

ILOS + ULO AS A PRACTICAL TECHNOLOGY FOR APPLES' SCALD PREVENTION

Mattè P. ¹, Fadanelli L. ^{*2}, Chiste C. ², Zeni F. ², Buglia L. ¹, Boschetti A. ³

1 Fruit Control Equipments, Locate di Triulzi, Italy 2 Istituto Agrario di San Michele all'Adige, Italy; 3 Istituto di Fotonica e Nanotecnologie, CNR-ITC, Trento, Italy

Keywords: I.L.O.S.-U.L.O., Apples, superficial scald, fruit quality, volatile compounds, Storage in Cooperative

INTRODUCTION

The experimental application of initial low oxygen stress (ILOS) for the superficial scald control, besides the beneficial effects on apples' quality keeping, is known since long time (A.B. Truter, J.C. Combrink and S.A. Burger 1994) with the best results obtained particularly in combination with ultra low oxygen (ULO) conditions (C.R. Little et al. 1982 and Wang and Dilley, 2000). After six years of experimental tests on small lots of Red Delicious and Golden Delicious apples with positive evaluation on the effects of better quality aspects such as pulp firmness and acidity (Rizzolo C., Vanoli M., Visai C., Fadanelli L. 1997), and superficial scald control (Visai C., Vanoli M., Fadanelli L., 1997), it was decided to apply on commercial scale the previous years knowledge (P.Matte, L.Buglia 1997) during the years 2000/01, 2001/02 and 2002/03. Commercial apple rooms of more than 300 tons each of Red Delicious apples were treated with ILOS + ULO, at the Cooperativa Alta Val di Non, in Casez (Val di Non Valley-Trentino-Italy), belonging to Melinda Group.

This choice was agreed with the sales managers of Melinda, strongly motivated by commercial reasons related to the sales of Red Delicious apples on the market after few months of storage with no chemical residues of post harvesting treatments (DPA 31%).

Specific protocols were applied, considering the variability of the apples introduced into the rooms and the risks of the initial ILOS treatments:

- reliability of the technical plants (room tightness, refrigeration system, CA equipments)
- harvesting (picking window)
- continuous monitoring of ILOS efficacy on the apples (periodical shelf-life tests)
- ethanol check inside the apples after two weeks of ILOS treatment.

A synergic working group was established among the technology supplier (Fruit Control Equipments), research and extension service centre (I.A.S.M.A.) and the qualified personnel of the technical storage staff and the commercial staff of the AVN Cooperative in Casez with the beneficial effects of reducing risks up to the AVN staff.

The evaluation of the results obtained in 3 different years (2000/2001, 2001/2002, 2002/2003), out of the commercial aspects during the shelf life period, comparing DPA treated apples with ILOS+ULO treated ones, were looking at conventional laboratory tests (physico-chemical analysis of fruits), at physio-pathological tests (evaluation on scald effect) and tests on the aromatic compounds emission (ethylene and other volatiles), as reported with interesting results by Lopez M. L. et al. (1998 a-b), in combination with a new research technology: P.T.R.M.S. (Proton Transfer Reaction Mass Spectrometry) (A. Boschetti et al. 2003).

MATERIALS AND METHODS

The whole production of Red Delicious apples of the Cooperative AVN in Casez (Val di Non Valley-Trentino-Italy) have been used in more than 320 tons CA rooms capacity (each room of 1410 m²) during the three years of commercial application (2000/2001, 2001/2002, 2002/2003).

Apples have been picked by the associated growers, inside the restricted picking window suggested by the "U.O. Frutticoltura-Conservazione", the extension service operating group of the IASMA:

year 2000 09/26 + 09/30
year 2001 09/24 + 09/30
year 2002 09/17 + 09/21

The compared thesis were for all the apples of each room as following:

- **room A** 2000 ppm DPA 31% (by drencher) + ULO (0,9-1% O₂; 1-1,2% CO₂ at T 0,8-1,2 °C and 95% RH
- **room B** ILOS (15 days at 0,5% O₂) + ULO as for room A
- **room C** ULO Test

ILOS and ULO conditions inside the commercial rooms at AVN were possible thanks to the high technological level of the installation:

1. perfect gas tightness of the rooms (from an initial pressure test of 30 mm of water column, down to 25 mm in 30 minutes);
2. refrigeration system (NH₃ + glycol) with cooling capacity of 60.000 kg/day of apples (20% of the capacity of each room) and large surface evaporators of about 0,6 m²/m² of room with fans capacity of 35-40 air recycling/hr, Delta T of 2°C, defrosting system by water + air;
3. membranes Nitrogen generator, type SWAN with >320 m³/h of N₂ and possibility to pull-down the oxygen in each room at 5-6% in less than 8 hrs, followed by final adjustment at 0,5%, done by fruits respiration in other 7 days;
4. single CO₂ adsorbers for each room, with capacity of 25 Kg CO₂/day at 1% of CO₂ in the room;
5. gas analysers (thermo-paramagnetic for O₂ and infrared for CO₂) and sophisticated computerized control system, in combination with daily manual control;
6. high professional technical education of the personnel in charge of the CA system and comprehensive attention of the sales department of the cooperative;

The storage periods of the apples were:

32 + 1 weeks in 2000/2001
30 + 1 weeks in 2001/2002
27 + 2 and + 3 weeks in 2002/2003

Quality measurements and physio-pathological controls were applied on 4 bins of Red D. apples (for a total amount of ~1400 Kg) stored in each room, coming from the same grower. An equal quantity of control fruits from the same grower were stored in normal ULO conditions.

The preliminary checks were done on:

- ethylene production by treated fruits (ILOS and DPA+ULO);
- ethanol concentration inside the apples after treatments (ILOS and DPA+ULO);
- periodical visual evaluation of superficial scald on apples taken at room temperature for 7+7 days, in order to determine the eventual anticipated opening of the room and consequent sale of the apples in time, in case of high scald development.

The qualitative methods at picking time and at the end of the storage period were applied with validated methods (Rossier J. Et Al., 1998 and Zanella A. and Werth, 2002) on randomised 400 fruits, divided in 4 lots and for Pimprelle analysis to determine:

firmness (kg/cm²)
sugar content (° Brix)
acidity (Malic acid, gr/l)
quality index (Thiault)

