Innovative Solutions for Reducing Copper-Based Pesticides in Sustainable Agriculture: The LIFE MICROFIGHTER Project

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Università degli Studi di Ferrara

LIFE MICROFIGHTER

BACKGROUND

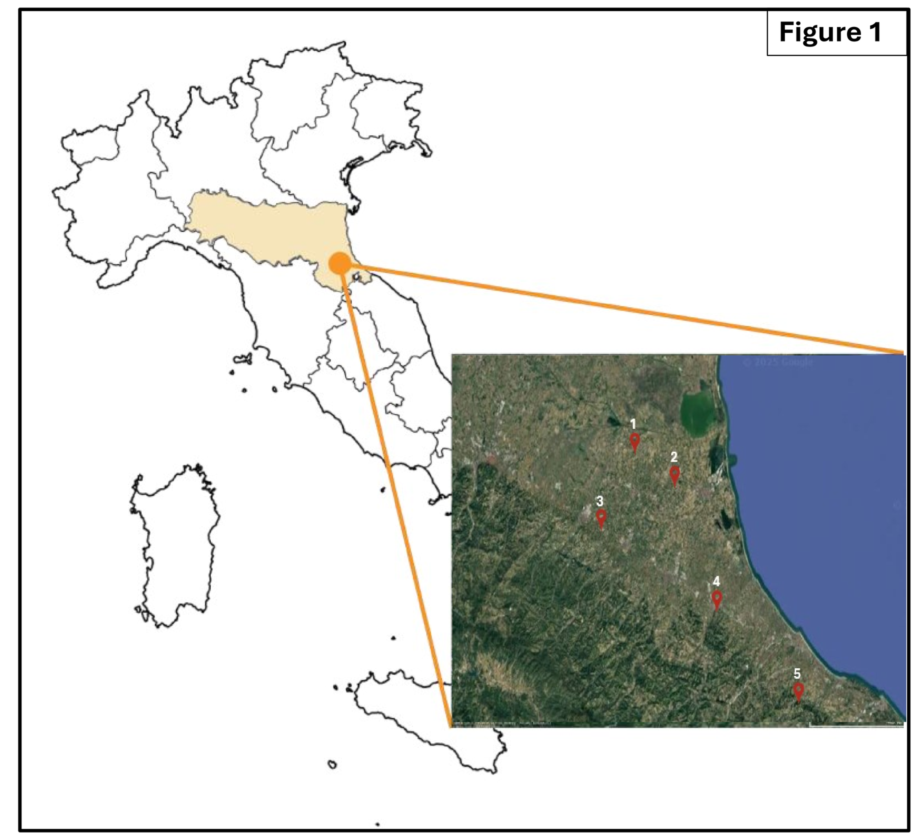
Copper-based agrochemicals are commonly used throughout Europe to manage bacterial and fungal diseases affecting key crops, such as downy mildew in grapevines. Their use is especially high in regions with humid conditions and frequent spring rainfall. However, the widespread application of copper compounds is not a sustainable practice, as copper tends to accumulate in fruits to potentially hazardous levels. Additionally, agricultural workers may be exposed to concentrations that exceed health safety thresholds. Long-term use of copper can also lead to increased soil phytotoxicity, promote resistance in pathogens, and raise production costs. Furthermore, copper runoff from treated fields can enter water bodies, settling in sediments where it poses a serious threat to aquatic life—including algae, invertebrates, and fish. Copper toxicity is also harmful to bees, birds, some mammals, and various soil macrofauna. Although the European Union is gradually restricting the use of copper-based pesticides, they are still extensively used in many countries—particularly in organic farming—due to the limited availability of effective alternatives.

