Comparing *Cucumis africanus* and *Cucumis myriocarpus* using a classical growth analysis tool under five irrigation frequencies

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Abstract

Greenhouse studies were conducted to compare wild watermelon (*Cucumis africanus)* and wild cucumber (*C. myriocarpus)* under five irrigation frequencies. The irrigation frequencies were 0, 1, 2, 3, 4 and 5 days, where 0 day implied daily irrigation. Samples were collected at T1 (70 days) and T2 (84 days) to determine (1) relative growth rate (RGR), (2) unit leaf rate (ULR), (3) leaf area ratio (LAR), (4) leaf weight fraction (LWF) and (5) specific leaf area (SLA) using the classical growth analysis tool. Generally, when using RGR and ULR, the model suggested that *C. africanus* had superior growth rate than *C. myriocarpus*, whereas for LAR and LWF *C. myriocarpus* was superior, variable results for SLA. In conclusion, *C. myriocarpus* exhibited potential for leafiness, a trait that is desirable since the plant leaves are harvested and used as a leafy-vegetable by smallholder farming communities in the Limpopo Province, South Africa.

Keywords: relative growth rate, unit leaf rate, leaf area ratio, leaf weight fraction, specific leaf area.

1 Introduction

The term plant growth analysis refers to a useful set of quantitative methods that describe and interpret the performance of whole plant systems grown under natural, semi-natural, or controlled conditions. Plant growth analysis provides an explanatory, holistic and integrative approach to interpret plant form and

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function [1]. One of the oldest methods in plant growth analysis is the classical approach. In classical growth analysis, relative growth rate (RGR) is calculated by dividing the difference in In-transformed plant weight at two harvests by the time difference between those harvests.

Classical growth analysis of indigenous plants is important in order to understand and assess their potential to be introduced into conventional farming systems to augment rural livelihoods. Indigenous plants have the potential to provide a valuable source of income as ethnomedicines and food in marginal areas for conventional agricultural crops.

Wild watermelon (*Cucumis africanus)* and wild cucumber (*C. myriocarpus,* indigenous to southern Africa, have various uses in Limpopo Province, South Africa. Like other indigenous plants that are drought-tolerant and can thrive under minimal water supply, their growth potentials under various irrigation intervals have not been determined. The objective of the study was to determine the effects of different irrigation water application intervals on classical growth of *Cucumis africanus* and *C. myriocarpus*.

2 Materials and methods

2.1 Study location/area

A study was conducted at the Horticultural Unit of the University of Limpopo, South Africa (23°53'10" S; 29°44'15" E) under greenhouse conditions during the 2009/2010 growing season to compare the growth potentials of *C. africanus* and *C. myriocarpus*. Ambient day/night temperatures averaged 28/21^{o}C, with maximum temperatures controlled using thermostatically-activated fans.

2.2 Procedures

Seedlings were raised in seedling trays using Mafeo and Mashela's method [2]. Thirty-cm-diameter plastic pots, filled with 10 L steam-pasteurised sand and Hygromix (3:1 v/v), were placed on greenhouse benches at 0.5 m inter-row and 0.6 m intra-row spacing. Uniform three-week-old *Cucumis* seedlings were transplanted to the pots one day after irrigating the growing medium to field capacity. Five irrigation intervals, namely, 0, 1, 2, 3, 4 and 5 days, were arranged in a randomised block design, with 5 replications. During each irrigation interval, 1 000 ml tap-water was applied per pot.

2.3 Data collection

At T1 (70 days) and T2 (84 days) plants were harvested, leaf area was measured using leaf area meter (LI-3100C, LI-COR, Bioscience, Lincoln, NE 68504 USA) and then whole plant organs oven-dried at 60°C for 72 hours. Dry root, stem and leaf weights were determined. Classical growth analysis on the data was performed using a Modern Tool for Classical Plant Growth Analysis [3].

3 Results

Results regenerated from the classical growth analysis model were depicted using the RGR, ULR, LAR, LWF and SLA (Table 1).

Table 1: Classical growth parameters of *Cucumis africanus* and *C. myriocarpus* at 5-day irrigation intervals.