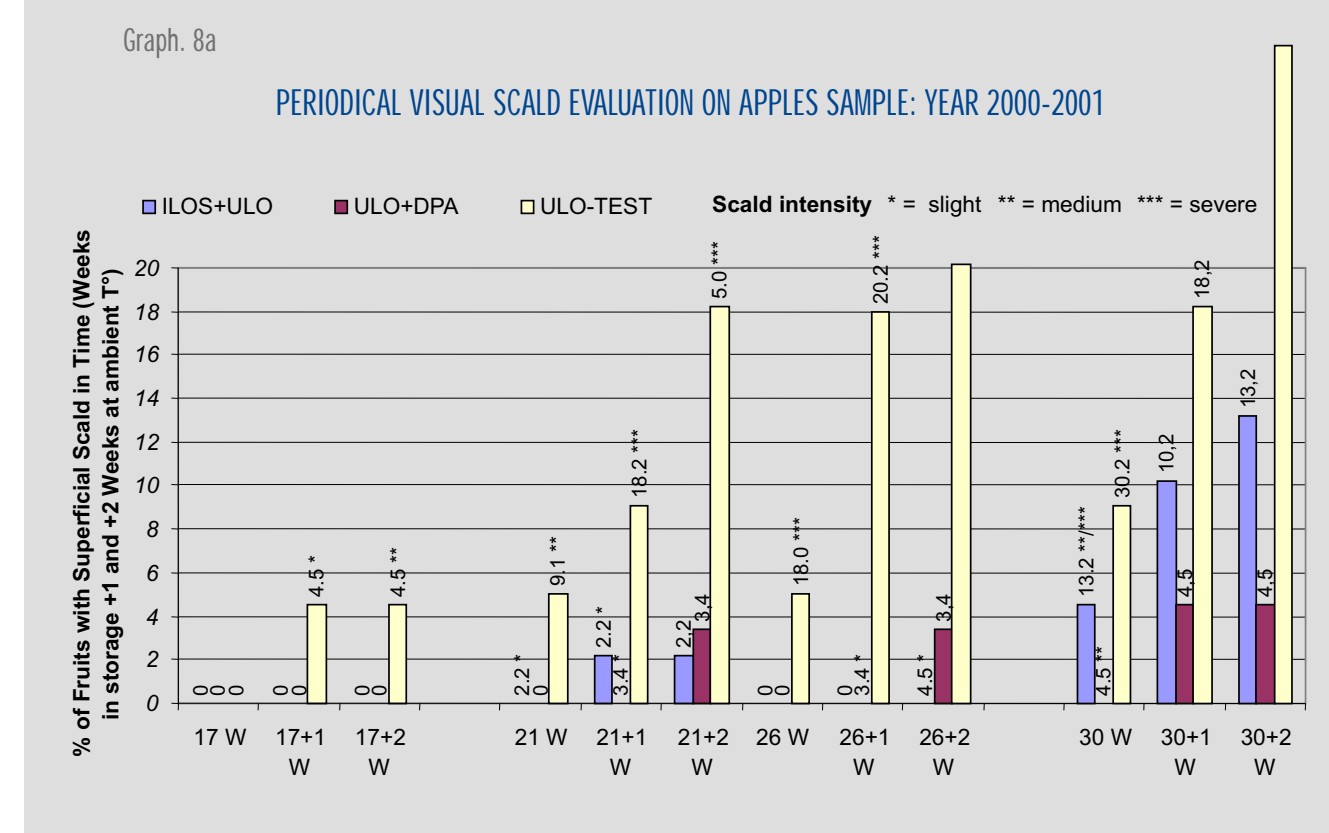
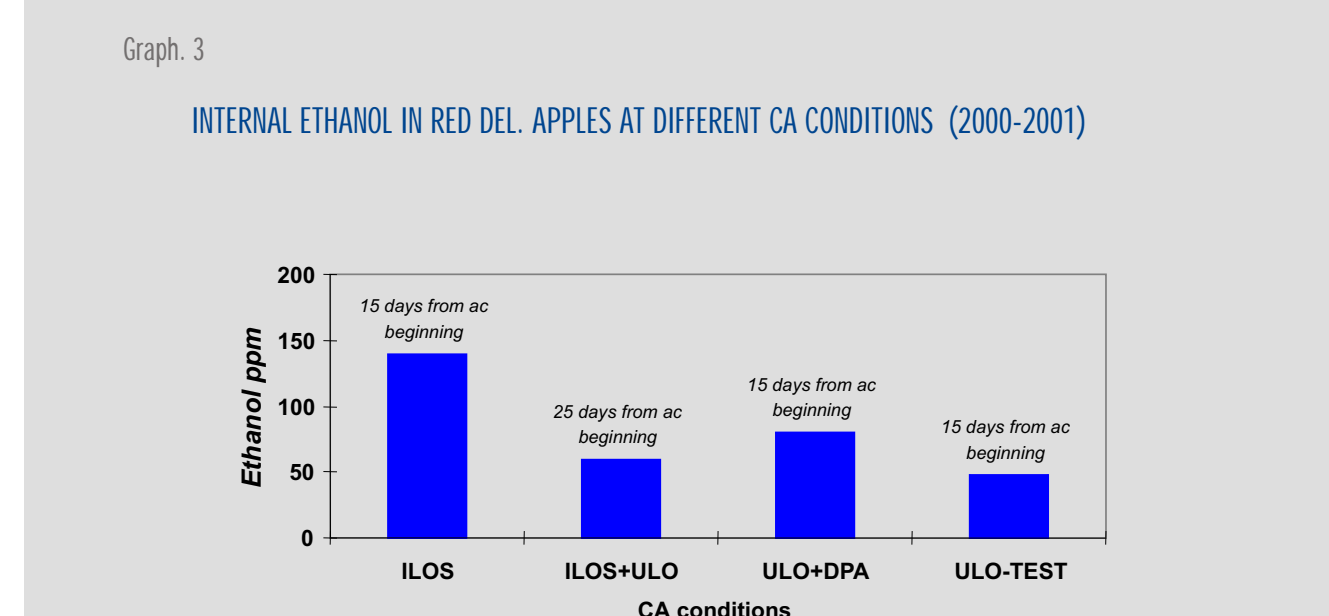
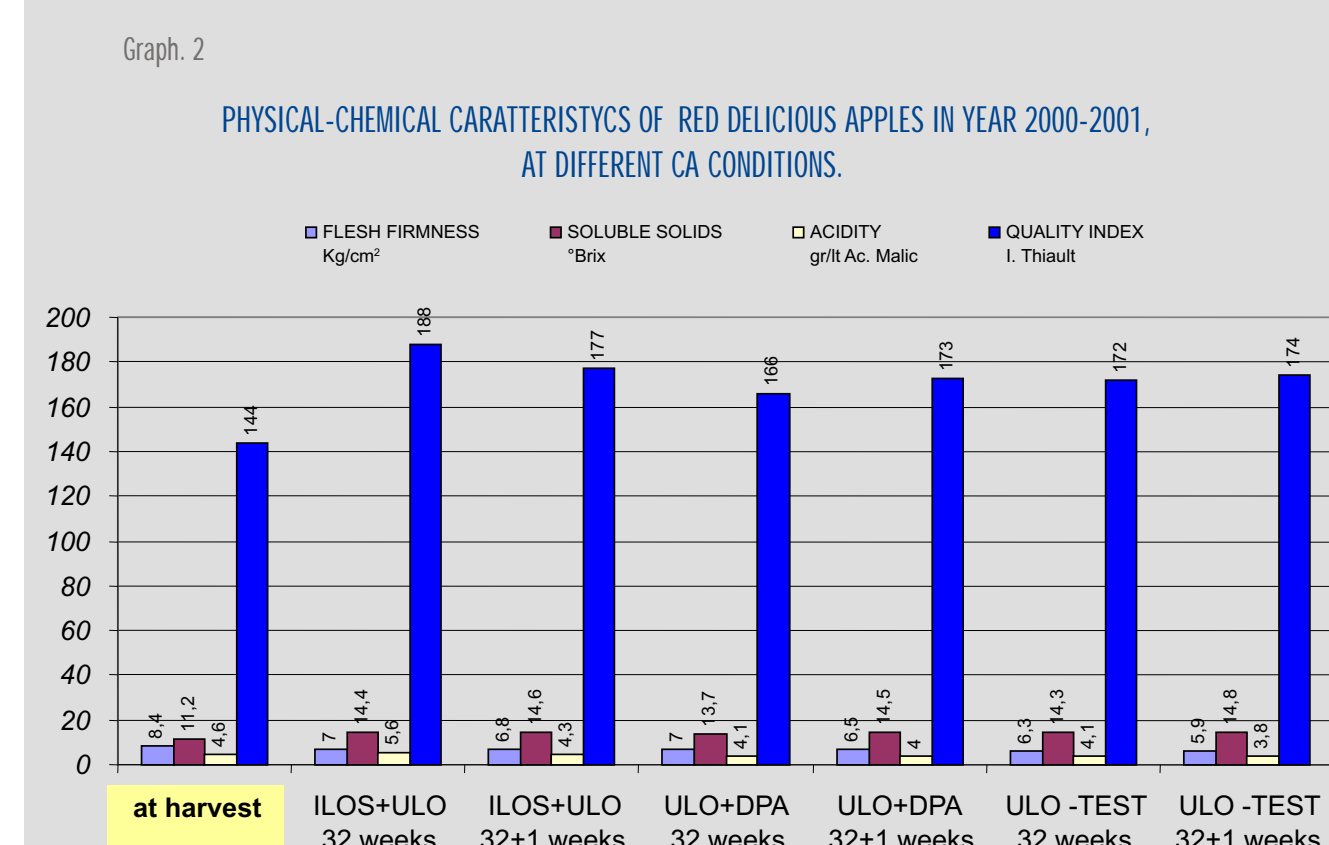
