Investigation on Early Softening of Kiwi Fruit

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Abstract

Early softening is the main problem for the exports of Chilean kiwi fruit. It has been related to orchard condition and to harvest and postharvest handling. In this investigation, experiments were carried out to test the influence of growing conditions and some fruit characteristics on the softening rate of kiwi fruit, from different orchard in the central zone of Chile. Fruits from all orchards were harvested at 6.2-6.5 soluble solid content, and kept under the same storage condition (0°C, regular air). Samples were taken every fifteen days to determine softening index (S.I.), which was calculated by the initial firmness minus final firmness, divided by the days till the fruit reached 20 N of firmness. There was a large variation in S.I. between orchards and also in the same orchard. The fruit characteristics assayed were size, position and illumination of fruit in the plant. For this purpose fruit from the same plants were harvested and tested in the same way as described before. The influence of size on early softening was found in 3 of the 4 orchards tested, having the larger fruit the lowest firmness loss. The position on the fruit on the plant (distance from the base of the cane) had no clear influence on fruit firmness. The fruit from better illuminated part of the plant had higher initial firmness, but also higher firmness loss during storage, nevertheless the final firmness was higher in the better-illuminated fruit.

INTRODUCTION

Kiwi fruit storage can be performed for long as the fruit is firm enough for subsequent commercialization. Early softening, i.e. fruit being not able to be kept in cold storage for 3-4 months and/or that may soften during subsequent transport, is being considered as an important limitation of Hayward kiwi fruit. Although it is known that kiwi fruit can soften as a consequence of exposure to ethylene during cold storage, even under ethylene-free conditions the problem can be present for certain fruit (Arpaia et al., 1994). Differences in terms of keeping fruit firmness for fruit belonging to different orchards or within orchards are strikingly large. It is assumed that orchard and environmental factors, like nutrition, vigour, fruit growth and position, light and temperature conditions are influencing softening behaviour (Pyke et al., 1996; Smith et al., 1994). Thus, a negative correlation has been observed between fruit size and softening rate (Crisosto et al., 1999) and distal fruits on a cane, having increased soluble solids, exhibited a reduced softening rate (Pyke et al., 1996). Further, fruits growing under shade tend to show increased softening rate (Ferguson, 1980).

Despite attempts to understand and to control early softening, though, the problem is far from being solved in the main kiwi fruit producing areas of the world. This problem is particularly prevalent in fruit from Chile. Therefore, a 4-year project has been started with the aim of studying the problem comprehensively in order to determine the main factors involved and possibilities of prediction and control of early softening of kiwi fruit. In this article data are presented concerning aspects related with orchard factors on the softening problem, particularly position, size and illumination of the fruit.

MATERIALS AND METHODS

In this investigation, experiments were carried out in 4 different orchards in the

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central zone of Chile. In the first set of trials, differential fruit position was assayed, i.e. by considering fruit growing on shoots close to the origin of the cane (basal fruits; within the first 30 cm), fruit from shoots originating in the middle part of the cane (middle fruits; about 80-100 cm) and those growing on shoots at the end of the cane (distal fruits). In separate experiments, the effect of size was studied, with large fruit weighing more than 115 g and small fruit weighing less than 80 g. Experiments for illumination (light exposure of the fruits) included exposed fruits having leaf coverage resulting in about 50% (ca. 40 μM of photosynthetically active radiation (PAR) and shaded fruits having 90% of leaf coverage (about 2-4 μM of PAR). In both cases measurements were done by using a LI-COR instrument (Model LI-250 Light Meter) at noon in an illuminated day in mid-summer.

Fruits from all orchards were harvested at 6.2-6.5 soluble solids content, then allowed to stay at ambient temperature for 48 hours (curing treatment) and kept afterwards under the same storage conditions (0°C in air, excluding ethylene). Fruit samples of 15 fruits each in 4 replications, were taken from cold storage every fifteen days till fruit reached minimum firmness for export (20 N). Firmness measurements were performed with a penetrometer (Effegi), once fruit reached 18-20°C. A softening index (S.I.) was determined, which was calculated by the initial firmness minus final firmness, divided by the days till the fruit reached 20 N of firmness.

