Friendly Fruit

PRACTICE PERFORMANCES & RESULTS

Pest and disease control with limited recourse to synthetic pesticides and enhanced use of biocontrol

François Lecompte (INRAE), Soukaina EL Mrini (INRA Maroc), Ahlam Hamim (INRA Maroc), Sophie Bomel (INRAE), Douae Lamrahli (Messem), Hicham Essrifi (Messem), Ahmed Taleb (Danone), Aziz Didicheikh (GIZ)

01.01.2018 to 31.12.2020

Supported by: eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Objectives

1. **Collect data on pesticide use** on strawberry field crops in 4 partner farms (Morocco);

2. Propose strategies to **reduce pesticide use** while maintaining **good health of crops;**

3. **Test reduction** strategies in 5 farm labs in the area of Gharb-Loukkos. → Objective not fully achieved

Summary of pesticide use in 4 partner farms

- **Treatment Frequency Index (TFI) calculation** → Issues on this calculation

$$\text{TFI's plot} = \sum \frac{\text{Applied dose}}{\text{Registered dose}} \times \frac{\text{Treated surface}}{\text{Plot surface}} = \text{Number of treatments on the plot}$$

As Applied dose = Registered dose and Treated surface = Plot surface

Sanitary pressure and nature of pests are not the same during the growing season

- **Data collection** (2017-2018):

Farm	TFI	Season (weeks)	TFI/weeks	Powdery Mildew	Grey Mould	Aphids	Mites	Noctuids
P1	22	17	1,29	12	6	1	2	1
P2	12	17	0,71	6	3			3
P3	7	31	0,22	4			1	2
P4	13	33	0,39	8		1	2	2

- The **specifications were scrupulously respected**: registered dose; authorized products on export markets; alternation of active ingredients

Strategies to reduce pesticide use while maintaining good health of crops

Protocol : Preventive strategy with **prophylaxis** (pest and disease outbreak checks, infested parts removed, etc.) and **biocontrol** (biological control agents, biocontrol products and defense inducers). **Reduce synthetic pesticides use** in prevention of diseases.

Pest and disease	Prevention	Identified risks	Proven severe infestation
Powdery Mildew	Sulfur, Essential oil, Potassium carbonate	Translaminar pesticide (Cyflufenamid)	Systemic fungicide (Azoxystrobin + Difenoconazol)
Grey mould	Essential oil, Biocontrol (*Bacillus subtilis, Pythium oligandrum*)	Contact pesticide (Fenhexamid)	Systemic fungicide (Cyprodinil + Fludioxonil)
Aphids	Biocontrol (*Aphidius colemani*)	Biocontrol (Maltodextrin, Pyrethrum)	Systemic insecticide (Pirimicarb, Cyantraniliprole)
Mites	Biocontrol (*Phytoseilus persimilis*)	Biocontrol (Maltodextrin, Pyrethrum)	Systemic insecticide (Bifenazate)
Thrips	Biocontrol (*Orius laevigatus*)		
Noctuids		Biocontrol (*Bacillus thuringiensis*)	Systemic pesticide (Emamectin benzoate)

Experiment 2019 - 2020

- Several issues (time for implementation combining with irrigation and fertilization protocol implementations, coordination with growers)

  Data collection: **October (plantation) 2019-March 2020**

  Protocol implementation (experimental plot = “exp.”) : **January-March 2020**
- Partial TFI 2019-2020 (farm plot vs experimental plot):

	October-March = total		Plantation-December	January-March			October-March=total		
Farm	**TFI total « farm »**	**TFI/week « farm »**	**TFI « farm »**	**TFI « farm »**	**TFI « exp.»**	**TFI Biocontrol « exp.»**	**Damage**	**Yield loss (waste) «exp.» (g/plant)**	**Yield loss (waste) « farm » (g/plant)**
P1	16	0,84	13	-	-	-		9 ± 2	7 ± 2
P2	14	0,58	9	5	0	2		19 ± 1	23 ± 2
P3	14	0,58	9	5	2	3	Mites	7 ± 2	6 ± 3
P4	15	0,63	8	7	2	3	Botrytis	58 ± 8	53 ± 7
P5	9	0,41	4	5	2	2		5 ± 1	0 ± 0

- No major damage observed during the first weeks of harvest → **results need to be consolidated**

Perspectives

- Substantial TFI observed → **reductions are possible**
- **Consider the implementation of IPM strategies** : prophylaxis, effective treatment equipment, use of biocontrol products instead of synthetic pesticides and avoid making preventive fungicide sprays.
- **Develop international scientific collaboration** on IPM strategies for the reduction of pesticide use in strawberry production basins.

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Innovative strategies for the control of grey mould on strawberry leaves

P. Nicot, J.F. Bourgeay, F. Lecompte, M.Bardin - INRAE

01.01.2018 to 31.12.2020

Supported by: Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

History of experiments and selection of practice

- **Background** : reduced N fertilization decreases leaf susceptibility to *Botrytis cinerea* and impacts the efficacy of biocontrol agents

Nicot, P.C., Bardin, M., Debruyne, F., Duffaud, M., Lecompte, F., Neu, L., Pascal, M (2013). Effect of nitrogen fertilisation of strawberry plants on the efficacy of defence-stimulating biocontrol products against *Botrytis cinerea*. IOBC/WPRS Bulletin 88, 39-42.

- **Varietal effect and possible negative impact** of continuously reduced N nutrition **on fruit yield ?**

- **How early** can the beneficial effect of reduced N against grey mould be **expressed ?**

  (avoid yield losses) => kinetic studies to target transient beneficial effects

Onset of differentiated nutritional treatments
"starvation" : 0.5 mmol NO_3^-
"1/2 reduced": 5 mmol NO_3^-
"normal" : 10 mmol NO_3^-

Strawberry growth with uniform N fertilization

Apply biocontrol agent

time

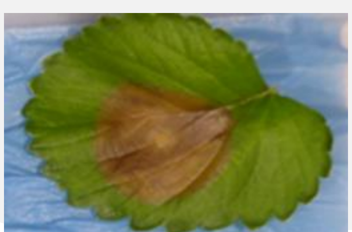
S0

S1
Week 1

S2
Week 2

S3
Week 3

S4
Week 4



Inoculation on leaves, lesions measured 96h after inoculation, without biocontrol

Description of the practice selected for the leaflet

What ?

Decrease leaf susceptibility to the agent of grey mould *Botrytis cinerea* by **transient reductions of nitrogen supply** and release of biocontrol agents.

Why ?

To control an important fungal disease of strawberry with little or no recourse of fungicides.

Status ?