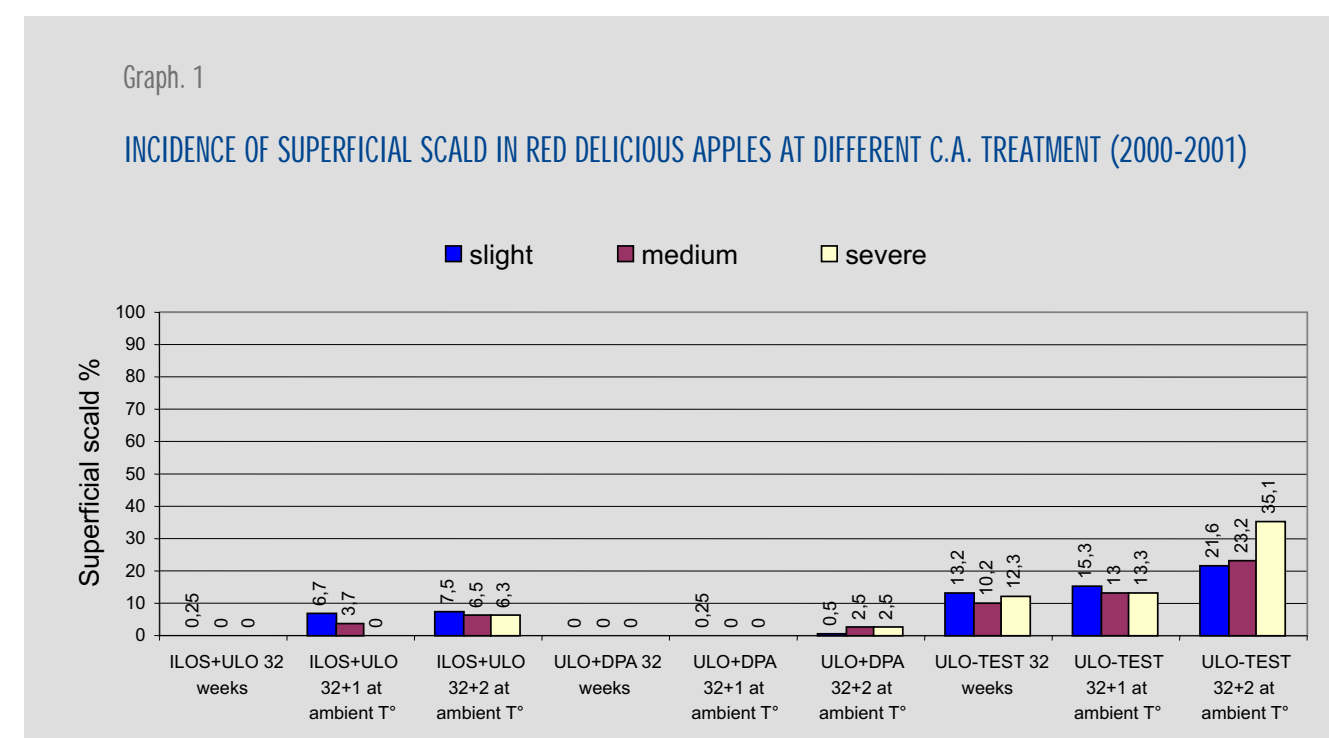
In 2001-2002, at three different storage periods, volatiles produced by apples were also measured using PTR-M.S method.

