

Effect of Light Intensity to Chlorophyll and Anthocyanin Content in Mangosteen Leaf

Eko Setiawan
Agrotechnology Department, University of Trunojoyo Madura
e_setiawan@trunojoyo.ac.id

Abstract

The objective of this study was to understand the light intensity conditions of mangosteen trees to various branch position in canopy. The experiment was conducted using mangosteen trees grown on commercial orchard in Bogor, Indonesia during August - October 2013. Mangosteen trees of three different ages, young (20 years), middle (35 years), and old ages (50 years), each of five trees, are selected for study. Canopy of each tree divided into 9 sectors. The highest light intensity in full sunlight conditions was found in sector 9 were 8.07; 7.53; and 7.74 $\mu\text{mol M}^{-2}\text{ s}^{-1}$, in young, middle and old age, respectively, in contrast, the lowest light intensity in sector 1 were 0.53; 0.42; and 0.49 $\mu\text{mol M}^{-2}\text{ s}^{-1}$, in young, middle and old age, respectively. Chlorophyll a/b ratio in mangosteen leaves increase gradually as an increase of age, each in young, middle, and old age were 2.20; 2.25; and 2.95, respectively. The highest chlorophyll index was in branch with fruit production, than decrease in dormancy condition, whereas the lowest chlorophyll index in new flush or vegetative condition.

Key words: age, chlorophyll, light intensity, mangosteen, sector.

INTRODUCTION

Mangosteen (*Garcinia mangostana* L.) is a tropical evergreen tree, believed to have originated in the Sunda Islands and the Moluccas (Misra et al., 2009), growing in humid and shaded environmental conditions (Osman and Milan, 2006). Mangosteen, a slow-growing tree, is adapted to shade and regarded as a shade tolerant tree, while shade is essential during the first 2-4 years of growth (Nakasone and Paull, 1998). There are no reports of photoperiod response. The photosynthetic rate is steady over a 27-35°C temperature range, under 20-50% shade (Weibel et al., 1993). Fruit is susceptible to sunburn in direct sunlight (Verheij, 1992).

Mangosteen orchards in Indonesia are generally found in villages and contain several fruit

species. Growing mangosteen together with durian, rambutan or longkong is a common practice in Thailand, because growers experienced that the young plants require nurse trees or artificial shade to encourage their growth (Salakpetch, 2005). The objective of this study was to understand the light intensity conditions of mangosteen trees to various sector in canopy.

MATERIALS AND METHODS

Plant material

The experiment was conducted using mangosteen trees grown on commercial orchard in Bogor, Indonesia during August - October 2013. Mangosteen trees of three different ages, young (20 years), middle (35 years), and old ages (50 years), each of five trees, are selected for study. Canopy of

