

# Impact of climate change on the duration of the phenological cycle of wine grapes in hot-dry areas

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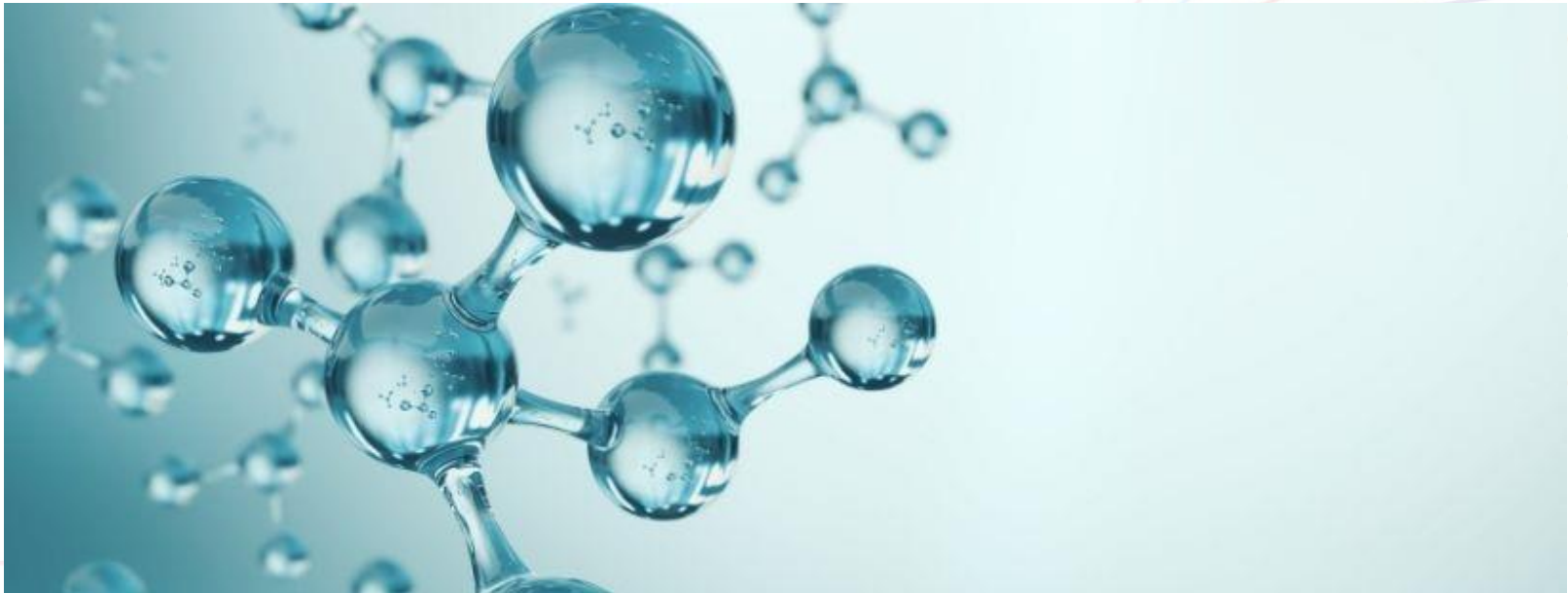
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- Introduction
- Molecular characteristics
- Market utilization
- Trial's approach
- Experimental design
- Pesticides
- Treatments
- Results
- Conclusion: considerations and future choices  
dealing with the results

- Ozone  $O_3$  as natural molecule in the environment



## Molecular characteristics

- **Environmentally component**
- ✓ **naturally generated** by the interaction of the rays of the lightning stroke **with oxygen atoms**
- ✓ **with the nitrogen dioxide** resulting from lightning strokes as it becomes the source of ozone production when exposed to **the ultraviolet light** component **lightning strokes**



D. R. DAVIS - *Influence of Thunderstorms on Environmental Ozone* National Weather Service Tallahassee, Florida

- **Environmental toxicity and safe limits**

- ✓ **Natural substance** classified as **GRAS** (generally recognized as safe) for food contact applications by FDA USA (*Document 21 CFR 173.368 (registr. n°00F-1482)*) and a secondary food additive safe for human health.
- ✓ **The ozone threshold** concentration for continuous human exposure (8 h standard) is **0.075 ppm (US Environmental Protection Agency, 2008)**.
- ✓ **The European Union has not set any indicative** occupational exposure limit values (IOELV, Indicative Occupational Exposure Limit Values)  
**Finland : 0,05 ppm**      **Italy : 0,1 ppm**      **France : 0,1 ppm**  
**Belgium : 0,1 ppm**      **Spain : 0,16 to 0,2 ppm**

## Industrial Ozone generation and capabilities

- ✓ It can be generated **artificially** by the passage of air or oxygen gas through a **high voltage electrical discharge** or by **ultraviolet light irradiation**
- ✓ One of the most **potent sanitizers** against a wide spectrum of microorganisms
- ✓ It leaves **no residues** on treated commodities (the ozone degrades in **oxygen**)
- ✓ It can be applied either as a **gas** or **dissolved in water**
- ✓ **COLD STORAGE .....**



Ozone  
monitor



Ozone gas  
generator



All images of plants and machines are provided courtesy of SAIM IMPIANTI srl <https://www.saimimpianti.com/>

✓ **continuative** and **low dosage (0,5 ppm)** of **O<sub>3</sub> gas generation** all along fruit cold storage

## What if .....

✓ **Pre** cold storage  
with **O<sub>3</sub> water  
solution** treatment

✓ **High dosage** O<sub>3</sub> in  
water solution  
treatment

**Variety:**  
***Melissa  
Seedless***



**Pesticides  
reduction**



## ➤ $T_0$ vs $T_1$ comparison

### ONE -WAY ANOVA

- Cold storage effect
- $SO_2$  effect
- Ozonated water effect

### TWO-WAY ANOVA

#### ➤ 1<sup>st</sup> FACTOR: ozonated water concentration

- 3 ppm
- 5 ppm
- 12 ppm

#### ➤ 2<sup>nd</sup> FACTOR : contact time

- 10 min
- 5 min

**Table 1.** Activity spectra, mobility, water solubility (W.S.), water DT50 (W.DT50), soil DT50 (S.DT50) and MRL on grapefruits in European Union of insecticides and fungicides studied.