The physio-pathological checks were done on:

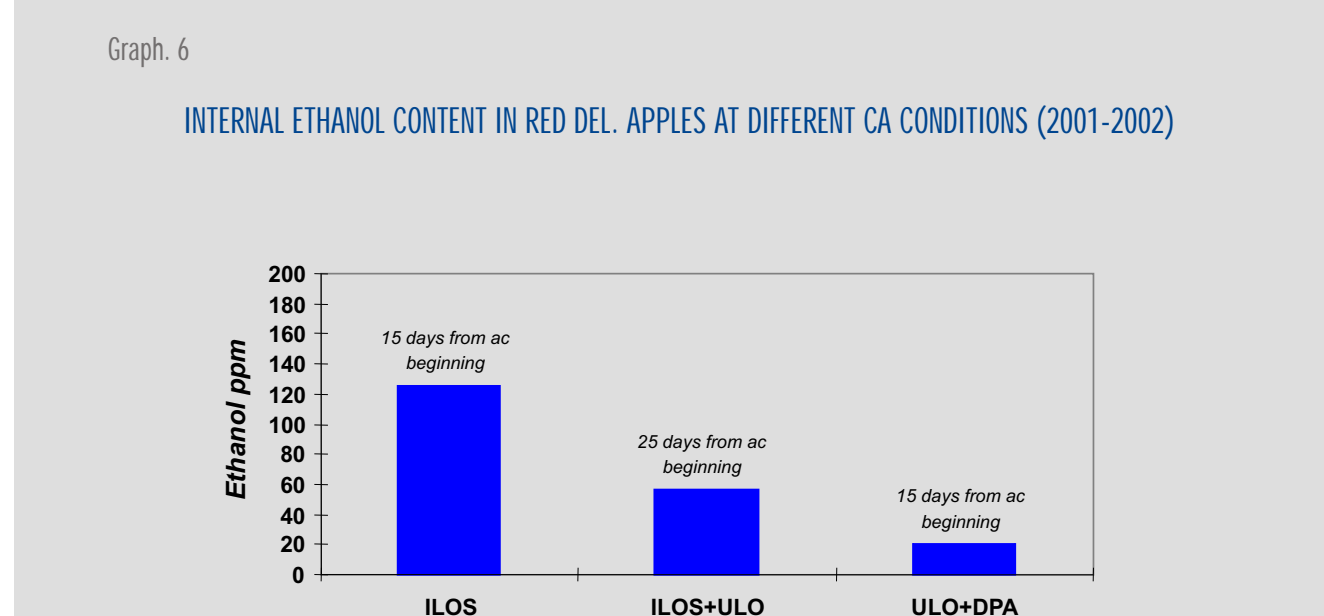
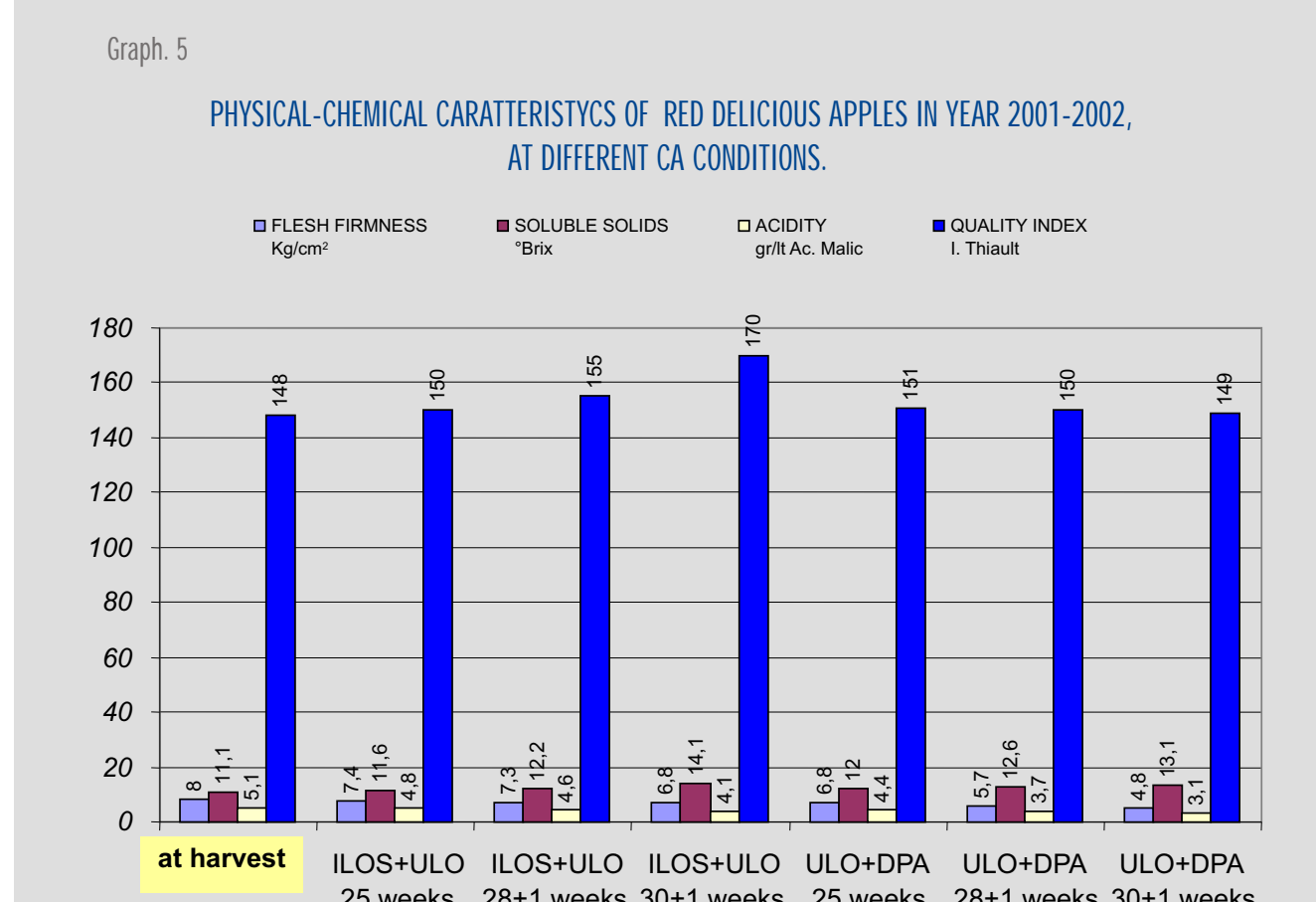
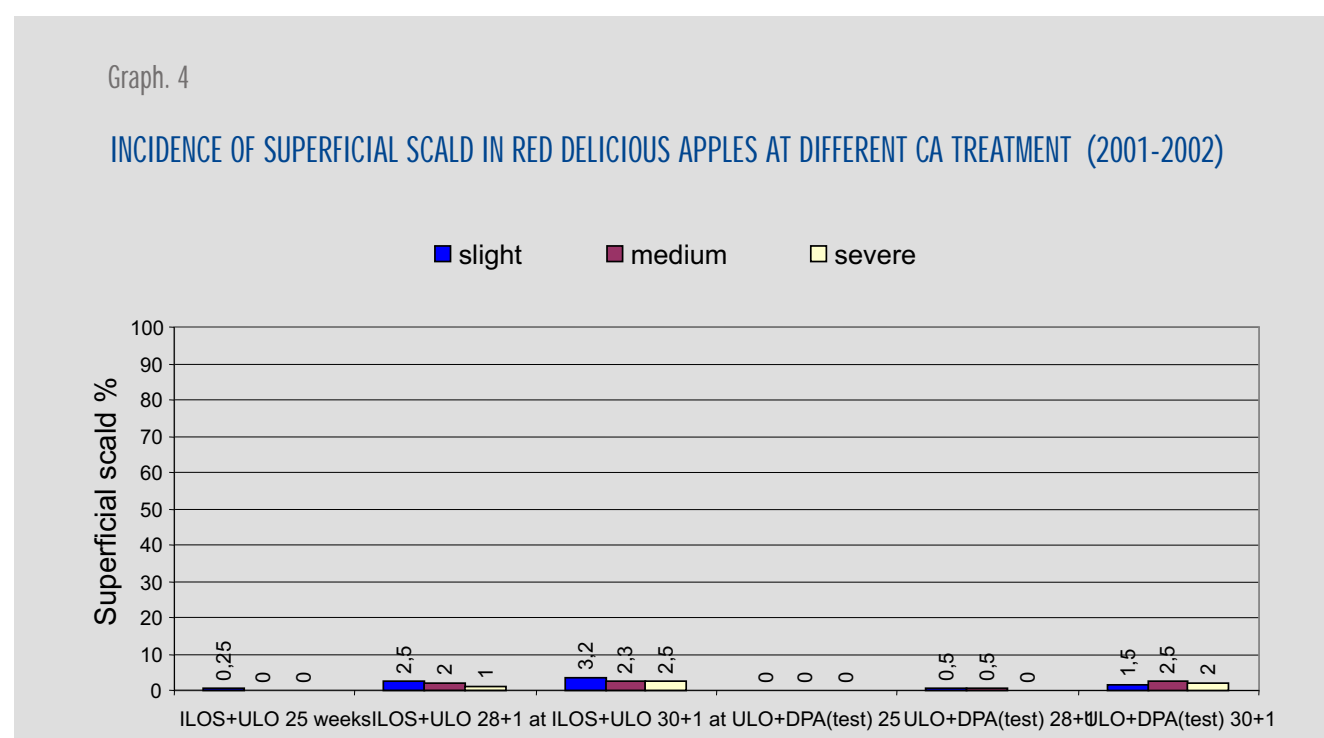
- evaluation (%) of superficial scald affected apples at different stage (slight: < 30% of the skin; medium: 30-60%; high: >60%);
- disorders (% of Internal breakdown etc) after 7+7 days shelf life at room temperature (20-22 °C) at the end of the storage period.