Validated experimentation requiring additional farm trials

Main steps to implement this practice

Implementation

Reduce N supply for 2-3 weeks

Complement with the application of a biocontrol agent

Conditions of use:

No extra time for the modification of the nutrient solution

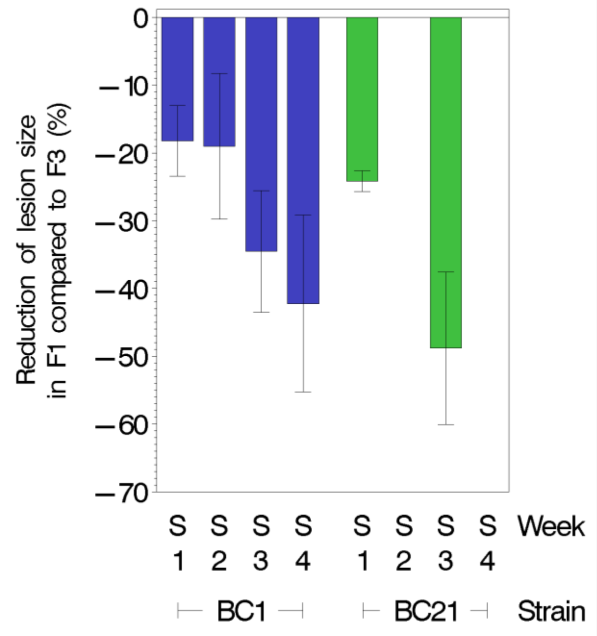
For the application of biocontrol agent, one or several sprays (ca 2.5 hours/ha).

Interactions:

Possible synergy with genetic resistance and defense inducers (not evaluated).

Expected Key result / Message to take home

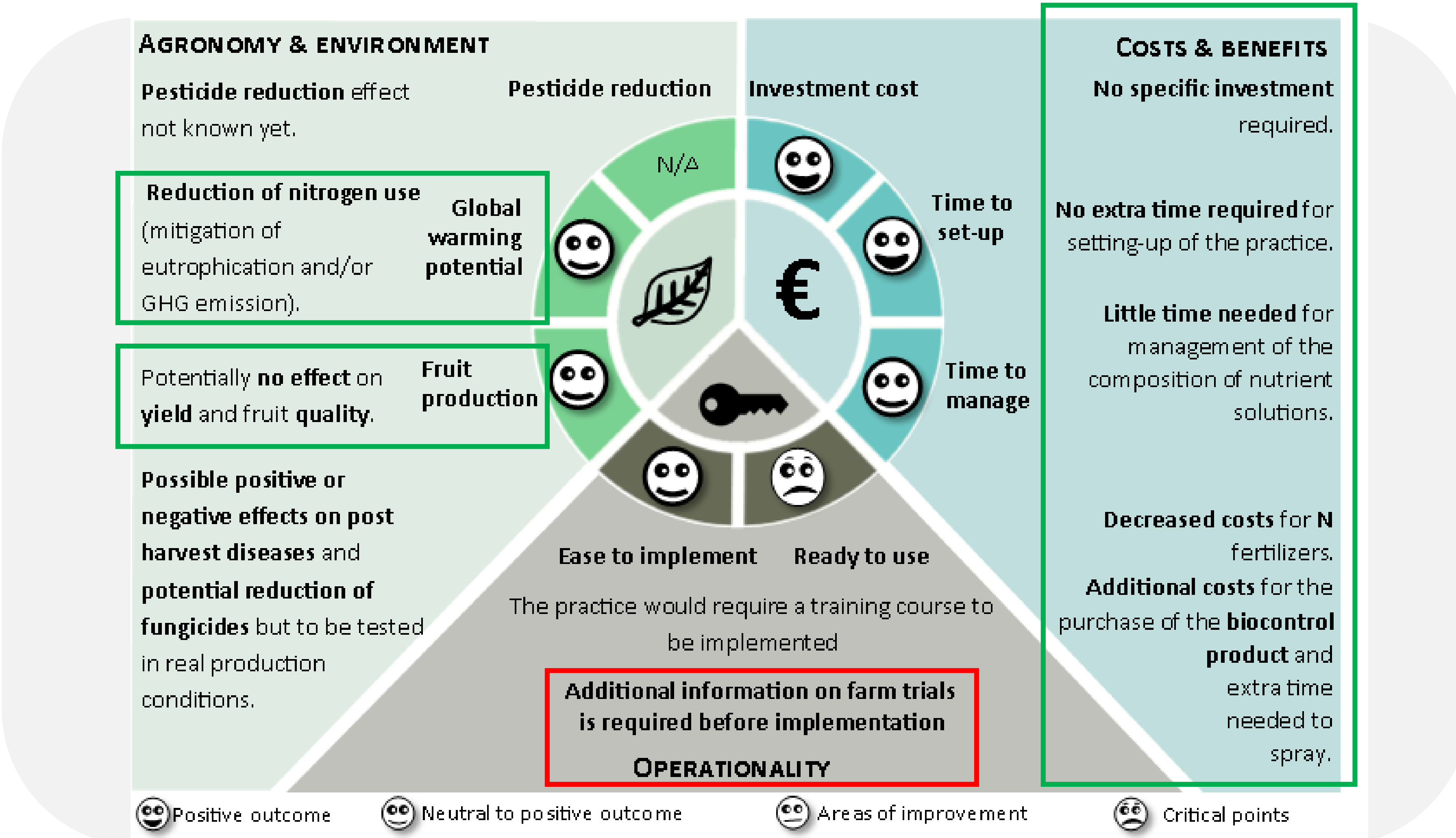
- Reduced disease severity with low N supply
  - starting 1-2 weeks after onset of N stravation (-20%)
  - ≈ -40% after 3-4 weeks
  - for 2 strawbery varieties
  - for 2 strains of *B. cinerea*



- Useful effect of biocontrol agent at high and half-reduced N level for one variety

Transient N reductions and applications of a biocontrol agent limit the severity of grey mould infections.

Practice Performances



Roadmap for transfer– Next steps

Communication through professional chanels (technical institutes and farms advisors)

This practice, validated in experimental conditions will require additional farm trials

Of particular interest would be an assessment of the practice (in experimental or farm conditions) on possible beneficial effects on

- flower protection against infection by airborne inoculum
- postharvest quality

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Optimization of the mineral nutrition of strawberry crop: Monitoring using a theoretical fertilization schedule and soil bioavailability tests

François Lecompte (INRAE), Soukaina EL Mrini (INRA Maroc), Ahlam Hamim (INRA Maroc), Sophie Bomel (INRAE), Douae Lamrahli (Messem), Hicham Essrifi (Messem), Ahmed Taleb (Danone), Aziz Didicheikh(GIZ)

01.01.2018 to 31.12.2020

Supported by: eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

History of the experiment and selection of practice

- **Context**

To meet the environmental challenges caused by the leaching of fertilizers into the environment, fertilization management is the key tool for farmers to reduce their consumption of inputs.

- **Method**

Monitoring of soil and plant status and adjustment of fertilizer inputs by moving from a static fertilization program to a new one based on data on soil and plant status.

The experiment was conducted in 5 farm-labs in the area of the Gharb-Loukkos in Morocco and lasted **for first 6 months of the growing season 2019-2020**

Practice description

What ?