<b>Molecule (commercial product, dose)</b>	<b>Activity spectra</b>	<b>Mobility</b>	<b>W.S. (mg/L)</b>	<b>W.DT50 (days)</b>	<b>S.DT50 (days)</b>	<b>MRL (mg/Kg)</b>
<b>Acetamiprid</b> (Epik SL, 2 L/ha)	Insects	Systemic	2950	4.7	3	0.5
<b>Flupyradifurone</b> (Sivanto Prime, 0.5 L/ha)	Insects	Systemic	3200	31.4	130	3
<b>Spirotetramat</b> (Movento 48 SC, 1.5 L/ha)	Insects	Systemic	29.9	0.8	0.7	2
<b>Fludioxonil</b> (Geoxe, 1 kg/ha)	Gray mold	Contact	1.8	2	16	5
<b>Fluxapyroxad</b> (Sercadis, 0.15 L/ha)	Powdery mildew	Locally systemic	3.4	4.4	181.5	3
<b>Penconazole</b> (Scudex, 0.2 L/ha)	Powdery mildew	Systemic	73	2	89.7	0.5
<b>Proquinazid</b> (Talendo, 0.2 L/ha)	Powdery mildew	Locally systemic	0.9	0.8	30.5	0.5
<b>Trifloxystrobin</b> (Flint, 0.15 kg/ha)	Powdery mildew	Locally systemic	0.6	1.1	1.7	3

