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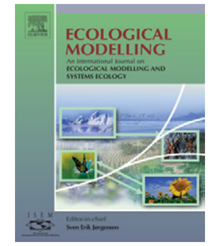

Relationship between fruit growth and peduncle cross-sectional area in durian (*Durio zibethinus* Murray)

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ABSTRACT

The relationship between fruit growth and peduncle cross-sectional area in the tropical tree *Durio zibethinus* Murray growing in an experimental field of Universiti Putra Malaysia (UPM), was examined. Fruit dry mass was allometrically related to the product of lateral and longitudinal fruit diameters by a power function, and the mass growth rate of the fruits was linearly related to the peduncle cross-sectional area. This linear relationship indicates that the specific fruit growth rate, defined as the fruit mass growth rate per unit cross-sectional area of peduncle, is constant. On the basis of previous findings of proportionality between the fruit growth rate and the rate of translocation of photosynthates into the fruit through the peduncle, it was concluded that fruit growth rate, translocation rate and peduncle cross-sectional area are proportional to each other.

1. Introduction

In woody plants including tropical species, growth and ripening of fruits depend primarily on the translocation of photosynthates from other organs into the fruits through their peduncles, with a weaker contribution from photosynthesis in the fruits themselves (cf., Bazzaz et al., 1979; Ogawa, 2002, 2004). The peduncle can be regarded as a pipe for the translocation of photosynthates.

El-Otmani et al. (1993) and Bustan et al. (1995) reported a correlation between pedicel cross-sectional area and fruit size for several *Citrus* cultivars. These observations suggest the possibility of a transport limitation during fruit growth. However, the relationship between phloem capacity and fruit growth is still controversial. Some studies showed that assimilate transport is controlled by sink strength (Kallarackel and Milburn, 1984; Burchou and Genard, 1999), resulting in that the capacity of the transport system is not regarded as a limiting factor for fruit growth (Marcelis, 1996; Garcia-Luis et al., 2002; Zhang et al., 2005).

There are several quantitative models on translocation within a plant including reproductive organs (Buwalda, 1991; Wermelinger and Baumgärtner, 1991; Berardinis et al., 1994). Since these models were based on sink–source relations (Kaitaniemi and Honkanen, 1996), little attentions were paid to the relationship between transport capacity and fruit growth.

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If there is a quantitative relationship between peduncle cross-sectional area and fruit growth, it may be possible to determine the quantitative role of peduncles in the translocation of photosynthates into the fruit, since fruit growth is known to be regulated by the translocated photosynthetic products (Bazzaz et al., 1979; Birkhold et al., 1992; Ogawa et al., 1996; Ogawa and Takano, 1997).

In the study reported here, we selected the fruit of durian (*Durio zibethinus* Murray), a well-known tropical woody species with large fruits (Idris, 1990; Subhadrabandhu et al., 1991; Smith et al., 1992; Yaacob and Subhadrabandhu, 1995), reaching 17 cm in diameter and 384 g d. wt when mature (Ogawa et al., 1995), because the large size of this species allows precise measurement of fruit mass. In *D. zibethinus*, photosynthetic assimilates, equivalent to 125% of the fruit dry mass, are translocated into the fruits from other organs until the fruits mature (Ogawa et al., 1996). We modeled the quantitative relationship between fruit growth and peduncle cross-sectional area, and analyzed the interrelationships between fruit growth, translocation into the fruits through the peduncle and peduncle cross-sectional area.

2. Materials and methods

2.1. Research site

The present study was carried out on five sample trees of durian (*D. zibethinus* Murray) growing in an experimental field station of Universiti Putra Malaysia (UPM) in Selangor, Peninsular Malaysia. The stem diameters at breast height of tree nos. 1, 2, 3, 4 and 5 were 25.0, 29.6, 27.4, 34.1 and 37.6 cm, respectively.