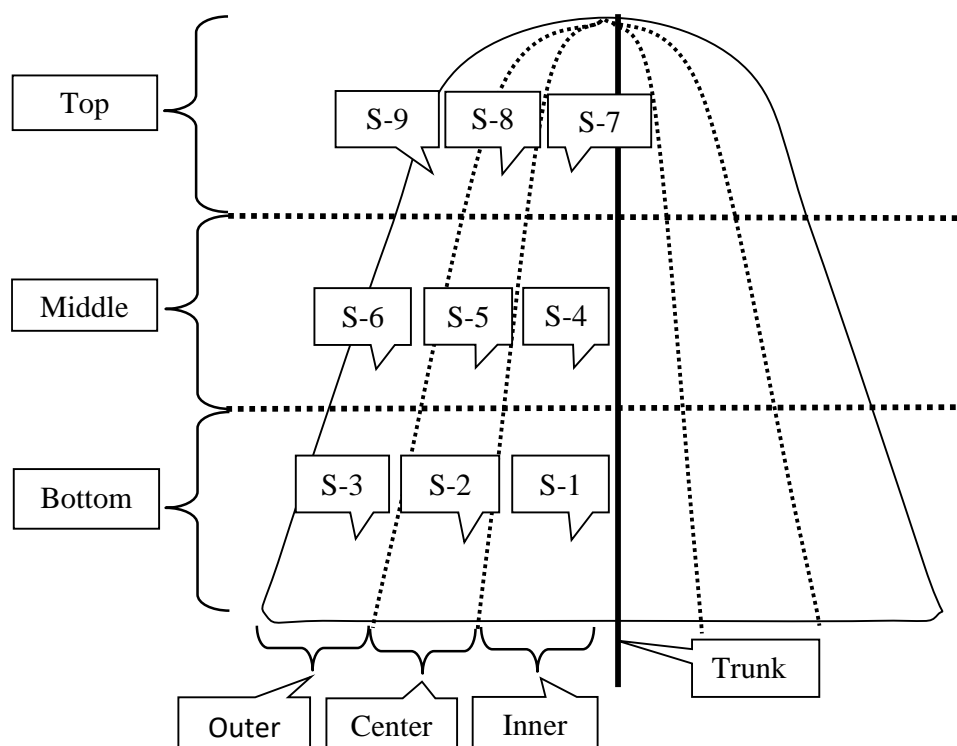


Figure 1. Illustration of the sectors (positions in the canopy, S-1 to S-9) defined for study of mangosteen trees.

each tree divided into 9 sectors, such as Sector 1 (inner bottom canopy); Sector 2 (center bottom canopy); Sector 3 (outer bottom canopy); Sector 4 (inner middle canopy); Sector 5 (center middle canopy); Sector 6 (outer middle canopy); Sector 7 (inner top canopy); Sector 8 (center top canopy); and Sector 9 (outer top canopy) (Figure 1).

Light intensity and chlorophyll index

Light Intensity was monitored by Light Meter LI-250A (LI-COR) in each sector per month. The measurement light intensity in each sectors are in full sunlight and cloudy conditions. Using the young, middle, and old age trees, two leaves are collected from 9 sectors in September 2013. The chlorophyll index of leaf samples was measured by a chlorophyll-meter (SPAD-502, Minolta). The chlorophyll contents are determined used the same leaf above. Data were analysed using DSAASTAT.

RESULTS AND DISCUSSION

Light intensity

Plant productivity associated with the process of plant photosynthesis. The light intensity in full sunlight in orchard conditions are presented in Figure 2. Light intensity at 6.30; 7.30; 8.30; 9.30 and 10.30 AM were 10.13; 54.55; 91.14; 140.30 and 174.38 $\mu\text{ mol M}^{-2}\text{ s}^{-1}$, respectively and then gradually decrease because cloudy. Daily afternoon conditions in Bogor are cloudy and that followed by rainy.

Figure 3 a shows the light intensity in cloudy conditions. The highest light intensity in cloudy conditions in sector 9 were 0.31; 0.32; and 0.28 $\mu\text{ mol M}^{-2}\text{ s}^{-1}$ in young, middle and old age, respectively. That followed by sector 8, sector 6 and sector 3. Whereas the lowest light intensity in sector 1 were 0.025; 0.03; and 0.021 $\mu\text{ mol M}^{-2}\text{ s}^{-1}$ in young, middle and old age, respectively.

Light intensity is not different significant in ages, but different significant in sector. The highest light

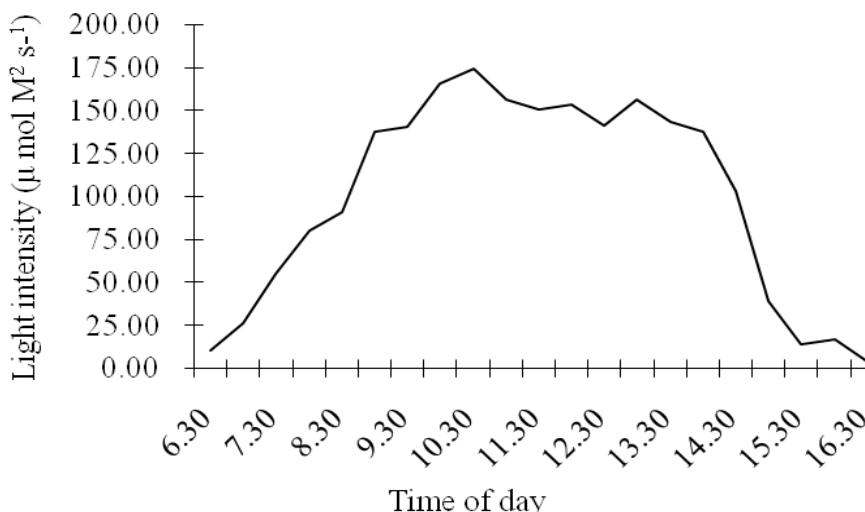


Fig. 2 Curves of diurnal of full sunlight during September 2013 in Bogor.

intensity in full sunlight conditions was found in sector 9 were 8.07; 7.53; and 7.74 $\mu\text{mol M}^{-2} \text{s}^{-1}$, in young, middle and old age, respectively (Figure 3b). That followed by sector 8 and sector 6. In contrast, the lowest light intensity in sector 1 were 0.53; 0.42; and 0.49 $\mu\text{mol M}^{-2} \text{s}^{-1}$, in young, middle and old age, respectively.