✓ **Ozonated water production  
and  
experimental plant installation**

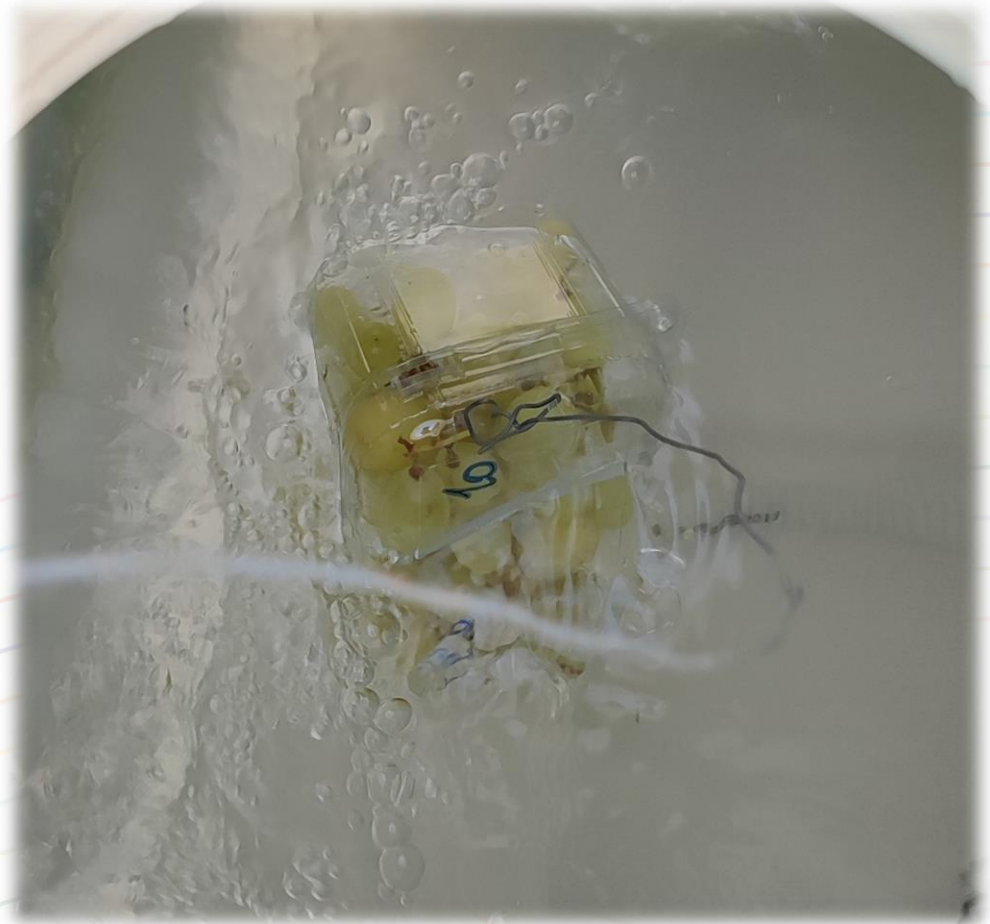


Oxygen

Current



✓ **Ozonated water washing**



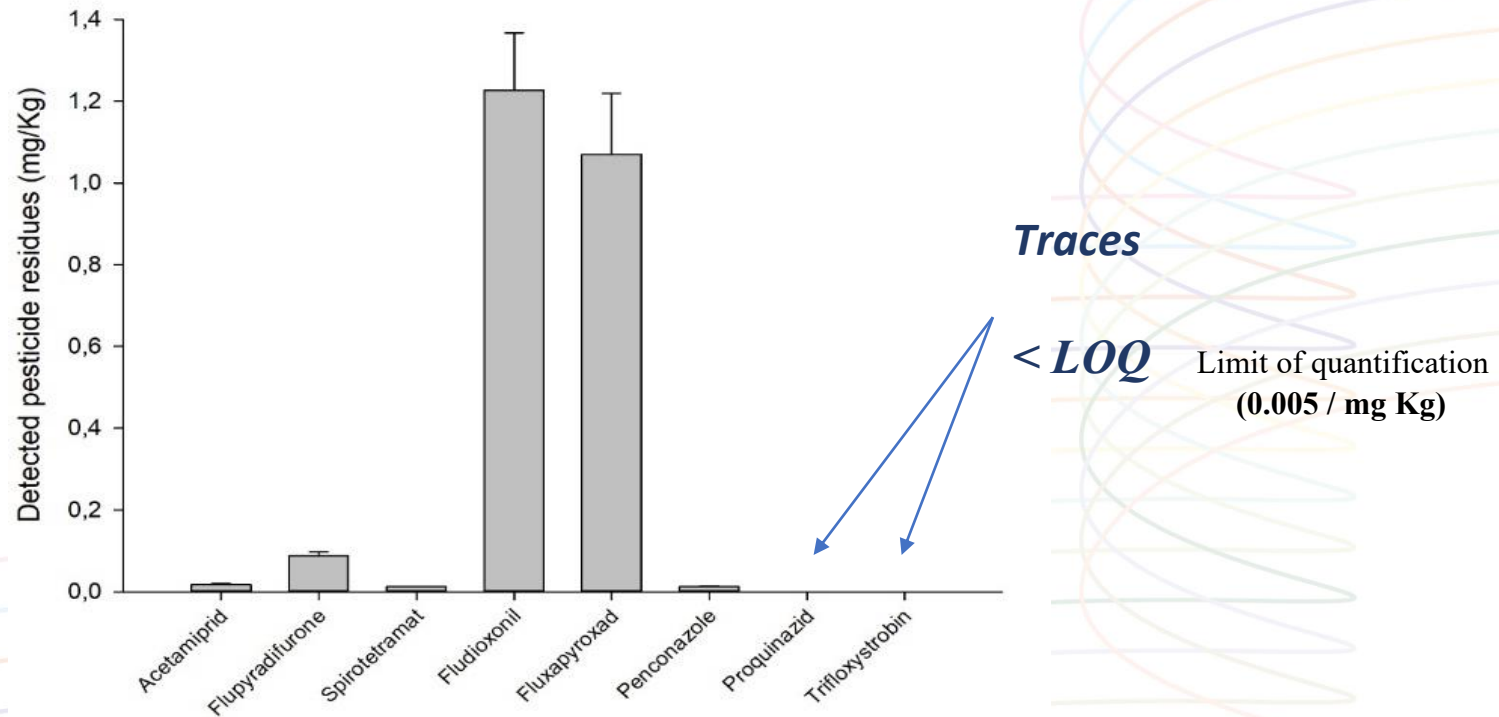
**500 g clamshell containers**

✓ **Cold storage**      **1 °C – 95% U.R. 30 days**



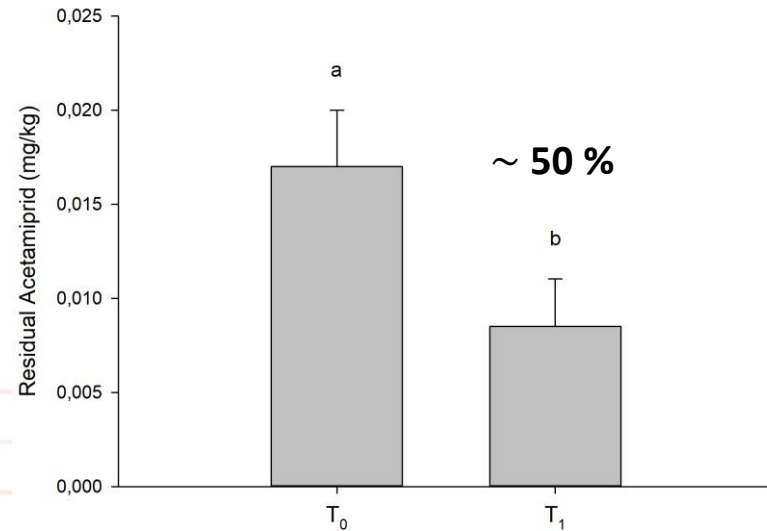
✓ **T<sub>0</sub> time ( pre cold storage pesticide determination )**

