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Soil water stress at bunch emergence increases maturity bronzing of banana fruit

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Abstract

Banana plants cv. Williams which had bunches emerge during a period of soil water stress (ψ_s=−0.5MPa) before rewatering developed significantly more severe maturity bronzing than the unstressed control (ψ_s=−0.04MPa). Maturity bronzing began developing on fruit at a much thinner finger diameter on water stressed bunches. There was a constant difference in finger diameter between the treatments for all maturity bronzing ratings. Water stress also reduced the greenlife of fruit at harvest. Soil water stress, while contributing, was not the only factor responsible for bronzing.

INTRODUCTION

Maturity bronzing is a physiological disorder affecting the skin of banana fruit in the period near to harvest (Daniells 1985). The disorder is worst from March to June in north Queensland. Bunches harvested during this period emerge from the pseudostem during November to February.

Daniells (1982) has postulated that if water stress occurs during flowering it may predispose banana plants to the development of maturity bronzing near harvest by either adversely affecting cell numbers, cell size or cell walls in the fruit skin.

In north Queensland water stress in irrigated plantations is most likely to occur during the November to February period when daily evaporation rates are at their highest. This water stress eventuates from insufficient irrigation to maintain adequate soil moisture and from the inability of the plant to move sufficient water from the soil, through the plant and out of the leaves during the middle of the day.

A study by Daniells and Watson (1984) showed that maturity bronzing was apparently worse on bunches which emerged during a water stress period. This paper reports on results of further work to examine this apparent association between water stress at flowering and maturity bronzing.

MATERIALS AND METHODS

Experimental

Banana plants, *Musa* (AAA group, Cavendish subgroup) cv. Williams were grown in sandy loam in large concrete pots (1 m diameter) in a glasshouse at Kamerunga Horticultural

Research Station, north Queensland (16°S) from 1984–85. Two large bits were planted in each pot in March 1984. All plants were maintained for maximum growth right up to bunch harvest, except for the relevant water stress periods. Thirty litres of well-rotted chicken manure plus 1 kg of dolomitic limestone was dug into each pot before planting. Each pot received 0.4 kg of a banana mix fertiliser (11:1.7:17.6 NPK) which was broadcast on each pot every two months after planting.

Leaf Spot caused by *Mycosphaerella musicola* Leach was controlled by the application of mancozeb and miscible oil at fortnightly intervals. Aldicarb was applied just prior to bunch emergence to control mites. Soil moisture in each pot was maintained at more than 80% available water capacity (approximately −0.04MPa) except for relevant water stress periods. Soil moisture was allowed to decline to approximately −0.5MPa in the water stress treatments before receiving a light watering to prevent leaf loss. Thus plants in the water stress treatments went through a series of drying cycles. Soil moisture tension was monitored by gypsum blocks positioned at a depth of 300 mm.

Bunch covers were applied to all bunches after the female flower bracts had fallen. These covers were tied top and bottom to give conditions of high humidity around the bunch (Daniells 1983).

Design

There were two treatments, one which consisted of imposing water stress for a period of four weeks from the thirty-fourth leaf stage, the other a no stress treatment referred to as control throughout the paper. The thirty-fourth leaf stage was chosen so that the bunch would emerge during the water stress period. However, because of variability between the two plants in each pot both bunches did not always emerge during the water stress period. Bunches that emerged after the water stress period were ignored. This left 15 single plant replications of the water stress treatment and 24 replications for the control.

Measurements and statistical analyses

Maturity bronzing damage was rated from 0 to 7, with 0=no blemish to 7=highest intensity blemish, on the top three hands (Campbell and Williams 1976) at weekly intervals from when the disorder first became visible on the bunches until harvest. On each occasion the diameter of fingers on the third hand was recorded. Bunches were harvested when the average diameter of the middle three fingers of the outer whorl of the third hand from the proximal end reached 37 mm.

Bunch fresh weight, number of fingers per bunch, average finger length of the third hand and weight of extra large fruit were recorded at harvest. Three fingers from each of the top three hands were sampled at harvest and greenlife (Peacock and Blake 1970) determined by maintaining these fingers at 19°C and more than 90% relative humidity in the absence of ethylene until they reached colour stage 4 (Anon. 1969). All these measurements were subjected to a one way analysis of variance. For each of the two treatments, the finger diameter of the bananas was quadratically regressed on maturity bronzing and tested for lack of fit.