Monitor the fertilization of strawberry crop based on a theoretical fertilization schedule, a P and K test at the beginning of the season and N tests during the cycle.

Why ?

To preserve nutrient resources and limit losses to the environment and pollution by adapting inputs to the crop's needs while maintaining yield levels.

Status ?

Ready to use

Main steps

1. Create a theoretical fertilization schedule (N, P, K) based on the expected biomass and nutrient levels.

2. Obtain a maximum quantity to be provided per element which is fractionated into theoretical doses according to the development kinetics of the crop.

3. These theoretical doses are adjusted according to an initial test for P and K, and during the cycle for nitrogen using a portable reflectometer (Nitrachek®).

Nitrate concentration in soil solution (mg/l)	Multiplying coefficient
< 100	1,5
100-150	1
150-200	0.8
C > 200	0.5

Key results

Values over 6 months	Low inputs	Farmer
Nitrogen (kg/ha)	54.2 ± 5.2	127.1 ± 8.1
Phosphorus (kg/ha)	5.7 ± 0.3	63.3 ± 14.8
Potassium (kg/ha)	108.4 ± 5.7	135.2 ± 8.3
Marketable yield (g/plant)	379 ± 63	392 ± 63

Average significant reduction of 88% for Phosphorus and 54% for Nitrogen over the first 6 months of the crop season

Monitoring with the help of theoretical fertilization planning and bioavailability tests makes it possible to reduce fertilizer consumption, maintain yield and limit environmental pollution.

Practice Performances

Positive outcome | Neutral to positive outcome | Areas of improvement | Critical points

AGRONOMY & ENVIRONMENT

Pesticide reduction has not been studied.

Reduction in the use of N & P (less GHGs) and energy related to the pump injecting the fertilizers.

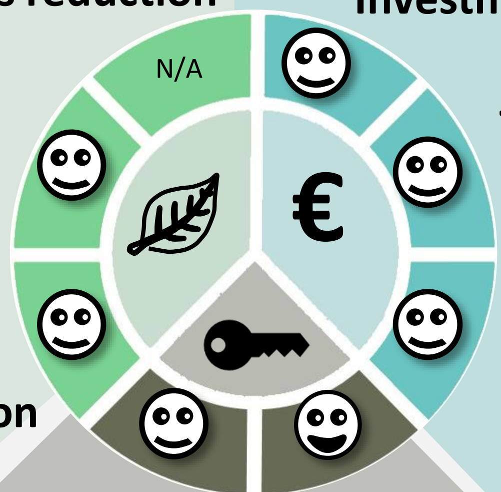
No loss of yield but result to be consolidated.

Reduction in the consumption of fertilizers, and potentially their loss in the environment.

Pesticides reduction

Climate change mitigation potential

Fruit production



COSTS & BENEFITS

Investment cost

Time to set-up

Time to manage

Low investment **cost** and quickly amortized

Time required to set up the schedule is **low**

Time required for monitoring is **low** and **distributed** over the production period.

Reduction of costs related to fertilizers.

Ease to implement

Ready to use

A **well-known** alternative practice that has already **proven successful**.

HUMAN ASPECTS & FEASIBILITY

Dissemination

The alternative practice is efficient and ready to implement

- **Leaflet** (overall method and results)
- **Short report** (detailed method and results) to be distributed to the 5 farmers
- **Short training session** for the technical consulting staff
- **Berry school event** (Morocco)

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Thank you for your attention !

François Lecompte (INRAE), Soukaina EL Mrini (INRA Maroc), Ahlam Hamim (INRA Maroc), Sophie Bomel (INRAE), Douae Lamrahli (Messem), Hicham Essrifi (Messem), Ahmed Taleb (Danone), Aziz Didicheikh(GIZ)

01.01.2018 to 31.12.2020

Supported by: eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Pesticides reduction on strawberry field with the development of a new sprayer

Sébastien Cavaignac - Invenio

01.01.2018 to 31.12.2020

Supported by: eit Climate-KIC

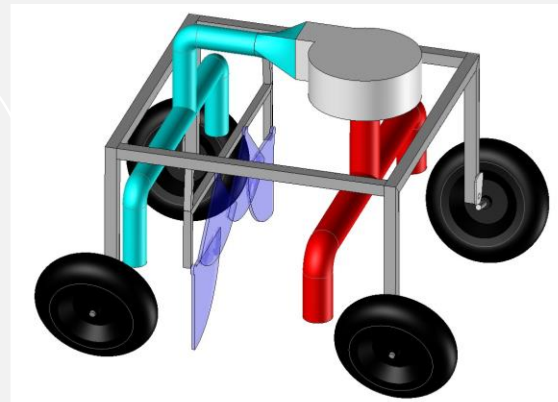
Climate-KIC is supported by the EIT, a body of the European Union

History of experiments and selection of practice

<write a **short overview of the experiments that have been tested since the start of the project**
AND
why this particular practice/experiment was retained as the most promising in terms of results and future transfer>

The sprayer that we developed have a treatment module with a protection box to avoid the treatment deviation and to protect the user. An impeller on the top and an air release allows a shuffling of leaves.

Nozzles are on the top and on the sides for an homogen and good application.



Description of the practice selected for the leaflet

What ? Developing a sprayer adapted to strawberry production which only sprays the necessary amount of product by mixing air with the product during the treatment.

Why ? Improving treatment efficiency, reducing phytopharmaceutical product quantity and reducing risks for the user.

Status ? Promising but needs further research

Main steps to implement this practice

1- The user of the sprayer needs :

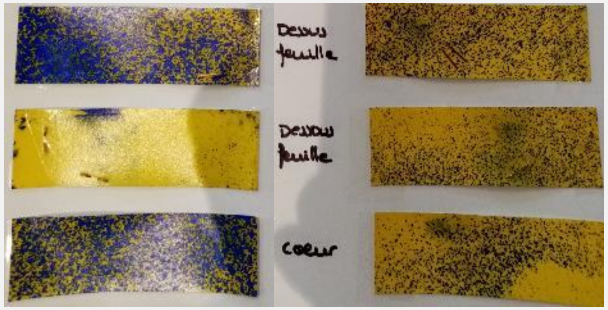
- The first possibility is to use a towed device with a traditional attachment.
- The second possibility is to use an independent motorisation which allows to work in autonomy (robotisation) or by electric control.

2- Same intervention date, same products for control and for new sprayer but with less volume for new sprayer

Condition of use : the practise is suitable for strawberry fields, as a substitute to classical treatement machine.

