to obtain dry weights.

Growth analysis was further carried out following the method of Wilson (1981). Plant growth was measured in terms of leaf area ratio (LAR), leaf weight ratio (LWR) stem weight ratio (SWR), root weight ratio (RWR), relative growth rate (RGR) and net assimilation rate (NAR), Percent water content was also determined.

The growth parameters were calculated using the following formulae:

% water Content = 100 (fresh weight-dry weight) / (fresh weight)

RGR = ($\log_e W_2$ - loge w,)/ ($t_r t$,)

NAR = (W_2-W.) (loge A_2 - loge A,)/(t_2-t_1)(A_2-A_1) LAR - Total leaf area

/Total plant dry weight LWR = leaf dry weight/Total plant dry weight

SWR = stem dry weight/Total plant dry weight RWR = Root dry

weight/Total plant dry weight

Where W1 and W_2 are the mean dry weight per plant, and A] and A_2 the leaf area per plant, in the beginning and at end of each experiment, t_2-t] is

the duration between the final and initial sampling times. Data were subjected to analysis of variance (ANOVA) procedures using SAS GLM procedure-(SAS, 1987). Means were compared by the Least Significant Different (LSD) test atp=0.05 (Clark, 1980).

Results And Discussion

Treatment effects were first observed during the third week. Leaves of *A crentus* grown in drought soils exhibited yellow colouration during the third week of drought and the plants were remarkably similar in their responses to drought conditions, indicating that water stress had imposed absorption of essential nutrients from the soils and thereby reduced metabolic processes. Although the plants experienced temporary wilting in response to water deficit, they were remarkably efficient at surviving drought condition as indicated by ability of the plants to survive the water stress up to week eight. The yellowish leaves with senescence observed in *A. cruentus* under drought condition was probably a response to drought conditions, which is similar to waterlogged effects found in *Corchorus Olitorius L.* (Anegbeh and Akomeah, 2002) and in other crops (Courts, 1981; Davies, 1984).

Plants grown in the control treatment showed extensive shoot and root development and they flowered at week eight, as compared with the plants grown in the drought condition. They also exhibited good traits such as large and green leaves, allowing them to produce good yields throughout the experimental period than the plants in drought condition. Although, plants grown in the control and drought conditions survived up to week eight of the experiment, it is most probably that the growth rate of the species depended on the water treatments imposed on the plants. But other factors, such as temperature (Eze 1973; Tawusi and Ormrod, 1981) have been known to contribute to plant growth. Further experiments that will include growing *A.cruentus* plants in different locations could help to confirm this assumption.

The dry matter of *A. cruentus* plants are shown in Fig. 1. Seedlings of the species grown in control treatment had higher dry weights than those in drought treatment. This was expected on the basis of availability of optimum water for physiological processes in the plants. As Boot et al., (1986) pointed out, the fact that the

RGR was reduced suggest strongly that drought reduces growth rate of plants because cell division and enlargement on which growth depends are affected.

Results of leaf weight ratio, stem weight ratio and root weight ratio are shown in Fig.2. Perhaps, the most important plant development in all treatments was found in the leaves, which had significant ($p<0.05$) more dry matter than the roots or stems. In the control treatment, leaf dry weight accounted, significantly, for 50% of the total plant dry weight whereas the stem and root accounted for 26% and 24% respectively.

Results of relative growth rate, leaf area ratio, and net assimilation rate

are shown in Fig. 3. Whereas increase in mean dry weights in all treatments was observed for the species (Fig.l.), the RGR, LAR and NAR tended to decrease with time. This appears to be the dependency of RGR on leaf area and NAR. In general, control treatment had higher dry weight, RGR, LAR and NAR, than drought treatment, indicating that plants in control treatment produced higher yields to account for the optimum water that was made available to them.

Interestingly, it was observed that drought seedlings of *A. cruentus* had more water content than seedlings grown in control treatment during week 5 to 8. All these plants exhibited reductions in transpiration and increases in water content. These changes, it seems, allow the plants to utilize water efficiently more than those growing in control treatment.

Drought plants did grow less, as expressed by dry weights and a reduced total leaf area, than control plants. Nevertheless, they maintained their healthy appearance and green qualities at the end of the experiment, implying that *Amaranthus cruentus* may be able to be grown under water stress (off-season) prevailing in the dry season.

Conclusion

These experiments show that drought conditions in vegetable production have distinct effects on growth of *A. cruentus*. The drought conditions largely affect plants of *A cruentus*. Clearly, the lower growth rate *of A. cruentus* plants in drought conditions is insurprising, in view of the stressed conditions imposed on them. However, the tolerance and adaptations of *A. cruentus* to drought condition seem to be an encouragingly feature of the species. That the effects of drought conditions seem to be less pronounced in the plants tested indicate that the capacity *of A. cruentus* to tolerate drought conditions may be relatively high.

