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SOME PHYSIOLOGICAL STUDIES ON ORNAMENTAL IPOMORA BATATAS AS A GROUNDCOVER SPECIES

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SOME PHYSIOLOGICAL STUDIES ON ORNAMENTAL *IPOMOEA BATATAS* AS A GROUNDCOVER SPECIES

by

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Lovingly dedicated to

ABU BAKAR

MOHD. AZIZI

NUR LIYANA

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Abstract of the thesis presented to the Senate of Universiti Pertanian Malaysia in fulfillment of the requirements for the degree of Master of Agricultural Science.

SOME PHYSIOLOGICAL STUDIES ON ORNAMENTAL IPOMOEA BATATAS AS A GROUNDCOVER SPECIES

by

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May 1991

Supervisor : Professor Mohd. Zain Haji Abdul Karim

Faculty : Agriculture

The morphological development and some physiological aspects were studied on two cultivars of sweet potato which are normally used as an ornamental plant. Among the studies undertaken were those on the botanical characteristics of the plants, effects of shade and fertilizer and nutrient uptake. The cultivar examined were Imelda and an unnamed 'variegated' type.

The effects of shading and fertilizer levels showed growth of the 'variegated' cultivar were severely reduced in heavy shading (70% and 80%). Increasing shade levels increased leaf area ratio (LAR) and leaf area to leaf weight (LALW), but decreased dry matter production, visible quality, chlorophyll content and elemental composition in the leaf tissue. However, fertilizer levels were less effective than shade in altering the parameters above. As shade levels increased, the content of nitrogen, phosphorus, potassium, calcium and magnesium in

the leaves increased. Shade levels significantly affected light compensation point (LCP) in both cultivars. Increasing shade levels decreased LCP. LCP of cv. 'variegated' is lower than cv. Imelda, suggesting that cv. 'variegated' is more adaptable to a moderate shade.

Studies on the nutrient uptake of both cultivars using hydroponic techniques showed that the highest element in the leaves, stem and root was potassium and followed in descending order by nitrogen, calcium, phosphorus and magnesium. However, instead of calcium, phosphorus was higher in the root.

In general, both cultivars are suitable as groundcover plants with the 'variegated' cultivar more adaptable to shade than cv. Imelda.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi syarat untuk Ijazah Master Sains Pertanian.

BEBERAPA KAJIAN FISIOLOGI KE ATAS *IPOMOEA BATATAS* SEBAGAI SPESIES TANAMAN HIASAN PENUTUP BUMI

oleh

Noriah Binti Othman

Mei 1991

Penyelia : Professor Mohd. Zain Haji Abdul Karim

Fakulti : Pertanian

Perkembangan morfologikal dan beberapa aspek fisiologikal telah dikaji ke atas dua kultivar ubi keledek yang biasanya digunakan sebagai tanaman hiasan. Kajian ini tertumpu pada ciri-ciri botanikal tanaman ini, kesan baja dan cahaya serta pengambilan nutrien. Kultivar yang dikaji ialah *Imelda* dan jenis warna-warni yang tidak bernama.

Hasil kajian kesan teduhan dan baja menunjukkan pertumbuhan kultivar yang berwarna-warni kelihatan jelas terencat di bawah teduhan yang tinggi (70% dan 80%). Peningkatan paras teduhan telah menambahkan kadar keluasan daun (LAR) dan kadar luas daun per berat daun (LALW), tetapi mengurangkan penghasilan berat kering, kualiti tanaman dilihat dari sudut mata kasar, kandungan klorofil dan komposisi elemen di dalam tisu daun. Namun demikian, paras baja kurang memberi kesan berbanding dengan teduhan di dalam mengubah parameter-parameter di atas. Apabila paras baja bertambah, kandungan nitrogen, posforus,

kalium, kalsium dan magnesium di dalam daun juga turut bertambah. Paras teduhan memberi kesan yang bererti pada tahap tepu cahaya (LCP) pada kedua-dua kultivar. Meninggikan paras teduhan menyebabkan tahap tepu cahaya menurun. Kultivar berwarna-warni mempunyai LCP yang lebih rendah dari kultivar Imelda, mencadangkan kultivar berwarna-warni ini lebih dapat mengadaptasi pada keadaan teduhan yang sederhana.