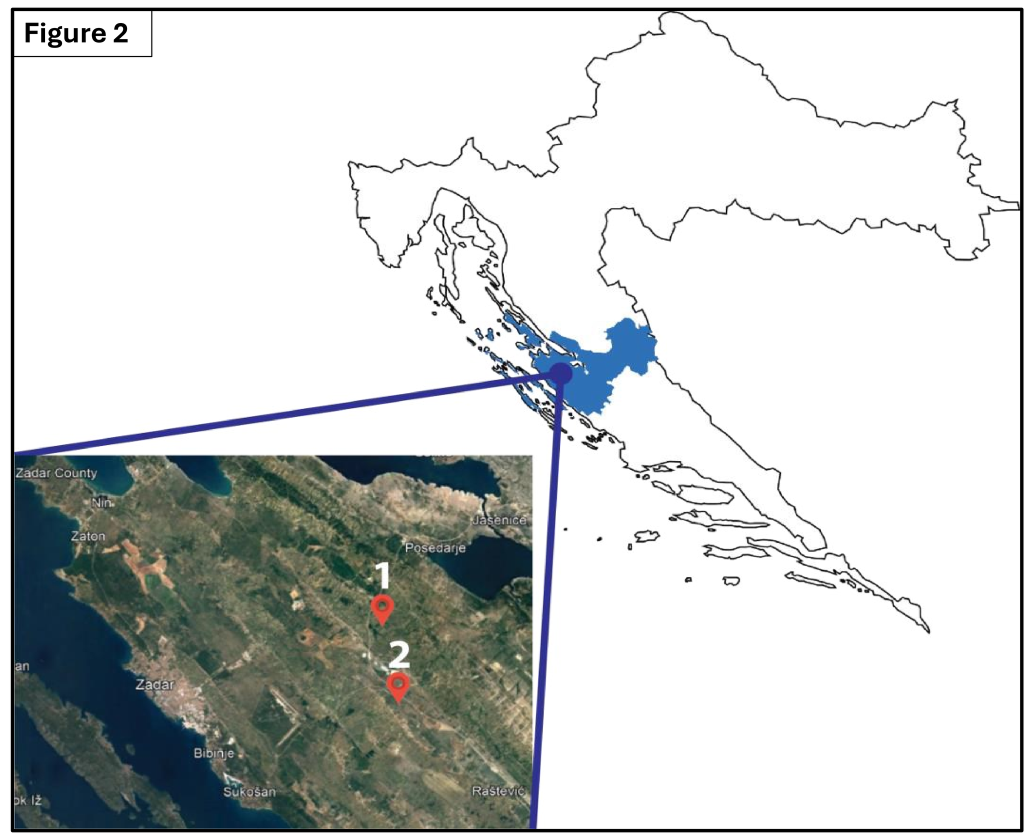
Natural zeolites, which are abundant in volcanic tuffs, have shown effectiveness in pest and disease control when applied as a foliar coating. **Microbial Biocontrol Agents (mBCAs)**, which are beneficial microorganisms, can also suppress certain pathogens through multiple mechanisms.