Chlorophyll and anthocyanin content

Chlorophyll contents are not different significant in ages, but different significant inter-sector. Figure 3 showed the highest chlorophyll a content in sector 3; sector 4; sector 5; sector 6; sector 7; sector 8; and sector 9 were 6.19; 5.85; 6.72; 5.94; 6.87; 6.87 and 6.78 μmol , respectively. In contrast, the lowest chlorophyll a contents in sector 1 and sector 2 were 5.58 and 5.35 μmol , respectively. Chlorophyll b content are not different significant, highest in sector 7 and lowest in sector 2 were 3.24 and 2.23 μmol , respectively.

Both chlorophyll a and b contents decreased gradually as an increase of ages. Average of chlorophyll a content gradually as a decrease of age in young, middle and

old age were 6.55; 6.44 and 5.72, respectively. Average of chlorophyll b content gradually as a decrease of age in young, middle and old age were 3.05; 2.95 and 2.44, respectively. Chlorophyll a/b ratio in mangosteen leaves increase gradually as an increase of age, each in young, middle, and old age were 2.20; 2.25; and 2.95, respectively. Chlorophyll total lowest in sector 2 and highest in sector 7 were 7.58 and 10.11 μmol , respectively.

Anthocyanin contents are not different significant both in ages and inter-sector. Figure 3a shows anthocyanin content in young age highest in sector 4 and sector 7, whereas lowest in sector 3 were 6.31; 6.19 and 2.59 μmol , respectively. Figure 3b shows the highest Anthocyanin content in middle age in sector 1, sector 4, sector 7 and sector 8 were 7.66; 6.76; 5.67; and 5.44 μmol , respectively. In contrast, the lowest Anthocyanin content in middle age in sector 6 and sector 9 were 3.48 and 3.91 μmol , respectively. Figure 3c shows the highest Anthocyanin content in old age are in sector 1, sector 4 and sector 5 were 8.59; 11.30 and 10.18 μmol , respectively. In contrast, the lowest Anthocyanin content in old age in

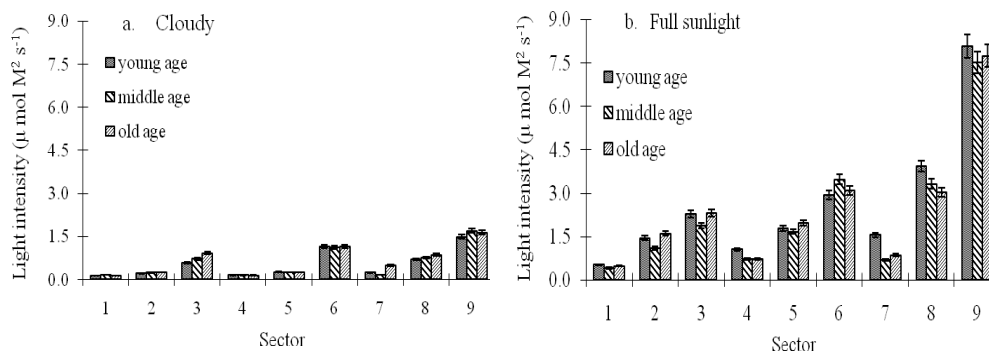


Fig. 3 Comparison of light intensity of mangosteen at various sector in canopy (a) cloudy and (b) full sunlight condition.

