

## Survival of Young Mangosteen in the Field as Influenced by Shading and Water Stress

Mohd Razi Ismail, Mohamad Hamad Awad and Adiwirwan Izhar

Faculty of Agriculture  
Universiti Putra Malaysia  
43400 UPM, Serdang, Selangor  
Malaysia

E-mail of Corresponding Author: [razi@agri.upm.edu.my](mailto:razi@agri.upm.edu.my)

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### Introduction

The mangosteen (*Garcinia mangostana* L.) which originated in the tropical rainforest is now cultivated commercially in most of tropical region. In Malaysia, mangosteen is designated to be one of the national fruit crops (NAP3, 1999). To ensure success of cultivation of mangosteen, fundamental responses of plants exposed to environmental factors need to be understood. This includes understanding of plant behaviour at various growth stages and the plant requirement for optimum growth and development. Young mangosteen plants are considered to be a drought sensitive and careful husbandry during early establishment is essential (Masri et al., 1997). There are reports that shading is also important to ensure survival of plants during transplanting (Rukayah et al. and Zabedah, 1992; Masri et al., 1992). Shading of mangosteen plants may consequently affect other cultural practices such as irrigation, fertiliser application and other related crop management. On the other hand, shading of mangosteen may be beneficial in improving plant microclimatic factors for plant survival. In rainfed cultivation, shading may reduce water availability to the root zone of mangosteen. At present, no information was available on the responses of mangosteen plants in relation to shading and water availability under field condition. This study was undertaken to examine the growth and physiological processes of mangosteen plants grown under shade and water availability.

### Materials and Methods

Uniform seedlings of 18 month old mangosteen were transplanted into planting holes containing soil mixture of 3: 2: 1 (top soil: chicken manure : sand) under field conditions. The seedlings were grown under two different shade treatments. The shade treatments

were control (unshaded) , and 60% shade achieved by using black nylon net. The plants were either watered daily or left unwatered. For well-watered treatment, plants were irrigated daily to maintain soil volumetric water content at above 20 %. The treatments were arranged in a randomised design with eight replicates. The transplanting of mangosteen seedlings was done in the evening. The experiment was conducted during the dry season at the experimental plot in Kelantan, located at the East Coast of Peninsular Malaysia. There was no rainfall at the site during experimental period. In addition, day air temperature was high and on several occasions, air temperature above 30<sup>o</sup> C could have been reached after 0930h.

The soil mixture in the planting holes was completely wetted during the transplanting of plants, which was carried out in the evening. At the beginning of the experiment, there were at least 14 green mature leaves on the plants. Leaf appearance was recorded daily and leaf scorch number was recorded. Leaf water potential was measured at transplanting, 3, 5, 6 and 8 day's plants in the treatments. Stomatal conductance was recorded daily using a transit time porometer ( AP-4, Delta T, Cambridge , England). Leaf adjacent to the leaf sampled for leaf water potential was used to record stomatal conductance to determine relationship between both parameters as influenced by the treatments.

### Results and Discussion

Within 24h exposure to light, leaves of newly transplanted mangosteen plants show discoloration of leaves or photo-bleaching. Leaf discoloration appeared on the tip of the leaf blades and spread to the whole leaves causing leaf scorching. Further exposure to unshaded condition had resulted to a progressive increase of leaf bleaching and necrosis of upper leaves spread to

lower leaves. After 8 day of unshaded conditions, all leaves exhibited bleaching and necrosis on both well watered and water stressed plants. In contrary, there was no bleaching of leaves on plants grown on both watering treatments under shaded conditions (Figure 2). Young mangosteen is a typical shade plant that light saturation occurred at about 400-500  $\mu\text{mol m}^{-2}\text{s}^{-1}$  ( Ramlan et al , 1992; Wiebel et al., 1993). Exposure of leaves to high irradiance will induce photoinhibition. The damage to the photosynthetic organelles can result in photodestruction of photosynthetic pigment. Powles et al. (1984) suggested that the destruction of pigment is evident as oxygen and light bleaching of pigments may result in the death of cell through photooxidation. This process was signified in the present study by complete bleaching of leaves with exposure to irradiance regardless of water availability in the root zone. Shading at early growth stage mangosteen plants may presumably restrict ultraviolet radiation that can contribute to the scorching and glazing of leaves. The present study showed a rapid discoloration of leaves when plants were exposed to irradiance with all leaves affected within 9 days after transplanting. Mangosteen leaves that were established under shaded condition at nursery may have high chlorophyll content by compensating for the thinner palisade mesophyll through extensive grana formation as reported on many shade plants (Goodchild et al., 1972). When exposed to irradiance, these organelles were not able to fully acclimatise. The results obtained from the present study was also consistent with those observed on shade grown beech (*Fagus sylvatica*) plants showing symptom of chlorophyll bleaching when exposed to irradiance and water stress within 8 days of exposure (Tognetti et al., 1994). In other crops like ginger (*Zingiber officianales*), chlorotic symptoms were observed

