

Biophysical Properties of Young 'Valencia' Oranges

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ABSTRACT

Functional relationships were established between fruit weight and fruit diameter, detachment force, and drop rate for young 'Valencia' oranges using data collected over 10 harvest seasons. Young fruit drop rate diminished with an exponential decay function as fruit increased in weight. Fruit detachment force and diameter increased with fruit weight by a power function.

INTRODUCTION

'Valencia' fruit normally reaches maturity suitable for processing after the young fruit for the next crop has formed, thus making it necessary to exercise care during harvest to avoid removing or injuring the young fruit crop.

Fruit removal equipment that shakes the limbs for mature fruit removal has reduced the subsequent 'Valencia' orange fruit yield from 0 to 40 percent (Coppock et al. 1981; Coppock, 1971; Sumner, 1973). The reduction is thought to be caused by excessive young fruit removal. However, good correlation between young fruit removal and subsequent yield has been difficult to verify in field tests because most of the natural young fruit drop occurs over part of the harvest season. Young fruit removal with limb shakers was affected by (a) stage of young fruit development, (b) looseness of mature fruit, (c) stage of young fruit drop, and (d) intensity of limb shaking equipment.

Over the normal harvest period (April to July) many physical and biological changes occur in the young 'Valencia' fruit. These changes affect the selective harvest of the mature fruit when harvesting with mass removal equipment that shakes the limbs of the trees (Coppock, 1972; Coppock et al., 1969). The 'Valencia' trees set many times the number of young fruit needed to produce a normal crop. A large percentage of the young fruit drop from the tree naturally during a 6-week period following bloom and then fruit drop continues at a minimal rate until the fruit matures the next year. The number of fruit that drop depends on (a) climatic conditions, (b) physiological condition of the trees, and (c) the degree of disease infestation.

Biophysical properties of young 'Valencia' fruit and their changes during the harvest season are important factors in evaluating the effect of mechanical harvesting

on subsequent fruit yield. Certain young fruit properties (drop rate, detachment force, diameter, and weight) are expected to be functionally related to each other, thus the value of these properties could be estimated by measuring the value of only one property.

The objective of this study was to establish for young 'Valencia' oranges the functional relationship of fruit weight with diameter, detachment force, and daily drop rate.

METHODS

Data of young fruit properties were collected at various times from 1969 to 1979 while conducting harvesting tests. The data consisted of 759 measurements of fruit weight and diameter from 1969-1973, 1020 measurements of weight and detachment force, and 39 measurements of weight and drop rate from 1976-79. These observations were taken over the normal harvest seasons at one- to two-week intervals in the same grove. In 1971, fruit drop was measured at 4-week intervals throughout the remainder of the year until the young fruit was mature. Fruit drop was determined by counting the fruit that dropped on ground cloths placed under four randomly located trees for a given time interval. The daily drop rate was determined by dividing the average fruit drop for a certain time interval by the number of days in the interval. The mature fruit yield was 1600 to 1800 fruit per tree.

Measurements of diameter, weight, and detachment force were determined from a composite of 40 young fruit collected at random from 4 trees. Each fruit was clipped from the tree leaving a stem 8 to 12 cm long. The detachment force was determined by pulling the stem off the fruit parallel to the major fruit axis at a loading rate of approximately 5 kg/s as reported by Coppock (1972). Each fruit was weighed and the equatorial diameter determined with calipers.

The data was fitted by least squares to several equation types. The R^2 values were used to evaluate how close the equations fit the observed data.

Since the average young fruit weight was the easiest fruit property to obtain, all the analyses were determined using young fruit weight as the independent variable.

RESULTS AND DISCUSSION

The correlation of young fruit weight and detachment force for individual years and for all four years (1976-79) combined gave the best R^2 values for the equation of $Y = AX^B$. The best estimate of detachment force (DF) for the combined data for 4 years fit the function

$$DF = (18.14) (WT)^{0.477} \quad R^2 = 0.801 \dots \dots \dots [1]$$

where the fruit weight (WT) was in grams and DF was in newtons.

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Diameter is probably the most widely used property to describe the stage of maturity of the young fruit. Fruit weight (WT) in grams and fruit diameter (D) in cm were best described by the equation:

$$D = (1.098) (WT)^{0.3874} \quad R^2 = 0.962 \quad \dots \dots \dots [2]$$

Average young fruit drop rate from April 20 to May 20 was 675 fruit per tree per day during the 1971 harvest season. The fruit drop rate diminished to 30 fruit per tree per day on approximately May 20. A much lower average fruit drop rate of 0.75 fruit per day per tree was observed near July 1 which continued throughout the year. Fruit drop data collected in 1976-79 harvest seasons showed dates of sharp change in fruit drop varied as much as 2 weeks between years in one grove. This variation might be expected since seasonal factors and fruit set vary considerably from year to year.

The fruit drop rate correlated with fruit weight and diminished with an exponential decay function as fruit increased in weight. The equation for drop rate (DR) was

$$DR = 677 e^{(-0.2203) WT} \quad R^2 = 0.822 \quad \dots \dots \dots [3]$$

for the observed data. Fruit weight (WT) was in grams and DR was the average daily fruit drop per tree. Fruit drop rate approached zero when the young fruit weight was approximately 25 g.

The data showed that young 'Valencia' fruit properties are functionally related. Average young fruit weight can be used to estimate fruit detachment force, diameter, and drop rate; however, caution should be exercised when using these formulas to predict young fruit drop and detachment force since these properties are highly influenced by seasonal conditions. The relationship between fruit weight and diameter would remain fairly consistent between harvest seasons. Further studies are needed in a wider range of grove situations to check the accuracy of the equations in diverse weather conditions.

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