Irrigation interval (day)	RGR (day^{-1})	ULR (kg m^{-2} day^{-1})	LAR (m^2 kg^{-1})	LWF (kg/kg)	SLA (m^2 kg^{-1})
Cucumis africanus					
0	0.076	4.102	0.024	0.36	0.069
2	0.079	4.179	0.025	0.37	0.069
3	0.045	0.531	0.025	0.472	0.056
4	0.051	1.766	0.025	0.499	0.056
5	0.072	3.521	0.026	0.489	0.053
Cucumis myriocarpus					
0	0.012	1.699	0.017	0.368	0.048
2	0.013	3.256	0.034	0.617	0.067
3	0.034	0.317	0.032	0.575	0.060
4	0.048	1.159	0.037	0.892	0.064
5	0.038	1.147	0.035	0.645	0.058

3.1 Relative growth rate (RGR) and unit leaf rate (ULR)

In all five irrigation frequencies, the RGR and ULR of *C. africanus* were superior to those of *C. myriocarpus* (Figure 1). Simply stated, it implies that in terms of the model used, *C. africanus* was, under the conditions of this study, more productive than *C. myriocarpus.*

The RGR is the rate of increase of total dry weight per plant, expressed per unit of the plant. This was originally termed an efficiency index because it expresses growth in terms of a rate of increase in size per unit of size. The ULR is an index of the productive efficiency of plants calculated in relation to total leaf area, which is synonymous to net assimilation rate (NAR).

3.2 Leaf area ratio (LAR) and specific leaf area (SLA)

The LAR is a morphological index describing the leafiness of the plant and it measures the balance of payments between income and expenditure in terms of the potentially photosynthesizing and respiring components of the plant. On the other hand, the SLA is an index of the "leafiness of the leaf", which is a measure of density or of relative thinness, which involves an assessment of the leaf area in relation to its dry weight.

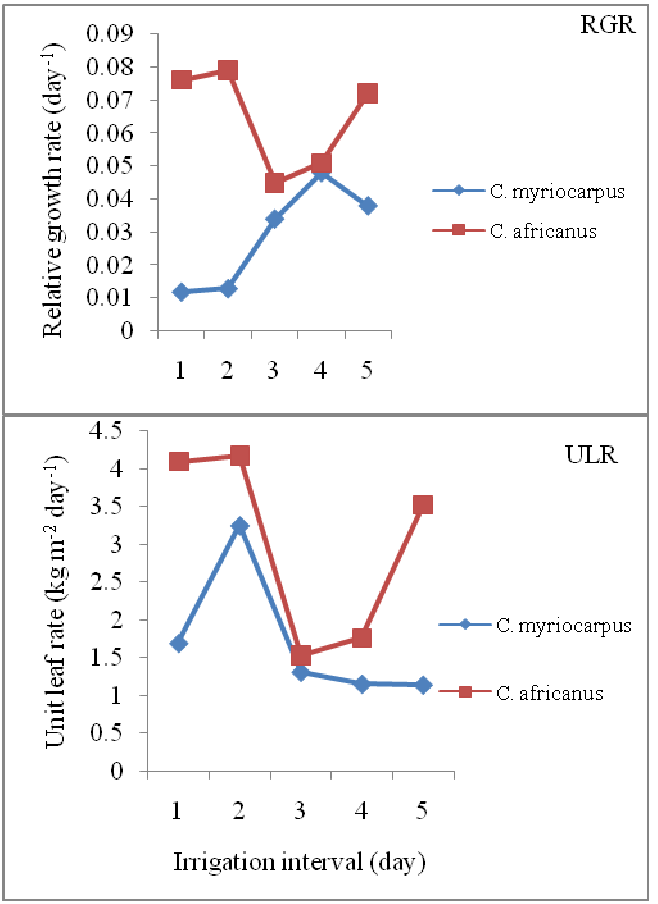

Figure 1: Relative growth rate and unit leaf rate of *Cucumis africanus* and *C. myriocarpus* at 5-day irrigation interval.

