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Physiological aspects of delayed marketing of avocado fruit

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SYNOPSIS

Physiological parameters of ripening were studied in avocado fruit of the Hass cultivar harvested in the middle of the months of April, May and June, while common practice in Israel is to harvest this cultivar between January and April. Simulations of delayed marketing by cold storage and delayed harvesting were carried out. It appears that at 20°C cellulase activity and softening precede ethylene production by the fruit. Changes in fruit firmness, cellulase, polygalacturonase and pectin methyl esterase activities and patterns of respiration and ethylene production, were studied in fruit stored at temperatures between 0° and 20°C. It is suggested that the levels of cellulase and pectin methyl esterase activity, on the day of harvest, may be used as guidelines for deciding how long fruit can be left on the tree and still subsequently reach the market in good condition.

INTRODUCTION

The expectation of an increase in the future production of avocado fruit necessitates a search for methods to extend the avocado marketing season. In Israel the common harvesting season for the Hass cultivar is between January and April. Furthermore, the need for delayed marketing may arise as a result of labour transportation or competition considerations. Today there are two obvious ways to delay marketing: the most common one is to keep fruit in cold storage, and the other is to delay the harvesting, as avocado fruit normally does not ripen on the tree.

Among aspects to consider when deciding whether to delay marketing, the physiological aspects are most important. Therefore, studies were carried out to characterise some of the ripening processes occurring in the fruit while delaying marketing, by either prolonged storage or delayed harvesting.

MATERIALS AND METHODS

Avocado fruit (*Persea americana* Mill), cv Hass, was harvested at three different times, a month apart from each other, starting in the middle of April. The oil content of the fruit was 13,9 per cent in April, 14,1 per cent in May and 16,4 per cent in June. Part of the fruit was continuously kept at 20°C and 90 per cent relative humidity (RH) and the other part was stored for two weeks at 2°C and then transferred to 20°C to ripen.

Five fruits from each storage treatment were sampled periodically under these storage regimes and as previously, their individual respiration rates (6), ethylene production (6), cellulase (4), pectin methyl esterase (5) and firmness (6) were determined.

The beginning of softening could be sensed by hand only when the resistance to penetration of the fruit pulp, measured by pressure tester, was reduced to approximately 35 Newtons, and the fruit was soft and suitable for consumption below 5 Newtons.

In another experiment Hass fruit harvested in the middle of May was stored at 0°, 5° and 20°C and 90 per cent (RH). After 12, 23 and 33 days at the two low temperatures, five fruits from each treatment were transferred to 20°C for ripening. In this experiment, determinations were made of firmness, cellulase activity, polygalacturonase activity, and the appearance of chilling injury (pitting) on the peel.

RESULTS

During 33 days of storing cv Hass at 0°C, no significant changes in polygalacturonase activity and firmness had occurred (Figure 1). There was, however, a slight increase in cellulase activity, after 23 days of storage at 0°C, which increased further after 33 days. At 5°C, polygalacturonase activity remained at the same low level for 33 days and increased only after the fruit was transferred to 20°C. At this temperature (5°C) cellulase reached more than half of its maximal activity after 23 days, and then continued to rise until day 33, when the fruit was transferred to 20°C for ripening. In addition the firmness, as measured with the pressure tester, decreased at 5°C parallel to cellulase but at a lower rate. Such a decrease in firmness cannot be detected by a hand squeeze. After 23 days of storage at 0°C, chilling injuries became evident on the fruit peel. The delayed harvest of Hass fruit resulted in a shorter storage life when stored directly at 20°C and also when stored first at 2°C for 14 days (to simulate shipment) and then transferred to 20°C for ripening. This is reflected in the firmness of the fruit; already on the day of harvest, fruit harvested in June was softer than those harvested in April (Figure 2). Also, the rate of softening was faster with fruit harvested later. Until March no cellulase activity was evident in Hass fruit on the day of harvest, and in April the activity was lower than in June (Figure 3). Cellulase activity seems to precede softening (Figures 2 and 3). In avocado fruit the activity of pectin methyl esterase is reduced during ripening and indeed, the study shows that, on the day of harvest in April, it was twice as high as in June (Figure 4). The respiratory peak of the fruit was reached 14 days after harvest (at 20°C) in April but after only 10 days in June (Figure 5). Ethylene evolution (Figure 6) was similar in its pattern to that of the respiration rate.

