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THE EFFECTS OF SHADE AND WATER RELATIONS IN THE AVOCADO CV EDRANOL

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In the past, emphasis has often been laid on increasing orchard tree production. However, production per unit area and not solely per tree, is the most important criterion for orchard profitability. In fact it was shown that in the long term, over 40% of an apple orchard planted at its ultimate spacing consists of unutilized land. The same is true of an avocado orchard. Initial close spacing with later pruning and tree removal when excessive mutual shading occurs is thus essential.

At present, tree spacing and thinning programmes are rather subjective. These could be placed on a far sounder scientific basis, with probable advantage to the industry, if one, or a combination of various mathematical models used successfully in apples to predict theoretically optimum tree spacing, could be used.

However, the various norms pertaining to the sunlight requirements and other factors affecting photosynthesis (production of food reserves) of the avocado are needed. Previous work in this regard is extremely limited, and that which is available is not wholly applicable.

It was therefore necessary to examine the characteristics of these plants, with special reference to sunlight, temperature and water relations, the latter being emphasized in this paper. Although the work was done for cultivars Fuerte, Mass and Edranol, due to the similar results obtained, and for the sake of brevity, only those of Edranol are discussed.

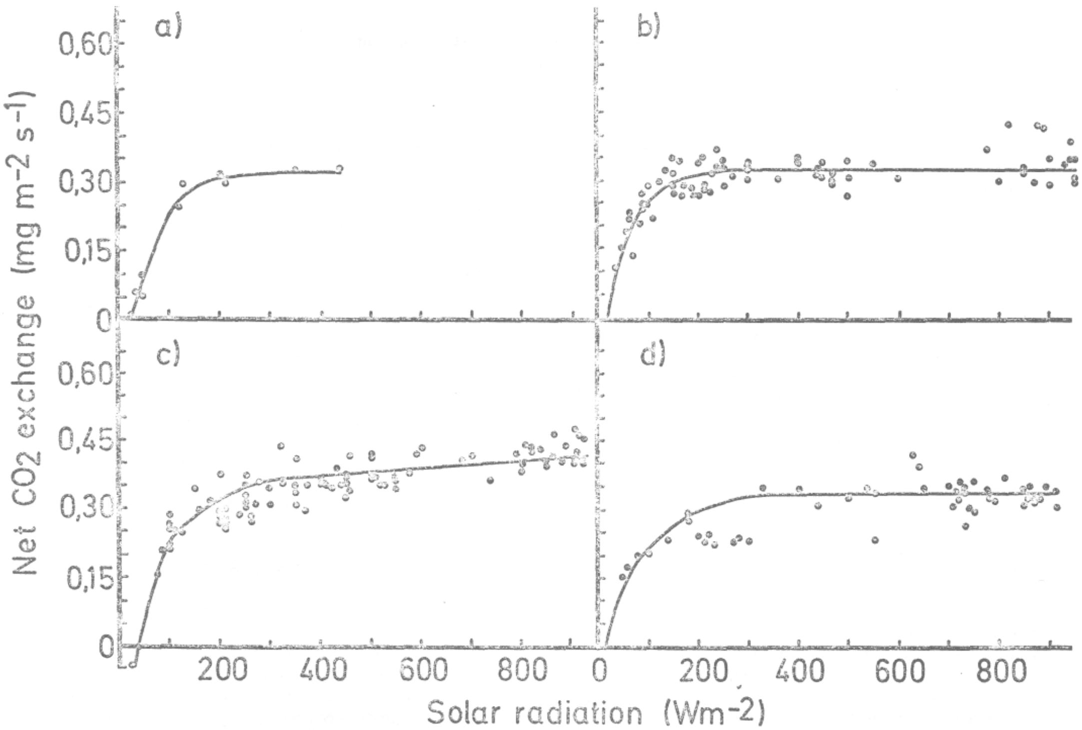

FIG. 1: Photosynthetic solar radiation response curves.
a) 10—15°C, b) 16—19°C, c) 20—24°C and d) 25—30°C

MATERIALS AND METHODS

To measure photosynthesis, the net uptake of carbon dioxide (CO_2) was found. The plants were arranged in a perspex chamber in a manner so as to simulate a full tree canopy, and all environmental conditions in the chamber were monitored.