within 30 days of sprouting and were severely affected after 4 months grown under unshaded conditions (Wilson et al. and Opid, 1993).

### Conclusions

Our observations indicate that water relations and plant development of mangosteen plants can be sustained or improved by imposing shade at earlier phase of vegetative growth. During the 9 day period after imposing treatments, water stressed plants were able to maintain leaf water potential close to the well watered plants suggesting that shading can offset the effect of water stress in mangosteen plants. In practice, survival of young mangosteen plants can be ascertained provided that plants grown under shade will be able to withstand water stress conditions. With proper crop management practices, mangosteen plant can be used as one of the component in agro forestry.

### Benefits from the study

In practice, survival of young mangosteen plants can be ascertained provided that plants grown under shade will be able to withstand water stress conditions. With proper crop management practices, mangosteen plant can be used as one of the component in agro forestry.

### Literature cited in the text

Goodchild, D.J., Bjorkman, O. and Pyliotis, N.A. 1972. Chloroplast ultrastructure, leaf anatomy and content of chlorophyll

and soluble protein in rainforest species. Carnegie Institute Washington Yearbook. 71: 102-107.

Masri, M. 1992. Stomatal activity of shaded and unshaded mangosteen seedlings. *Transactions Malaysian Society Plant Physiology*. 3: 84-85.

Masri, M. 1997. Effect of water stress and micorhyza on growth of mangosteen. Ph D Thesis. Universiti Putra Malaysia.

Ministry of Agriculture, Malaysia 1999. Third National Agricultural Policy (1998-2010) Executive Summary. Publication Unit, Ministry of Agriculture Malaysia, Kuala Lumpur; 36pp.

Powles, S.B. 1984. Photoinhibition of photosynthesis induced by visible light. *Annual Review Plant Physiology*. 35: 15-44.

Ramlan, M.F., Mahmud, T.M.M, Hassan, B.M. and Karim, M.Z. 1992. Studies on photosynthesis on young mangosteen plants grown under several growth conditions. *Acta Horticulturue*. 321: 482-489.

Rukayah, A. and Zabedah. 1992. Studies on early growth of mangosteen (*Garcinia mangostana* L.) *Acta Horticulturue*. 292: 93-100.

Tognetti, R., Michelozzi, M., Borghetti, M. and Scarascia-Mugnozza, G.E. 1994. Ecophysiology and genetics of trees and forests in a changing environment. *Tree Physiology*. 14: 7-9

Wilson, H. and Ovid, A. 1993. Growth and yield responses of ginger (*Zingiber officinale* Roscoe) as affected by shade and fertilizer applications. *Journal of Plant Nutrition*. 16: 1539-1545.

### Project Publications in Refereed Journals

Masri, M. Azizah, H., Mohd Razi Ismail, and Mamat, A.S. 1998. Arbuscular-mycorrhiza enhances growth and reduces the nursery period of mangosteen (*Garcinia mangostana* L.) Seedlings. *Journal Tropical Agriculture and Food Science*. 26(1): 7-15.

Masri, M. Azizah, H., and Mohd Razi Ismail. 1998. Root morphological characteristics in relations to growth of four tropical fruit seedlings. *Journal Tropical Agriculture and Food Science*. 26(1): 17-24.

### Project Publications in Conference Proceedings

Mohd Razi Ismail, Davies, W.J. and Awad, M.H. 2000. The way ahead in managing environmental stress: A multidisciplinary approach. *Transaction Malaysian Plant Physiology*. 9: 29-35.

Mohd Razi Ismail, Awad, M.H. and Adiwirwan, I. 2000. Improvement of water use efficiency in young mangosteen plants. *Transaction Malaysian Plant Physiology*. 9: 240-245.

### Graduate Research

None.