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A METHOD FOR MEASURING THE "COVERING AREA" OF AVOCADO TREES*

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The effects of various cultural treatments on the development and yields of avocado trees are being studied in long-term field research projects in different regions of Israel. The development of the tree is determined by the variations in its growth, which can be determined by measurements of the trunk's circumference or diameter, the tree's volume and height, etc.

From a practical point of view, it is important to consider the lateral extension of the tree, namely, the ground area which is covered by the tree. This area is determined by extending a vertical line from a certain spot in the tree's circumference, to the ground. Calculating the "covering area" enables us to exchange the usual parameter of "yield per tree" by "yield per area unit" (of a certain tree)—which is of more practical significance. The lateral extension of the tree determines the density of the orchard and, therefore, the thinning regime, and eventually the final number of trees in the orchard. The form of an avocado tree is generally less regular than that of most other fruit trees, and therefore the measuring the volume of the top of the tree is especially difficult, and its practical significance is doubtful.

In the present study a method of measuring the "covering area" which was carried out on the ground surface of the orchard, is compared with measurements obtained from aerial photographs.

METHODS

For several years infrared aerial photographs have been taken in some experimental avocado orchards, in order to follow the development and the situation of the trees. In interpreting such photographs, the area of extension of every tree is measured by means of a series of rings of various diameters, drawn on a transparent plate. The plate is laid on the photograph and the ring that best fits the area of the measured tree, is chosen (Fig. 1). This procedure is easy as long as the spaces between trees are not completely closed.

In order to check the method's reliability, field measurements of sample trees were carried out by means of an instrument that was developed especially for this purpose.

However, while many trees can be measured relatively easily by the aerial photography method, field measurements which entail much work, were carried out only to check the reliability of the measurements obtained with the photographs, without taking into account the work entailed.

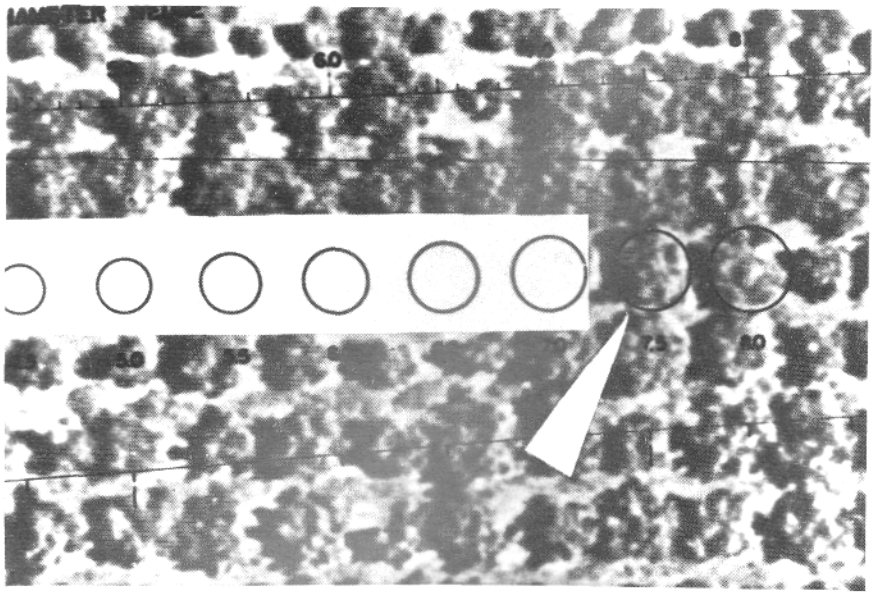

Figure 1 — Fitting a measuring ring to the measured tree on the aerial photo (marked by an arrow).

