COLD TREAMENT FOR FRENCH APPLE INDUSTRY

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Cold treatment for French Apple industry

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Ctifl - Technical institute for fruits and vegetables – France

A technical centre…

- Established in 1952, Ctifl is a non-profit organisation.
- All experimentation, studies, training and publications are aimed at improving the level of expertise necessary in all sectors of the fruit and vegetable industry, as well as improving company performance.

mission-oriented for the public sector…

- Ctifl is particularly involved in carrying out work of general interest to the public sector under the aegis of the government.
- In answer to consumer concerns Ctifl's expertise contributes to managing quality, guaranteeing food safety and hygiene as well as traceability, preserving the environment and striving for sustainable development.

Ctifl - Technical institute for fruits and vegetables – France

…that represents all professions within the industry

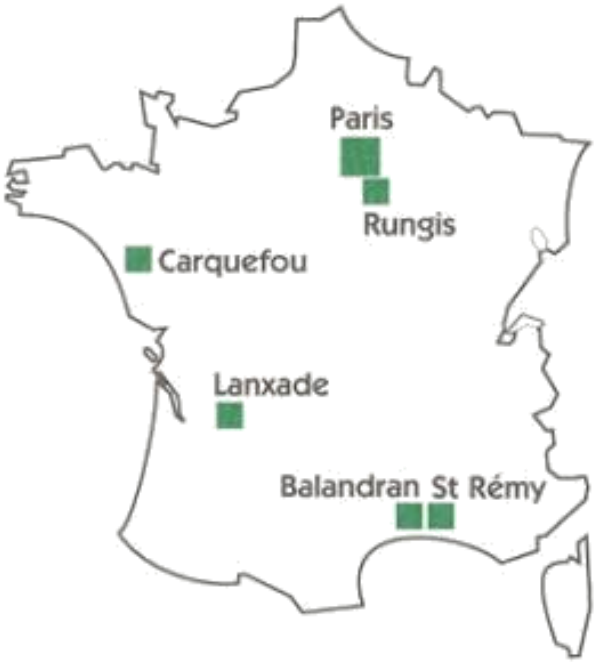
- Facing society's demands and the challenges of tomorrow, Ctifl aids communication and consultation between all those involved in the fruit and vegetable industry.
- From the grower to the retailer*, everybody is represented in its decision-making organization: board of directors, executive board and committees.

**growers, shippers, wholesalers, retailers and mass-market distributors*

For example, board of directors made up of:

- *20 company or farm managers, 10 representing production, and 10 representing trade*
- *1 representative from higher education in agriculture / 4 experienced professionals / 3 representatives of technical professions / 4 permanent experts*
- *1 state inspector / 1 government commissioner*

Ctifl in France



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Ctifl - Technical institute for fruits and vegetables – France

Annual Budget of 23 € M

Financial resources

Government tax : 65 %
0,18 % on wholesale transactions (French products and foreign imports) and direct sales.

Grants : 18 %
accorded for specific programmes from FRANCE AGRIMER, CASDAR, the Ministries of Agriculture and Research, European Union, regional and country authorities.

Other sources of income : 17 %
Sales from plants and seeds, training courses, services, publications.

