GROWTH OF SPIGELIA ANTHELMIA L. CH. IN RESPONSE TO WATER STRESS IMPOSED AT SET STAGES OF DEVELOPMENT

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ABSTRACT

Seedlings of Spigelia anthelmia L. Ch. were subjected to 7 days water stress at two growth stages (vegetative and flowering). Seedlings subjected to water stress at the vegetative stage (SV), showed a 2-fold increase in virtually all the growth parameters studied: leaf area, plant height and girth, dry weight of whole plant roots and fruit and fruit number. Seedlings stressed at the flowering stage (SF) had a significantly higher (at P = 0.05) root length, shoot-root mass ratio and shoot weight ratio than SV-seedlings and NS-seedlings (control). A higher yield of leaves and fruits is obtained in Spigelia when plants are subjected to 7 days water stress at the vegetative stage of development.

INTRODUCTION

Water stress affects the growth, yield and quality of plants and the degree of effect depends on the duration of the stress (Hsiao, 1973) and the timing of the stress in relation to the stage of development of the plant (Forbes and Watson, 1992). Stress given during organ formation causes adverse effects on the plant. The stage at which water stress imposes very drastic effects on the plant is referred to as the crucial / critical stage (Forbes and Watson, 1992).

Spigelia anthelmia L. Ch. (pink root, wormweed) of the family Loganiaceae, is a common weed of wasteland, cleared areas and roadsides. The plant is very toxic with leaves and roots that have local medicinal use as an anthelmintic (Oliver, 1960). It produces the alkaloid, spigeline (Claus and Tyler, 1965). This study investigates the growth response of Spigelia subjected to water stress at set stages of growth. The main objective is to outline stages at which water stress could favour root growth or leaf growth when required for medicinal purposes.

MATERIALS AND METHODS

Seeds of Spigelia anthelmia L. Ch. (wormweed) were collected from the side lawn of the Faculty of Science, University of Lagos. The seeds were stored for a week, soaked in water for a week and again dried for a week to enhance germination and even establishment prior to planting as in Oseni (1981). The experiments took place in a greenhouse in the Botanical Garden of the University of Lagos.

PLANTING PROCEDURE

Seeds were sown in 90 planting bags with loamy soil and the lay-out was according to the Fully Randomized Design. A batch of seedlings was subjected to 7 days water stress at the vegetative stage (30^{th}-36^{th} days after sowing) and this was tagged SV-seedlings. A second batch of seedling was given the 7 days water stress at the flowering stage (52^{nd}-58^{th} day after sowing) and tagged SF-seedlings. A third batch of seedlings was given no water stress but watered daily. This batch served as control and was tagged NS-seedlings. The experiment was terminated at fruit maturity (77 days).

GROWTH ANALYSIS

At bi-weekly intervals, samples of seedlings were harvested and the fresh and dry weights, height and girth of stem, fruit weight and number were determined. The leaf area was determined as described by Eze (1965). Each leaf was carefully traced on paper and the leaf traces were weighed. The weight of 100 cm^2 of that paper (standard area) represented the standard weight. The area of the leaf traces was thus determined using the formula:

Leaf Area = [weight of leaf traces (g) $\times$ 100 cm^2 (standard area)] / standard weight (g)

The shoot-root mass ration, root weight ratio and shoot weight ratio were calculated as percentages of total dry weight as outlined by Meyer et al. (1973). Five replicates of plants were used at each stage of analysis and tests of significance between means at P = 0.05, were carried out according to the New Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Seedlings of Spigelia anthelmia that were watered daily (NS-seedlings) showed the least growth compared with seedlings subjected to 7 days of water stress at the vegetative stage (SV-seedlings) or at the flowering stage (SF-seedlings). SV-seedlings had a two-fold increase in root dry weight (Figs. 1B and 1C). Furthermore, the SV-seedlings had significantly higher (at P = 0.01) plant dry weight, leaf area, plant height and stem girth than SF-seedlings and NS-seedlings (Figs. 1A, 2 and Table 1). This suggests that daily watering of seedlings of Spigelia, does not promote maximum yield. A short period of water stress imposed on the plant at the vegetative stage promotes rapid growth and yield. Fischer and Turner (1978) reported that a special rooting pattern is developed under early water stress which is used advantageously to enhance the subsequent growth of the plant when water supply is resumed. Shanahan and Nielson (1987) also showed that corn subjected to water stress at the early vegetative stage has restricted vegetative top growth and hence is able to make better used of available water to improve grain yield.