On the basis of the observations in growth rate, the vegetable crop can be grown in the dry and rainy seasons since it is capable of striving in drought conditions. Consequently, it would be available in the dry season when most other vegetable crops are scarce.

Essentially, widespread adoption of off- season production, cultivation in both rural and peri-urban areas, marketing and utilization of vegetable crops will ensure increased production. This will enhance food security, increase incomes for farmers, contribute to poverty alleviation, reduce hunger and child malnutrition and enhance livelihood of the people. Consequently sustainable development in Nigeria is guaranteed.

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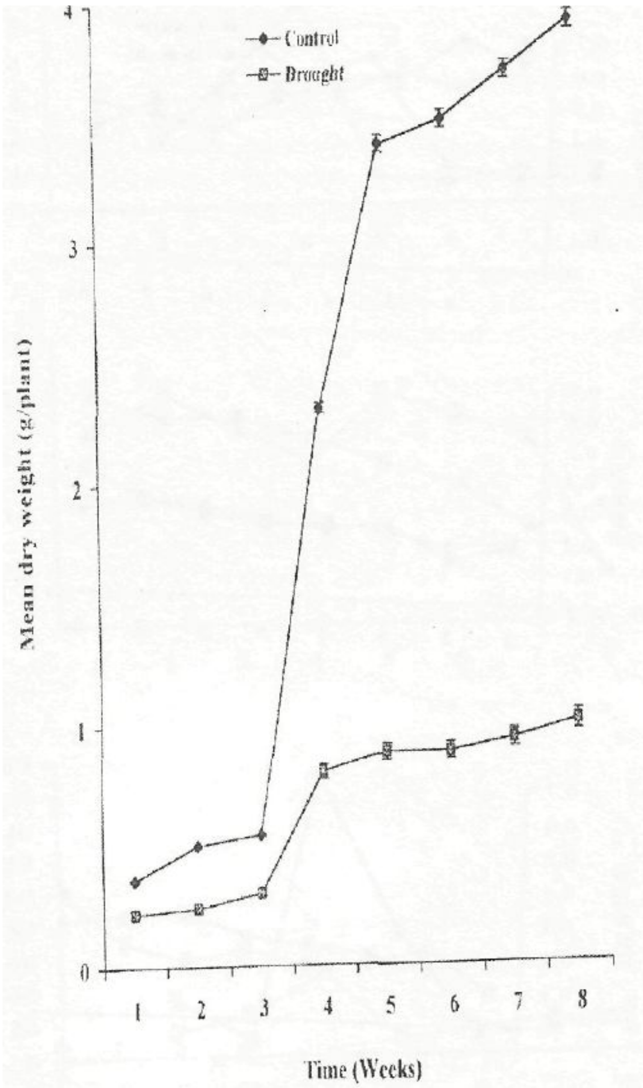