The trees used were approximately 1 m high, in 18 ℓ black polyethylene pots.

In addition to these plants, larger plants of approximately 3 m in height were used in water stress experiments, where the reaction of the plants to decreasing soil moisture was measured.

The stomata are pores in the leaves through which CO_2 moves into the leaf, and water vapour moves out. As the water content of the leaves (known as leaf water potential) decreases, so a point is reached where the stomata close, to prevent further loss of water. The extent of closure is estimated by measuring the resistance to water vapour movement out of the pores. Immediately after this measurement, leaf water potential was measured.

RESULTS AND DISCUSSION Influence of sunlight and temperature

The response of these plants to increasing sunlight (solar radiation) at different temperatures is shown in Figure 1.

These curves indicate that the plants are sunlight saturated at a low level (approximately 20% of summer midday sunlight) and from a vegetative point of view, are shade tolerant. Also of interest, is the fact that between 10°C and 30°C, temperature does not seem to make any real difference to this saturation level.

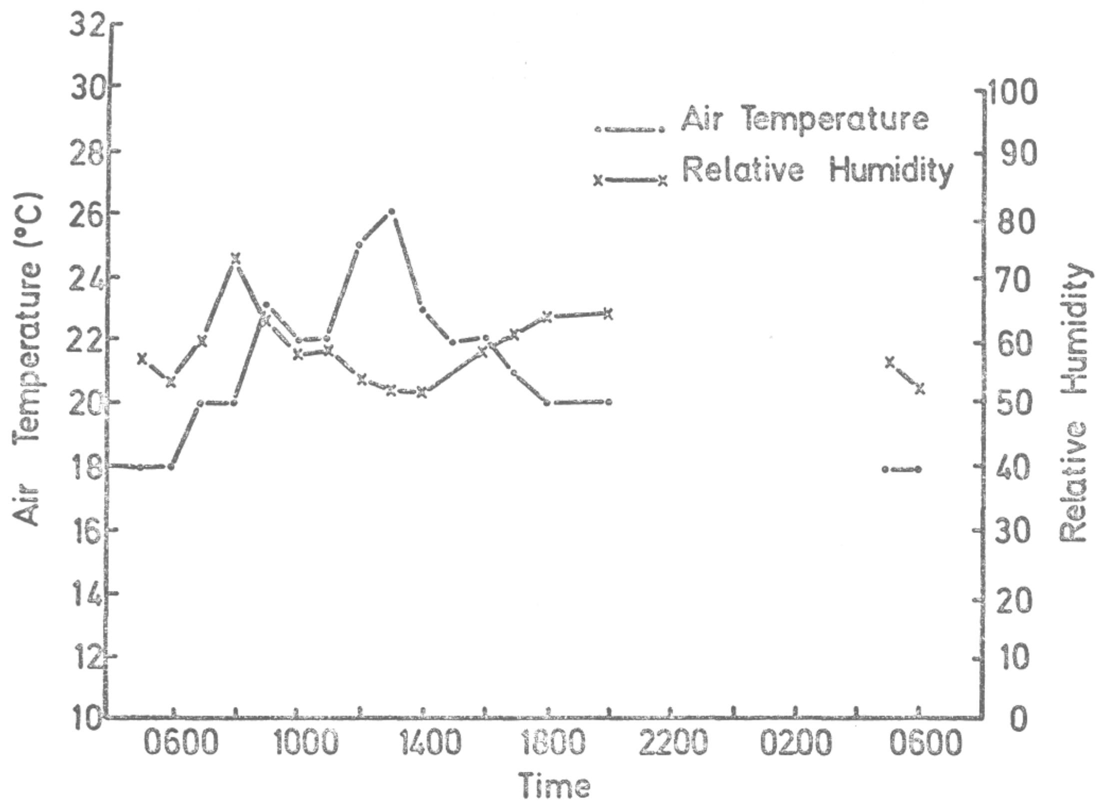

FIG. 2: Diurnal air temperature and relative humidity changes in the greenhouse

Responses to plant and soil water conditions

In order to place the plant responses to progressive drying in perspective, it is necessary to examine the daily changes in stomatal resistance and leaf water potential.

Atmospheric conditions, notably temperature and humidity dictate plant water loss. Figure 2 indicates the atmospheric conditions during the experiment.

These conditions can be construed as being moderate, even when atmospheric water demand was greatest, at about 13h00.

Figure 3 indicates the changes in stomatal resistance (and therefore aperture) and leaf water potential during the day.

Stomata began opening at dawn, and within half an hour, appeared to be fully open. During the remainder of the day, stomata showed no evidence of closure, until sunset, when rapid closure occurred.