DISCUSSION

The process of softening is only delayed, not prevented completely, during cold storage. This is demonstrated in Figure 1 by the changes in cellulase activity and firmness. Polygalacturonase activity did not change during the cold storage period. The difference between the ripening time of fruit stored continuously at 20°C after harvest and fruit which was cold-stored at first and then transferred to ripen at 20°C (Figures 1-6), suggests that during the cold storage period some changes which have not yet been identified, enhance the 'readiness' of the fruit to ripen. Not only does cold storage not

'freeze' ripening processes, but it may cause chilling injuries, as indicated in Figure 1 and in previous studies (2,8).

Early in the season no cellulase activity in the fruit was found on the day of harvest, but later in the season (Figure 3) cellulase activity reached about 30 per cent of its maximal activity already on the day of harvest. Based on the data presented (Figures 2, 3 and 6) and supported by data which were presented previously (1,3,4), it appears that cellulase activity and softening of avocado fruit at 20°C are not triggered by ethylene produced by the fruit, but rather precede it. Judging from the ripening parameters at the different harvests, it is obvious that the later the harvest, the shorter the storage life of the fruit (Figures 2-6), as has been shown previously (7). Obviously the decision whether to delay marketing by storage or by delayed harvest must be based on additional parameters and factors - such as the total yield that may increase as a result of the delayed harvest, saving on expensive cold storage space - but also on the weather, possible fruit drop and the general condition of the orchard and the individual tree. By studying ripening parameters (cellulase and pectin methyl esterase activities on the day of harvest), a mechanism was developed to determine how long harvesting could be delayed, for the fruit to still have a long enough storage life to reach the market. The more studies done on physiological processes connected with avocado fruit maturity, storage and ripening, the better the solutions to problems associated with harvest timing, handling and marketing will be.