Kajian mengenai pengambilan nutrien pada kedua-dua kultivar menggunakan teknik hidroponik menunjukkan elemen yang tertinggi di dalam daun, batang dan akar ialah kalium diikuti dalam susunan menurun nitrogen, kalsium, posforus dan magnesium. Sungguhpun demikian, bukannya kalsium tetapi posforus lebih tinggi di dalam akar.

Amnya, kedua-dua kultivar adalah sesuai sebagai tanaman penutup bumi dan kultivar yang berwarna-warni lebih dapat mengadaptasikan diri daripada kultivar Imelda.

CHAPTER 1

INTRODUCTION

The development of the sweet potato (*Ipomoea batatas*) as a food crop is as old as civilization itself. Its ancestral home is Tropical America, in Central America or North Western South America (Brand, 1971). The species was an important food crop of the Mayans in Central America and of the Peruvians in the Andes. Both civilizations developed an advanced type of agriculture. Although maize was the major crop, the natives also grew sweet potatoes. In fact by the time of the discovery of America, they had extended the culture of this important crop to Mexico, the West Indies and certain parts of South America (Brand 1971).

Many records show that Spanish explorers of the early part of the sixteenth century carried the plant, presumably by means of the fleshy roots, in both the easterly and westerly directions, to Spain, Africa and the Far East (Hornel, 1945).

The present day sweet potato was developed through centuries of culture in which a large number of cultivars have risen through natural hybridization and selection, mutations as well as through systematic breeding efforts (Purseglove, 1968).

One of the advantages of sweet potato compared to other tuber crops, e.g., tapioca, is that it is more drought tolerant (Culwick, 1941). Furthermore, the crop is considered useful as a famine reserve (Brooke, 1972). Sweet potato has the advantage of being a good cover crop, minimizing soil erosion and suppresses weed growth as well as providing additional income from the tubers. The protective cover provided by its vines reduces the erosivity of raindrops and run off, and competes well with weeds.

So far, studies on sweet potato have been emphasized on the tuber production and as food crop (Lantican and Soriano, 1961; Biswas and Bose, 1980; Bartolini, 1983). Recently, two cultivars of sweet potato were introduced to Malaysia and were planted as ornamental groundcover along the roadsides and under trees. One cultivar is characterised by large yellowish green leaves believed to be originated from the Philippines. The cultivar is known as Imelda. It is used as borders of yield tests because of its distinct colour at Philippine Root Crop Research & Training Center (PRCRTC). However, it is low yielding and is susceptible to attack by weevils (Cylas formicarius). A second cultivar is a 'variegated' type with the leaves having two different colours, i.e. dark green and purplish. It is said to be originated from Hawaii. Unfortunately the name of this cultivar is still unknown. The attractive colour of the leaves is the main reason that triggered the interest of some horticulturists to cultivate them as ornamental plants either as individuals or in combination with other ornamental plants to emphasize the colour and to give an appealing look to onlookers. Because there is little information on the two cultivars, especially on the morphological and physiological behaviour under

Malaysian conditions, it is essential that certain aspects of their physiology be studied. It is hoped that these studies will help to assess the potential of the cultivars as ornamental groundcover.

Effects of varied light intensities on the growth of the plants, and mineral requirements for the growth and development of the cultivars are important physiological aspects that will contribute towards our understanding of the physiological behaviour of the two cultivars thus enabling us to provide the appropriate environment for their growth. The studies reported here examine the aspects mentioned above. With a better understanding of the characteristics of these two cultivars, it is hoped that they can be grown as ornamentals under appropriate conditions and establish as important groundcover plants in Malaysia.

The specific objectives of the investigation reported in this thesis are:

1. To study the morphological development of the two cultivars under lathhouse conditions (Experiment 1).
2. To study the effects of shading and different rates of fertilizer on the growth, nutrient composition and quality of the 'variegated' cultivar (Experiment 2).
3. To determine the light compensation point of the two cultivars at varying degrees of shading (Experiment 3).
4. To study the mineral requirement of the two cultivars (Experiment 4).