2.2. Measurement procedures

In Tree 1, 100 attached fruits were selected after fruiting. Their diameters in lateral and longitudinal directions and the diameter of the fruit peduncle in two perpendicular directions were measured by a vernier caliper (CD-15 and CD-30, Mitsutoyo, Japan) on April 14, 1992. The diameter of each peduncle was measured 2 cm from its point of attachment to the fruit. These measurements were repeated on attached fruits 10 times, at intervals of 6–11 days until June 30, 1992. Since the tree drops fruits continuously from fruiting to maturation (Ogawa et al., 2005a), only five fruits were measured on the last of these occasions.

One hundred and ninety two fruits that had fallen from Trees 1 to 5 were collected from April 11 to October 28, 1992 and the diameters of these fallen fruits were measured using the vernier caliper. Volumes of these fruits were also measured using measuring cylinders filled with water. After these measurements, the fruits were dried at 85 °C and weighed.

2.3. Data analysis

Data obtained up to June 30 from five fruits attached to Tree 1 were analyzed by averaging their dry masses and the cross-sectional areas of their peduncles. The dry mass of each of these five attached fruits was estimated from the allometric relationship between fruit dry mass and the product of lateral and longitudinal fruit diameters obtained from the 192 fruits that had fallen from Trees 1 to 5 (Fig. 1). The cross-sectional areas of the peduncles of the five attached fruits were estimated from the average of their perpendicular peduncle diameters, assuming that the cross-sectional shape of the peduncle is circular.

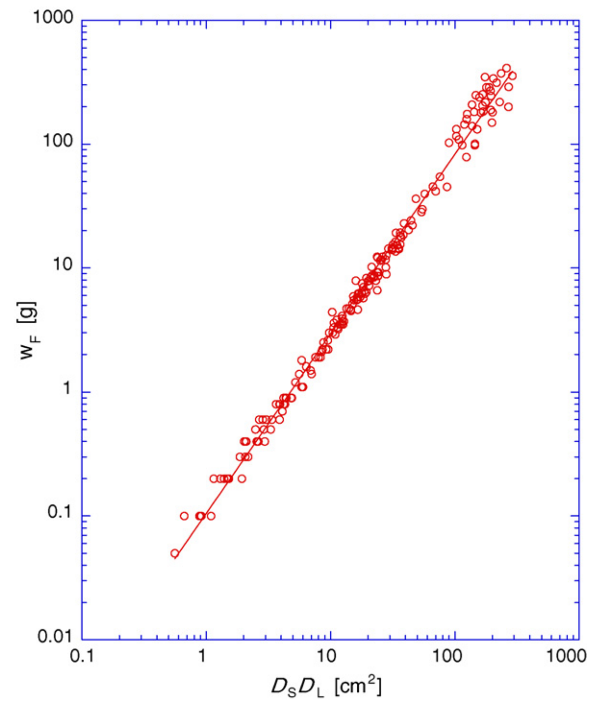

Fig. 1 – Allometric relationship between fruit dry mass, w_F, and the product of lateral and longitudinal fruit diameters, $D_S D_L$, of 192 fallen fruits. The straight line shows an approximation given by Eq. (2).

The cross-sectional area of a peduncle, s, during a given time interval was calculated from:

$$s = \frac{ds}{d(\ln s)} \approx \frac{\Delta s}{\Delta \ln s} = \frac{s_2 - s_1}{\ln s_2 - \ln s_1} \quad (1)$$

where s_1 and s_2 are the cross-sectional area of the peduncle obtained at times t_1 and t_2 ($t_2 > t_1$), respectively. The calculated values of s in Eq. (1) were used for the relation of Eq. (4) in Fig. 3.

3. Results

3.1. Fruit mass estimation

Regression models are required for the non-destructive estimation of fruit dry mass using external fruit dimensions. Therefore, the dry mass, w_F, of the 192 fallen fruits was plotted and regressed against the product of lateral and longitudinal fruit diameters, $D_S D_L$ (Fig. 1). The relationship, which was power functional, was given by:

$$w_F = 0.105(D_S D_L)^{1.449}, \quad (R^2 = 0.90) \quad (2)$$