All molecules were found lower than EU MRL

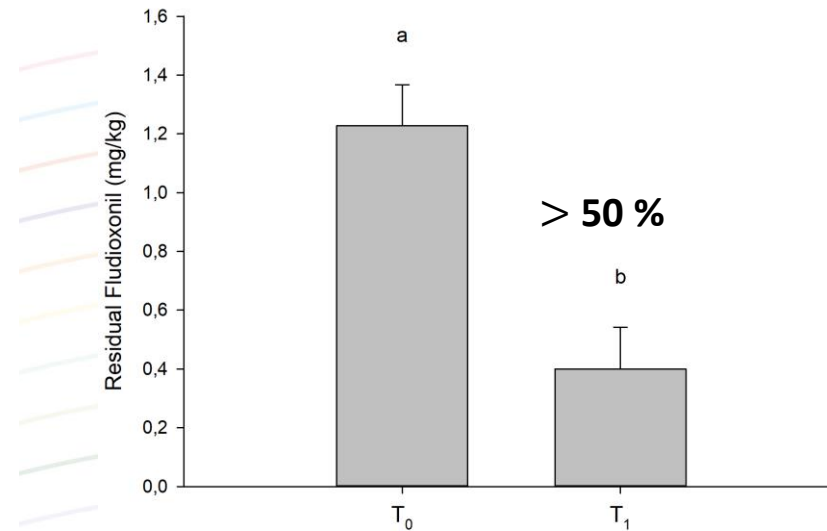


## ✓ Cold storage effect at $T_1$ time

✓ **Acetamiprid**  
*Systemic insect.*

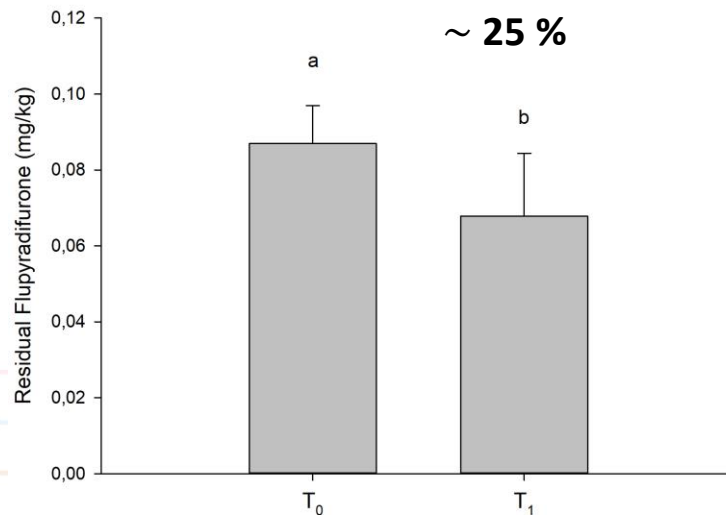


✓ **Fludioxonil**  
*Fungicide contact*

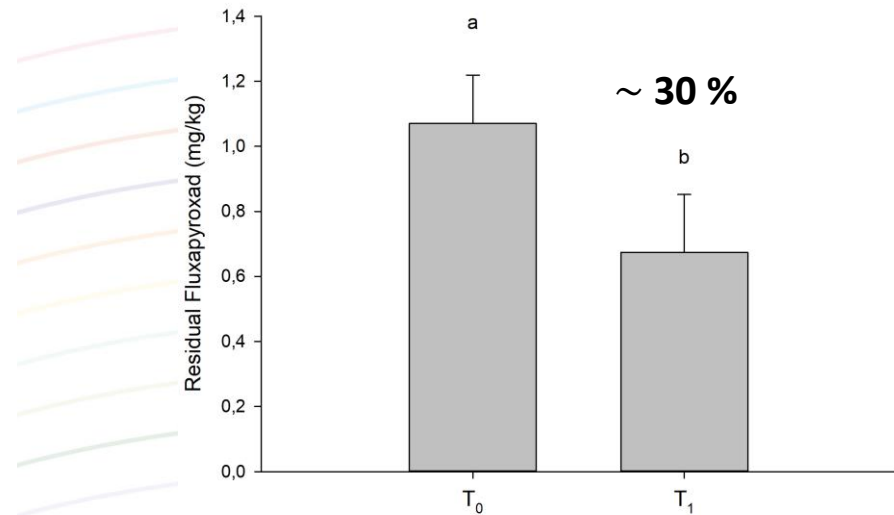


✓ **Cold storage effect at  $T_1$  time**

✓ **Flupyradifurone**  
*Systemic insect.*



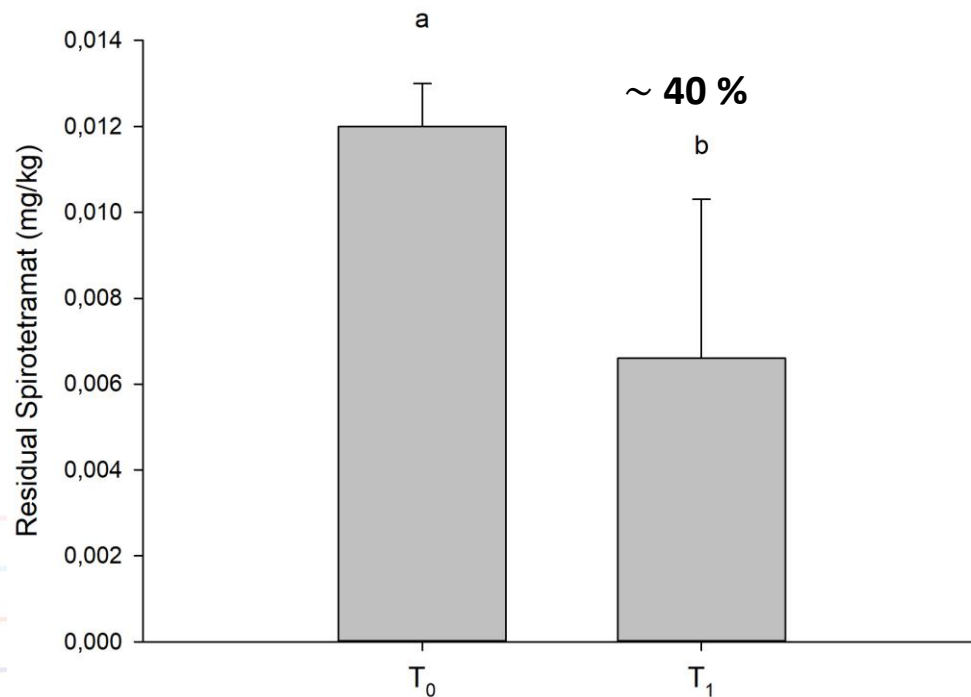
✓ **Fluxapiroxad**  
*Locally systemic fung.*





✓ **Cold storage effect at  $T_1$  time**

✓ **Spirotetramat**  
*Systemic insect.*



✓ **Proquinazid**  
*Fungicide locally systemic*

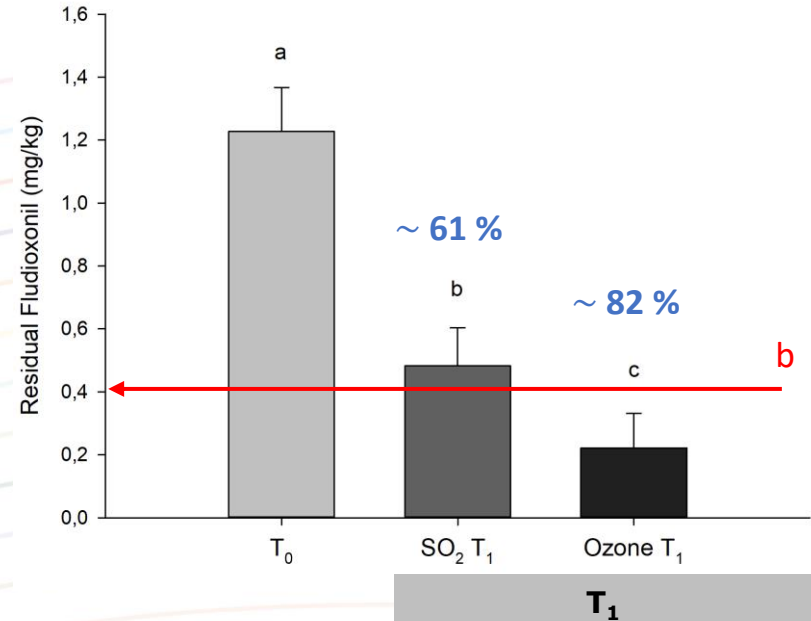
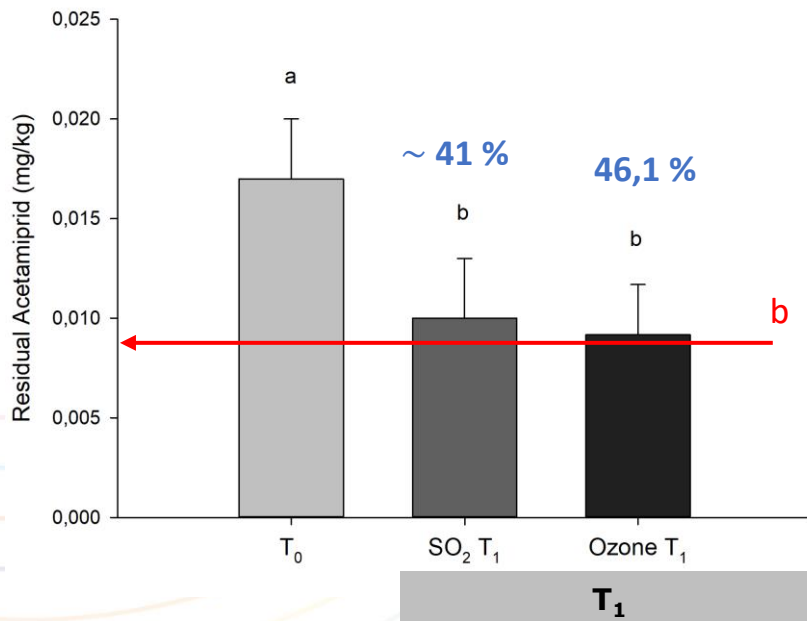
✓ **Trifloxystrobin**  
*Fungicide locally systemic*