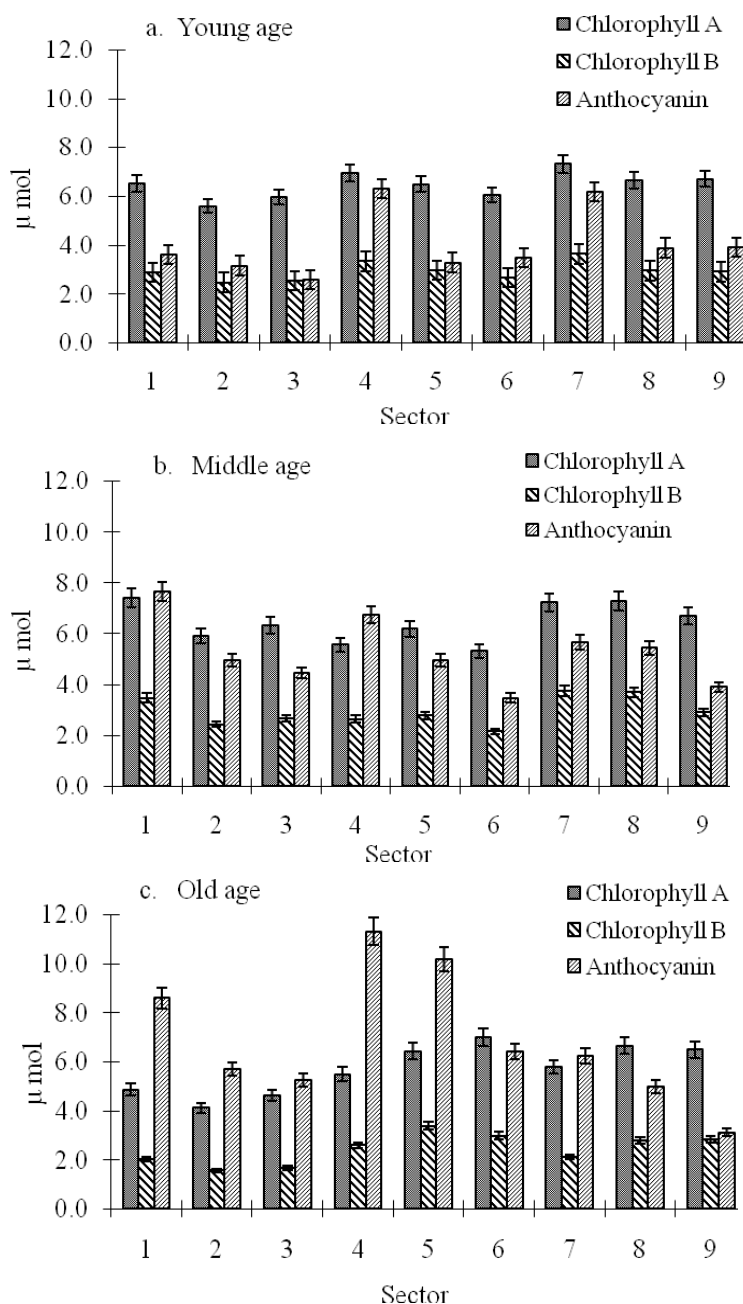


Fig. 4 Comparison of chlorophyll and anthocyanin content in leaves of mangosteen at various sector in canopy (a) young age, (b) middle age and (c) old age.

sector 9 and 8 were 3.11 and 4.98 μ mol, respectively.

Figure 5 shows the relationship between chlorophyll index and chlorophyll content in

leaves of mangosteen at various sector in canopy (a) young age, (b) middle age and (c) old age. Table 1 shows comparison of leaves season time of the presence on chlorophyll

index of leaves. The highest chlorophyll index was in branch with fruit production, than decrease in dormancy condition, whereas the lowest chlorophyll index in new flush or vegetative condition.

The highest light intensity in full sunlight conditions was found in sector 9, in contrast, the lowest light intensity in sector 1. Sector 9, sector 6 and sector 3 are outer position in canopy get high light intensity