RESULTS

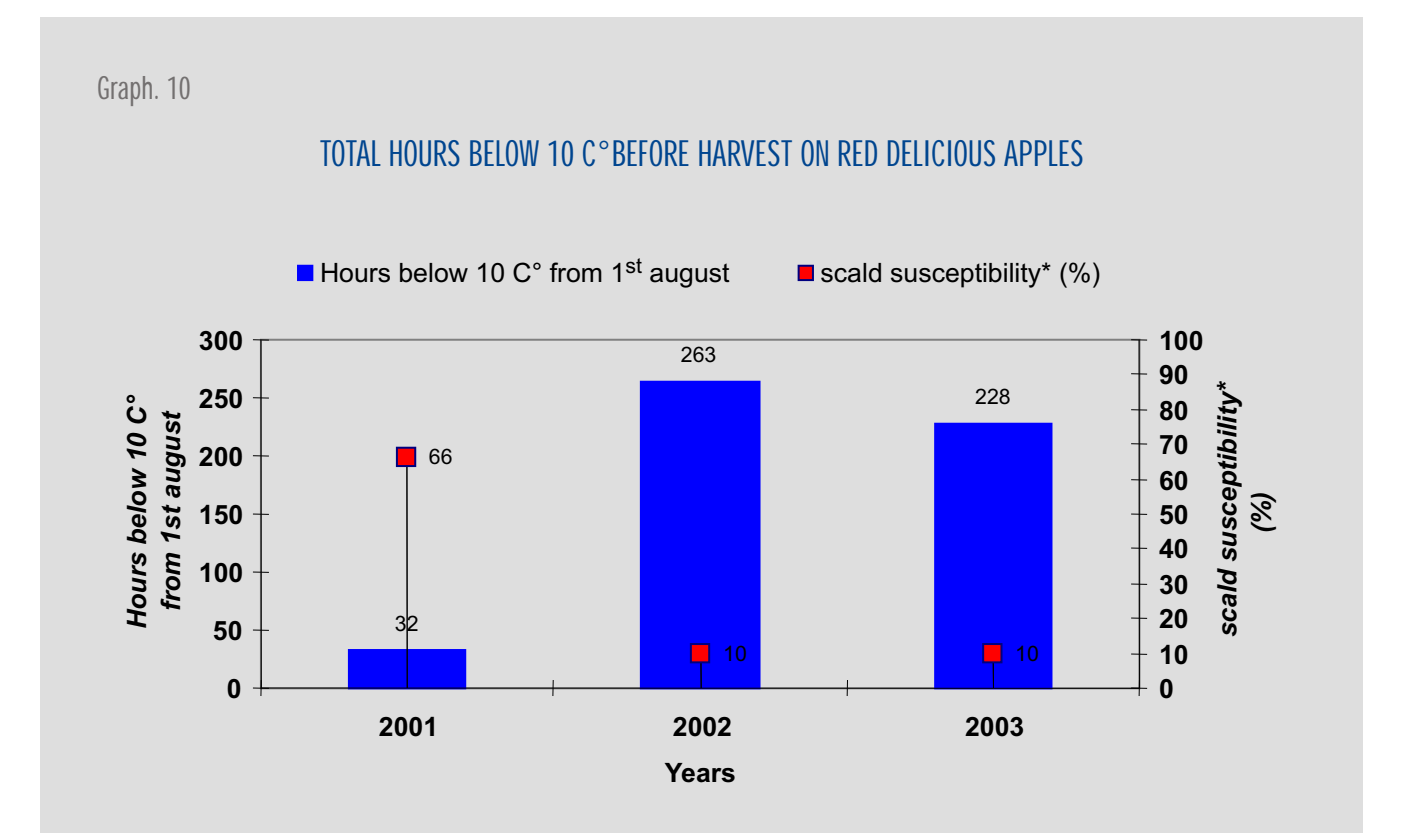
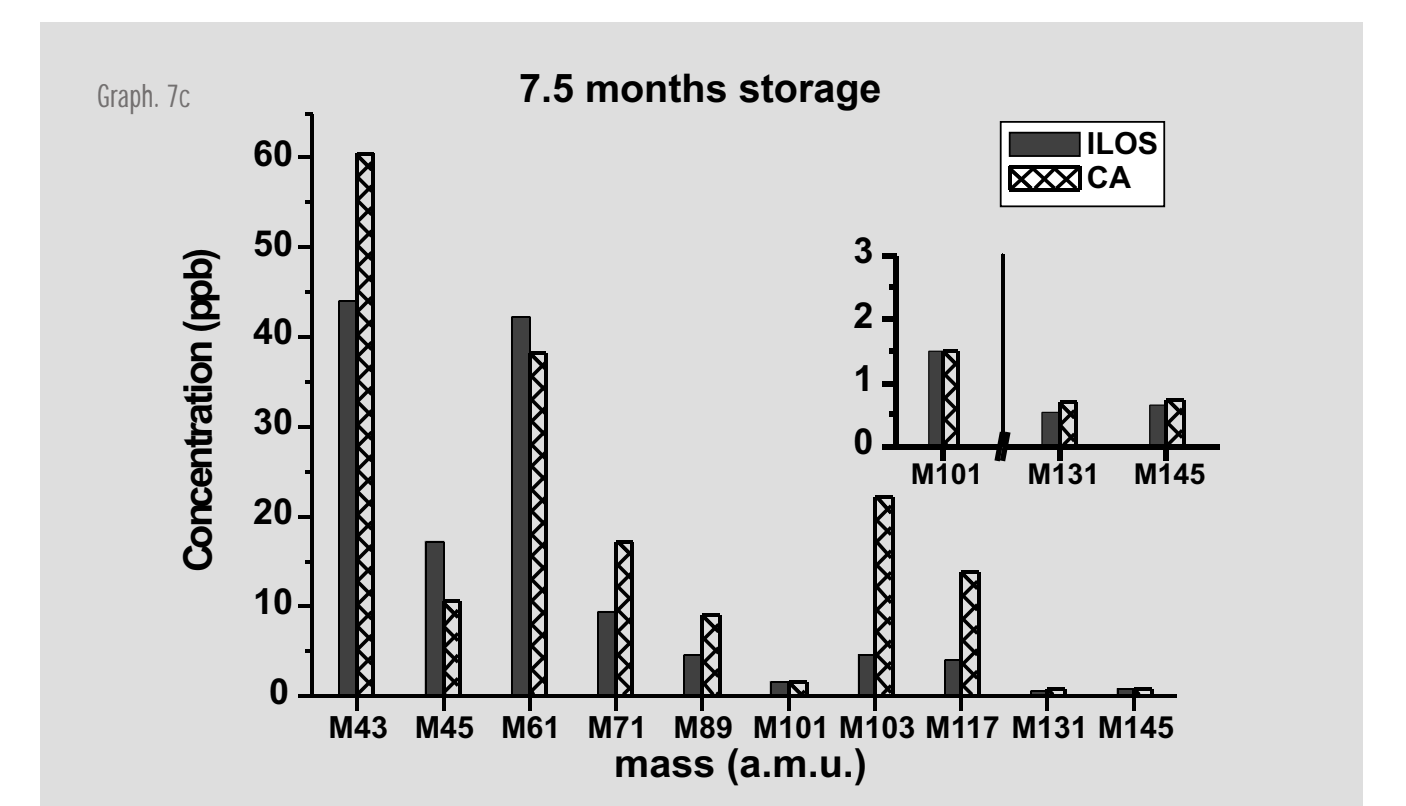