Traces

## ✓ Treatments effect at $T_1$ time

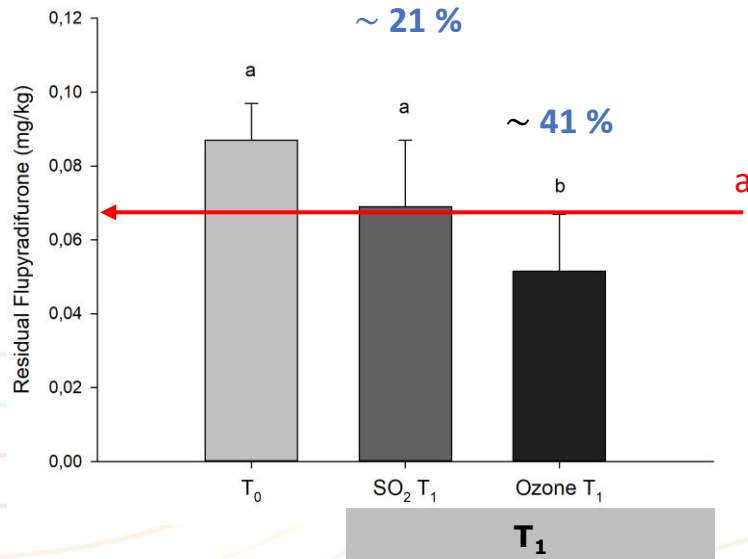
✓ **Acetamiprid**  
*Systemic insect*

✓ **Fludioxonil**  
*Fungicide contact*

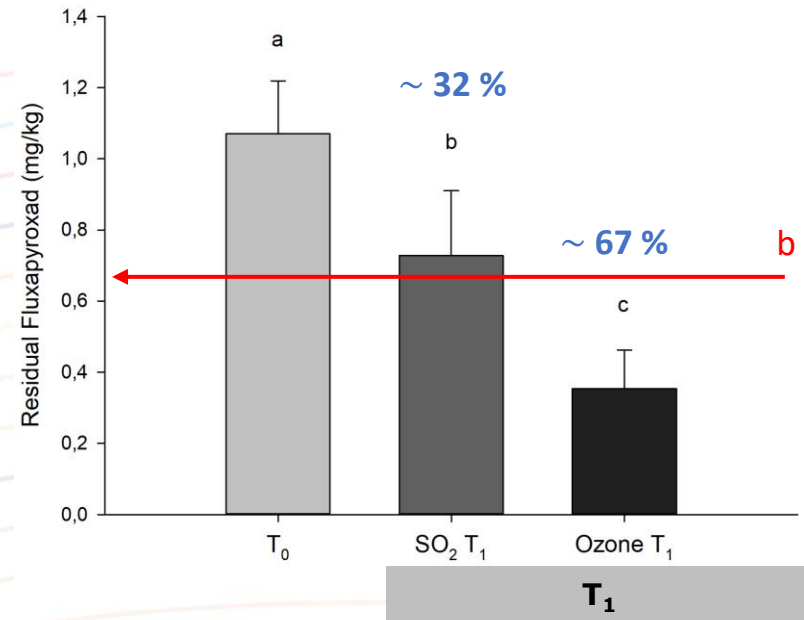


## ✓ Treatments effect at T<sub>1</sub> time

✓ **Flupyradifurone**  