RESULTS AND DISCUSSION

Although there were no differences in firmness of fruit of different size at harvest, larger fruit (>115 g) showed higher firmness values in all 4 orchards along the cold storage period. The greatest differences were recorded in the first half of the storage period and they were diminishing as storage progressed. In Fig. 1 a representative firmness curve of one orchard is shown. These results are in agreement with previous research in other countries, in which larger fruits have shown reduced softening rates (Crisosto et al., 1999), both in air and in controlled atmosphere, although in our case differences were modest and not always statistically significant.

Regarding exposure of the fruit to different sunlight intensity (illumination), the behaviour of fruit softening was rather variable between orchards. However, a trend could be discerned. Thus, fruit originated from exposed positions tended to keep higher firmness during cold storage and, in most cases, with such fruit showing increased firmness already at harvest time. In Fig. 2, a representative firmness curve is shown. Previous research under conditions other than in Chile have already shown that less exposed fruits tended to soften more rapidly, being of poorer quality because of reduced carbohydrate accumulation (Tombesi et al., 1993). In our case, however, only half of the more illuminated fruit had increased dry matter.

The position of the fruit on the plant (distance from the base of the cane) had no clear influence on softening, though in 2 of the 4 orchards the basal fruit showed higher firmness after 60 days of storage (Fig. 3). No differences in accumulation of soluble solids could be observed in such cases, a fact that is different from what has been previously reported (Pyke et al., 1996). Opposite behaviour, i.e. less firm fruit from basal positions, as shown previously by other researchers (Pyke et al., 1996), was not found in our case, as shown in Fig. 4, where no differences in softening were available according to position. On the other hand, no differences in initial firmness were determined as related with fruit position.

CONCLUSIONS

Despite some differences in softening rate according to the factors studied, apparently such factors by themselves are not able to account for the ample variation observed between and within orchards. From the factors studied in the first year of this project, fruit size and light conditions during the development of fruits seem to be more relevant than fruit position, in which no definite behaviour could be established. Therefore, consideration should be given to further factors and also to long term

consistency of the trends observed so far.