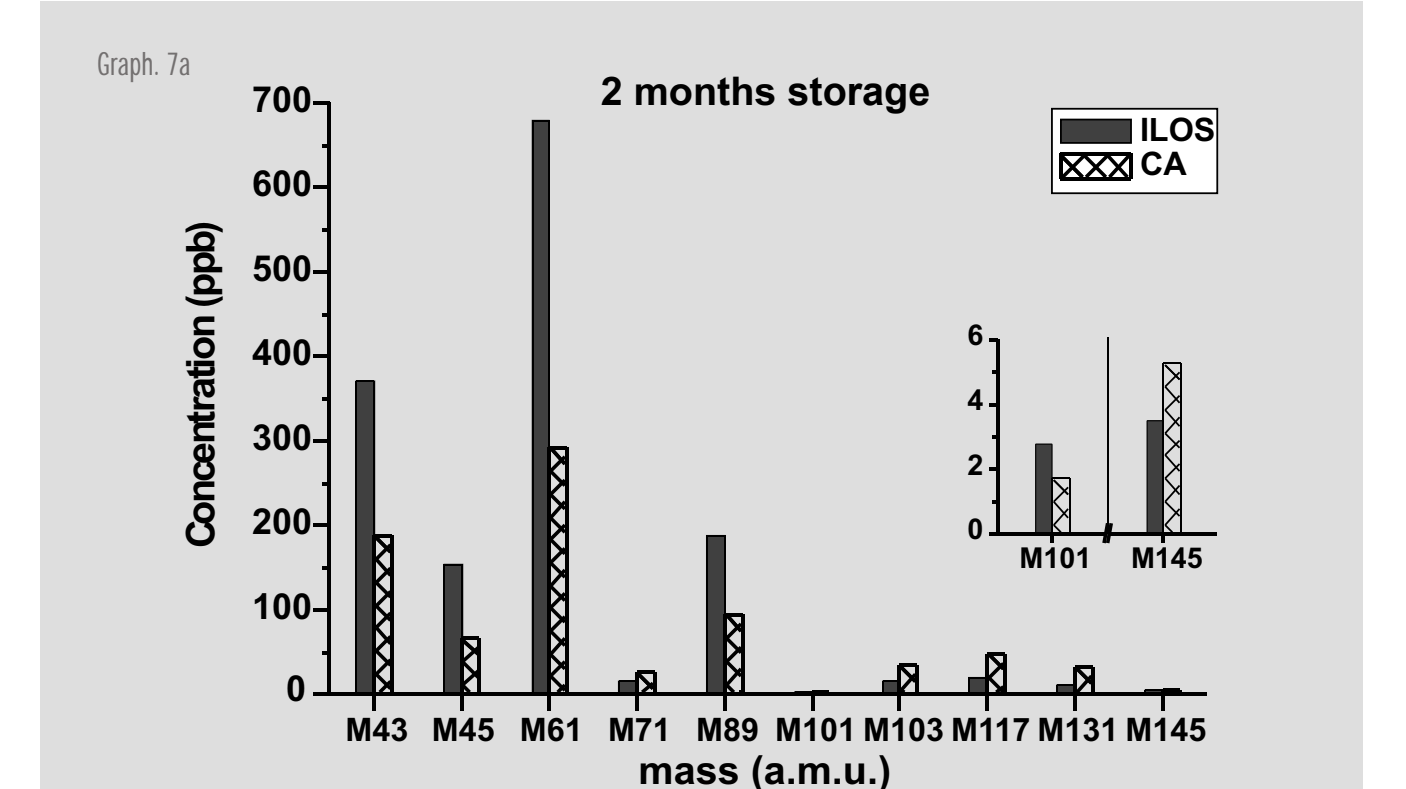
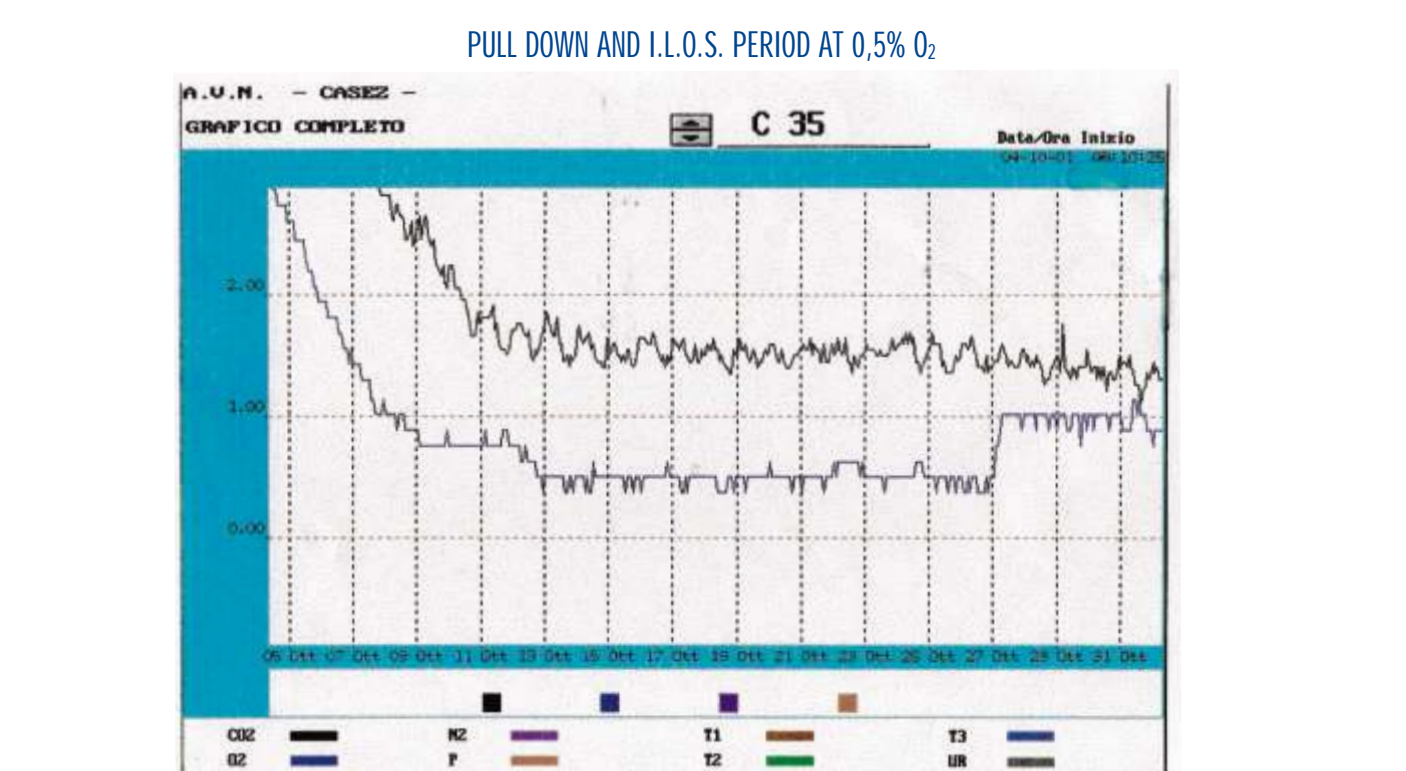
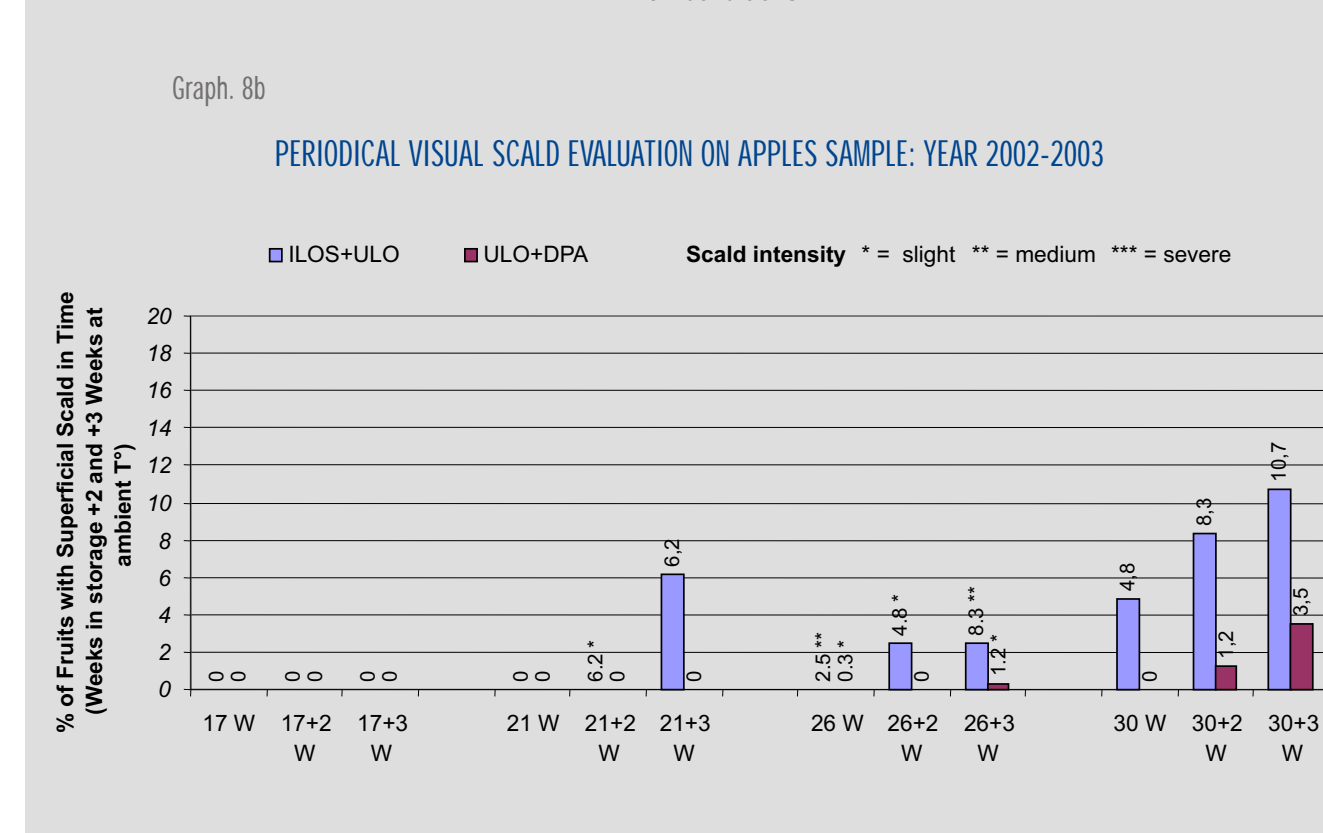
