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EFFECT OF FRUIT WATER STRESS AND IRRIGATION REGIME IN THE RIPENING OF STORED AVOCADO FRUIT, CULTIVAR; FUERTE


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OPSOMMING

Vruggehalte by avokado 's wat per see uitgevoer word bly 'n probleem. Vorige navorsingswerk het 'n verwantskap tussen rypwordingsfisiologie en vrugvog aangedui, maar geen inligting tov verlengde opberging of die effek van besproeiing was beskikbaar nie.

Vrugte van vier verskillende besproeiingspeile is dwarsdeur die uitvoerseisoen gepluk. 'n Beraming van vrug waterpotensiaal is sigometries bepaal, waarna die vrugte vir 30 dae by 5,5 °C opgeberg is, en daarna by 22 °C gehou is om ryp te word.

Die tydsduur vir rypwording van vrugte na opberging het 'n verwantskap met water potensiaal getoon waar die rypwording tussen 0 en 6 dae geneem het. Daarteenoor het die wat langer geneem het nie dieselfde verwantskap getoon nie. Besproeiing teen 55 *kPa grondvog het vrugwaterpotensiaal op 'n vlak gehou wat selfs volwasse vrugte tussen 5 en 6 dae laat ryp word het. Onvoldoende of geen besproeiing het vinniger rypwording veroorsaak. Laasgenoemde* ton *nie deur besproeiing net voor pluk reggestel word nie.*

Dit word aanbeveel dat borne dwarsdeur die seisoen besproei word, om 'n aanvaarbare vrughouvermoe en -gehalte te verseker. Dit bring ook mee dat, behalwe lae temperatuur, geen rypwordings vertragingsmiddels benodig word nie.

SUMMARY

Fruit quality remains problematical in avocados exported by sea. Previous work indicated a relationship between ripening physiology and fruit moisture, but no information was available for fruit after prolonged storage, or the effect of irrigation.

Fruit was picked throughout the export season from four irrigation regimes. An estimate of fruit water potential was made psychometrically, where after fruit was stored at 5,5 °C for 30 days before being allowed to ripen at 22 °C.

The time taken for fruit to ripen after removal from storage showed a relationship with water

Internal quality of fruit remains a problem when avocados are exported by sea. On the one hand, fruit can ripen extremely rapidly after discharge, (sometimes as soon as one day), thus leaving little time for sale, while on the other hand fruit which ripen approximately one week after arrival, often show a high incidence of internal disorders.

While both the temperature (Eaks, 1978) and CO_2 content (Van Lelyveld & Bower, 1984) in the containers could have a profound influence on the ripening physiology, other factors are clearly important, as the rate of fruit ripening often varies within a container.

Adato & Gazit (1974) showed that avocado fruit which were allowed to lose moisture during storage and ripening, tended to ripen faster than those protected from desiccation. Bower, Van Lelyveld & Nel (1982) showed a highly significant correlation between an estimate of fruit water potential at picking and the rate of ripening. However, no work has previously been done to examine this relationship after extended storage (30 days). The direct role of harvest period as influenced by fruit maturity has been shown by Wang & Schiffmann-Nadel (1972) and Eaks (1980) to be important in avocado ripening physiology, whereas the role of irrigation has not been adequately investigated, especially in relation to fruit water potential. This study was thus undertaken to evaluate these aspects in relation to fruit ripening after prolonged storage.

MATERIALS AND METHODS

The orchard used in the experiment consisted of 4-year-old healthy Fuerte trees. The orchard was divided into four separate plots of 25 trees each, for the irrigation regimes. All trees received regular irrigation to supplement rainfall until the end of February, 1982. Thereafter, the following irrigation regimes were imposed, scheduling being done with the aid of tensiometers in the root zone.

1. No irrigation.
2. Irrigation at soil moisture tension of 35 kPa.
3. Irrigation at soil moisture tension of 55 kPa.
4. Irrigation at soil moisture tension of 80 kPa.

A micro-irrigation system was used, resulting in accurate irrigation control. Fruit were picked at random from each irrigation regime throughout the period 17 March through the next 12 weeks until 8 June 1982. This period covered the normal export season.

