Water Loss of Conference-pears during Long Term CA-storage: Prediction and Practical Measures

Alex C.R van Schaik, Jan A. Verschoor and Herman Peppelenbos
Agrotechnology and Food Innovations, Wageningen University and Research Centre, Wageningen
The Netherlands

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Abstract

Conference is by far the most important variety in the Netherlands. It is expected that the production will increase in the next years. Noticeable is a demand in the market to have year round supply, which means a longer storage period is required. Up to now the maximum storage period of Conference-pears is 8 months in CA-storage. Limiting quality factor is shrivelling, especially at the neck of the pear, resulting in the so-called "slack necks".

In research influence of different harvest factors is investigated in a specially designed system to force weight loss in a short time. Factors like growing area, season, harvesting time, orchard and pear size have their specific influence. Most important and independent from other factors is pear size, smaller pears have much more weight loss. Based on possibilities for prediction of weight loss at harvest, a specific apparatus was developed to measure weight loss in a very short time.

In addition, during CA-storage the influence of bin packaging has been investigated to reduce weight loss. An important result is that weight loss could be reduced to levels that guarantee a longer storage period. As a result of this research, this packaging-system is being broadly applied nowadays for long term storage in the fruit industry.

INTRODUCTION

In the Netherlands the yearly production of Conference-pears will increase to an expected volume of 175.000 t. as a result of extension of the plantation area.
In addition, a good market for high quality pears during the whole year is expected in the years to come. Probably this extended marketing period will compensate for the increase in production.

However, currently Conference-pears can be stored in standard CA-conditions for 8 month maximally, which limits the supply period of the pears. An almost year round storage is required to be able to provide the market.

The limiting factor for long term storage is dehydration of the pears, despite the high humidity in the rooms. In many cases shrivelling develops, especially at the stem end of the pears, which leads to a flexible neck. The long shaped Conference-pear is very sensitive to this defect. Several causes are responsible for the disorder, like (pre-) harvest factors and storage circumstances. Normally, Conference pears in the Netherlands are stored in Controlled Atmosphere (-0.5°C, 3% oxygen, <0.7% carbon dioxide). The rooms have a capacity ranging from 80 to 175 tons. To monitor dehydration in practice, the amount of defrosting water is measured regularly, giving an indication of water loss. The current guideline for long term storage of Conference-pears is to keep the water loss below 2.5l/ton/month. but only a few storage facilities are able to comply. In the past, only improvement of the cooling installations had a considerable positive effect on the reduction of water loss.

Together with the entire Dutch Fruit Industry (Auctions, Exporters, etc), the Product Board of Horticultural Crops and the Dutch Fruit Growers Association a research project was initiated which should deliver integrated solutions for the future. Within a 3 year project several topics are addressed:

1) Physiological and physical factors of pears influencing water loss
2) Prediction of water loss on batch level during storage.
3) Determination of optimal water loss of the pears during storage in relation with other quality factors.
4) Technical requirements for the ideal cooling room for Conference pears.
5) Influence of different packaging- and moistening systems during storage.

Scope of this work is mainly focussed on harvest factors influencing weight loss of the pears during storage. Also equipment is developed to predict weight loss at harvest. Furthermore attention is given to solutions for practice during storage like packaging of complete bins (300-400 kg) is an important part of the study.

MATERIALS AND METHODS

Conference-pears were harvested from 12 orchards located in 3 geographical areas in the Netherlands (Southwest, Middle and North). Three harvest dates were selected: early, commercial and late harvest, generally with an interval of one week. Forced weight loss of individual pears was measured after harvest and after 4-month storage in a small CA room. Conditions in this room were –0.5 ^{o}C, 3% O_2 and 0.7 % CO_2.

To measure the individual weight loss of the pears, a system was designed generating very constant and specific conditions around the pear. These measurements took place at a constant temperature of 20^{o}C, a relative humidity of 60% and in an air velocity of 0.4 m/sec, after 2 days preconditioning. Weight loss of the individual pears was measured over a 2 day interval. As a control for these measurements, during storage weight loss of batches of pears from the same orchards and harvest dates were measured three times during storage.

Also presented in this paper is research on practical scale concerning packaging systems covering complete bins (wooden crates, 300-400 kg) to limit water loss of the pears during storage. Three different packaging systems were studied: plastic foil on the top of the bin only and or in combination with border foil, and a perforated bag. Each combination of these packed bins were placed in three areas of the storage room filled with a bulk of packaged pears. Areas in the cooling room were: directly in the airflow of the refrigerator, in the middle of the load and on the floor of the room below the refrigerator.