In all five irrigation frequencies, the LAR and SLA of *C. myriocarpus* were superior to those of *C. africanus* (Figure 1). Simply stated, it implies that in terms of the classical growth analysis tool, *C. myriocarpus*, under the conditions of this study, was more suitable for its vegetative parts than *C. africanus*. Incidentally, leaves of *C. myriocarpus* are widely used as greens in Limpopo Province by local people, whereas those of *C. africanus* are not edible since they contain cucurbitacins, which are highly toxic to humans and animals.

3.3 Leaf weight fraction (LWF)

The LWF is an index of leafiness of the plant on a dry weight basis - a measure of the productive investment of the plant as a whole, dealing with relative expenditure on potentially photosynthezing organs. *Cucumis myriocarpus* was, in terms of LWF, superior to *C. africanus*.

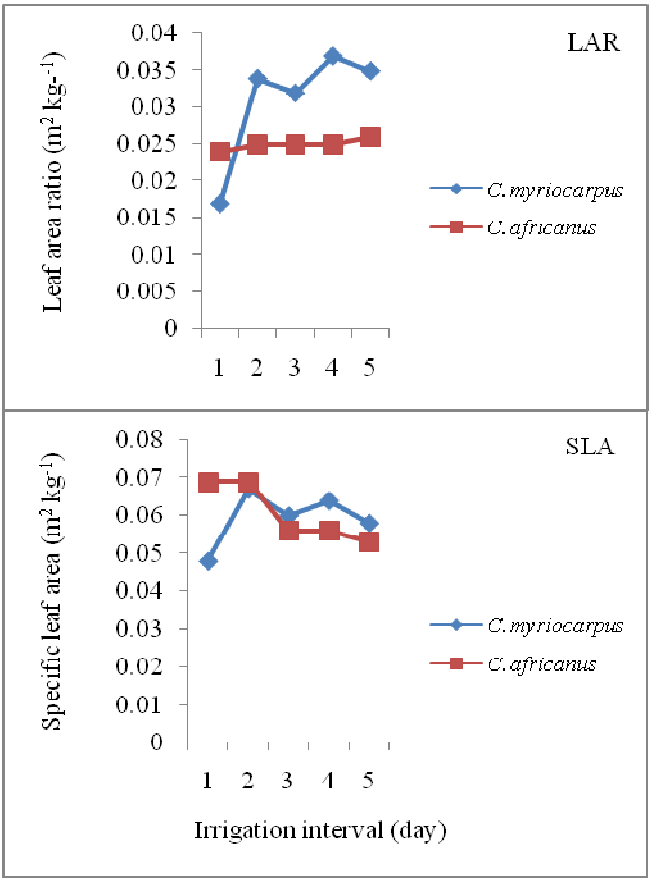

Figure 2: Leaf area ratio and specific leaf area of *Cucumis africanus* and *C. myriocarpus* under 5 irrigation intervals.

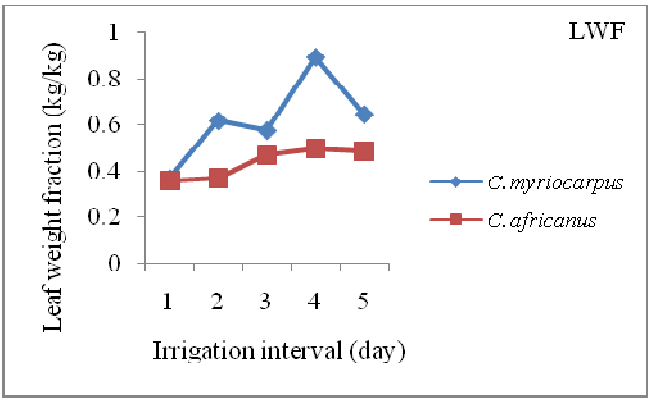

Figure 3: Leaf weight fraction of *Cucumis africanus* and *C. myriocarpus* under 5-day irrigation interval.

4 Conclusions

On the basis of three superior variables of growth (LAR, SLA, LWF) in *C. myriocarpus* over two of *C. africanus* (RGR, ULR), it appears that *C. myriocarpus* would be a better candidate to serve as an alternative vegetable crop. However, further information on the two plant species under marginal irrigation regime would be necessary in flawless selection of a suitable plant for serving as an alternative crop in semi-arid areas of Limpopo Province.

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