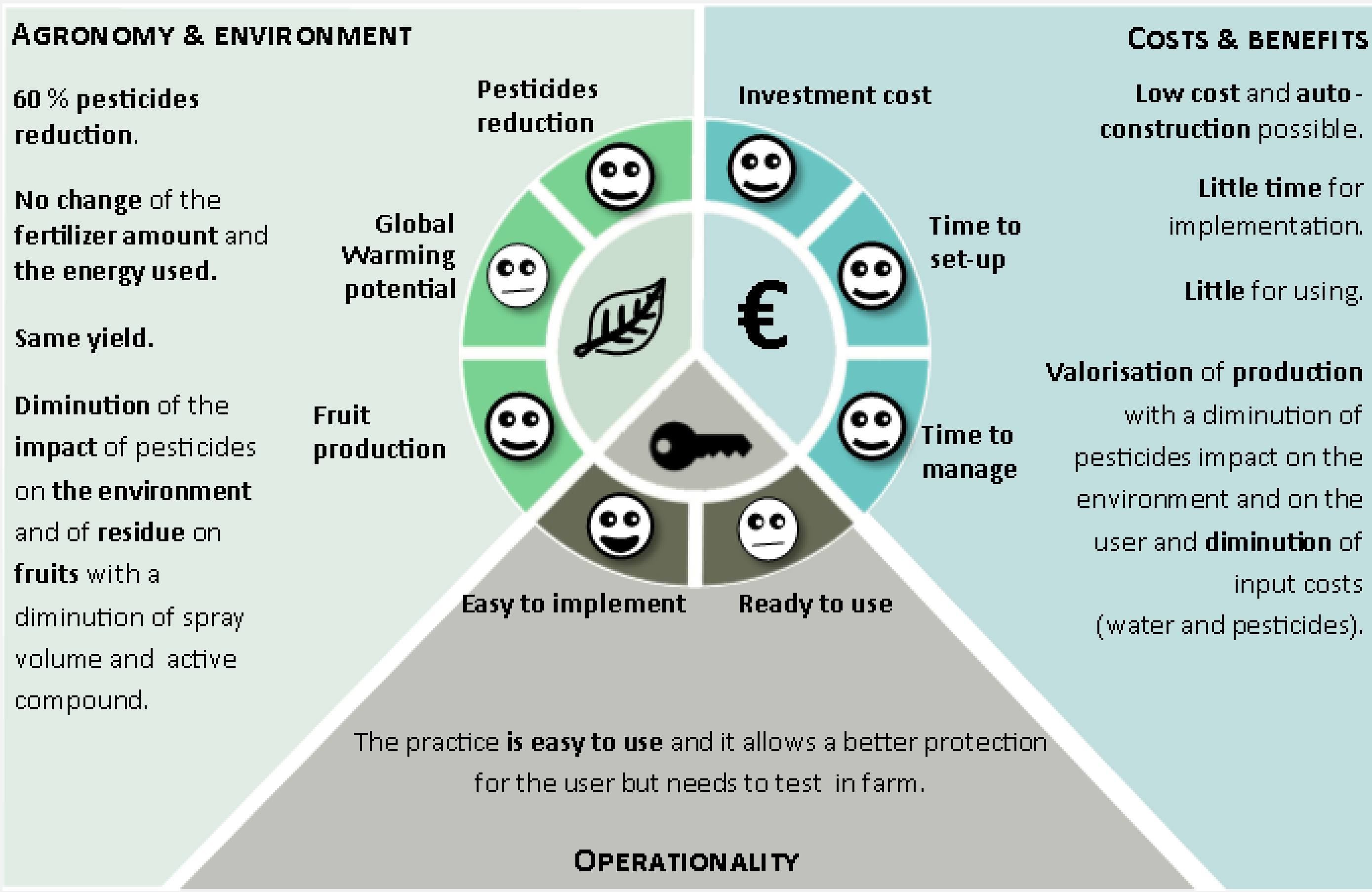
Expected Key result / Message to take home

Control Sprayer



- With new sprayer :
  - No difference on insect pest and disease protection (same percent of plants with aphids)
  - Spraying of pesticides is more homogen on the old and young leaves, on the floral scape and on the heart with the new sprayer.
  - With the same products concentration, reduction of 60 % spray volume and active compound.
  - Same yield

Practice Performances



Roadmap for transfer– Next steps

<please describe how the practice can/ will be transferred to growers after the end of Friendly Fruit>

- Apply for a « Enveloppe soleau » and if it is relevant for a patent
- Apply for « innovation competitions » in order to promote the solution
- Validate Friendly Fruit results and try to optimize pesticide use (until which level is it possible to decrease? are the results depending on the products or pest ?)
- Once validated, in partnership with INRAE, transfer to the producers
  - either directly (plan for self-construction)
  - or via agro equipment manufacturer

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Biocontrol on apple for primary scab

Anne Duval-Chaboussou, CTIFL
Antony Leblois, La Morinière
Claude Coureau, CTIFL

01.01.2018 to 31.12.2020

Supported by: Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

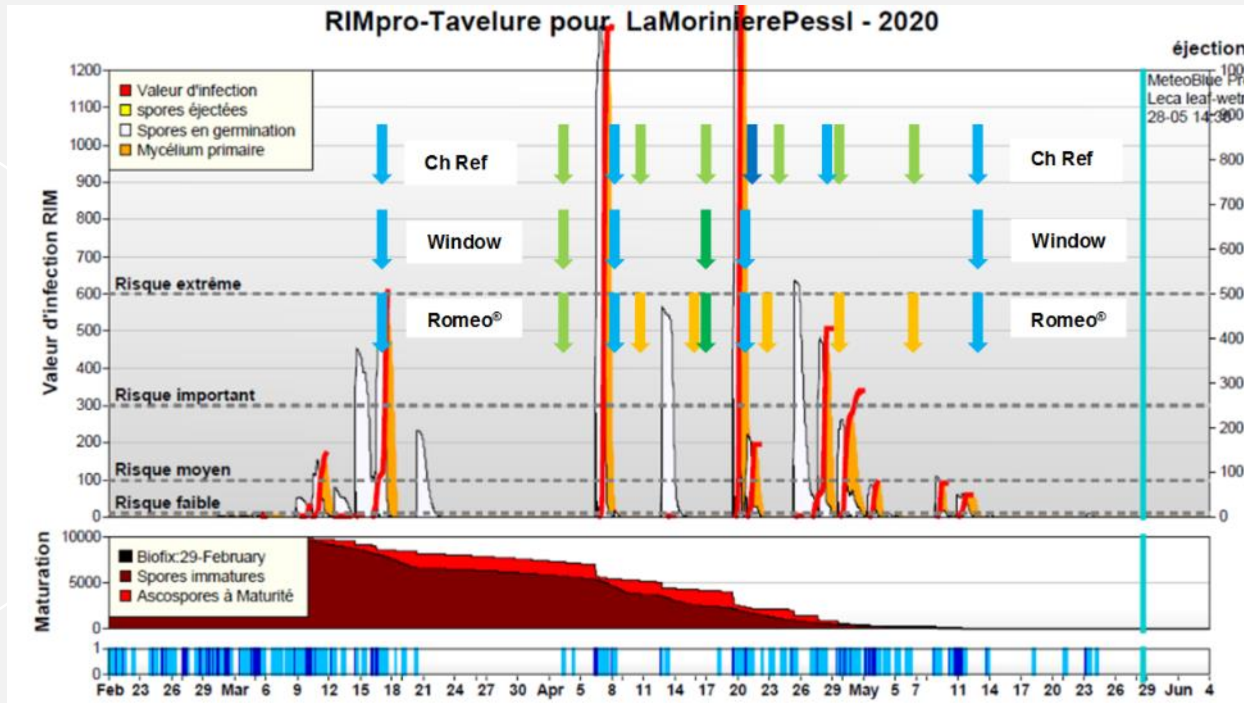
History of experiments and selection of practice