Expenditure

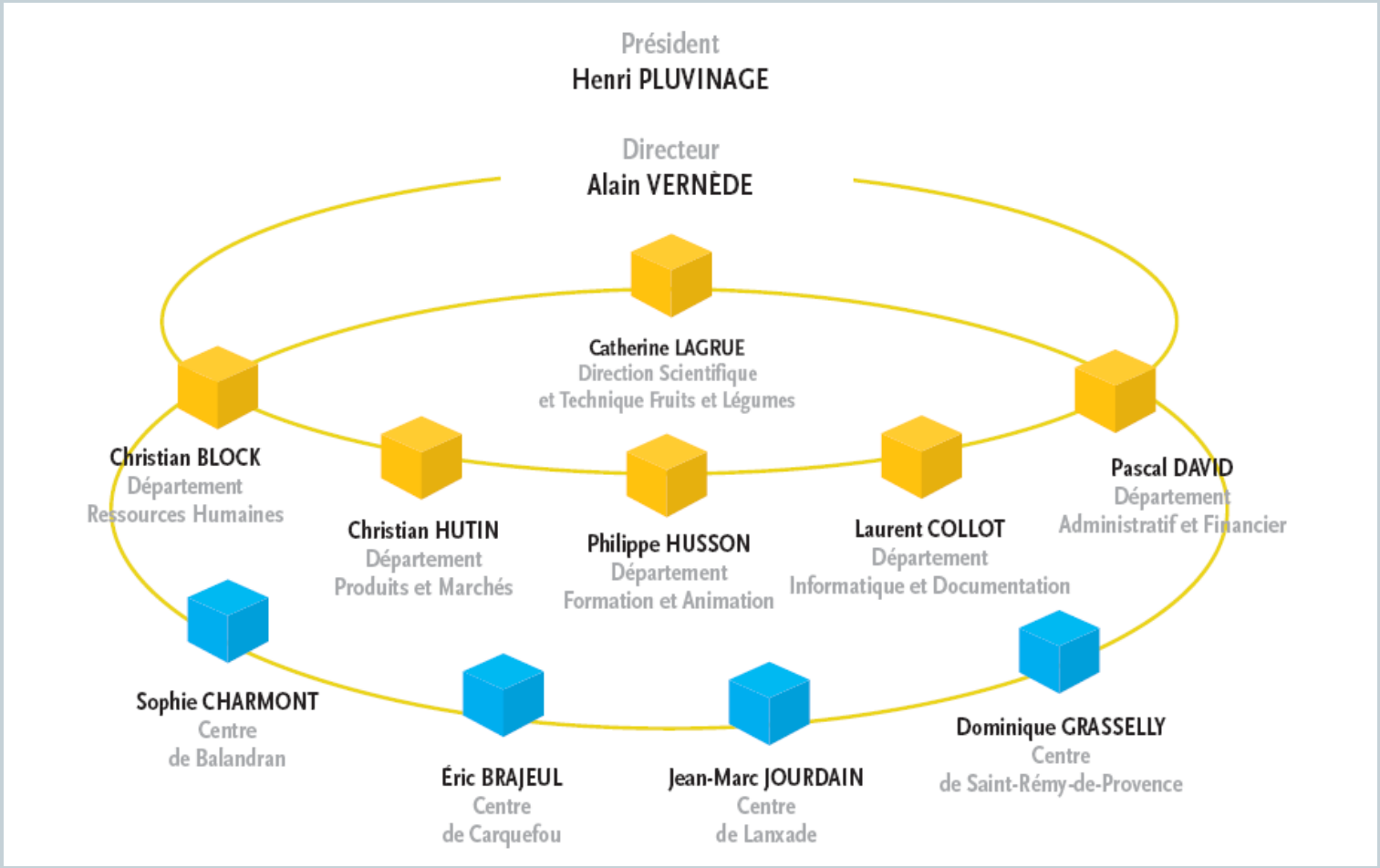
Personnel : 62 %

Purchases (products and services) : 25 %

Other expenses : 13 %

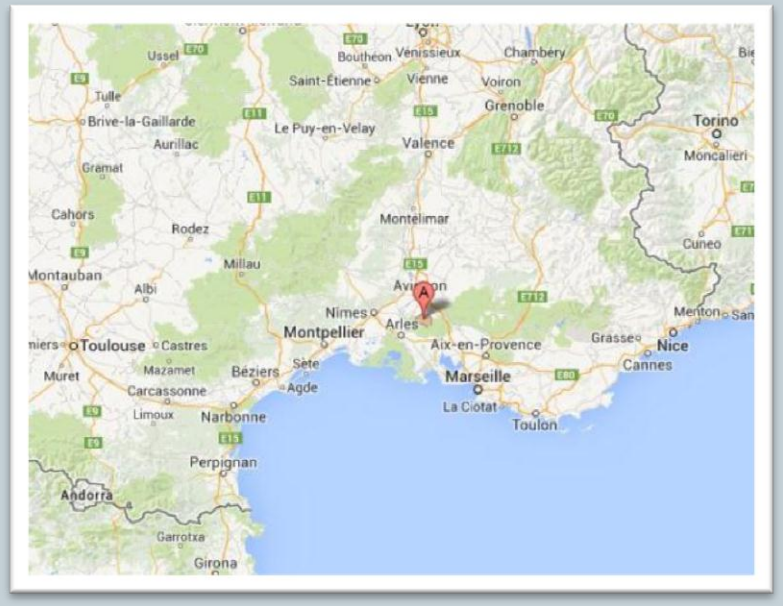
As in all companies that provide services, staff costs account for a high percentage of expenditure.

Ctifl - Technical institute for fruits and vegetables – France



Ctifl - Saint Rémy de Provence

- ...is situated in the heart of France's main fruit & vegetable growing and shipping area.
- It specialises in research on quality and post-harvest management and technology.
- It also houses the regional headquarters of Ctifl Training & Promotion department.



- 16 people (including administrative staff)
- Equipment: cold chambers, CA cells, laboratories...

Ctifl - Saint Rémy de Provence

Programmes are dedicated to maintaining quality throughout the storage and marketing stages, and to improving storage, packing, packaging and quality control techniques.

- Main topic:
  - *Quality assessment and measurement*
  - *Behaviour of fruits and vegetables during storage and in the marketing circuit*
  - *Packaging*
  - *Training, services and promotional actions in the retail circuit*
  - *…*

Products under study : apple, pear, peach, apricot, kiwi, grape, cherry, tomato, lettuce, melon, asparagus, strawberry, carrot…




Ctifl national Programme "Equipment and technology for fruit storage"

Research and experimentation mainly on:

- Storage methods under low oxygen conditions and their impacts on apple quality *(with a national project during 3 years)*
- Use of pesticides and their impact quality and preservation of fruits *(1-MCP for example…)*
- Characterization of the storability of new varieties of apples, pears or cherries.