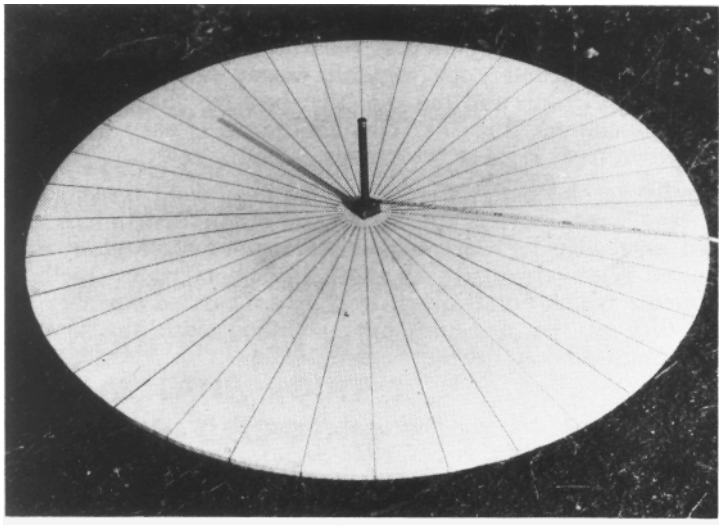

Figure 2 — The plate used for measuring the "covering area" of the tree.

The instrument which was developed for measurements on the ground is composed of a wooden plate with a diameter of 100 cm on which 36 radial lines are drawn. The angle between adjacent radial lines is 10°. The plate is anchored to the ground at some spot

under the tree's canopy by means of a central wedge (Fig. 2). A measuring tape is then stretched from the center of the plate along each of the 36 radial lines drawn on the plate to a spot forming a vertical line with the circumference of the tree. Thus, 36 distances between the center of the plate and 36 spots around the tree circumference are measured. Knowing the length of lines and the angle between adjacent lines, the area of 36 triangles can be calculated easily, giving the total sum of the "covering area" of the tree.

Field measurements were carried out at dates close to the aerial photographs in three avocado orchards, at Ma'barot, Bene Deror and 'En Shemer. In the first orchard 20 5-year-old Fuerte trees were measured; in the second orchard 20 4-year-old Fuerte trees; and in the third orchard 13 4-year-old Ettinger trees. The data collected by the two measuring methods were used for the calculation of the actual "covering area" of the trees. The correlation between the two methods was calculated; and the correction factor for the calibrated rings' method was determined by dividing the tree area calculated from the field measurements by that measured from the aerial photograph. (In our case the correction factor is 0.9.)

RESULTS

The results of tree measurements by the two methods are given in Table 1.

TABLE 1: Comparison of two methods for measuring the "covering area" of trees in three orchards.

Orchard	Variety	Tree age (years)	No. of trees measured	Average area per tree (m^2)		Correlation coefficient	Correction factor for aerial photo
				Field measured	From aerial photo		
Ma'-barot	Fuerte	5	20	25.46	28.17	0.85	0.90
Bene Deror	Fuerte	4	20	9.27	10.38	0.87	0.89
'En Shemer	Ettinger	4	13	9.41	14.84	0.78	0.63

DISCUSSION & CONCLUSIONS

From an analysis of the results obtained by the two measuring methods, a high correlation coefficient was found for the Fuerte variety, which is the most important one in Israel. It is therefore possible to use the data obtained from aerial photographs by means of the calibrated rings, for reliable determination of the actual "covering area" of each tree.

For the Ettinger variety a good correlation coefficient was also found, but the figures obtained by the two measuring methods are quite different. It is therefore necessary to use a high correction factor, and it is doubtful whether the results obtained from aerial photographs would be sufficiently reliable. This is probably due to the great height of the Ettinger tree. It is possible that for such tall trees a combined method of measuring should be developed, in which the height of the tree is taken into account in addition to

the "covering area." For other varieties, such as Hass and Nabal, this method has not yet been tested.

SUMMARY

In field experiments carried out in avocado orchards, a method for quick determination of the "covering area" of the trees from aerial photographs by means of calibrated rings has been developed. In order to determine the reliability of the results, ground measurements of the covering area were carried out.

A high correlation coefficient was found between the results obtained by the two methods, and a correction factor was therefore calculated for the determination of the actual area from the aerial photographs.

It thus seems that in an orchard in which the trees have not yet closed up the spaces, measurements obtained from aerial photographs can be used to determine the covering area of avocado trees of the Fuerte variety. The adaptation of this method for other varieties needs further examination.