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Fruit Core Tissue Deterioration in Pineapple (*Ananas comosus* cv Mauritius) Under Cold Storage

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ABSTRACT: The initial symptoms of core-deterioration is the formation of watery tissue in the core and its adjacent areas. However, these symptoms are undetectable externally, since the fruits appear normal.

A field experiment followed by cold storage investigations using fruits of various physiological maturity were carried out to study this phenomenon. The treatments consisted of three concentrations of Calcium carbide (CaC_2), Alpha Napthaline Acetic Acid (a-NAA) and Ethrel (Ethephon) superimposed on limed and unlimed plots arranged in a split plot design. Immediately after harvest fruits were packed in corrugated pare cartons and stored in a cold-room (10 C and 80-85% R.H.) in simulated sea-freight reefer container conditions for periods of one week, two weeks, three weeks and four weeks. Results showed that the response to these concentrations (15, 30 & 45 ppm) of different flowering hormones was essentially the same. Hormones and lime application failed to prevent this deterioration which was due to mobilization of K^+, resulting from CAM pathway. The supporting evidence for this hypothesis is that the stomata were opened under cold storage condition without light and there was also an increase in evaporation.

INTRODUCTION

The pineapple (*Ananas comosus* cv Mauritius) is a popular fruit and it is economically important in the local as well as in the foreign markets. High quality and assured supplies of uniform sized fruits are important for the fresh fruit market. Although pineapple can be grown as a monocrop, it is commonly grown as an intercrop under coconut in the Gampaha and Kurunegala districts (Yatawara, 1990). It is expected that the area under cultivation would increase from 10,000 ha to at least 50,000 ha.

The development of core deterioration in the fruit and browning of the flesh is a problem in the fresh fruit export market. The cartons of fruits are placed in clod storage maintained at 10 C soon after harvest, in any event within 6 hours. The cartons are staked on pellets to allow air circulation around and through the cartons. When the cartons are stored at low temperature (8 – 10 C) and 80–85% R.H. the fruits are subjected to the physiological disorder. Teission *et al.*, (1978) reported an increase of black heart in pineapple during storage at 10 C and 80–85% R.H. which increased with the duration of cold storage from 1–4 weeks in the Ivory Coast. They stated 20 C as a threshold temperature, which was low for slight induction and high for revelation of disorder.

Leverington (1969) reported that a brown or black discolouration of the flesh around the core begins as brown water soaked spots about 2 to 3 cm in diameter arranged symmetrically a few cm from the base and about 1 cm from the core. The early stage of this deterioration is called "endogenous brown spot" and the latter stage, black heart (Dull, 1971). Bose *et al.*, (1962) demonstrated that the disorder was of non–parasitic origin. Abdullah (1984) stated that if the storage period was extended a temperature lower than 20 C also cause the disorder without any exposure to higher temperature.

The fruit core tissue deterioration could be due to the result of interactions between the flowering hormones used and to their different concentrations and also possibility due to nutritional deficiency of Calcium.

MATERIALS AND METHODS

A field experiment was laid out during 1988–1990 at Divulapitiya as a split–plot in 4 blocks. The suckers were planted in a single row system under coconut. The recommended fertilizer application (N 10; P 7; K 31) was kept constant for all treatments.

The treatment consisted of three flowering hormones, namely, Alpha Napthalene acetic acid (α–NAA), Ethrel (Ethephon) and Calcium carbide (CaC_2) at three concentrations (15, 30, 45 ppm). These were superimposed on limed (5 tons/ha) and unlimed plots. Each plot of

pineapple plants in a row was treated uniformly with 50 ml of each treatment.

The fruits which slightly ripe (5%) were harvested early morning and transported immediately to the laboratory at Central Agricultural Research Institute, Gannoruwa. The base of the fruit was dipped in a 4 percent Benomyl (fungicide) suspension to control soft rot caused by Thielaviopsis paradoxa fungi. They were stored in corrugated fibre cartons in a cold room at 8 C – 10 C and 80 – 85 relative humidity for periods of 1, 2, 3 and 4 weeks. They were removed at one week intervals and held for a week at 28 C for final observations. The control fruits were stored at 28 C.