Table 1. Growth attributes of stressed Spigelia plants

Growth Attributes	Control	SV	SF
		Seedlings	
Mean leaf area (cm^2)	62.90+3.41b	96.60+1.30a	69.77+0.84b
Root length (cm)	3.44+0.51b	3.02+0.67b	7.48+1.10a
Plant height ()	19.00+0.31b	22.50+0.75a	18.50+0.89b
Stem girth ()	0.84+0.27b	0.90+0.22a	0.74+0.19b
Shoot : root mass ratio (g/g)	10.71	11.50	11.86
Shoot weight ratio (% of total dry weight	91.46	92.00	92.22
Root weight ratio (% of total dry weight	8.54	8.00	7.78

SV-stressed at vegetative stage, SF-stressed at flowering stage.
Means followed by similar letters on the horizontal axis, are not significantly different at P = 0.05

Water stress imposed on Spigelia seedlings at the flowering stage had very little effect on its growth and fruit yield. Water stress at this stage of growth only resulted in a significantly higher root length (at P = 0.05), than in SV and NS seedlings (Table 1).

Mapfumo et al. (1994) also noted that grapevine plants had longer roots when moisture supply is inadequate. However, seedlings subjected to water stress at the vegetative stage (SV-seedlings) did not grow longer roots. The SF-seedlings also had a slightly higher shoot-root ratio than other seedlings (Table 1). Though the SF-seedlings had longer roots, the root dry weight was similar to that of NS-seedlings and significantly lower than that of the VS-seedlings (Fig. 1B). Apparently, the growth and yield of Spigelia seedlings subjected to 7 days water stress at the reproductive stage, were not adversely affected. This deviates from reports by Hsiao (1973), describing the reproductive stage as the crucial stage at which water stress affects growth and yield and this is contrary to reports of Forbes and Watson (1992) that water stress given in the period of organ formation leads to reduction in yield.

The stage of development, at which Spigelia is subjected to water stress affects the growth and yield. A 7-day water stress given at the vegetative stage, causes a two-fold increase in growth and yield. Longer periods of water stress may cause adverse effects. Leaf and fruit yield of Spigelia plant can be enhanced when required for medicinal use, by subjecting the plant to 7 days water stress at the vegetative stage of development.

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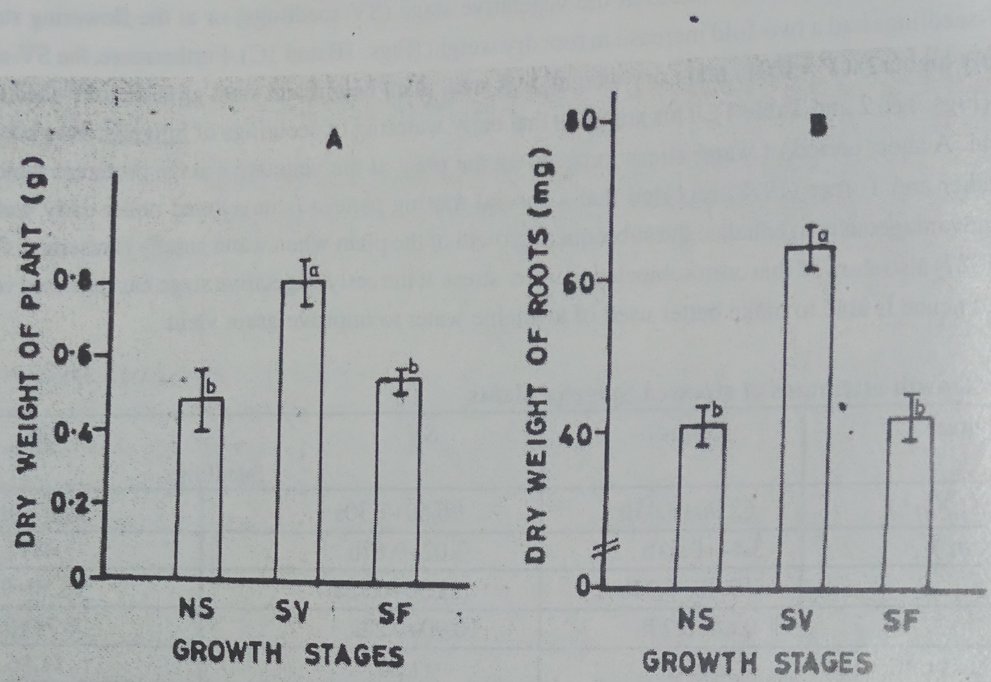