List of Biocontrol tested on primary scab :

Year	Active substance	Commercial name	Mode of action
2018	Phosphonate de potassium	Soriale® 1,86 L/ha	Fungicide + Elicitor
		Soriale® 4 L/ha	
2019	Essentiel oil Basic substances	Medinbio Several products	Fungicide + Elicitor
	Cerevisiane	Romeo®	Elicitor
2020	Cerevisiane	Romeo®	Elicitor
	Sulfuric clay + horsetail extract	Myco-Sin®	Fungicide

What ? Alternative substances applied as preventive or curative control on primary scab, Rule to applied : scab modelisation “RIMpro model” and level of risk

Why ?
Control primary scab contamination

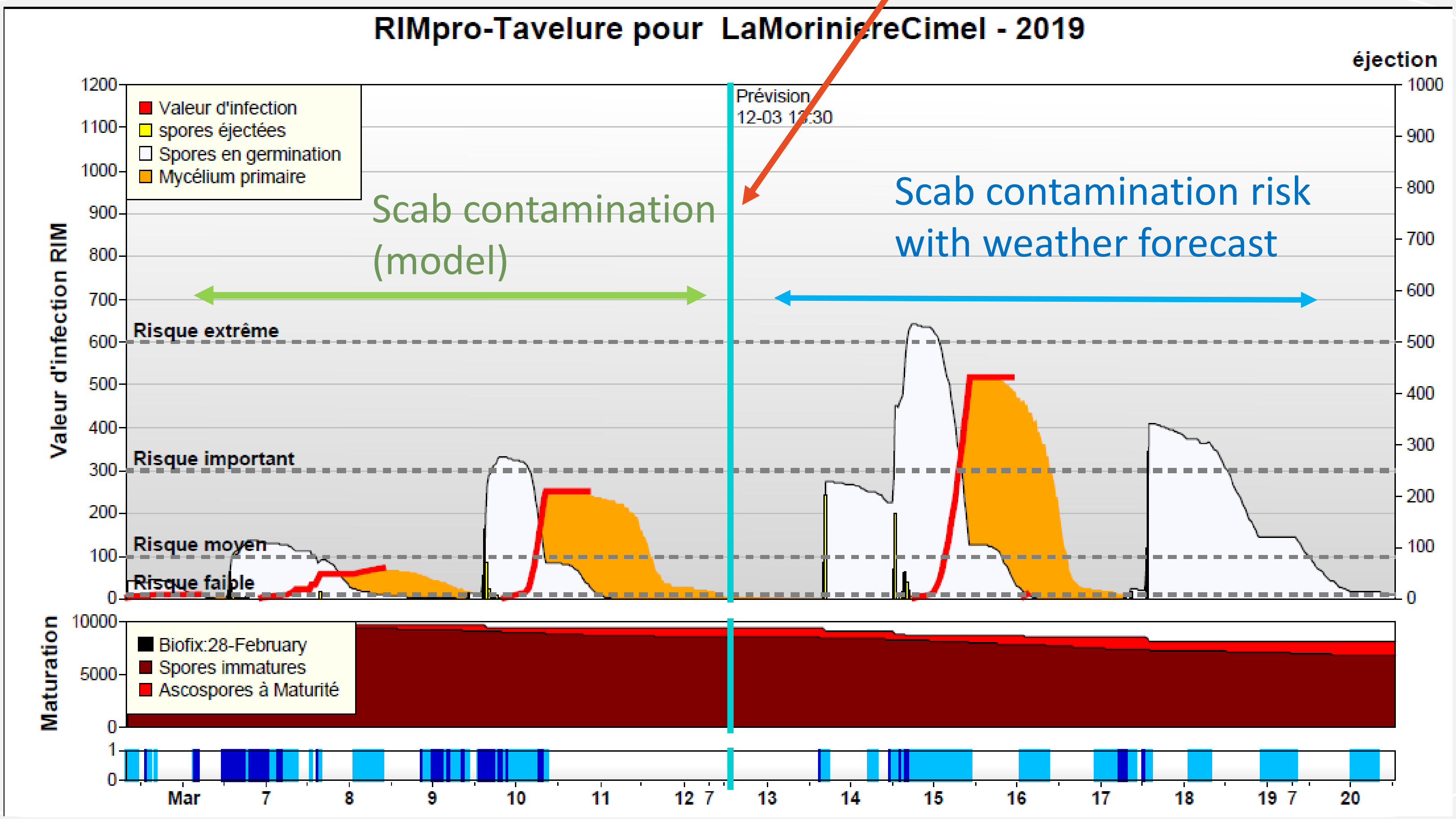


Status ? Substances not registrated for scab control (registration on other species or use, basic substances or essential oil, physical barrier)