fig. I. Mean dry weight *of AmaranthusCruentus L.* subjected to drought

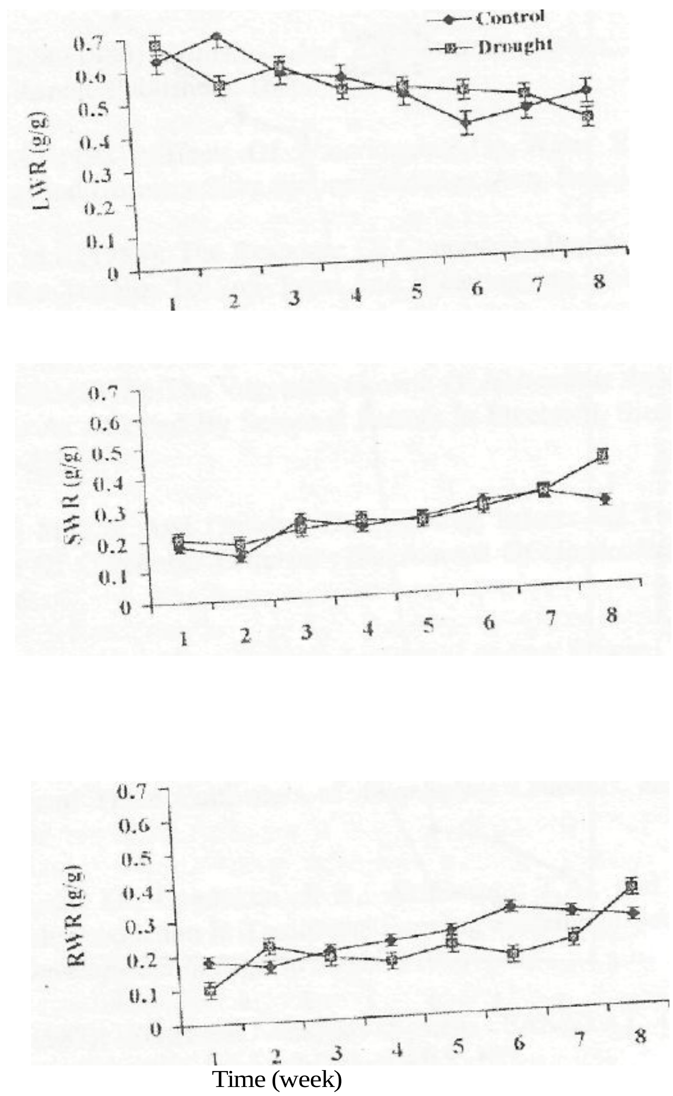

Fig. 2. Leaf weight ratio (LWR). Stem Weight Ratio (SWR), and root weight ratio of Amaranthus cruentus L. subjected to drought

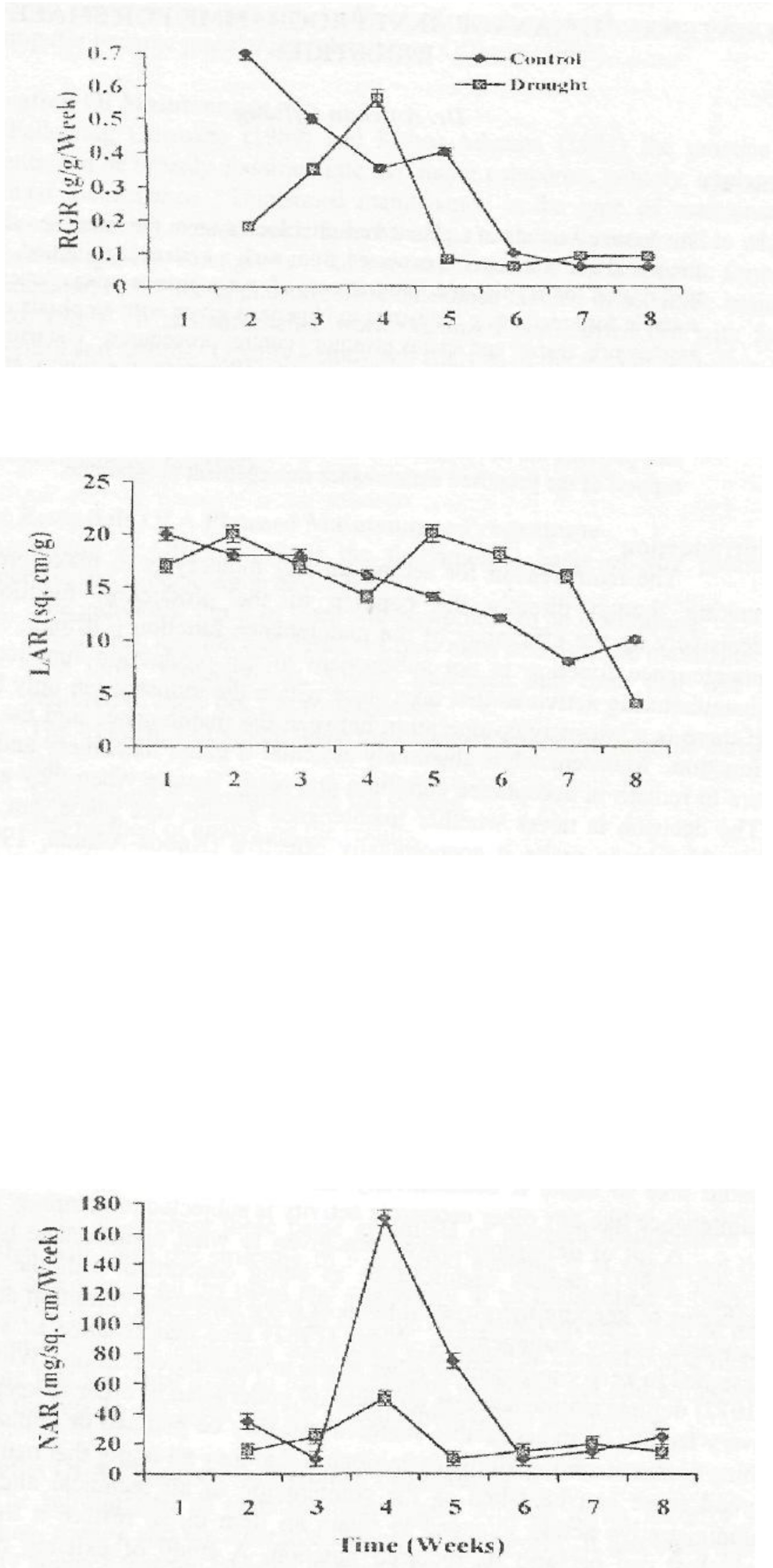

Fig. 3. Relative growth rate (RGR), Leaf area ratio (LAR), and Net assimilation rate (NAR) of