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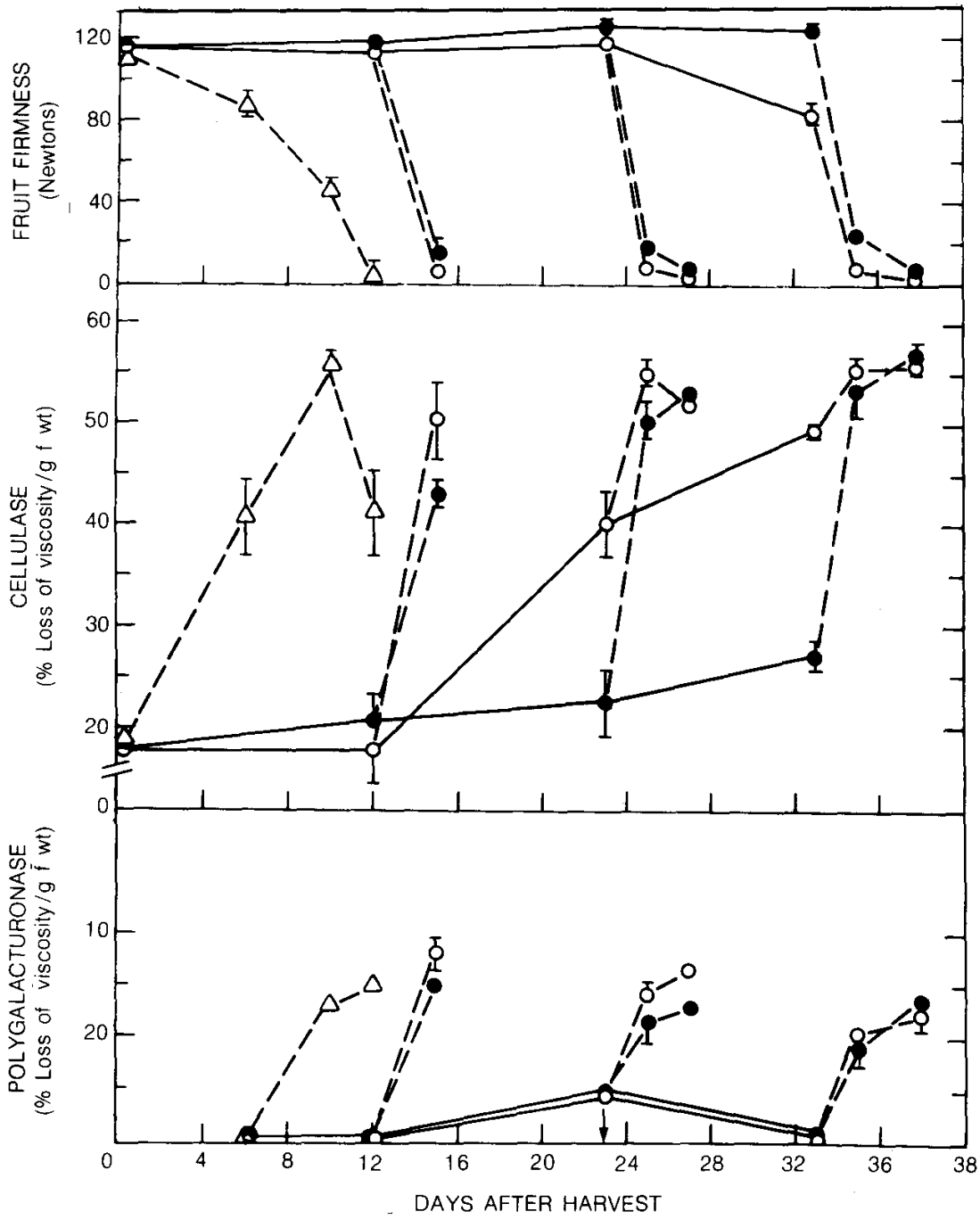

Fig 1 Cellulase and polygalacturonase activities and firmness of cv Hass stored for 0, 12, 23 and 33 days at 0° —•— and 5°C —o— (solid lines) and subsequently transferred to 20°C —△— (broken lines) for ripening. Standard error of five replicates —⌶. Appearance of chilling injury on fruit stored at 0°C —↓