Determination of core deterioration, internal browning intensity, total soluble solids (TSS), cidity, potassium content in the core and pH value were made as follows.

During infections, fruits were cut longitudinally into two halves and the breakdown of the core was determined visually using the scale modified by Teisson (1979). Internal browning (IB) intensity was scored by using a scale of 0 – 5 as reported by Abdullah and Rohaya (1983). Acidity was determined by a Beckmen digital pH meter. Determination of potassium ions made using a flame photometer (Ranganna, 1977).

RESULTS AND DISCUSSIONS

Addition of the three flowering hormones at different concentrations did not show a significant increase over the control in core deterioration and internal browning of pineapple under cold storage. It was also found that there were no significant differences in deterioration of fruit core with the application of lime into the soil.

Weight loss

Figure 1 shows the weight loss of fruits during the storage from 1 – 4 weeks. Maximum weight loss occurred during the first week followed by the second week. When the storage was prolonged over one week, the weight loss was much less. These losses in weight were due to the loss of moisture as a result of constant opening of stomata of the crown

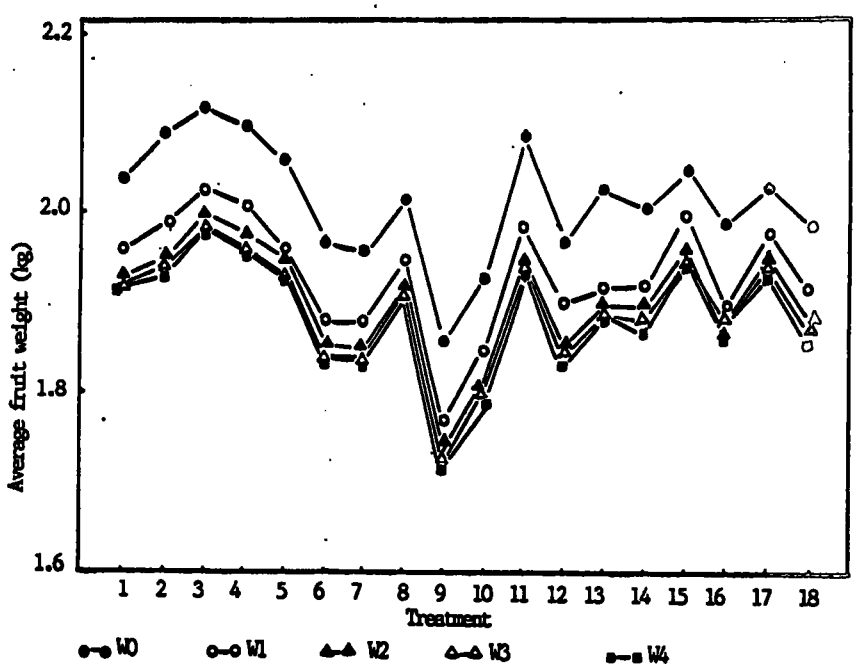

Fig. 1. Changes in fruit weight after storage for one week (W_1) from 1-4 weeks (W_4) at 10°C and 85% RH).

leaves. It may also be in relation to the differences between the vapour pressure in the fruit and the cold room.

Titratable acidity (TA) and pulp pH

Before cold storage (w_0), the titratable acidity remained constant around 0.85 in all treatments (Figure 2). After 4 weeks (w_4) it was increased to 1.88. There was little difference in acidity from the third to fourth weeks. In the meantime rapid decline in pH was accompanied by increase of TA. Increase in TA may be due to the accumulation of organic acids as a result of CAM metabolism in the peel and crown leaves under stress conditions. Miller (1951) found that pineapples showing the symptoms were characterized by a lower content of ascorbic acid than the normal fruits. Black heart incidence has also been connected to total sugars and acidity (Van Lelyveld and De Bruyn, 1976).