*Systemic insect.*

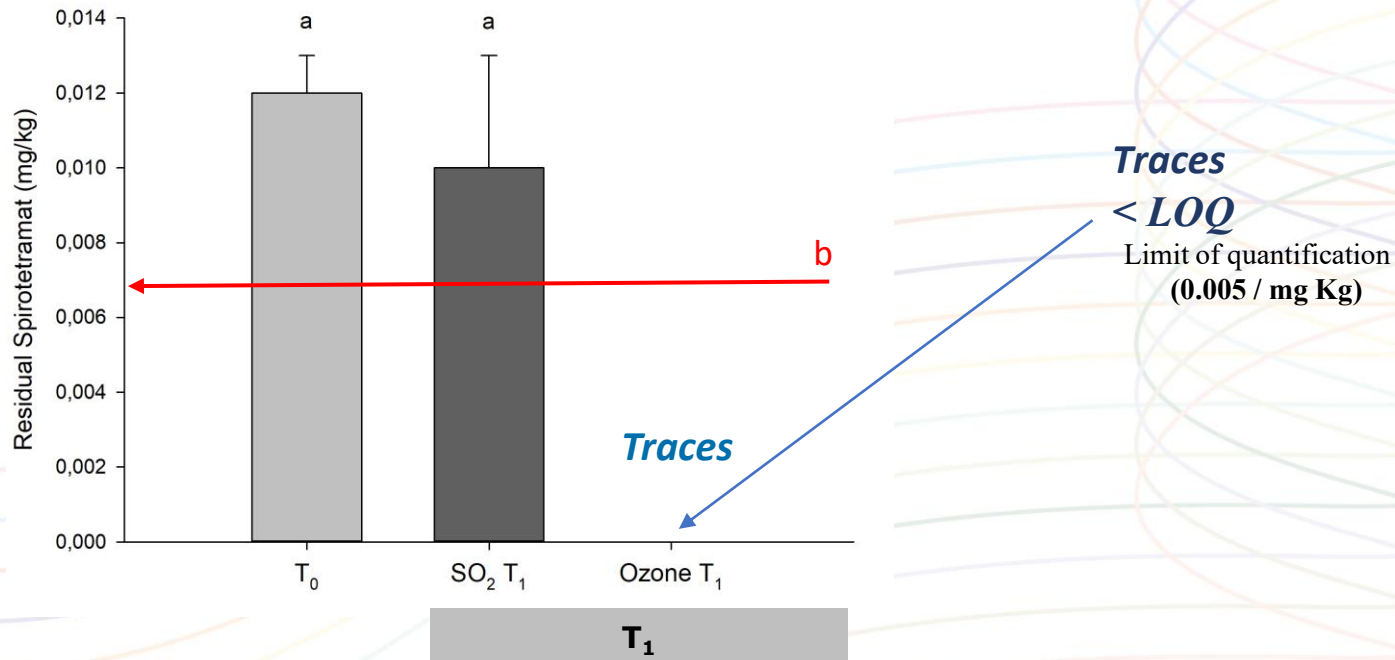


✓ **Fluxapyroxad**  
*Locally systemic fung.*



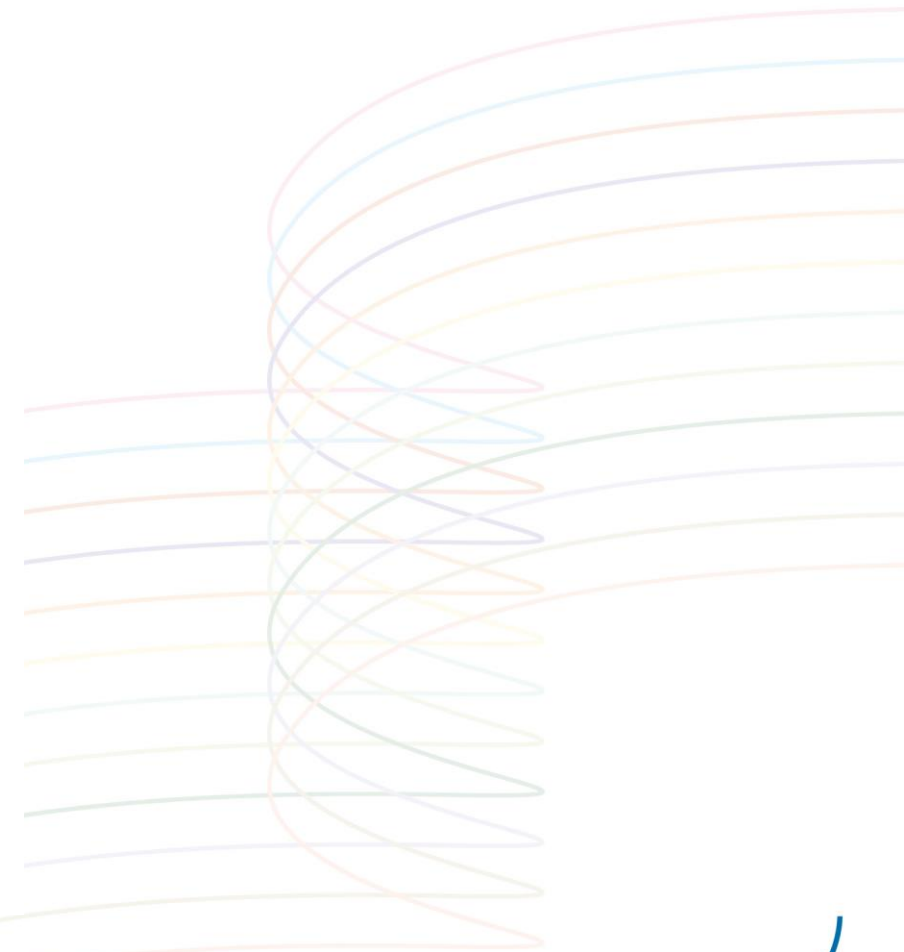
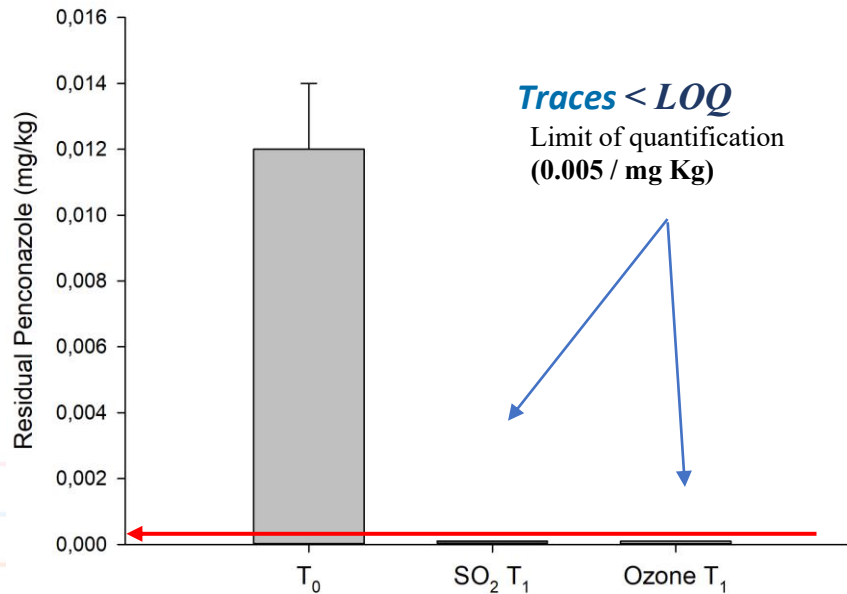
✓ **Treatments effect at T<sub>1</sub> time**