In an additional experiment, the bins with top foil only were partly packed directly after harvest and after 7 days pre-cooling to understand more about the effect of packaging on cooling of the pears directly after harvest. The pears were judged on weight loss, colour, internal- and external decay. During the cooling period of the first 7 days, the internal temperature in the bin was monitored.

The data presented here is based on research over 2 subsequent storage seasons.

RESULTS AND CONCLUSIONS

Water Loss

With the described method of forced weight loss, the effect of respiration of the pears should be taken into account. However, it was calculated that respiration contributes a small part only of the total weight loss. It was also assumed that this small contribution would not be different for pears from different harvesting times, seasons and orchards. So with this method it is possible to measure water loss in an appropriate way, as was shown for apples. (Maguire et al., 2001).

Using the facility to force the weight loss, several factors around the harvesting period of the pears are subjected to study. Important is to prove the real relationship between weight loss and slack necks, as demonstrated in Fig. 1. It confirms clearly that slack necks will appear more with increased weight loss of the pears. Therefore measurement of weight loss seems to be a good indication for slack necks.

Investigated factors for water loss were harvesting time, region, season, orchard and fruit weight. The influence of provenance exceeded that of growing region, and the

inconsistent behaviour of both factors over 2 years makes it impractical to relate them with selective criteria for practise. The influence of orchard has much more importance and can go up to mutual differences of 40% (Fig. 2). It can be assumed that joint storage of pears from different batches in one room induces more slack necks in the sensitive pears. But the problem is how to recognise these sensitive batches before storage.

Another factor of importance is the harvesting time. Generally, measured over seasons, regions and orchards, early picked fruits showed more water loss (Fig. 3).

But the main factor is the influence of the pear size or pear weight (Fig. 4). Generally the smaller pears showed much more water loss per kg. This difference is observed on pears from al regions, seasons, orchards and harvest dates. The real difference in water loss between large and small pears is substantial with the consequence that smaller pears develop much more slack necks during storage.

On the other hand the average weight of the pears increased with later picking, which largely explains the differences for the harvest dates (Fig. 3).

Therefore we conclude that pear size is the main factor influencing water loss.

In Figure 1 weight loss is shown in relation to fruit weight, directly after harvest and after storage. Forced weight loss was decreased with about 8% after 4 months of storage for all harvest dates and orchards. Thus, individual differences between weight loss of pears from different orchards and harvest dates remained consistent from harvest to storage This observation shows that water loss at harvest can possibly be used to predict behaviour during storage. To verify this effect, a test method is developed to predict weight loss at batch level. The method is based on a measurement of RH changes resulting from water loss of the fruit in a closed system. Intention is that the measurement can be done in a very short time. For storage operators, this method could be a helpful tool to determine relative sensitivity for slack necks of batches of pears independent from other factors, and select the appropriate storage method/duration on batch level.

Packaging of Bins

To overcome the water loss and slack neck problem in practice, trials were carried out in storage rooms. As shown in table 1 the different types of bin packaging reduced weight loss in a substantial way. The largest reduction of weight loss was found using the perforated bag inside the bin and covered by a plastic top foil

However, a disadvantage of this system is the danger of carbon dioxide accumulation that can result in internal browning. But it was also found that besides carbon dioxide-accumulation, internal browning sensitivity is stimulated in pears with a prolonged period of very low level of water loss. Fruits with a weight loss lower than 1% total over a 9 month period showed much more risk to develop the disorder. The other types of packaging with only top foil and/or in combination with border foil in the bin showed also an important reduction on weight loss with a lower risk on internal browning and spoilage.

At what moment the top foil could be applied to cover the bin is also examined as shown in Fig. 5.

The cooling rate in bins, covered with top foil directly after harvest, was gradually slower during the first days of cooling compared to the bare bins. But after four days the internal temperatures were comparable in general. The quality of the pears after storage and during shelf life did not show any difference depending to these cooling scenarios.

For logistical reasons it is a considerable advantage to cover the bins just before cooling.

In many storage rooms this system of bin packaging is practically used now as a result of this investigation. Especially for pears with an expected storage period longer than 6 months the system is utilised in the Netherlands.

Literature Cited

Maguire, K.M., Banks, N.H. and Opara, L.U. 2001, Massey University. Palmerston North, New Zealand. 2004. Horticultural Reviews, Volume 25, pp 197-235.

Tables

Table 1. Results of bin packaging type on weight loss.