The pattern of change in pH with storage period given in Figure 3 shows that it decreased from 3.75 to 3.25 after 4 weeks. A similar pattern of TSS and pH was observed in this investigation. Decrease in pH is associated with the accumulation of organic acids as a result of the onset of senescence changes in the flesh.

Total soluble solids (TSS)

Figure 4 shows the changes in total soluble solids (TSS) of the fruits before and after storage. Decrease in TSS was not significant in all treatments up to 3 weeks (w_3). However, the decrease in TSS was significant after 3–4 weeks. Decrease in TSS may be due to degradation of sugars into sugar acids that are produced by the pulp which could initiate some senescence changes in non-climatic fruits. As the internal enzymatic activities were not investigated in this study the exact mechanism could not be explained. Fruits affected by core deterioration were significantly lower in TSS.

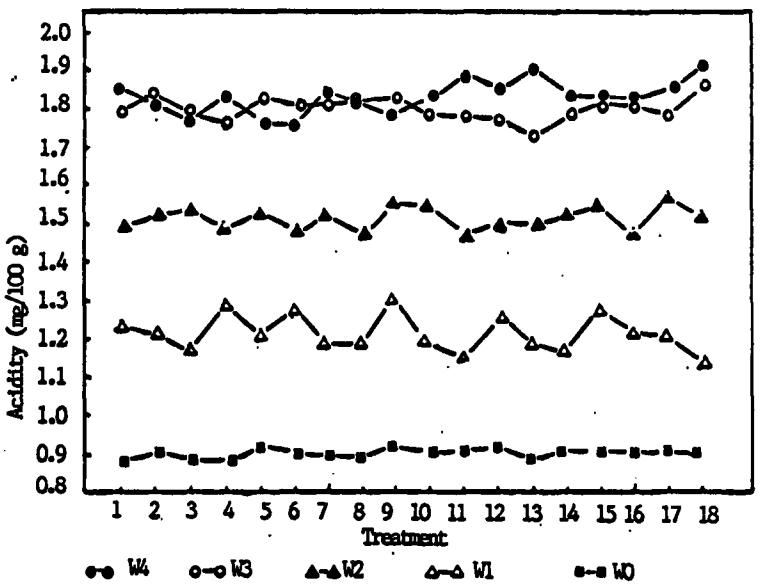

Fig.2. Changes in acid content after storage from 1-4 weeks at 10°C and 85% R.H.

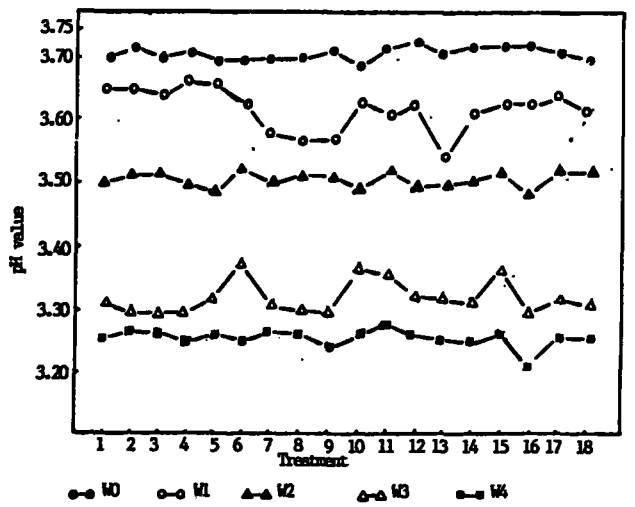

Fig. 3. Changes in pH value after storage storage from 1-4 weeks at 10°C and 85% R.H.