- Also in charge of a working group on fruit storage and sometimes consulted as expert.

Example of publications from a 3 years national project on apple scald :

- *Bordonaba, J. G., **Mathieu-Hurtiger V.,** Westercamp P., Coureau C., Dupille E., Larrigaudière C., 2013, **Dynamic changes in conjugated trienols during storage may be employed to predict superficial scald in 'Granny Smith' apples**, LWT - Food Science and Technology, volume 54, issue 2, 535-541.*
- *Aubert C., **Mathieu-Hurtiger V.,** Vaysse P. , 2013, Ctifl, **Effects of Dynamic Atmosphere on Volatile Compounds, Polyphenolic Content, Overall Fruit Quality, and Sensory Evaluation of Pink Lady® Apples**, Poster at XI International Controlled and Modified Atmosphere Research Conference, Trani (Italy), 3-7 june 2013.*

Cold treatment for French Apple industry
Introduction

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Apple industry in France

- In France, apple ranks first among fruits and vegetables, both in terms of consumption and exports.
- In Europe, France is the 3rd producing country behind Italy and Poland (1.7-1.8 million tons) .
- And one of the leaders in exports (with 0.6-0.7 million tons) :
  - Mainly to Europe (70-80%)
  - Also to Russia, North Africa, Middle East, Southeast Asia.

- Main varieties are Golden, Gala, Granny, Braeburn & Pink Lady®

circa 70% of French production

Cold Treatment for french Apple Industry

- In order to export apples, French operators sometimes have to apply cold treatments, depending on the importing country.
- Those cold treatments are often imposed against quarantine insects such as the fruit flies (especially *Ceratitis capitata*).