✓ **Spirotetramat**  
*Systemic insect.*



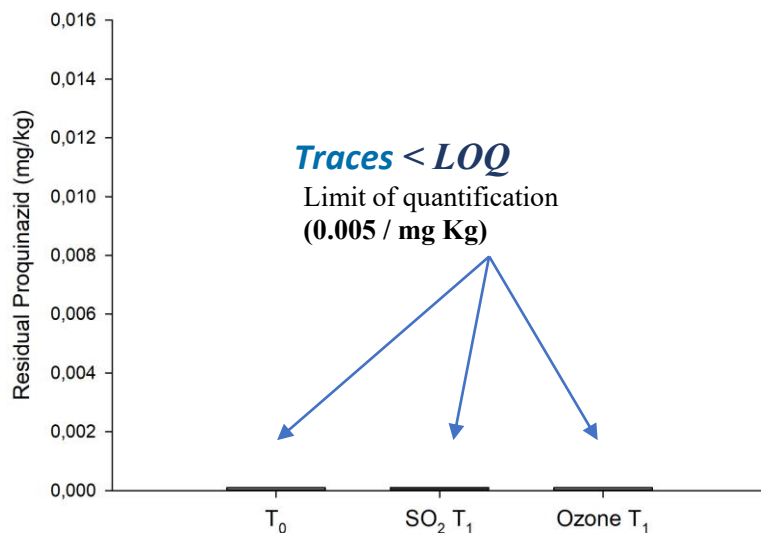
✓ **Treatments effect at  $T_1$  time**

✓ **Penconazolo**  
*Systemic fungicide*

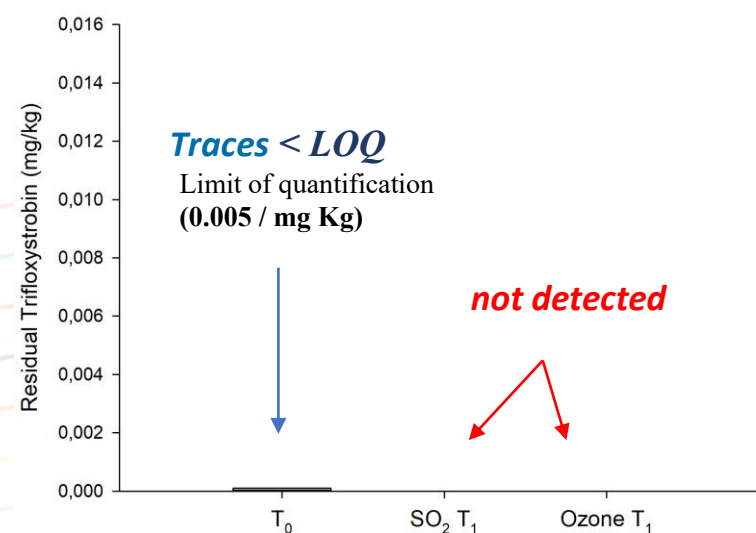


## ✓ Treatments effect at T1

✓ **Proquinazid**  
*Locally systemic fung.*



✓ **Trifloxystrobin**  
*Locally systemic fung.*

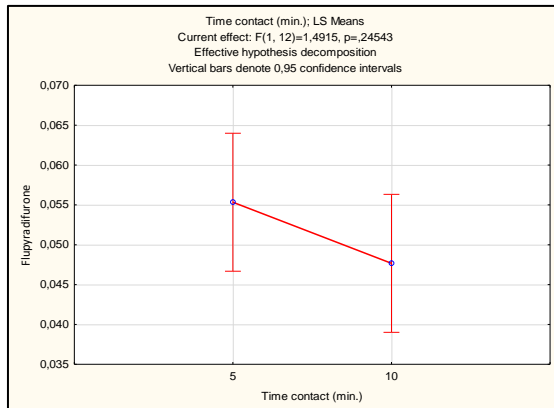


- ✓ Overall ozone effect at T1 time
  - ✓ reduced regardless of ozone treatment
    - ✓ **Trifloxystrobin**
    - ✓ **Proquinazid**
    - ✓ **Penconazolo**
    - ✓ **Acetamiprid**
  - ✓ canceled by ozone treatment regardless of washing contact and concentration
    - ✓ **Spirotetramat**
- ✓ depending on washing contact time and concentration
  - ✓ **Flupyradifurone**
  - ✓ **Fluxapiroxad**
  - ✓ **Fludioxonil**

## ✓ Ozone detailed effect

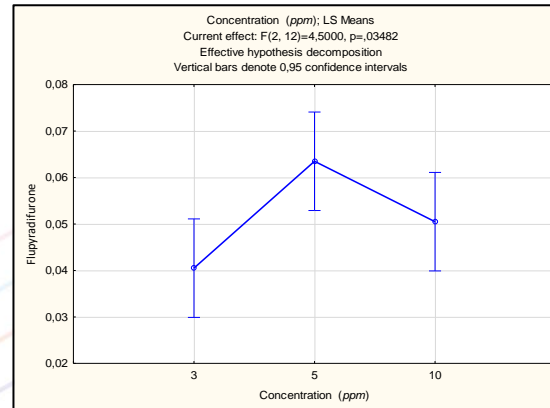
### ✓ Flupyradifurone

#### Washing time



Sign.  
n.s.