Packaging system	Percentual reduction (%)	Total weight loss (%)
Not packed	0	>3
Top foil	30-40	1.7
Top- and border foil	50-60	1.2
Top foil and perforated bag	>80	0.3

Figures

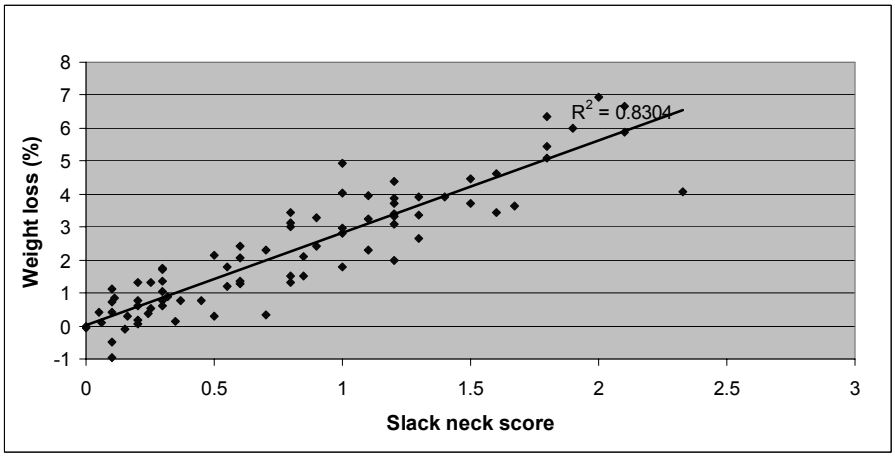

Fig. 1. Relation of actual weight loss of Conference with visually determined shriveling (slack neck score).

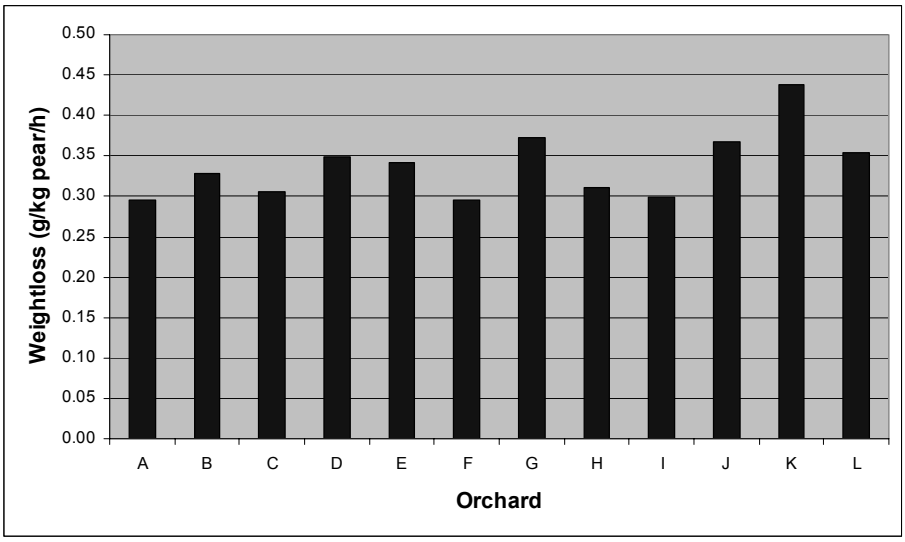

Fig. 2. Influence of provenance on forced weight loss.