Main steps to implement this practice

Follow risk forecast on a scab model and decide to spray

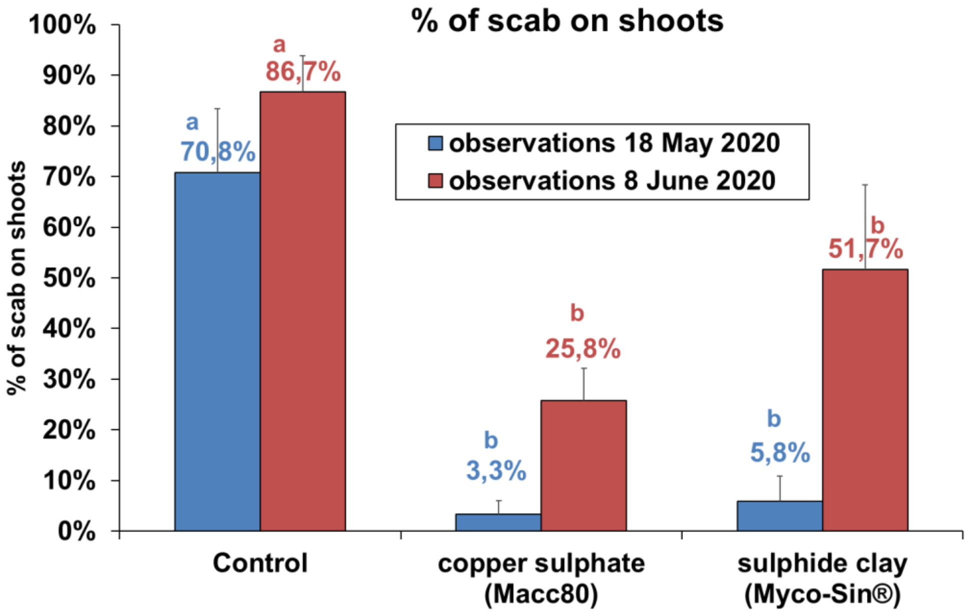
Day of the view



Synthesis of results

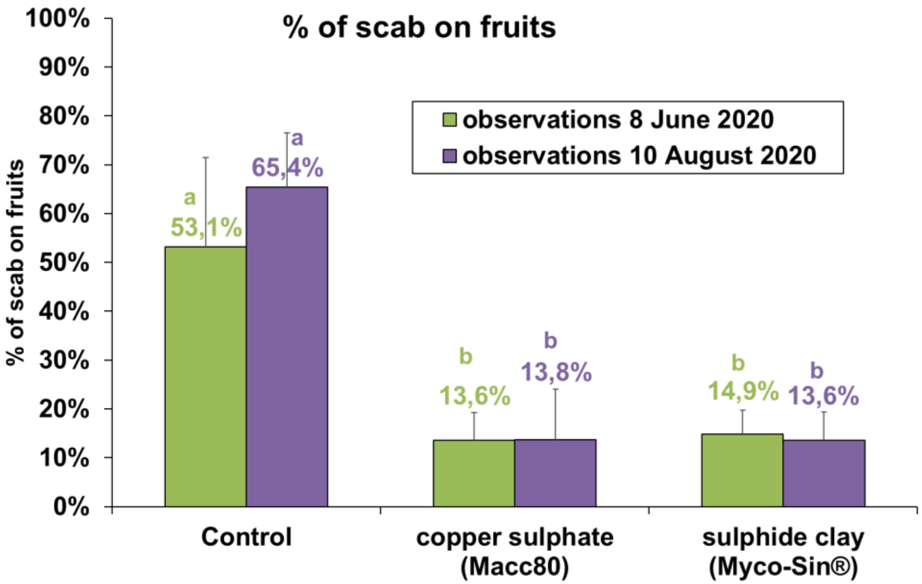
Year	Active substance	efficiency	comment
2018	Phosphonate de potassium	0 (1,86 L/ha) ++ (4 L/ha)	Registrade to 1,86 L/ha
2019	Essentiel oil Basic substances	++	Expensive (X3 normal price)
	Cerevisiane	0	No efficiency
2020	Cerevisiane	0	No efficiency
	Sulfuric clay + horsetail extract	+++	Same as Copper

Result with Myco-Sin®



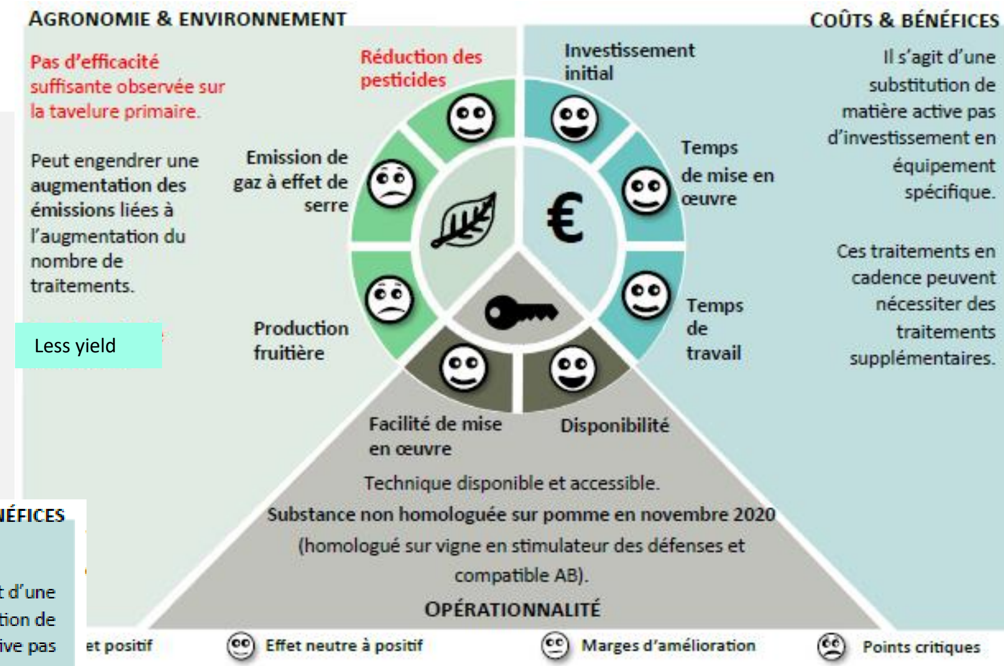
Same efficiency than Copper in preventive scab control

+ addition of sulfur

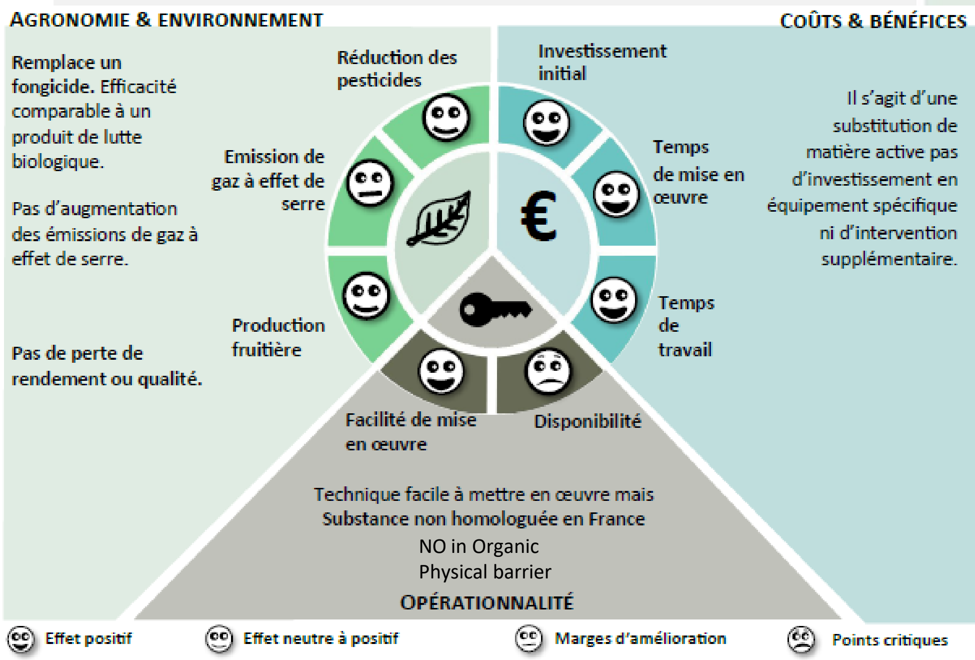


Practice Performances

Cerevisane (Romeo®)



Sulfur Clay + Horsetail extract (Myco-Sin®)