As soon after picking as possible, an estimate of the fruit water potential was measured. As it was essential not to damage the fruit, a small section of the pedicel immediately adjacent to the fruit was used. The xylem was excised, and crushed onto a small filter paper disc placed in an envelope of aluminium foil, with a window cut into it to expose the filter paper, in a similar manner as outlined by Savage, Cass & De Jager (1981). This envelope was sealed into a "Wescor L51" leaf psychrometer, and after a 10 minute equilibration period, water potential was measured. A constant 20 second cooling time was used, and the plateau region shown by the microvolt meter, estimated by eye. The instrument had previously been calibrated using similar parameters. Care was taken to minimize temperature gradients (Campbell, 1979) and readings were adjusted to those at 25 °C using the equation of Wiebe, Brown, Daniel & Campbell (1970). This method was found to accurately represent the interior of the fruit (Bower, 1983).

The fruit were then wrapped in cellophane export-type wrappers and packed in 4,5 kg export cartons, before storage at 5,5 °C for 30 days, followed by ripening at 22 °C. During the ripening phase, the percentage ripeness was estimated daily, with the aid of the firmometer described by Swarts (1980), "eating soft" being indicated by a reading of 100.

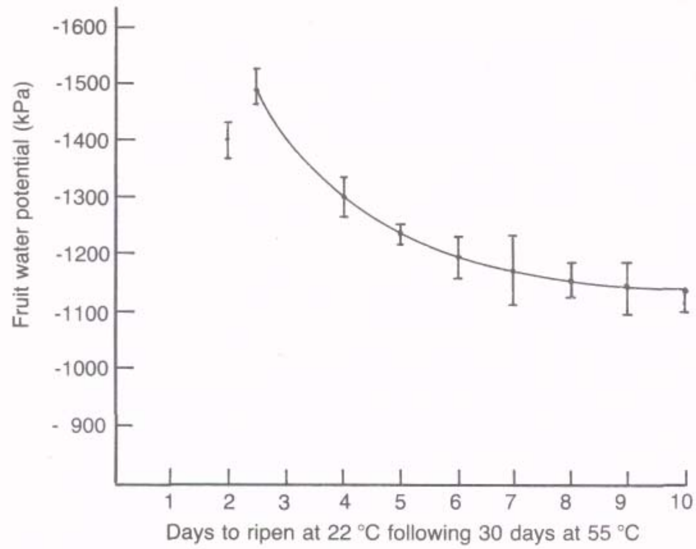

Fig. 1 Influence of fruit water potential on days to ripening after storage

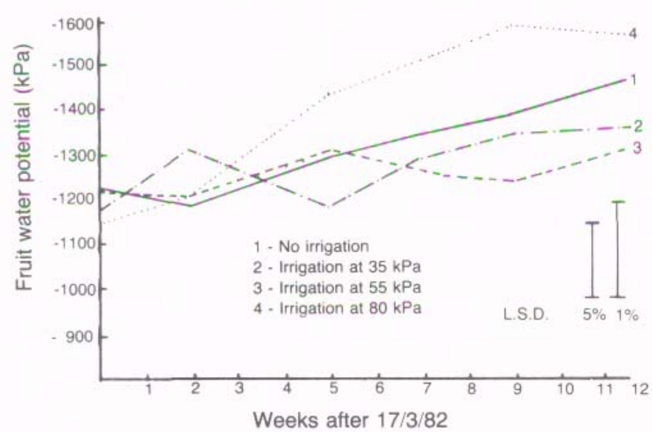

Fig. 2 Relationship between fruit water potential, irrigation regime and time during season

RESULTS

Fig 1 indicates the relationship between the estimate of fruit water potential (Ψ f) and the days taken by the fruit to ripen (100% soft as indicated by the firmometer).

The data would seem to be most suited to a curvilinear relationship. There would seem to be little influence of water content on ripening for fruit taking longer than 6 days to ripen. For fruit ripening faster than this, however, the estimate of Ψ f markedly influenced the rate of ripening.

Of particular note in Fig 1 are the results of fruit ripening on day 2. The Ψ f value was somewhat less negative than expected. However, all this fruit came from stressed trees (treatment 4) which had been irrigated 2 days before picking. The less negative water potential can thus be ascribed to the irrigation prior to picking, but the lack of consequential change in ripening rate may be important.