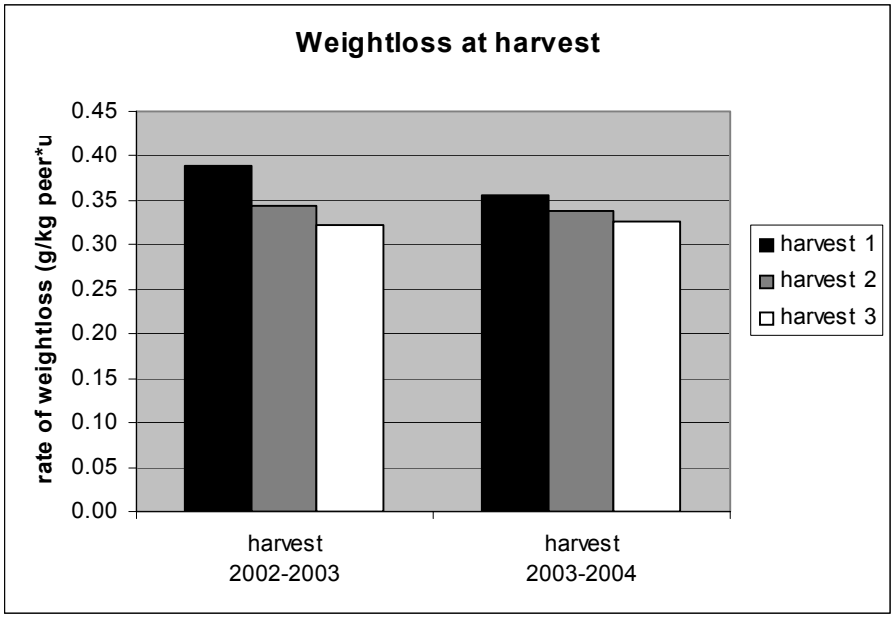

Fig. 3. Influence of harvest time on forced weight loss of conference pears. Harvest 2 is the optimal commercial harvest. Harvest 1 and 3 are 1 week earlier and later respectively.

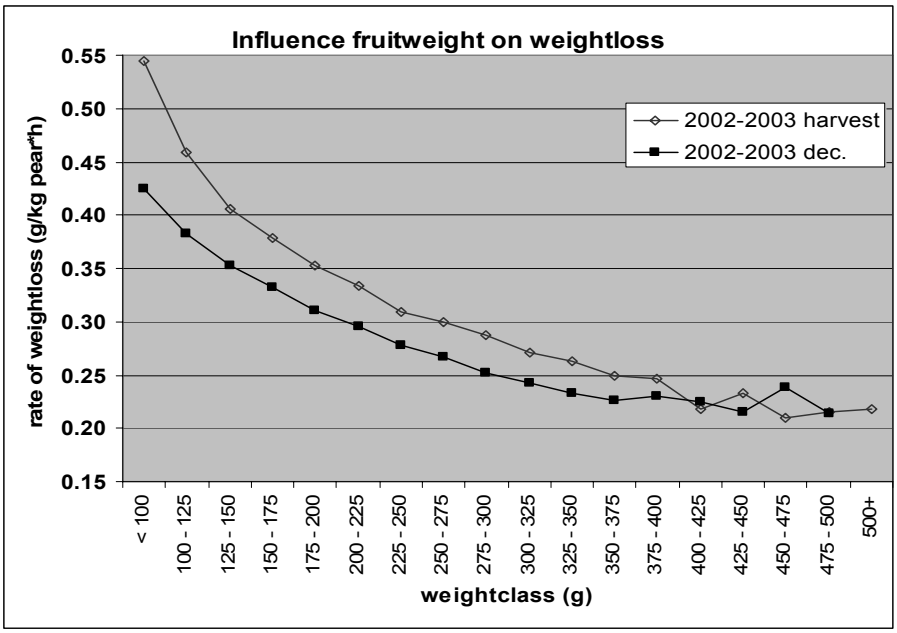

Fig. 4. Relationship between fruit weight and weight loss of conference pears after harvest and storage.

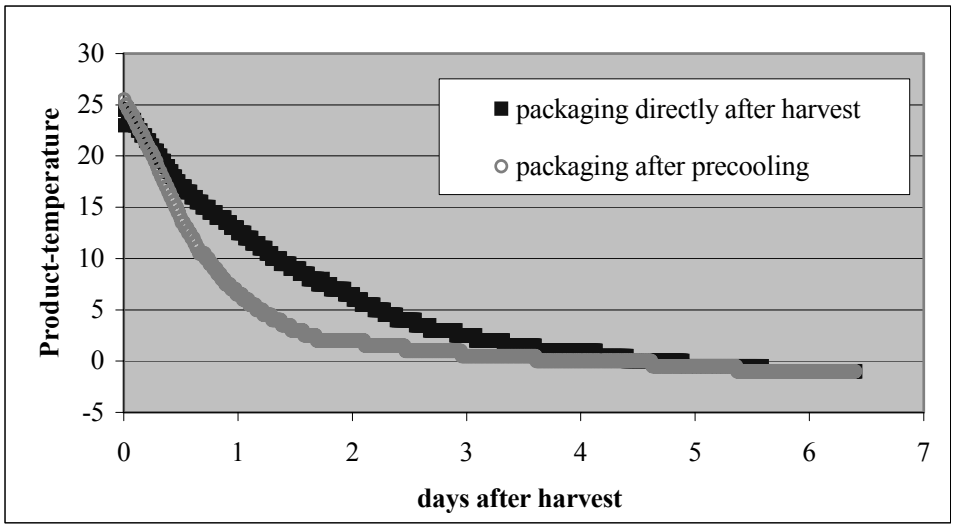

Fig. 5. Effect of moment of packaging on the temperature inside the bin**.**