- Ctifl is working on an experimental design, which could give us the ability to test some cold treatments.
- **Our final goal is to evaluate alternative techniques using cold treatment against medfly (Ceratitis Capitata) in packing houses.**

In 2014, Ctifl will be involved in a national research project "SustainApple" funded by ANR (National Research Agency – France).

Cold Treatment for french Apple Industry

- Cold treatment usually following USDA recommandation *(T°C in the pulp of the fruit)*

Apple, Apricot[22], Avocado, Blueberry, Cape Gooseberry, Cherry, Ethrog, Grape, Grapefruit, Kiwi, Lemon, Loquat, Litchi (Lychee), Nectarine, Orange, Ortanique, Peach, Pear, Persimmon, Plum, Plumcot, Pomegranate, Pummelo, Quince, Sand Pear, Tangerine (includes Clementine)

Pest: *Ceratitis capitata* (Mediterranean fruit fly) and *Ceratitis rosa* (Natal fruit fly)

Treatment: T107-a Cold treatment

Temperature	Exposure Period
34 °F (1.11 °C) or below	14 days
35 °F (1.67 °C) or below	16 days
36 °F (2.22 °C) or below	18 days

- This can be done either **before** or **during** shipping transit (in container).
- Those requirements are particularly demanding for French exporters. They are looking for effective, simple and economical solutions.

Preliminary study on cold treatment

- **Ctifl is currently working on some preliminary tests** in order to define methodology and to have some initial results *(1st tests in October 2013)*
  - Goal is to have an efficient treatment on different stages of the insect.
  - **We work here on artificially infested fruits** in order to perform the test «off season » .

- First hypothesis is to test combination of cold treatment and controlled atmosphere (CA) against medfly.
  - As many fruits are stored in CA , the idea would be to check that this regular storage method guarantees having no viable fruit flies (whatever the stage of the pest).
  - Then we could be able to move on to other tests…

Preliminary study on cold treatment

<u>Goal:</u> Test combination of cold treatment and controlled atmosphere (CA) against medfly.

- Materials and Methods
  - Factors and experimental device
  - Fruits
  - *Ceratitis capitata* / Method of infection
  - Conditions for Treated and Untreated fruits
  - Observations
- Results and Discussions

Materials and Methods

- **Factors and Experimental device**
  - Treatment: Treated /Untreated fruits
    - Treated: T°C **(2,2°C*)** - CA conditions : 2,5-3% O_2 – 2-2,5% CO_2
    - Untreated: T°C (25°C) – normal atmosphere

  (2,2°C : in the pulp)*
  - Trials on: eggs, larvae & pupae of *Ceratitis Capitata*
  - 4 blocks of 25 fruits for each treatment

- **Fruits**
  - Trial on **artificially infested fruits**.
  - On Golden Delicious, Granny Smith or Pink Lady®
    - With an homogeneous batch (maturity, size, color).

Treatment depending on the target

Flie cycle:

Egg: 5 days / Larva: 9-15 days / Pupa: 10-15 days / Adult

<u>Trial n°1</u>: Larvae

	Infestation	Eggs and larvae	Treatment on larvae	Return at temperature	Final observation on **larvae**
Treated	2-3 days at 25°C	10 days at 25°C	18 days at 2,2°C in CA*	1 day at 25°C	29-30 days after infestation
Untreated			-	-	10-11 days after infestation

** 1 day at 2,2°C and 17 days at 2,2°C + CA*

Treatment depending on the target

Trial n°2: Eggs

	Infestation	Treatment on eggs	Eggs and larvae	Final observation on **larvae**
Treated	2-3 days at 25°C	18 days at 2,2°C in CA*	10 days at 25°C	28-29 days after infestation
Untreated		-		10-11 days after infestation