RESULTS AND DISCUSSION

Water stress at the time of bunch emergence led to more severe maturity bronzing at harvest than the control (Table 1). Both treatments showed acceptable quadratic relationships between maturity bronzing and finger diameter. The two curves were found to be parallel and to differ by a constant 2.35 mm finger diameter. That is maturity bronzing appeared on fingers that were 2.35 mm thinner than the control (Figure 1). These symptoms occurred earlier in bunch development of the water stressed plants and thus the symptoms had a longer period of time to intensify (Campbell and Williams 1976).

Table 1. Effect of water stress at the time of bunch emergence on bunch and plant characteristics

	Days BE-BH*	Bunch wt. (kg)	Finger no per bunch	Maturity bronzing rating (0—7)	Greenlife (days)	% XL†	Av. finger length 3rd hand (mm)
Water stress at BE	171	25.4	117	5.2	13.8	98.1	288
No stress control	161	25.6	113	3.5	19.5	98.4	296
LSD P=0.05	n.s.‡	n.s.	n.s.	0.8	4.0	n.s.	8

* BE = Bunch emergence; BH = Bunch harvest.

† % XL = % Extra large fruit by weight. XL fruit are >216 mm in length.

‡ n.s. = not significant.

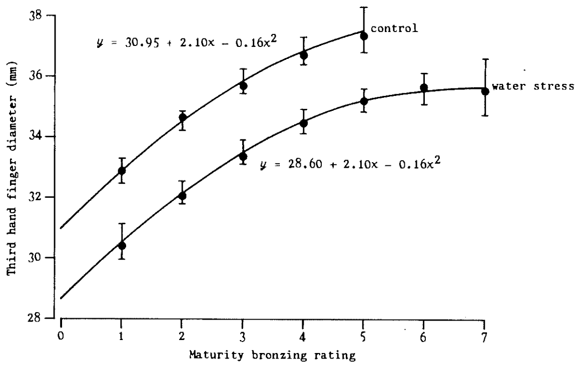

Figure 1. The relationship between maturity bronzing and finger diameter as affected by water stress at the time of bunch emergence. Actual points (*) shown are average finger diameter and the line segments are the 95% confidence limits of the estimated average finger diameter at a given maturity bronzing rating. These equations should not be used in modelling because of the discrete nature and subjectiveness of the maturity bronzing scale.

Growers counteract maturity bronzing by harvesting the fruit at a thinner finger diameter, before the symptoms have the opportunity to intensify. In this experiment the control plants also had bronzing despite the maintenance of high soil moisture. It is quite possible that some level of water stress was experienced by these plants during flowering when daily evaporation rates were high (from 7 to 8 mm/day), with plants being unable to transpire sufficient water. This topic should be studied further by examining the usefulness of overhead misting to reduce water stress. The effect of different levels of water stress for various durations is also worthy of further experimentation.

Water stress did not affect bunch weight or the percentage of fruit that were extra large. Extra large fruit receive a higher price in the market place and in this trial most (98%) of the fruit were extra large. Fruit on water stressed plants were noticeably shorter (Table 1). Water stress reduced the greenlife of fruit by 29%. This relationship has been noted previously by Daniells and Watson (1984). These reductions in greenlife seem to be related to the longer (not significant) duration of bunch filling caused by water stress. Part of the greenlife of the fruit has probably been used for bunch filling.

Yust (1959) noted that maturity bronzing was considered to be due to slow growth of fruit caused by water stress, amongst other things. It seems that the higher level of bronzing damage in the water stressed treatment is at least partly due to the longer, 171 versus 161 days, period for it to develop before harvest. Figure 1 shows that if the water stressed treatment had been harvested when it had a similar greenlife to the control; that is, at a finger diameter of 35 mm which was approximately 10 days earlier, rather than at the same size then there would probably have been little difference in the severity of maturity bronzing. Maturity bronzing is, to some extent, a problem related to over-maturity of fruit. It seems that soil water stress by itself may not necessarily be the causative factor in maturity bronzing. However, it can be concluded from this work that water stress should be avoided at the time of bunch emergence to reduce symptoms of the maturity bronzing disorder. This could probably be achieved by solid-set irrigation, either over- or under-tree systems, which will allow irrigation as frequently as is necessary.

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