The interaction between time (progression of the season) and Ψ f for fruit from the four irrigation regimes is shown in Fig 2. The nonor poorly-irrigated treatments (1 and 4) progressively dried out through the season, and Ψ f was significantly more negative by the end of the experimental period ($P < 0,01$). This is particularly notable in treatment 4, which had some supplementary irrigation during the season. On the other hand, treatment 2 showed no significant change in Ψ f

DISCUSSION AND CONCLUSIONS

There is little doubt that an increasing fruit water stress (as indicated by more negative Ψ f values) has an effect on fruit ripening physiology, provided that Ψ f is more negative than the threshold value of approximately — 1 250 kPa. The shape of the curve shown in Fig 1 nevertheless indicates that other factors such as percentage oil content required for respiration during the ripening phase (Leopold & Kriedemann, 1975) also play a role in ripening physiology.

The mechanism by which increasing water stress causes earlier stimulation of the ripening process is not as yet understood, but it suggested that it may affect the activities and interactions of a number of enzymes necessary to the ripening of avocado fruit (Award & Young, 1979).

Irrigation management can have a profound effect on the development of Ψ f levels which is liable to lead to rapid ripening after removal from storage. While even the best-watered treatments exceeded the threshold level where Ψ f becomes important, the Ψ f remained at a level where a shelf-life of 4 to 5 days could be expected even towards the end of the season. Where stress was allowed to develop (treatments 1 and 4) increasingly rapid ripening occurs.

A decrease in water uptake due to poor irrigation, especially over the long term, could lead to decreased calcium uptake by fruits (Bangerth, 1979) known to be important in certain disorders (Shear, 1975). This is of importance not only during the early part of fruit growth when the majority of calcium is taken up (Hanger, 1979) but also later in the season when calcium withdrawal can take place should tree water stress occur, and water flows from fruit to leaves (Tramp, 1979). Irrigation shortly before harvest, although improving Ψ f, is unlikely to assist in calcium deposition, and as indicated in this work, does not restore normal ripening rates.

In conclusion, it may be said that poor irrigation resulting in tree stress, will adversely influence the ripening and quality of avocado fruit after storage. Regular irrigation at a soil moisture tension of 55 kPa should result in an acceptable fruit shelf-life and quality after storage which, as shown by Van Lelyveld & Bower (1984) suppressants such as wax without the possibility of internal disorders developing.

REFERENCES

ADATO, I & GAZIT, S, 1974. Water deficit stress, ethylene production and ripening in avocado fruit. *Pl Physiol* 53, 45 - 46.

AWAD, M & YOUNG, RE, 1979. Post harvest variation in cellulose, polygalac-turonase and pectin-methylesterase in avocado (*Persea ameriana* (Mill) cv Fuerte) fruits in relation to respiration and ethylene production. *Pl Physiol* 64, 306 - 308.

BOWER, JP, 1983. A method for non destructive estimation of avocado fruit water potential *Subtropica* 4 (2), 13.

BOWER, JP, VAN LELYVELD, LJ & NEL, ME, 1982. The influence of Fuerte fruit water potential on ripening. *S Afr Avocado Grower's Ass Yrbk* 5, 36-38.

CAMBELL, GS, 1979. Improved thermocouple psychrometers for measurement of soil water potential in a temperature gradient. *J Phys E: Sci Instrum* 12, 739.

EAKS, IL, 1978. Ripening, respiration and ethylene production of Hass avocado fruits at 20 °C to 40 °C. J *Am Soc hort Sci* 103, 576 - 578.

EAKS, IL, 1980. Respiratory rate, ethylene production, and ripening response of avocado fruit to ethylene or propylene following harvest at different maturities *J Am Soc hort Sci* 105, 744 - 747.

HANGER, BC, 1979. The movement of calcium in plants. *Commun Soil Sci Pl Anal* 10, 171-192.

LEOPOLD, AC & KRIEDENMANN, PE, 1975. Plant growth and development. New York: McGraw-Hill.

SAVAGE, MJ, CASS, A & DE JAGER, JM, 1981. Calibration of thermocouple hygrometers. *Irrig Sci* 2, 113 - 125.

TRAMP, J, 1979. The intake curve for calcium into apple fruits under various environmental conditions. *Commun Soil Sci Pl Anal* 10, 325 - 335.

VAN LELYVELD, LJ & BOWER, JP, Enzyme reactions leading to avocado fruit mesocarp discoloration. *J hort Sci.* In Press.

WANG, CY, & SCHIFFMANN-NADEL, M, 1972. Respiration of whole fruit and seed of avocado at various stages of development. *J Am Soc hort Sci* 97, 313 - 315

WIEBE, HH, BROWN, RW, DANIEL, RW & CAMPBELL, EC, 1970. Water potential measurements in trees. *Bio Science* 20, 225.