CHAPTER 2

LITERATURE REVIEW

Introduction

Very little studies have been made on Ipomoea batatas from the point of view of the use of the species for ornamental purposes. The review of literature therefore will consider physiological studies on the species as a whole particularly those aspects that relate to the present investigations.

Some Botanical Aspects of Sweet Potato

The sweet potato belongs to the family Convolvulaceae, a group which comprises about 50 genera, 1200 or more species (Purseglove, 1968). The plant is a twining perennial herb but treated as an annual in cultivation. The plants in this family have distinguishing characteristics: latex is present in their sap, the stems are erect, trailing or climbing according to the species, and contain bicollateral vascular bundles. Adventitious roots are progressively at the nodes and in this manner the plants creep along (Purseglove, 1968). The flowers are complete with a superior pistil, five stamens, and a trumpet shaped corolla. The fruit is a capsule and the seed contains an embryo with folded cotyledons (Purseglove, 1968).

The major part of the top system of the stem consists of primary laterals. Varietal differences and similarities occured in length of the main axis and in number of primary and secondary laterals (Purseglove, 1968). The leaf system in the sweet potato develops a relatively large number of simple, moderately large- bladed, long petiolated leaf (Purseglove, 1968). Hayward (1938) stated the first leaves were cordate while those formed later may be hastate, cut or lobed. Thus the leaf shade varies with the age of the plant.

The tubers are the fleshy enlargement of certain of the larger roots and develop in the first 22.5 cm of the soil. They are either bunched together or borne on laterals, varying in length from several centimeter to 30 cm. The shape of the tubers could vary considerably even in the same variety depending on soil or other environmental factors (Purseglove, 1968).

Growth Pattern and Development of Sweet Potato

Milthorpe (1967) and Milthorpe and Moorby (1974) have described the growth pattern of root crops (with particular references to the potato, sugar beet and sweet potato) as roughly consisting of three vegetative phases. The phases comprise a pre-emergence or establishment phase, a canopy development phase and the storage or bulking phase.

Sweet potato may also exhibit an initial lag phase in which no tubers are formed until a certain amount of leaf growth has taken place (Milthorpe, 1967). In yet another pattern of growth there is simultaneous shoot and tuber growth without the requirement for an initial canopy development phase (Lowe and Wilson, 1974). There are contrasting opinions as to the importance of leaf area in the sweet potato. It has been shown that staking the plants improves leaf display and increases Leaf Area Index (LAI) with the final result of increased yields (Chapman and Cowling, 1965). Haynes et al., (1967) believed in the existence of an optimal LAI. Lowe and Wilson (1974), on the other hand were of the opinion that the sink effect of the developing tubers was more crucial in determining yield rather than foliage characteristics. Nevertheless, their work, showing that early vigorous shoot growth delayed tuber bulking in general and leading to lowered partitioning of total dry matter to the tubers, seems to be consistent with the concept of an optimal LAI for economic yield.

Major Factors Affecting Growth of Sweet Potato

Light

Growth of autotrophic plants is influenced by the intensity of light. Plants occupying sunny habitats (sun plants) are generally capable of higher photosynthetic rates at high quantum flux densities (light intensity) than plants restricted toshaded locations (shade plants) (Gabrielsen, 1960).

At low quantum flux densities, photosynthesis is linearly dependent on quantum flux density and the efficiency of light as shown in figure 1 (Bjorkman, 1981). At higher quantum flux densities, the