Changes in leaf water potential are perhaps of greater interest. Before dawn, leaf water content was at its maximum. This declined rapidly as stomata opened. There then seemed to be some degree of stabilization, until about midday, when atmospheric water demand became greater than the amount the plants could take up from the soil, under even moderate conditions, the soil also being adequately wet. A minimum value of -300 kPa water potential was obtained.

Figure 4 indicates the reaction of the stomata to decreasing leaf water potential on a drying cycle. It seems that at a leaf water potential value of between -300 kPa and -400 kPa stomata begin to show closure. Bearing figure 3 in mind, it can be said that under harsh environmental conditions, stomata may close temporarily during the afternoon, as the decrease in leaf water potential may exceed the -300 kPa to -400 kPa value.

But of perhaps greater importance, is the influence of soil moisture, soil moisture potential determining the amount of water which the plant can extract, so as to satisfy demand. The relationship between decreasing soil water potential and the stomata is shown in Figure 5.

A similar pattern to that shown by decreasing plant water content was evidenced.

At even moderately dry soil conditions, plants were close to the stress threshold level. This then indicated sensitivity to moisture stress, and that if irrigation is insufficient, stomata could close for at least part of the afternoon, resulting in a reduction of photosynthesis, and thus tree productivity. The extent of this decline in photosynthesis with increasing stomatal resistance (closure) is shown in Figure 6.

CONCLUSIONS

It would seem that from a vegetative point of view, these plants are shade tolerant, and therefore well suited to high density plantings. However, their sensitivity to water stress means that without very careful irrigation to guard against root rot on the one hand, and depressed photosynthesis on the other, the economic benefits of high density planting may not be realised. In addition, while a period of stress before flowering may be desirable, the high energy requirements of the avocado fruit mean that under stress conditions, alternate bearing may be aggravated.

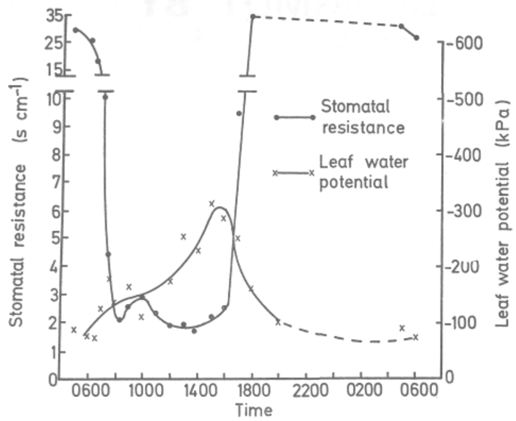

FIG. 3: Diurnal stomatal resistance and leaf water potential changes for cultivar Edranol