Trial n°3: Pupae

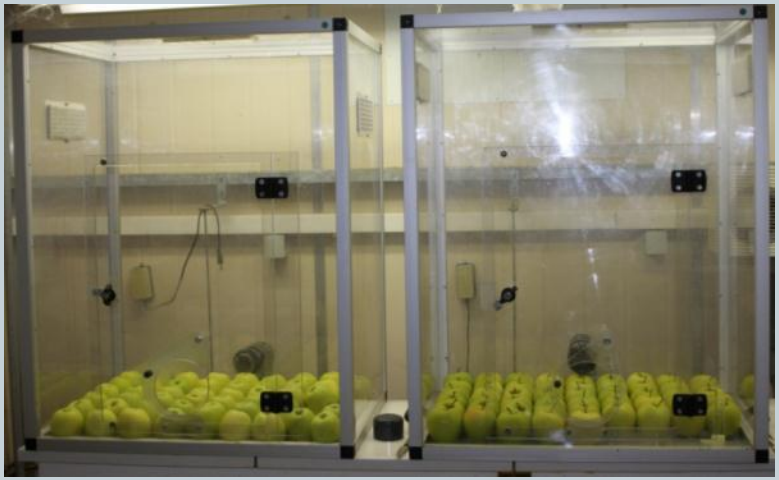
	Infestation	Eggs, larvae and pupae	Treatment on pupae	Emergence of adults	Final observation on **adults**
Treated	2-3 days at 25°C	21-24 days at 25°C	18 days at 2,2°C in CA*	10-15 days at 25°C	Depending on the other step
Untreated			-		

Ceratitis Capitata / Method of infection

- 4 blocks (cage)
- 75-100 flies for each block
- 50 apples per block

(later divided into treated and untreated)

- T°C: 25°C
- Light: 16h / 24h
- RH: 60-75%



Ceratitis Capitata was taken from infested peach. Then we did the breeding with apple, in order to have enough adults.

Conditions for Untreated Fruits

- 4 boxes « insect proof » with 25 apples (1 per block)
- Climatic room at 25°C and around 80% RH.

Conditions for Treated Fruits

- 4 boxes « insect proof » with 25 apples (1 per block)
- CA cell in a cold room

Observations

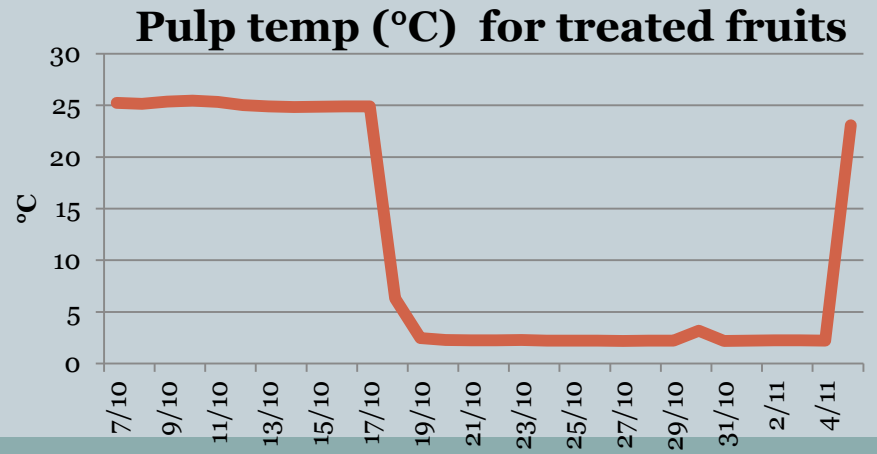
- **On larvae (trial 1 & 2):**
  - Number of infested fruits
    - If no larvae, presence of galleries ?
  - Number of larvae: alive / dead
  - Color / Size of the larvae (?)

- **On adult (trial 3):**
  - Number of adult alive.