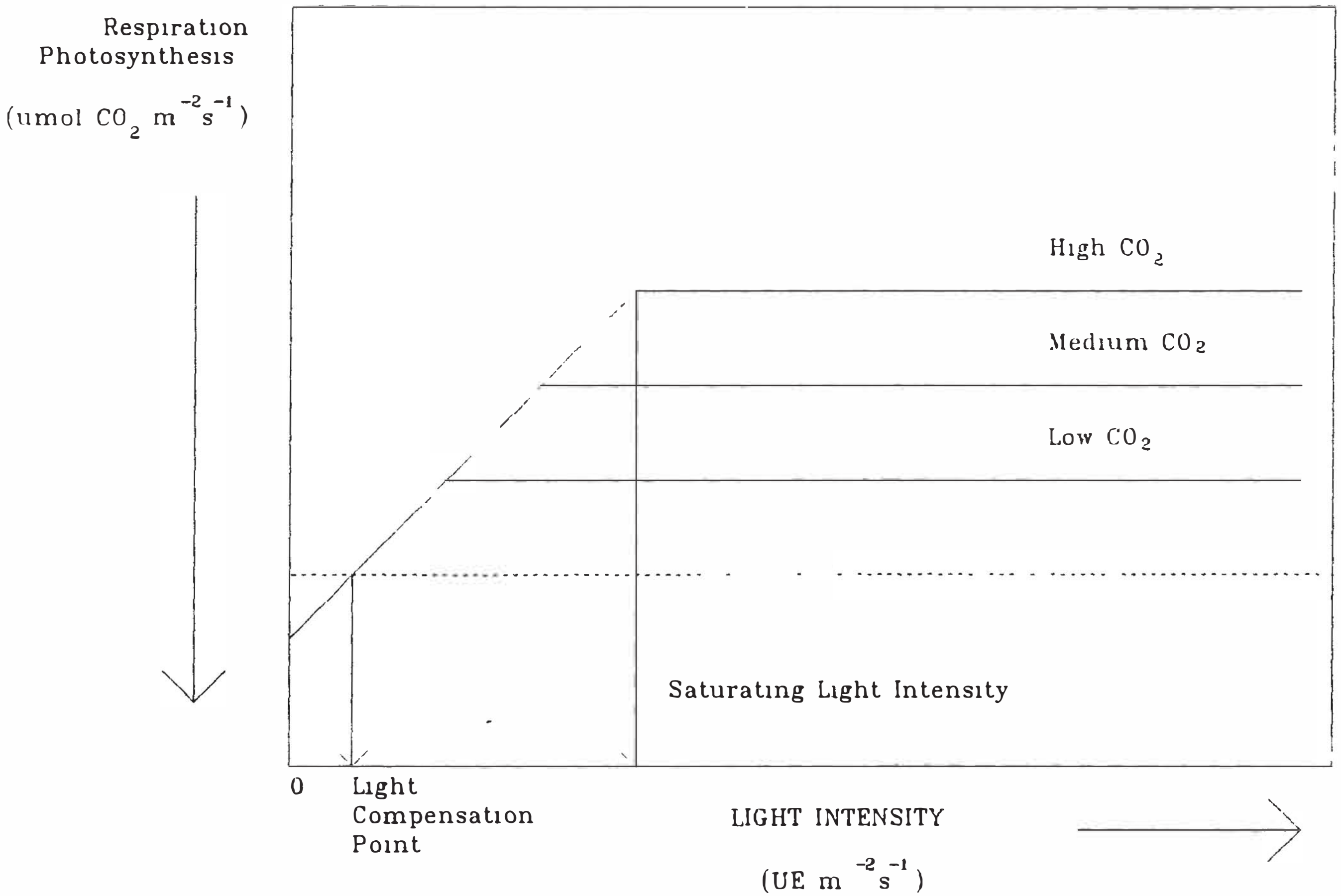

Figure 1. The Hypothetical Response of Photosynthesis to Light Intensity and CO_2 Concentration

increase in photosynthesis is less than proportional to the increase in quantum flux densities (partial light saturation) and ultimately, photosynthesis fails to increase with increasing light intensity (light saturation) (Bjorkman, 1981).

Reduced light intensity may also stimulate compensatory growth or movement, including new chlorophyll production, epinasty and leaf expansion. In contrast, changes in photoperiodism or in light-induced germination are often controlled by very low light intensities and brief exposure (Bickford and Dunn, 1972).

The light intensity at which photosynthesis just balances respiration (net carbon dioxide exchange is zero) is called the light compensation point (Salisbury and Ross, 1978). This point varies with the species, with the light intensity during growth (Conover and Poole, 1975) and to some extent with the temperature at which measurements are made and carbon dioxide concentration (Salisbury and Ross, 1978). Species with a steep photosynthetic curve would be expected to show an unfavourable photosynthetic balance when subjected to changed light or temperature while those with shallow curve would be expected to be little affected by the environment (Bannister, 1976).

At atmospheric concentrations of carbon dioxide, the values of the light compensation point are strongly influenced by temperature; this effect may be very marked at high temperatures and even at lower