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Figures

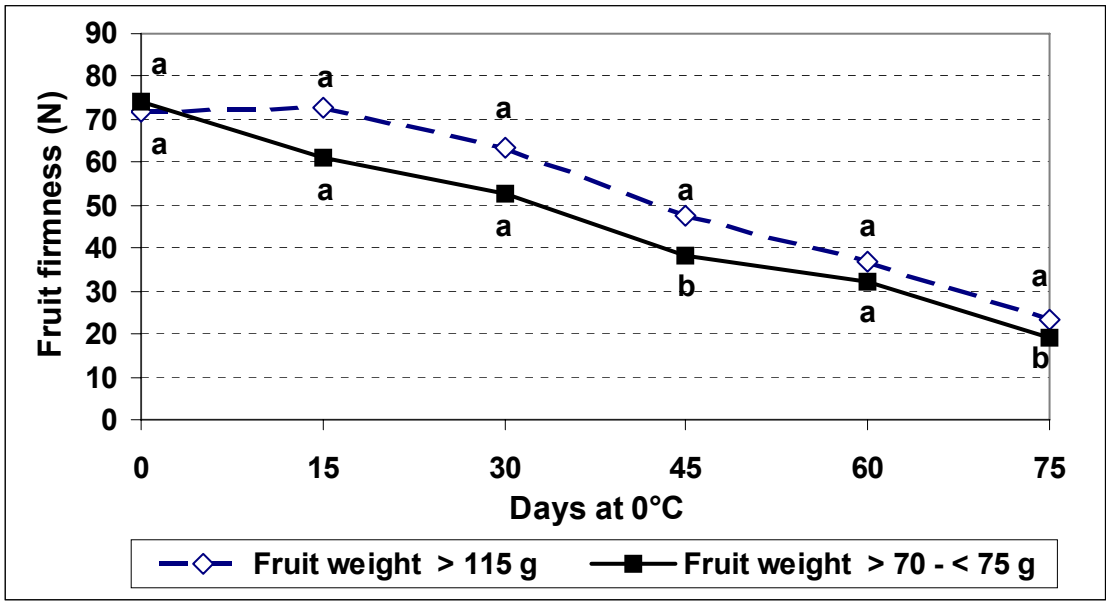

Fig. 1. Softening of kiwi fruit of different size during storage at 0ºC in regular air. Site of orchard: Huelquen, Metropolitan Region.

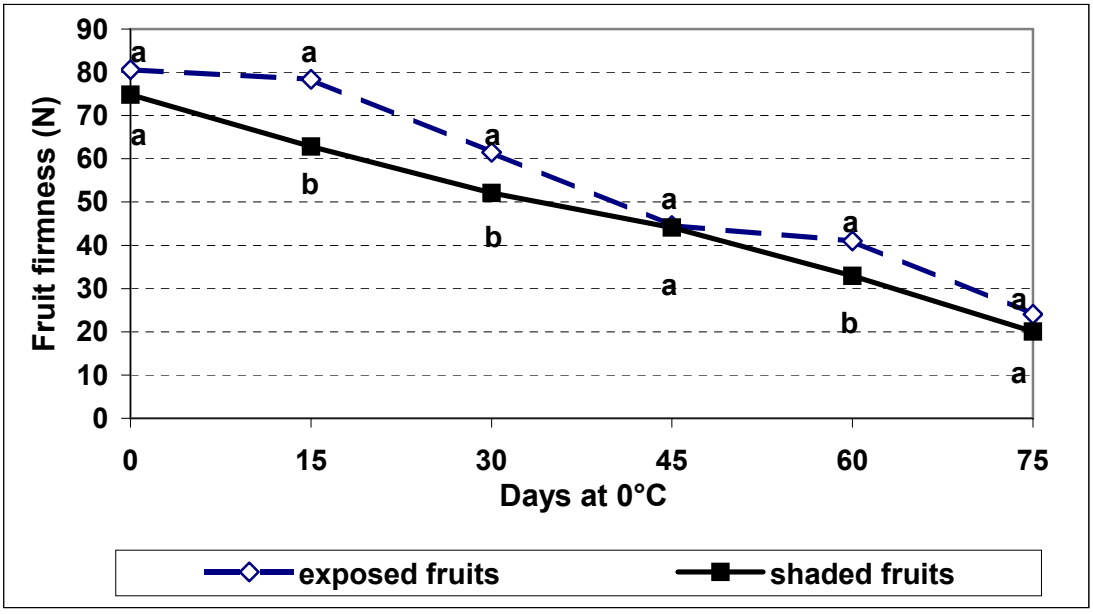

Fig. 2. Softening of kiwi fruit during storage at 0ºC in regular air. Fruits were exposed to different illumination in the orchard. Site of orchard: Huelquen, Metropolitan Region.