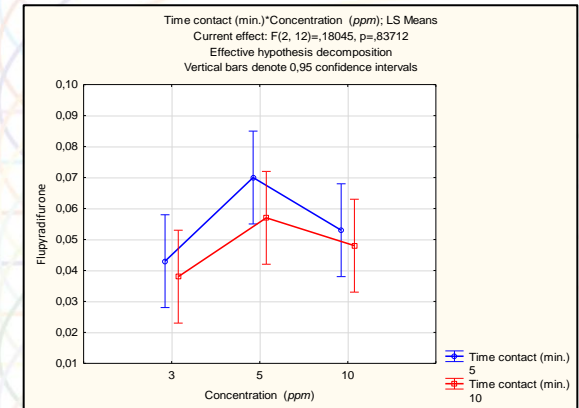
#### Concentration



Sign. \*  
 $p=0,03$

3 ppm (- 56,6 %)

#### Interaction



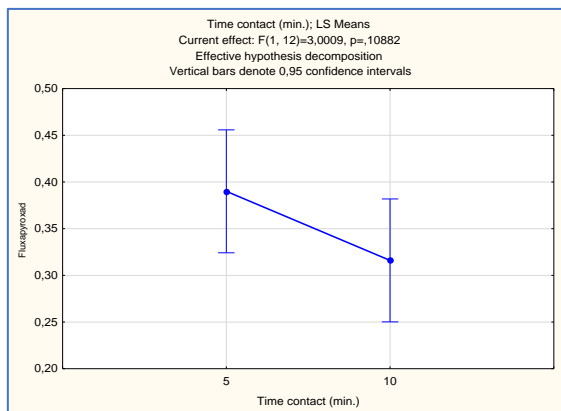
Sign.  
n.s.



## ✓ Ozone detailed effect

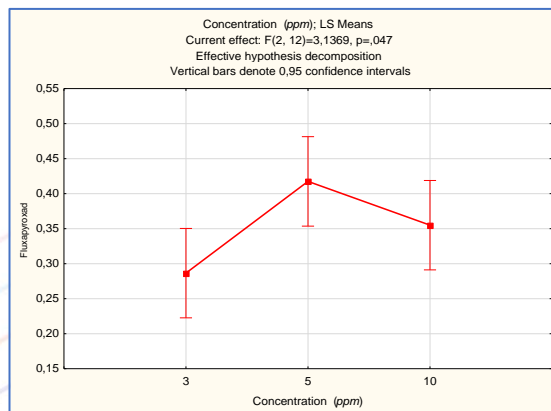
### ✓ Fluxapiroxad

#### Washing time



Sign.  
n.s.

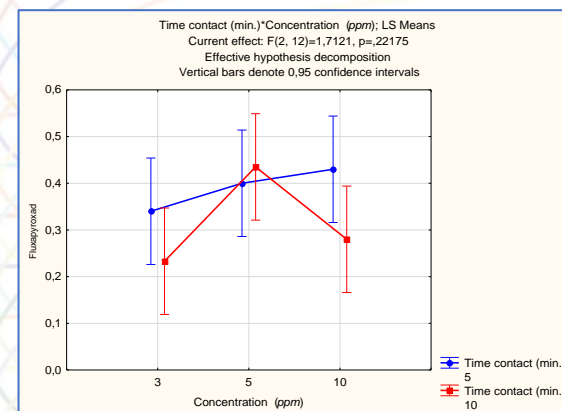
#### Concentration



Sign. \*  
 $p= 0,04$

3 ppm (- 78,2 %)

#### Interaction

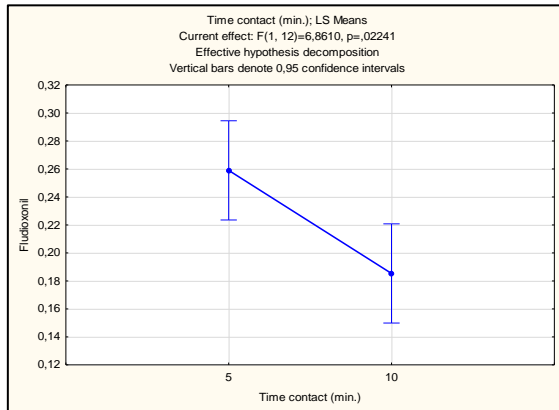


Sign.  
n.s.

## ✓ Ozone detailed effect

### ✓ Fludioxonil

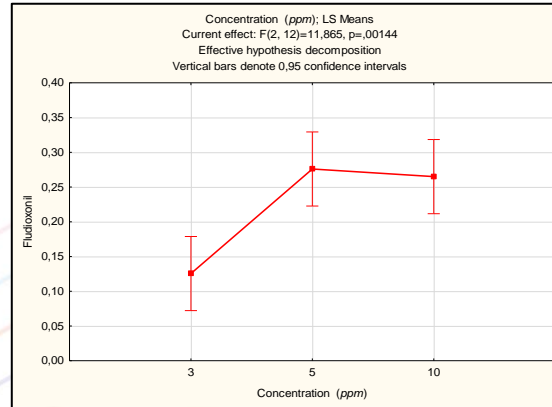
#### Washing time



**Sign. \***  
 $p= 0,02$

**10 min (- 84 %)**

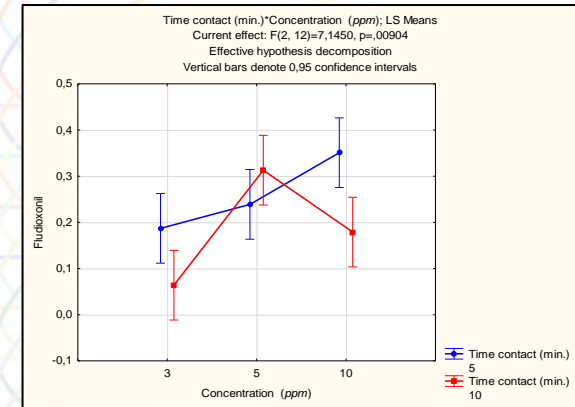
#### Concentration



**Sign. \*\***  
 $p= 0,001$

**3 ppm (- 90 %)**

#### Interaction



**Sign. \*\***  
 $p= 0,009$

**3 ppm x 10 min (- 94,8 %)**

- ✓ **Different pesticide behavior.**
- ✓ **Not discriminant way of action (systemic and contact).**
- ✓ **Application on Ready to eat table grape by means of washing treatments.**
- ✓ **Ozonated water for washing grapes destined to wine-making.**
- ✓ **Future tests to confirm results by means of ozone gas application.**