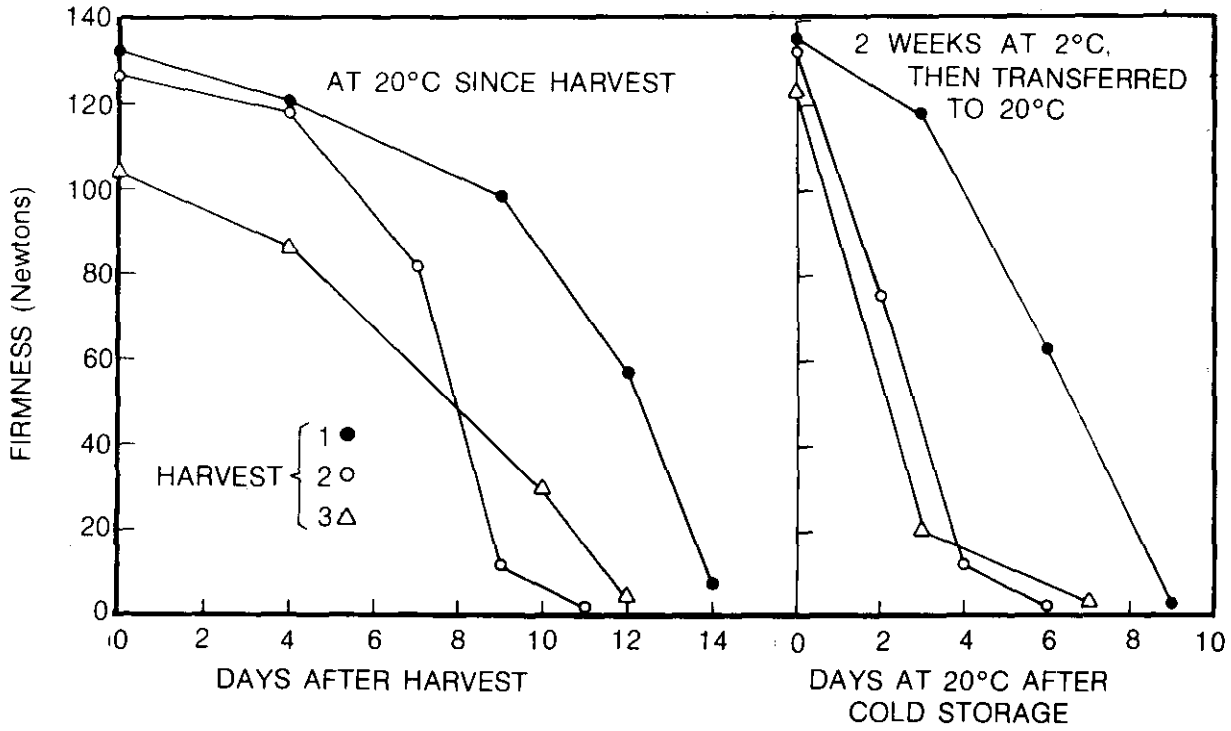

Fig 2 Firmness of cv Hass harvested in April, May and June and stored at 2° and 20°C.