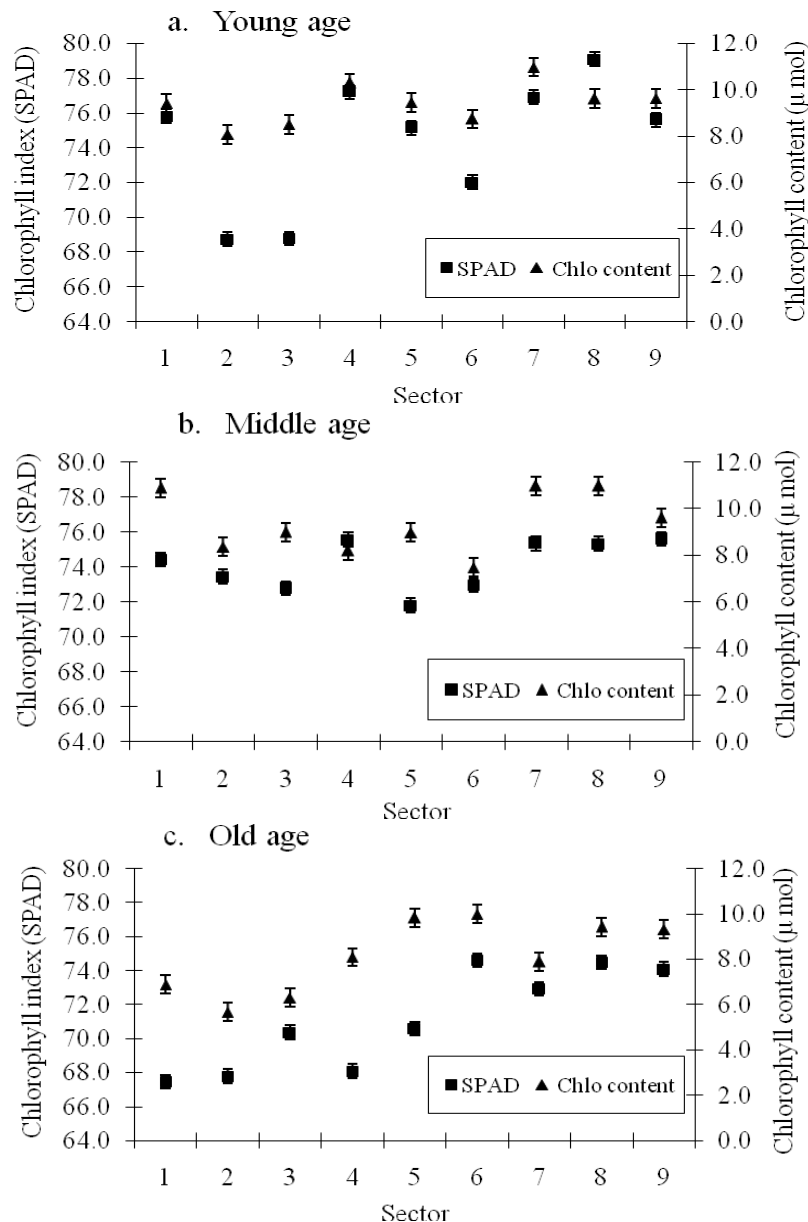


Fig. 5 The relationship between chlorophyll index and chlorophyll content in leaves of mangosteen at various sector in canopy (a) young age, (b) middle age and (c) old age.

Table 1 Comparison of leaves season time of the presence on chlorophyll index of leaves

Type of trees	Leaves season time	Chlorophyll index (SPAD)
1	With fruit	71.77231
	Dormancy	71.58503
	New flush / vegetative	58.99455
2	With fruit	72.63910
	Dormancy	70.93641
3	Dormancy	68.12375
	New flush / vegetative	55.76864

because unshaded condition. In contrast sector 7, sector 4 and sector 1 are inner position in canopy get low light intensity because shaded condition. Ramlan (1992), reported increasing light intensity would result in increased value of photosynthesis when light saturation was achieved. Tabatabaei (2008), reported in both shaded and unshaded plants, the index of chlorophyll was increased with increasing NH₄ ratio in the solution. The chlorophyll index (SPAD) in strawberries were highest in unshaded condition and lowest in shade condition. Issarakraisila (2008), reported both chlorophyll a and b contents in mangosteen per fresh weight were low at full sun and increased gradually as an increase of light shading or lower light intensity. In this study shows both chlorophyll a and b contents decreased gradually as an increase of ages.

Issarakraisila (2008), reported chlorophyll a/b ratio in mangosteen leaves seedlings was low with an average of 0.808. In this study shows chlorophyll a/b ratio in mangosteen leaves increase gradually as an increase of age, each in young, middle, and old age were 2.20; 2.25; and 2.95, respectively. This mean biggest canopy because increasing ages made dense inner canopy. Dense canopy structure of upper branches has inner and bottom

canopy protect from light availability (Setiawan, Poerwanto and Susanto, 2005). Atwell (1999), a lower a/b ratio reflects an increase in light harvesting chlorophyll II complexes relative to reaction centers since both chlorophyll a and b associated with light harvesting complexes, but only chlorophyll a was found in the reaction centers.

SUMMARY

Chlorophyll a/b ratio in mangosteen leaves increase gradually as an increase of age, each in young, middle, and old age were 2.20; 2.25; and 2.95, respectively. The highest chlorophyll index was in branch with fruit production, than decrease in dormancy condition, whereas the lowest chlorophyll index in new flush or vegetative condition.

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