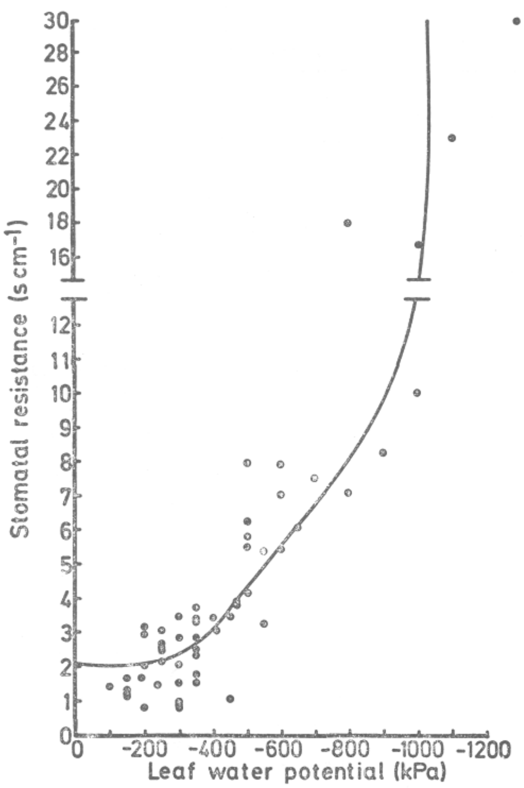

FIG. 4: Stomatal resistance vs leaf water potential

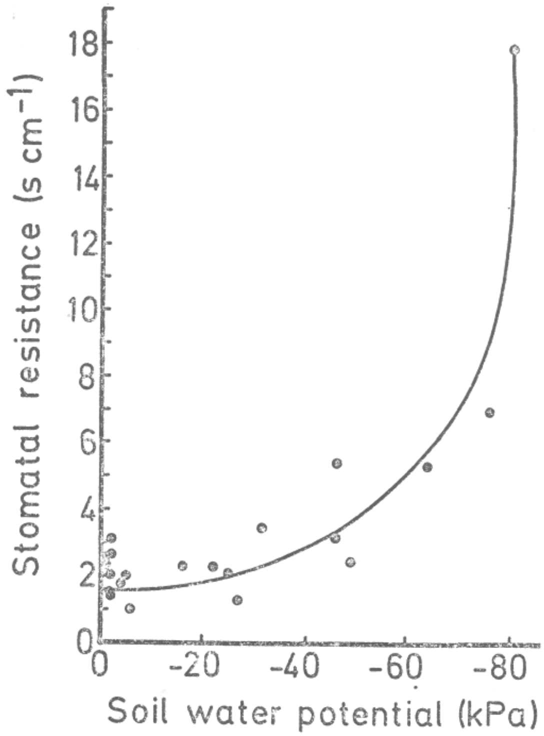

FIG. 5: Stomatal resistance vs soil water potential

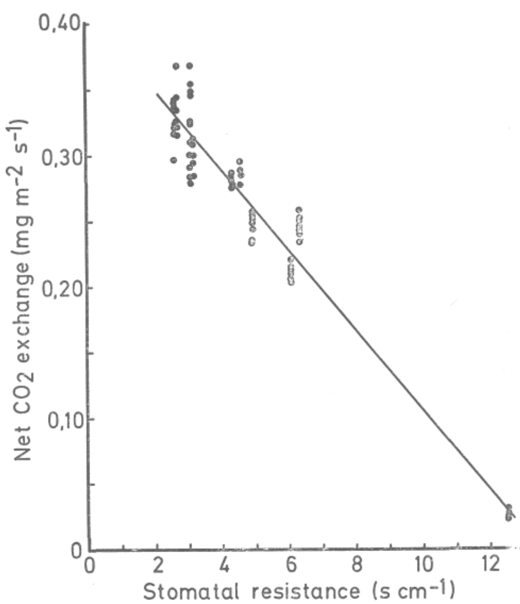

FIG. 6: Net CO_2 exchange vs stomatal resistance