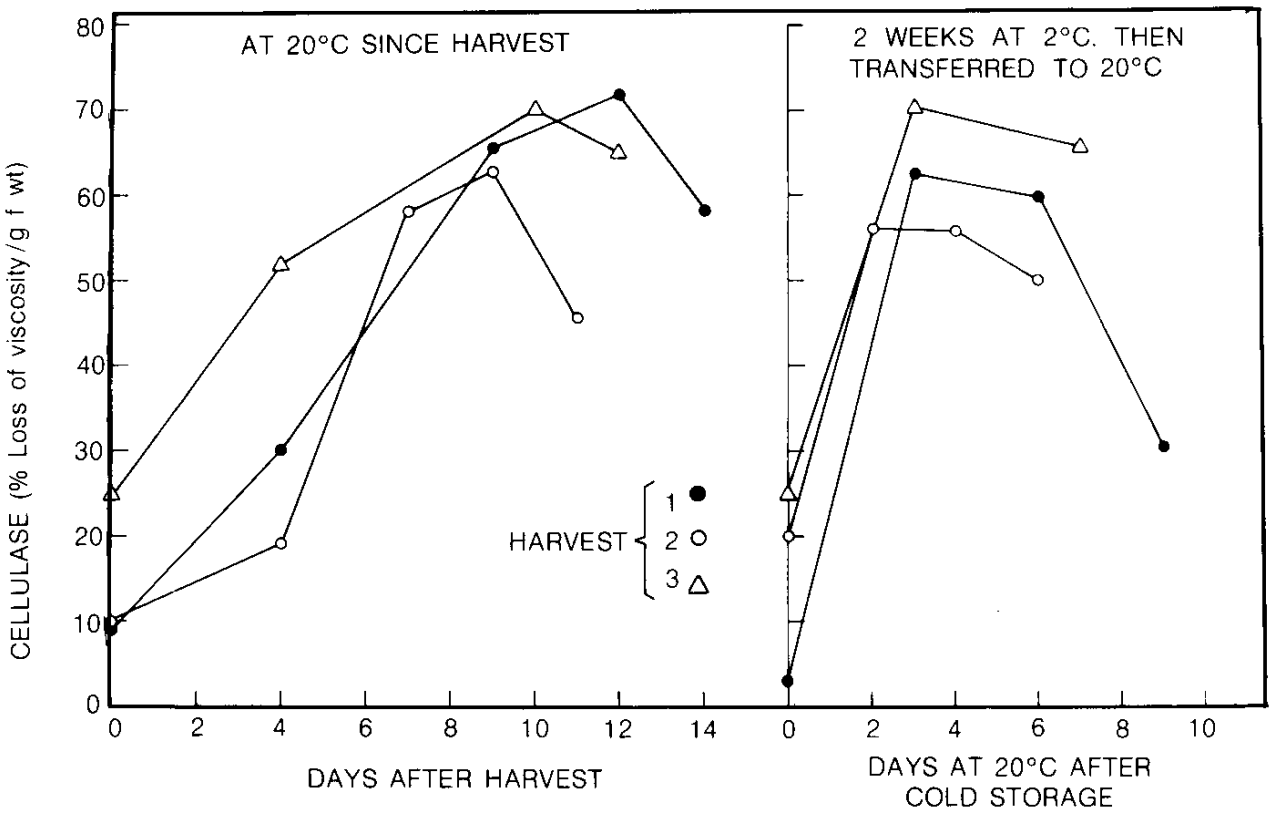

Fig 3 Cellulase activity in cv Hass harvested in April, May and June and stored at 2° and 20°C.

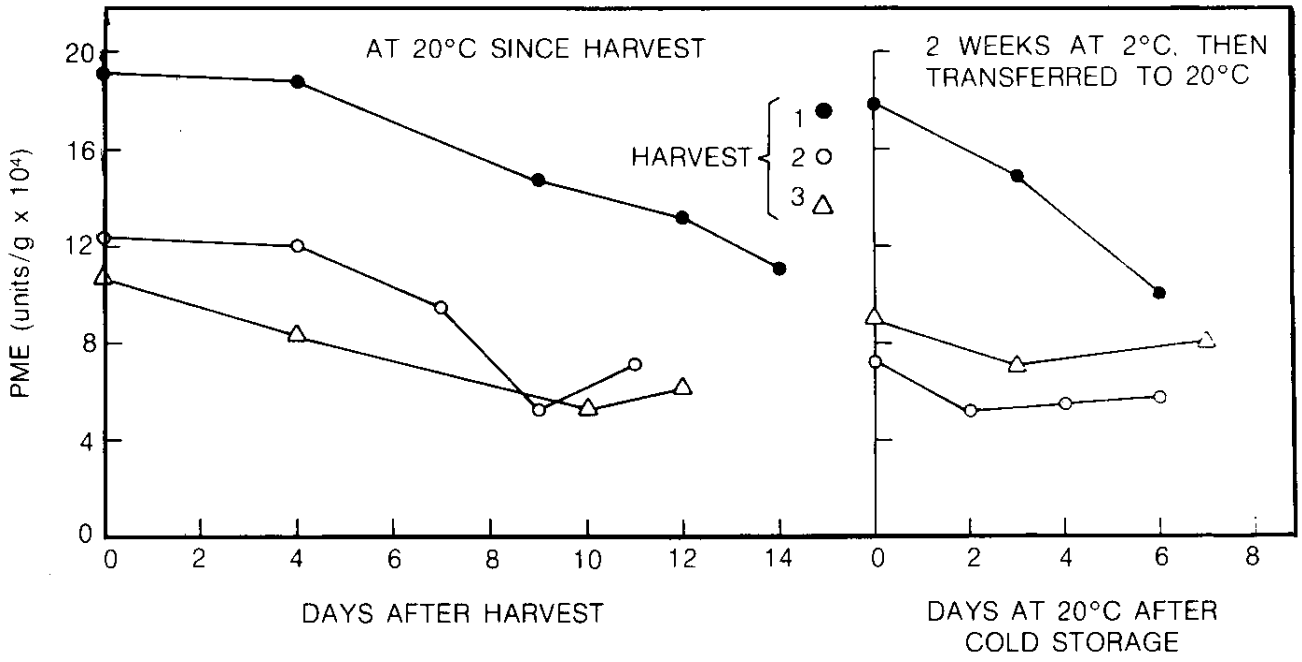

Fig 4 Pectin methyl esterase activity in cv Hass harvested in April, May and June and stored at 2° and 20°C.