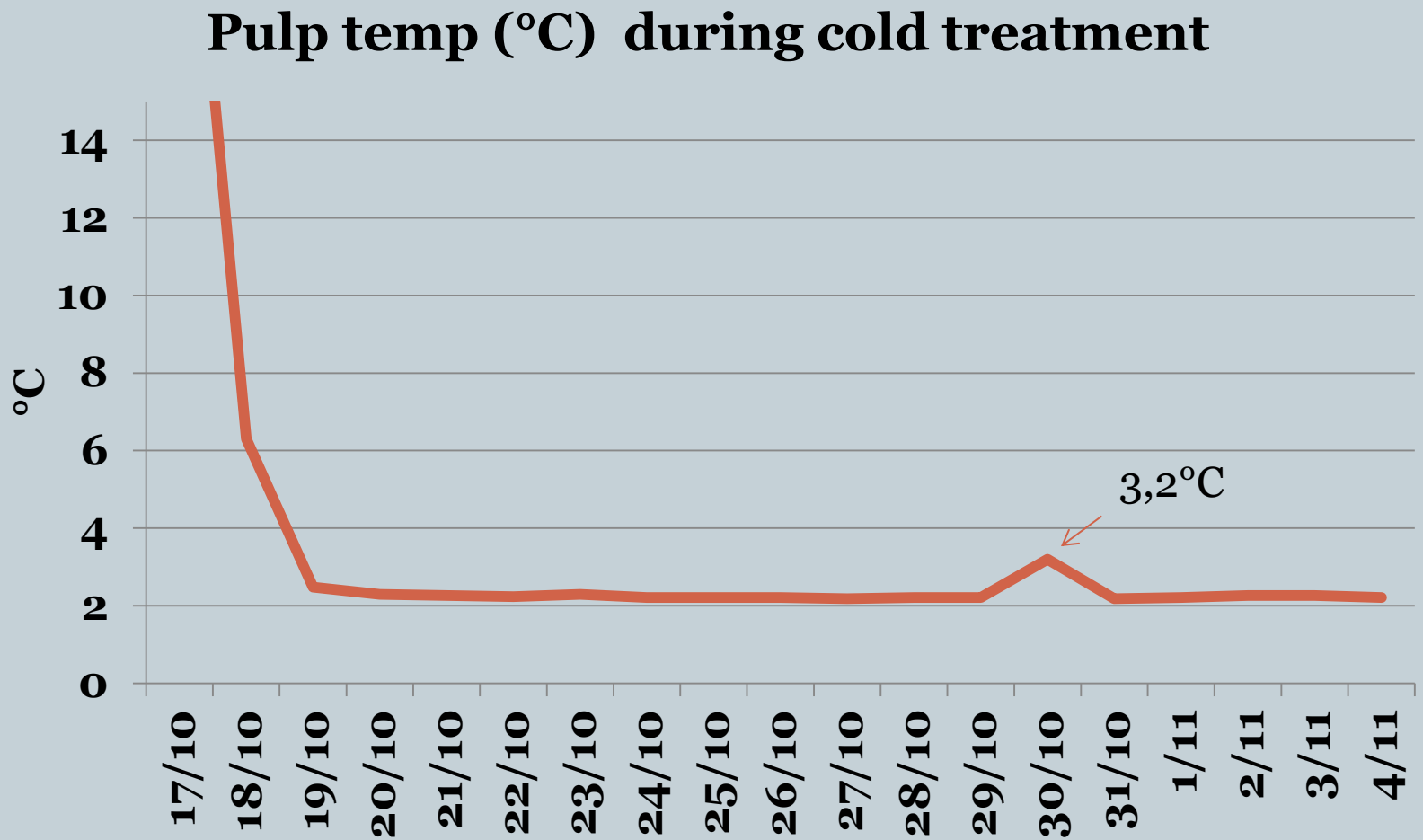
Results
1st trial on Larvae on Golden Delicious

Results
1st trial on Larvae on Golden Delicious

- **Infestation**: 3 days (04/10 – 07/10)
  - 75 adults per block.
- **Development of eggs and larvae**: 10 days (07/10-17/10)
  - Observations of untreated fruits
- **Cold Treatment**: 18 days (17/10 – 04/11)
  - 1 day in the cold room (in order to have a quick drop in temperature)
  - 17 days in the cold room + CA
- **Return at temperature**: 1 day (04/11 – 05/11)
  - Observations of treated fruits