Roadmap for transfer– Next steps

Very easy if it is registered

☞ high expectation from growers

many actives substances removed

Friendly Fruit

PRACTICES PERFORMANCES & RESULTS

Biocontrol on apple for fungal diseases in storage

Christine Tessier, La Morinière
Claude Coureau, CTIFL

CTIFL SCIENCES & INNOVATION

La Morinière Station d'expérimentations

01.01.2018 to 31.12.2020

Supported by: eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

History of experiments and selection of practice

List of Biocontrol tested on *gloeosporium*:

Year	Active substance	Commercial name	Mode of action
2018	Phosphonate de potassium	Soriale® 1,86 L/ha	Fungicide + Elicitor
	Yeast extract	JDE01	Elicitor
	Cerevisiane (yeast)	Romeo®	Elicitor
2019	Essentiel oil Basic substances	Medinbio HPRO à 40 L/ha Khi² à 5 L/ha	Fungicide + Elicitor
	Cerevisiane	Romeo®	Elicitor
2020	Calcium polysulfur	Curatio®	Fungicide
	Calcium Polysulfur	Curatio®	Fungicide

What ? Alternative substances applied as preventive or curative control on storage diseases, Rule to applied : before or after a rain, 6 weeks before harvest, repeat each 20 mm.

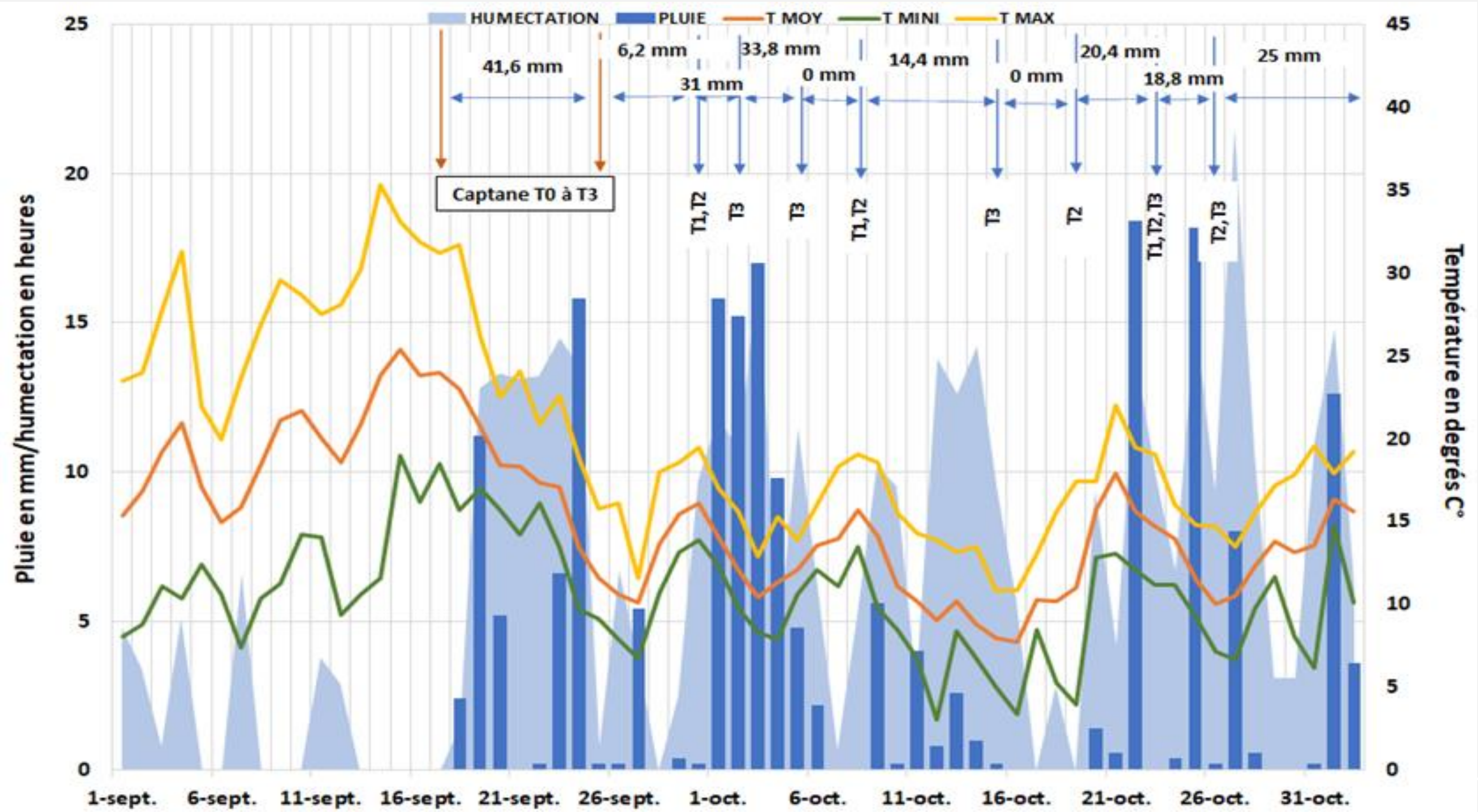
Why ?
Control *Gloeosporium* (most *Neofabraea Alba*)

Status ? Substances not registrated for preharvest (registration on other species or use, basic substances or essential oil, physical barrier)

Main steps to implement this practice

Follow rain 6 weeks before harvest, prevent treatment (try curative too for Myco-Sin®)