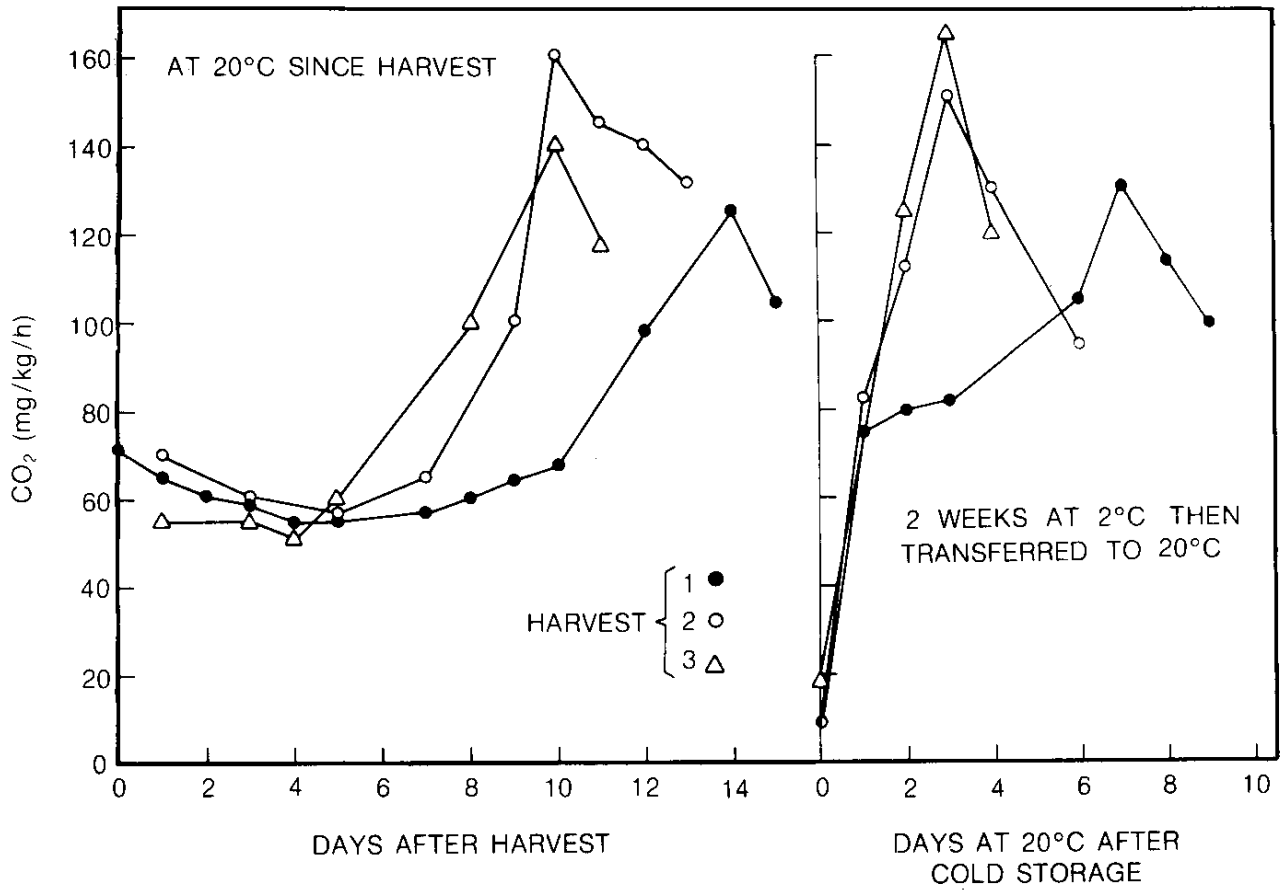

Fig 5 Respiration rates of cv Hass harvested in April, May and June and stored at 2° and 20°C.