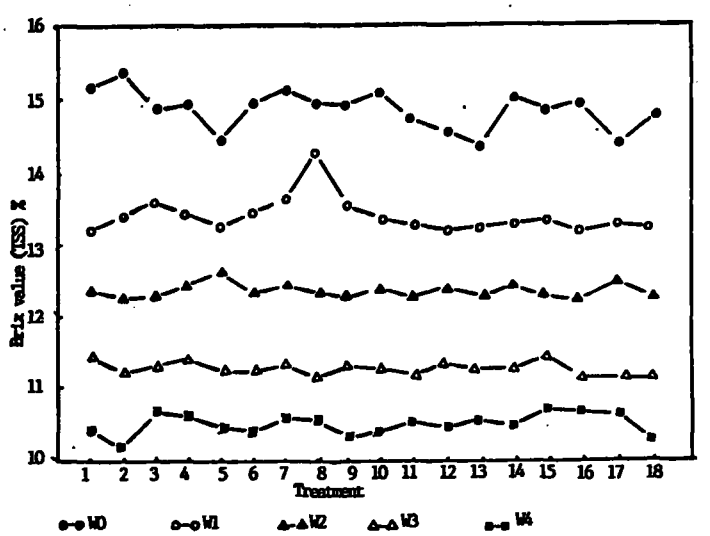

Fig. 4. Changes in Brix value after storage from 1-4 weeks at 10°C and 85% R.H.

Intensity of fruit core tissue deterioration

Figure 5 shows the development of fruit core deterioration after cold storage from 1 to 4 weeks ($w_1 - w_4$). There was no sign of damage before cold storage. However when the storage period was prolonged, the intensity of damage increased proportionally to the duration of cold storage.

Potassium ion content

Figure 6 shows K^+ content before storage was slightly higher than fruits stored for one week. From 1 to 4 weeks after storage it shows a decrease as the duration of storage prolonged. The decrease was more pronounced during the first 3 weeks. There was hardly any difference between the third and fourth weeks. There was also a relationship between fruit core damage and rapid decline of K^+ in the flesh. K^+ loss may be in relation to the loss of permeability of the cells. This could also be affected to the development of slimy patches in the core as a result of dissolving the cell-walls.

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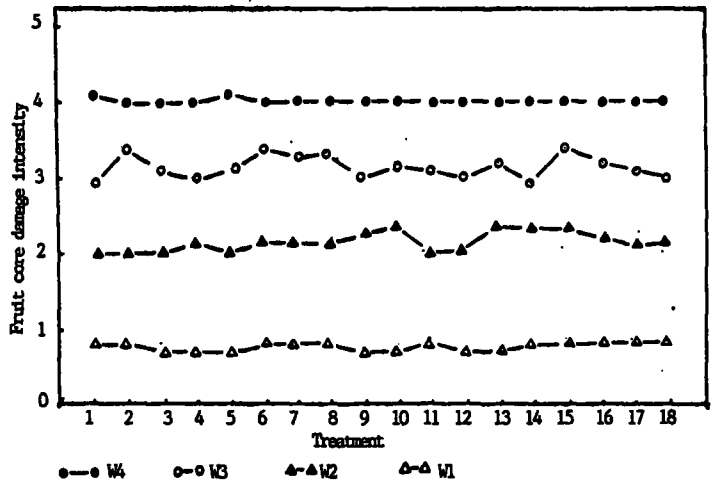

Fig. 5. Development of core damage after storage from 1-4 weeks at 10°C and 85% RH.

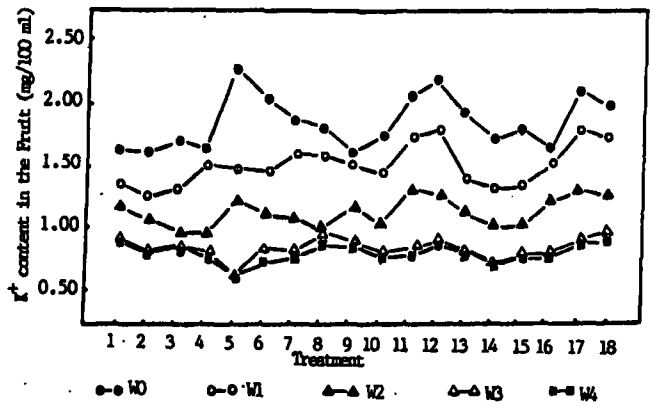

Fig. 6. Changes in K^+ in the Core after storage. from 1-4 weeks at 10°C and 85% R.H.

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