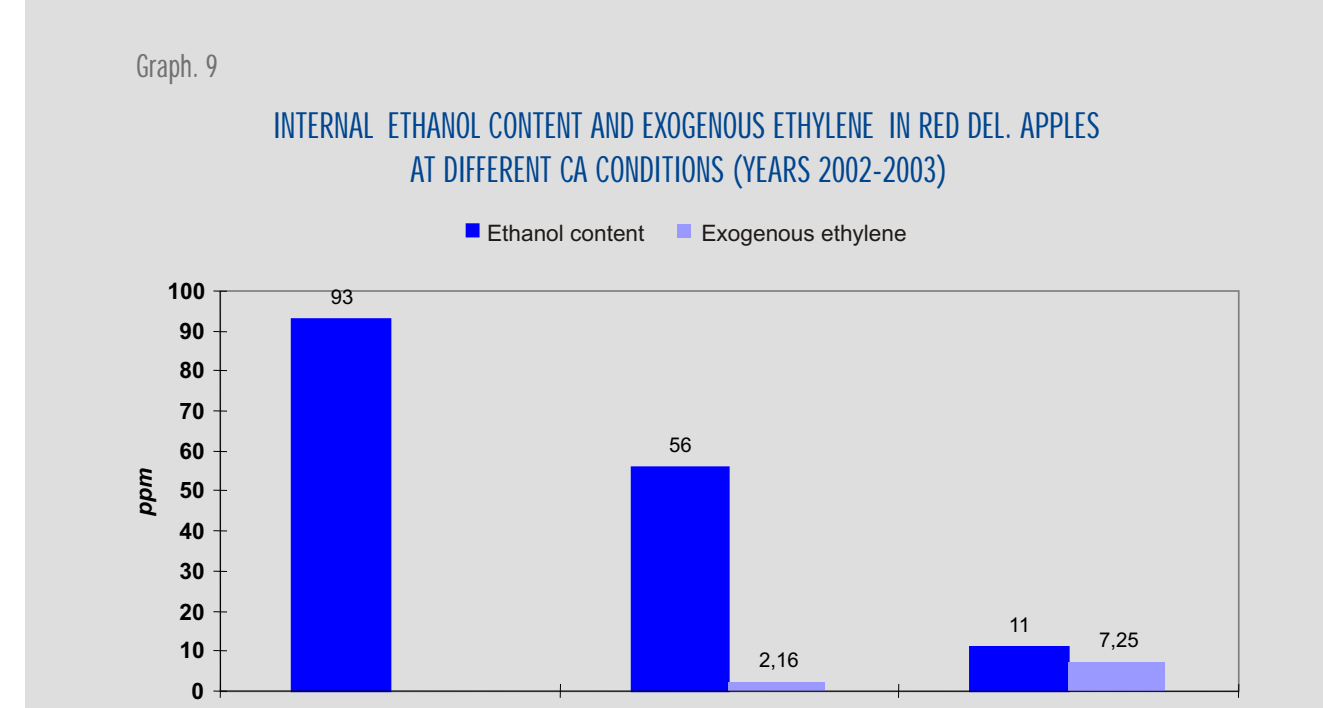
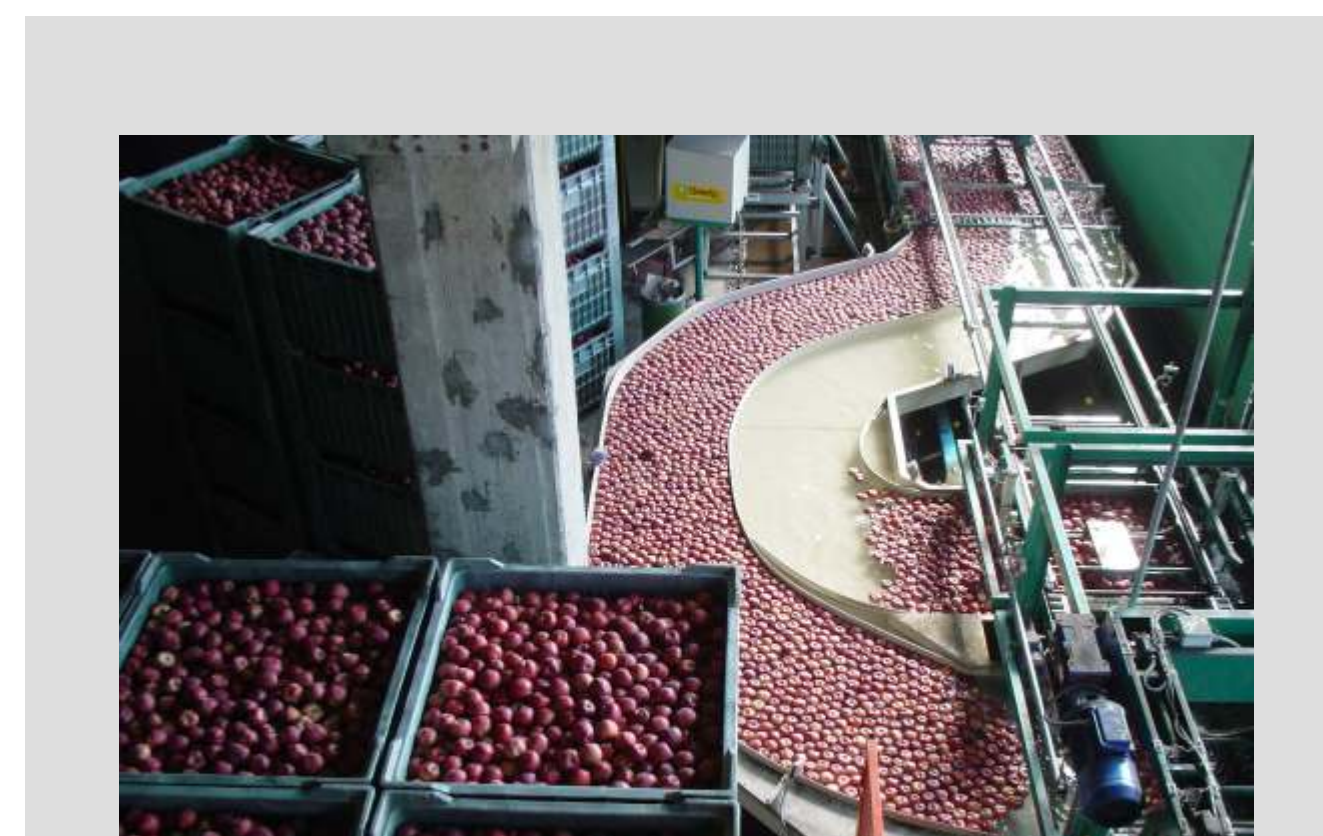
Year 2000-2001:



Year 2001-2002



Year 2002-2003



DISCUSSION

While ILOS beneficial effects on keeping quality of apples and preventing scald development are well known and were deeply studied in the past in experimental tests (Little C.R. 1982, Van Der Merwe et al. 2001, Truter A.B. 1994, Wang Z. 2000), the same cannot be said for commercial applications, where valuable quantity of apples (> 300 tons) are involved.

Our commercial application tests done in last 4 years have shown that this is possible, with very interesting results on quality and commercial aspects of the apples as well as for the lower costs in comparison to alternative solutions (i.e. post-harvest DPA treatments).

In order to obtain such positive results it is necessary to pay professional attention either to the equipment reliability and to the periodical provisional checks. Never to forget that ILOS gives good results in terms of scald prevention on medium term periods (23-26 WEEKS), while special attention has to be paid whenever the storage length should be up to 28-31 weeks.

Periodical spot weekly checks (Graph.8a- 8b), together with analytical lab tests (ethylene, VOC, ethanol etc.), allow to ILOS treatments to be fully reliable, with very low risks for the apples.

Three years of commercial tests with different climatic scald sensibility (see Graph 10) can easily permit a better comprehension of the results of ILOS+ULO application (i.e. in the years 2001/2002 and 2002/2003), in comparison with the traditional ULO application in Trentino.

From the practical point of view we can summarize:

- ILOS choice can represent a "clean" answer to the market of scald sensible apples varieties like Red Delicious even after 6-7 months after harvest;
- Specific technical requirements must be adopted for the ILOS rooms, specially on gas tightness and gas analysing and control systems;
- Apple lots in each room should be homogeneous (if possible), cooling and O₂ pull-down should be as quick as possible, high management capacity required for the technician, quick response in sales planning of apples in between 7-14 days from room opening date; all these points, together

represent indispensable requirements for applying in the best way ILOS technology and get the best beneficial effects

- Keeping quality characteristics of apples longer, with no chemical postharvest treatments residues, may represent for ILOS a strategic application for a better qualified distribution of apples on specific markets, sensible to these points.

The present job may be considered useful not only for opening new research areas (i.e. further development of VOC and prevision scald development survey), but also to express the validity of the co-operation between Research and Extension Service (I.A.S.M.A., San Michele all'Adige, Trento), the advanced technology (Fruit Control Equipments, Milano) and the end user (AVN Cooperative, Melinda group, Casez, Trento).

Acknowledgements

Special thanks to Mr de Concini Pio, the technician in charge of refrigeration and CA at AVN Cooperative of Casez (Melinda group), for his professional and precious collaboration given inside the working group