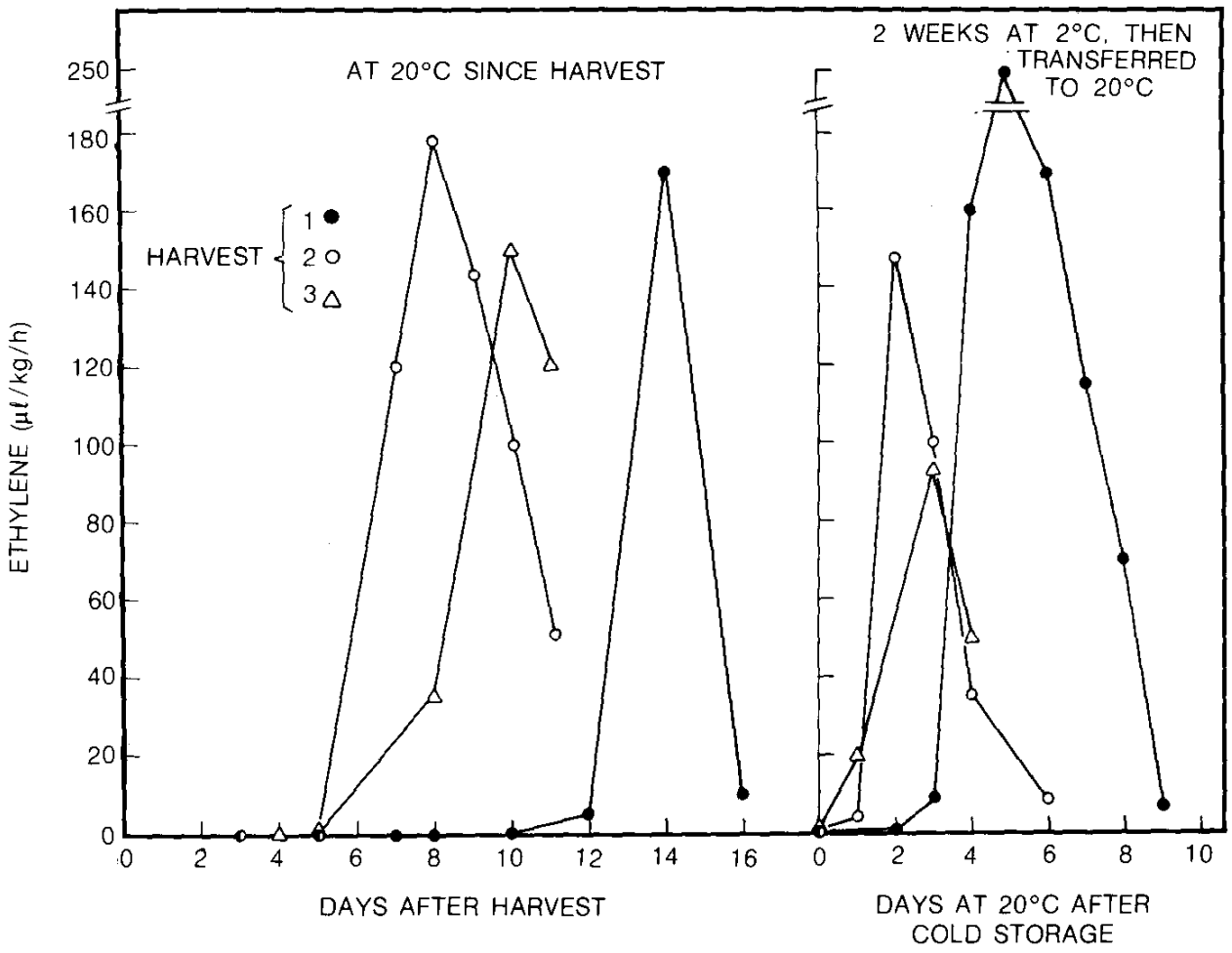

Fig 6 Ethylene evolution rates of cv Hass harvested in April, May and June and stored at 2° and 20°C.