2020

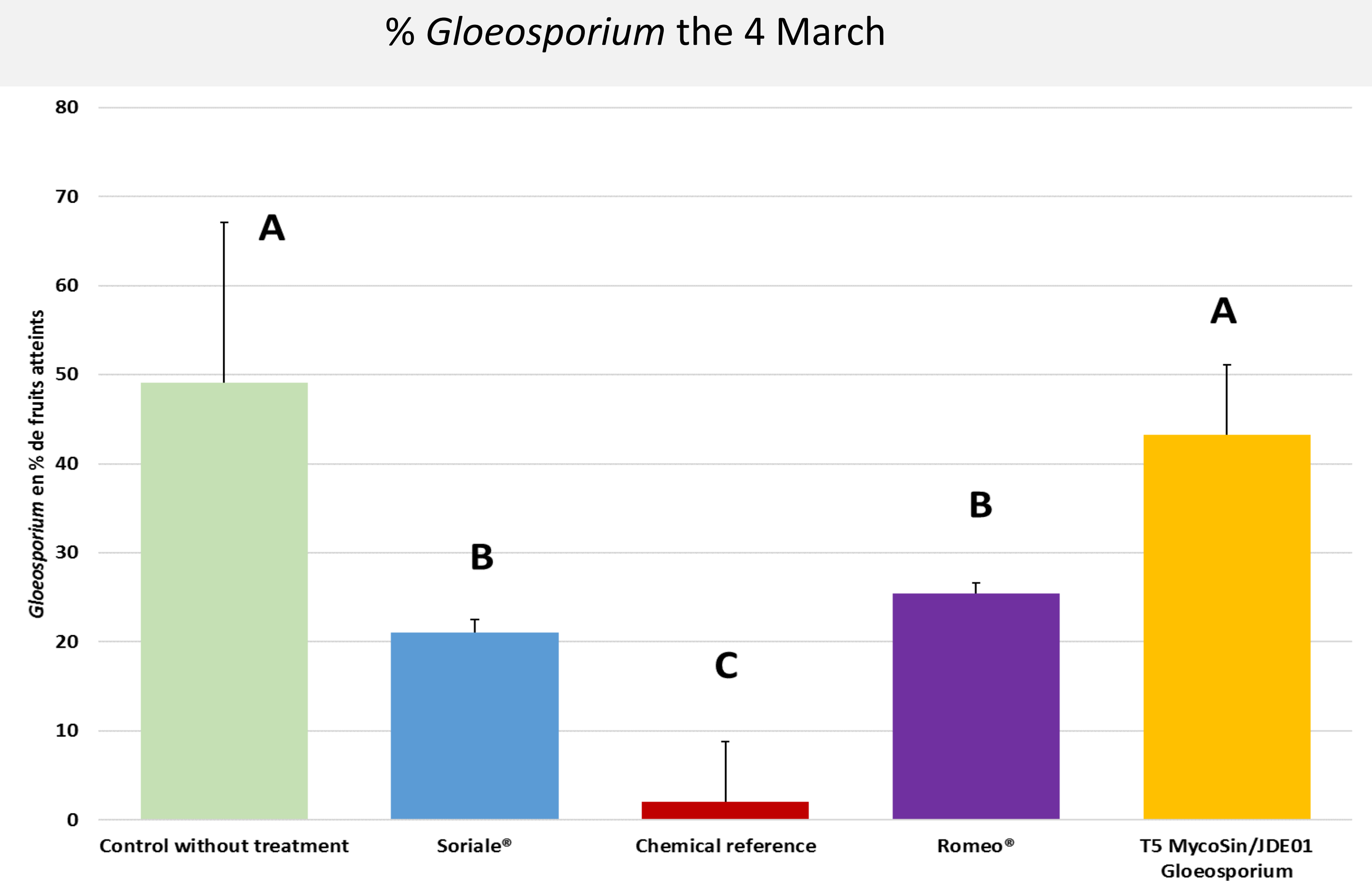


Synthesis of results

Year	Active substance	Efficiency	Comment
2018	Phosphonate de potassium	+	Works at the beginning of storage (3 months)
	Yeast extract (JDE1)	0	
	Cerevisiane (yeast)	+	Works at the beginning of storage (3 months)
2019	Essentiel oil Basic substances	0	A lot of rain in 2019, hard to have a good protection (more than of 40 mm between two spray)
	Cerevisiane	0	
2020	Calcium polysulfur	In storage	
	Calcium Polysulfur	In storage	

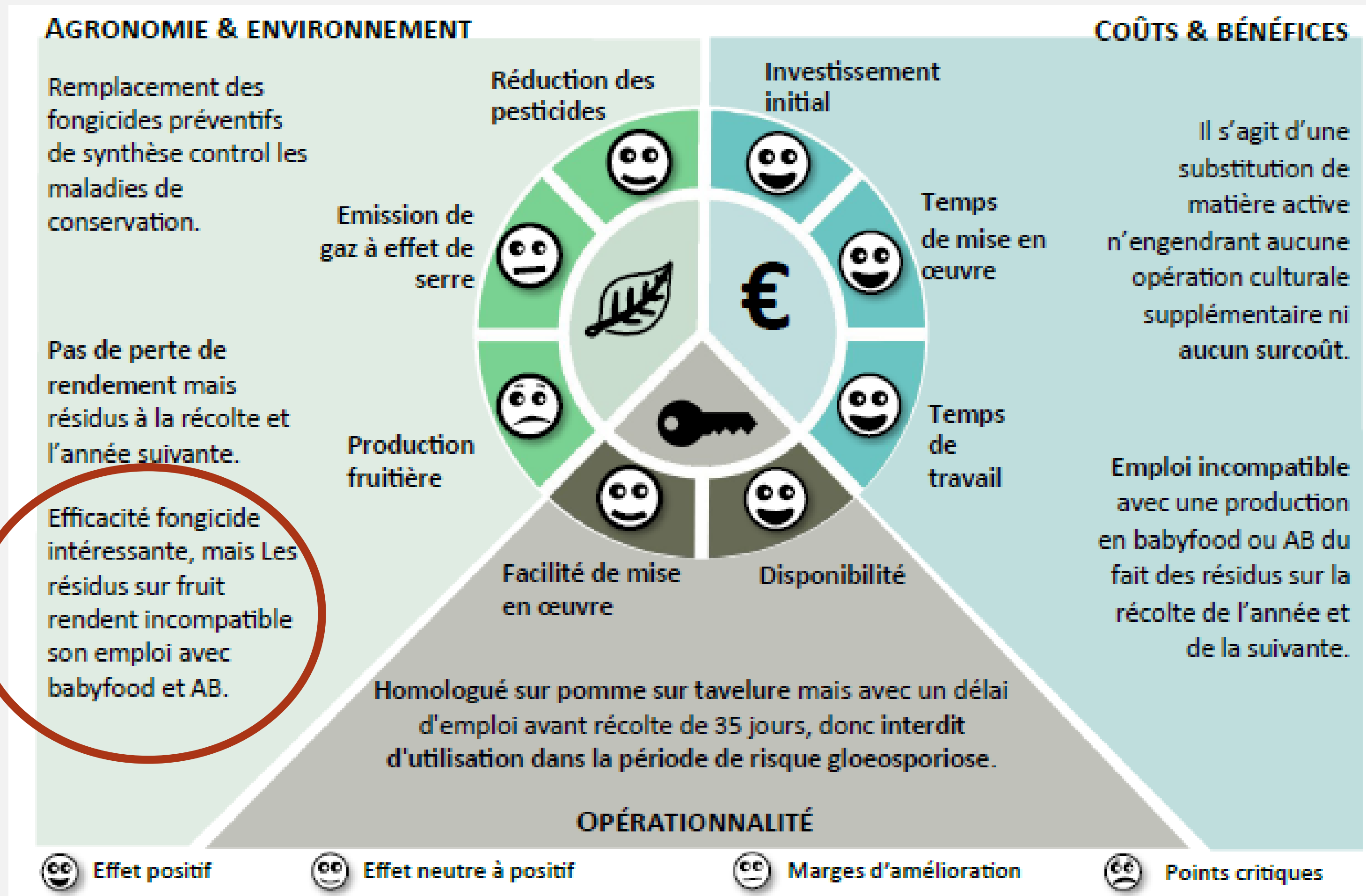
Result 2018

Less efficiency than the chemical reference



Practice Performances

Soriale®



Roadmap for transfer– Next steps

Very easy if it is registered and <u>efficient</u>

☞ high expectation from growers to be free residue at harvest

☞ No registered products in organic