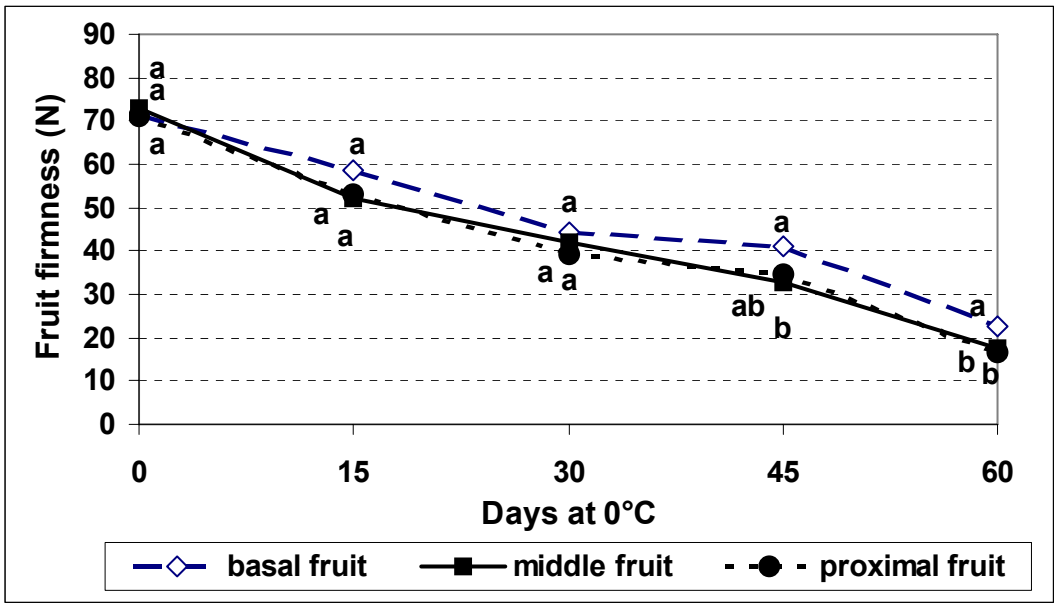

Fig. 3. Softening of kiwi fruit from different position on the cane during storage at 0ºC in regular air. Site of orchard: Naicura, VII Region.

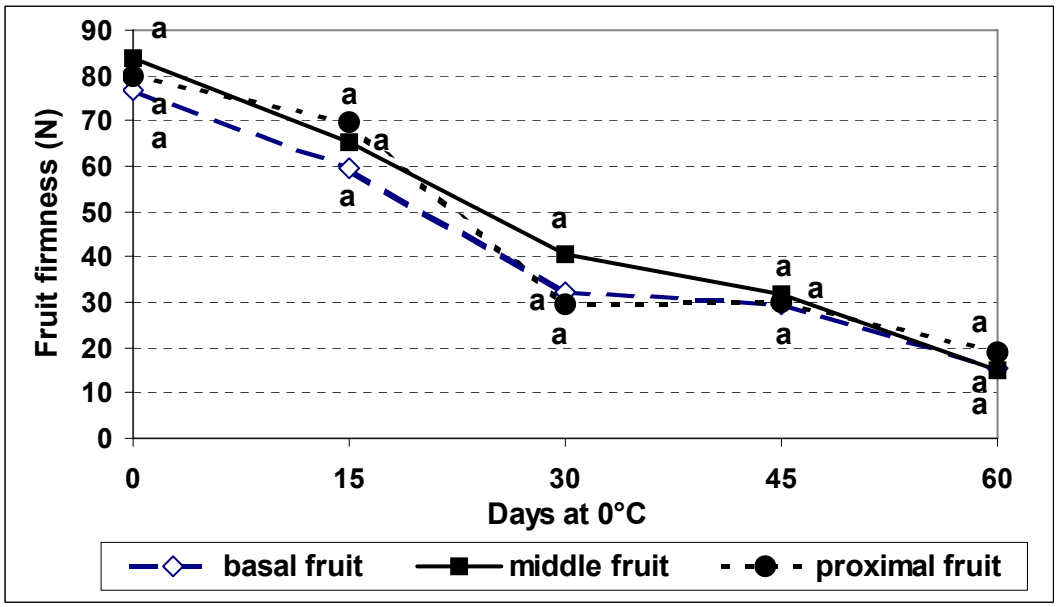

Fig. 4. Softening of kiwi fruit from different position on the cane during storage at 0ºC in regular air. Site of orchard: Curico. VII Region.