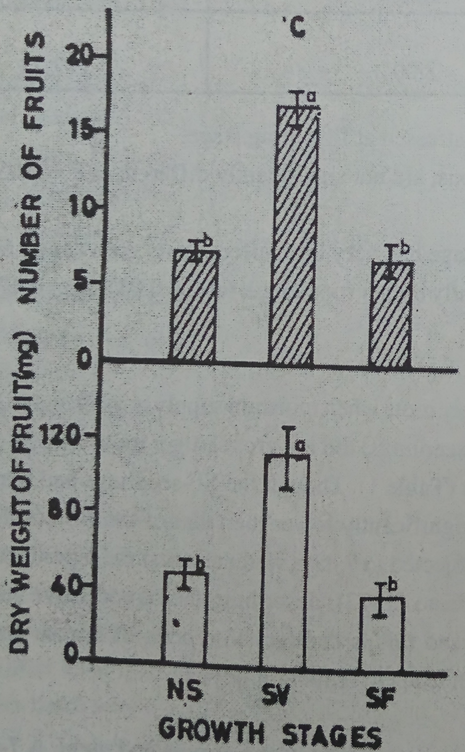

Fig. 1. Effect of water stress on the dry weights of the whole plant (A), roots (B), fruits and the fruit number (C) of *Spigelia* plants at fruit maturity (78 days). Means followed by similar letters are not significantly different at P = 0.05

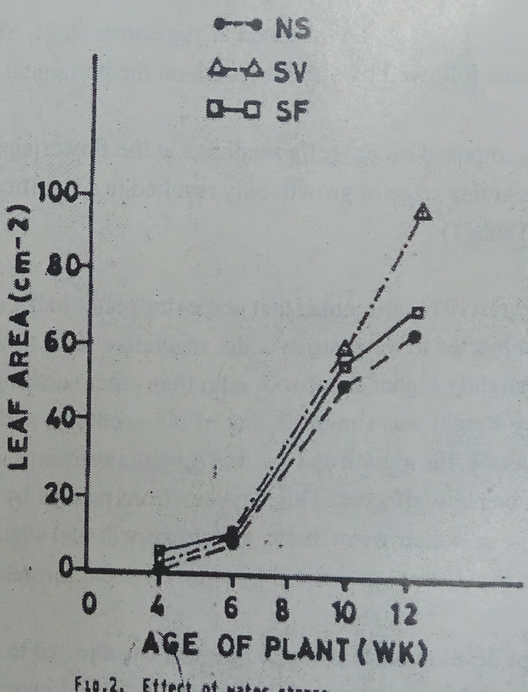

Fig.2. Effect of water stress on the mean leaf area of seedlings of *Spigelia*. VS - stressed at vegetative stage, SF - stressed at flowering stage, NS - control

REFERENCES

Claus, E. P. and Tyler, V. E. Jnr. (1965). Pharmacognosy (5th Edition). London, Kimpton. 572 pp.

Eze, I. M. O. (1965). Studies on Growth Regulation, Salt Uptake and Translocation. Ph.D. Thesis, University of Durham, England.

Fischer, R. A. and Turner, N. C. (1978). Plant Productivity in the Arid and Semi-arid zones. Annual Review of Plant Physiology 29: 277-317.

Forbes, J. C. and Watson, R. D. (1992). Plants in Agriculture. University Press, Cambridge 355pp.

Hsiao, T. C. (1973). Plant responses to water stress. Ann. Rev. Plant. Physiol. 24: 519-570.

Mapfumo, E., Aspinall, D. and Hancock, T. W. (1994). Growth and development of roots of grapevine (Vitis vinifera L.) in relation to water uptake from the soil. Annals of Botany 74: 75-85.

Meyer, B. S., Anderson, D. S. Bohning, R. H. and Frantianne, D. G. (1973). Introduction to Plant Physiology. D. van Nostrand Company, New York.

Oliver, B. (1960). Medicinal Plants in Nigeria. The Nigerian College of Arts, Science and Technology, Ibadan.

Oseni, C. E. (1981). The 'hardening' treatment of seeds: germinability and metabolic changes induced. M.Sc. Thesis, University of Ibadan.

Shanahan, J. F. and Nielson, D. C. (1987). Influence of Growth Retardation (Anti-Gibberellin) on corn vegetative growth, water use and grain yield under different levels of water stress. Agronomy Journal 79: 103-109.