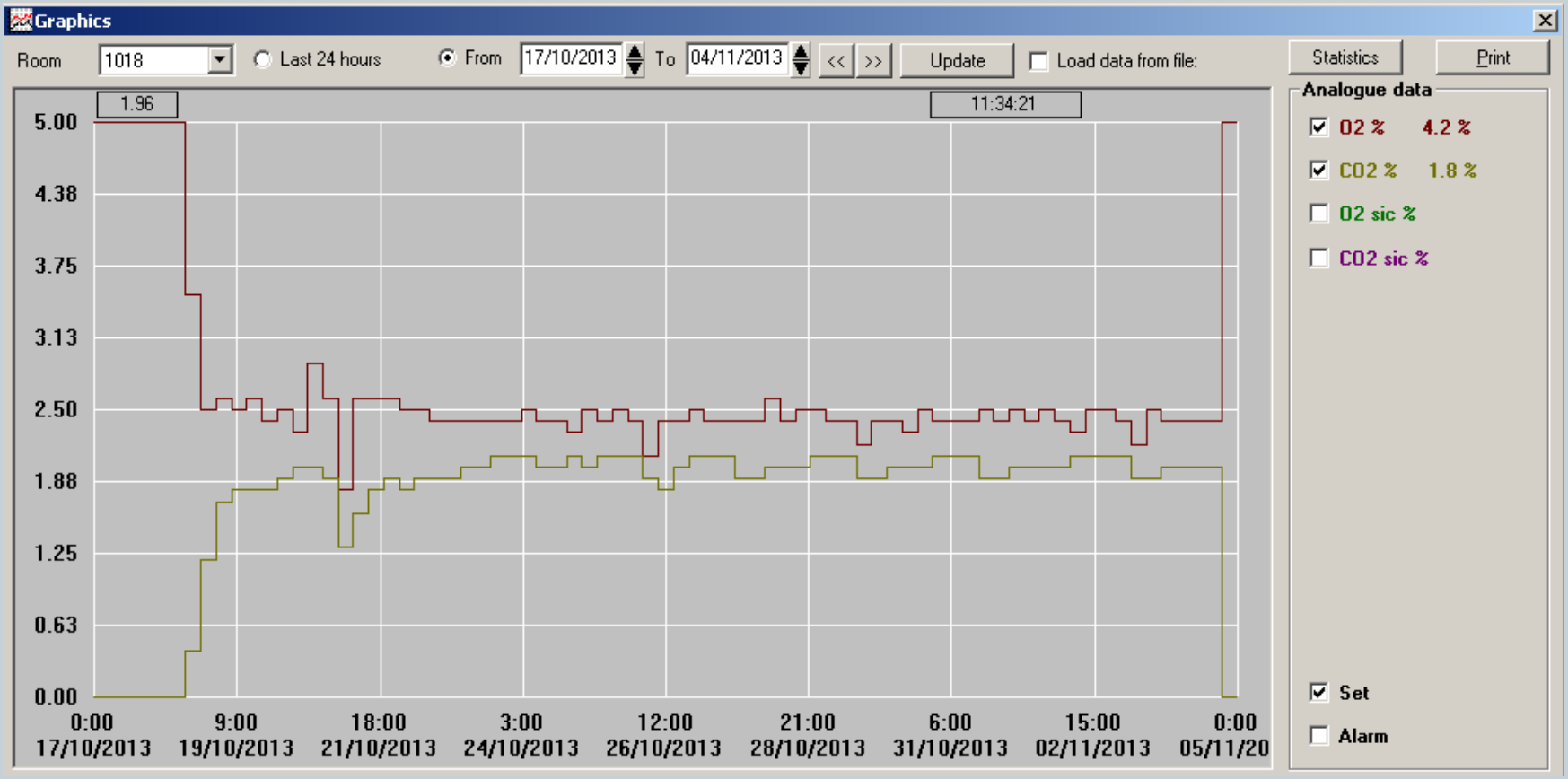


Results
1st trial on Larvae on Golden Delicious



Results
1st trial on Larvae on Golden Delicious

Controlled Atmosphere during cold treatment



Results
1st trial on Larvae on Golden Delicious

- Untreated fruits – Observations after 10 days:

Block	Nb of Fruits	Infested with active larvae	Presence of gallery without larvae	Nb of infested fruits	%	Nb of larvae alive	Nb of larvae dead	Total Larvae
1	25	8	2	10	*40%*	82	2	84
2	25	4	0	4	*16%*	59	2	61
3	25	4	0	4	*16%*	44	1	45
4	25	12	2	14	*56%*	238	6	244
Avg	***25***	***7***	***1***	***8***	***32%***	***106***	***3***	***109***

Results
1st trial on Larvae on Golden Delicious

- Treated fruits – Observations after cold treatment:

Block	Nb of Fruits	Infested with larvae	Presence of gallery without larvae	Nb of infested fruits	%	Nb of larvae alive	Nb of larvae dead	Total Larvae
1	25	7	0	7	*28%*	0	109	109
2	25	1	0	1	*4%*	0	47	47
3	25	5	0	5	*20%*	0	70	70
4	25	12	0	12	*48%*	0	131	131
Avg	***25***	***6,3***	***0***	***6,3***	***25%***	***0***	***89***	***89***

Results
2nd trial on Larvae on Golden Delicious

Results
2nd trial on Larvae on Golden Delicious

- **Infestation**: 3 days (07/10 – 10/10)
  - 40 adults per block (mortality between the 1st and the 2nd trial)
- **Development of eggs and larvae**: 11 days (10/10-21/10)
  - Observations of untreated fruits
- **Cold Treatment**: 18 days (21/10-08/11)
  - 1 day in the cold room (in order to have a quick drop in temperature)
  - 17 days in the cold room + CA
- **Return at temperature**: 1/2 day (08/11 in the morning – 08/11 in the afternoon)
  - Observations of treated fruits

Results
2nd trial on Larvae on Golden Delicious

- Untreated fruits – Observations after 11 days:

Block	Nb of Fruits	Infested with active larvae	Presence of gallery without larvae	Nb of infested fruits	%	Nb of larvae alive	Nb of larvae dead	Total Larvae
1	25	4	2	6	*24%*	27	1	28
2	25	3	0	3	*12%*	20	1	21
3	24	0	0	0	*0%*	0	0	0
4	25	2	0	2	*8%*	6	0	6
Avg	***25***	***2,25***	***0,5***	***2,75***	***11%***	***13***	***1***	***14***

Results and Discussions
2nd trial on Larvae on Golden Delicious

- Treated fruits – Observations after cold treatment:

Block	Nb of Fruits	Infested with active larvae	Presence of gallery without larvae	Nb of infested fruits	%	Nb of larvae alive	Nb of larvae dead	Total Larvae
1	25	2	0	2	*8%*	0	23	23
2	25	0	1	1	*4%*	0	0	0
3	24	1	0	1	*4%*	0	4	4
4	25	2	0	2	*8%*	0	17	17
Avg	***25***	***1,25***	***0,25***	***1,5***	***6%***	***0***	***11***	***11***

Results for the trial on Larvae (on Golden)

100% of larvae dead at end of trial!

Trial	Treated or not	% of infested fruits	Avg number of larvae per block (dead or alive)
1st trial	Treated	25%	89
	Untreated	32%	109
2nd trial	Treated	6%	11
	Untreated	11%	14

Discussion / Questions

- Why such difference between the two trials?
- How to have a better infestation?
  - Link with fruit maturity, variety…
- What are the most important criteria?
  - Alive / Dead
  - Size? Color?

Cold treatment for French Apple industry

Thank you very much for your attention !

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