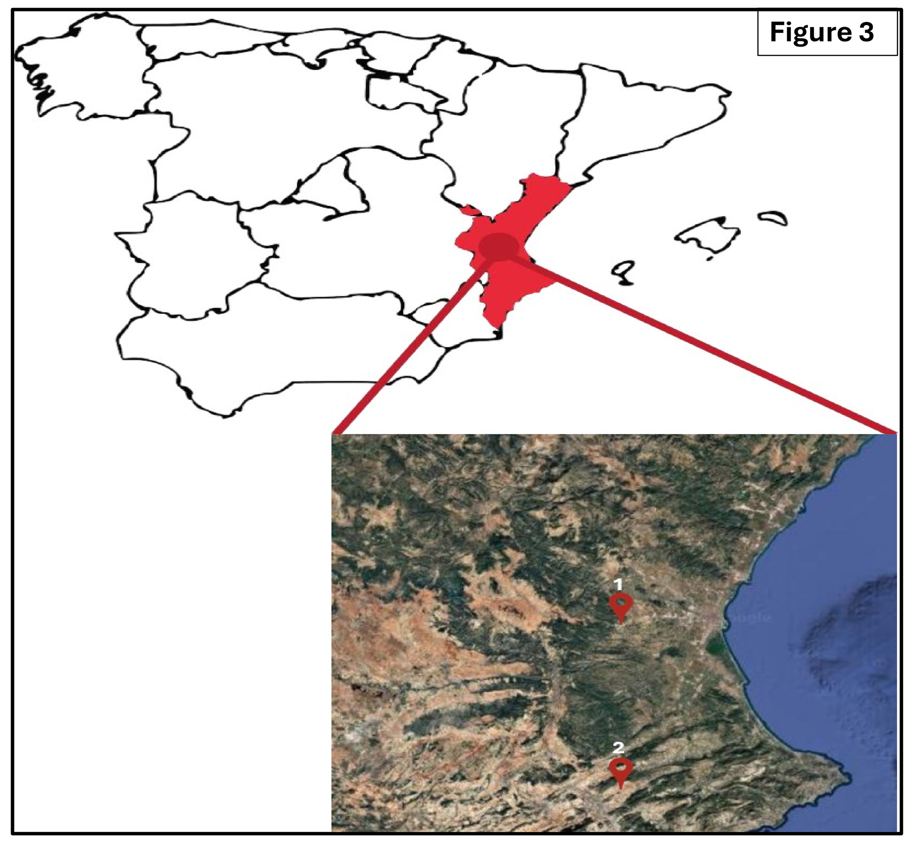
The combined use of **natural zeolites** and mBCAs—successfully demonstrated under laboratory conditions—offers a promising strategy for protecting crops while reducing copper input in agricultural systems.

The goal is to control major pathogens of grapevine, tomato, and olive (including downy mildew, bacterial speck, bacterial spot, olive knot, and peacock spot) exploiting **Zeo-Biopesticide** and hence reducing or avoiding the use of copper in organic and integrated agricultural systems. The efficacy of the method will be demonstrated with field trials (2-3 years duration) in **Italy** (Figure 1), **Croatia** (Figure 2), and **Spain** (Figure 3) (total of 9 fields)

EXPERIMENTAL FIELD







OBJECTIVES OF THE PROJECT

- Validate the effectiveness of a new, naturally-derived and environmentally friendly Zeo-Biopesticide, formulated with potassium-rich chabasite and the microbial biocontrol agent Pseudomonas sp. DLS65, as a sustainable alternative to conventional copper-based agrochemicals. The focus will be on controlling major plant diseases—such as downy mildew, bacterial speck, bacterial spot, olive knot disease, and peacock spot—that severely impact the cultivation of grapevines, tomatoes, and olives in both integrated pest management systems and organic farming across Italy, Croatia, and Spain.
- Lower copper inputs in agricultural soils from approximately 4 kg/ha/year to 2 kg/ha/year without compromising crop yield or quality. The project will also assess the potential for complete replacement of copper with the Zeo-Biopesticide, in light of a possible future ban on copper-based products.
- Show that annual use of the new Zeo-Biopesticide can reduce copper accumulation in topsoil by at least 0.7 ppm per year, while simultaneously enhancing soil biodiversity.
- Promote and support the adoption of the Zeo-Biopesticide and the associated cultivation practices as viable alternatives to copper use in grape, tomato, and olive production. This will be achieved through targeted dissemination efforts aimed at stakeholders, including farmers, advisors, and policy-makers.
- Conduct comprehensive monitoring of all field trials, perform a life cycle assessment (LCA) of the Zeo-Biopesticide, and develop a business plan to enable its commercialization within five years after project completion

EXPECTED RESULTS

- Across all demonstration sites in Italy, Spain, and Croatia:

1. Copper input will be significantly reduced, dropping from the current 4 kg/ha/year to approximately 2.33 kg/ha/year. This means that, instead of applying 72 kg of copper-based pesticides across the trial areas, only 42 kg will be used, resulting in a reduction of around 30 kg—equivalent to 41.7% less copper than current practices.
2. In plots where no copper is applied, the accumulation of copper in the top 30 cm of soil is expected to decrease by at least 0.7 ppm per year, amounting to 1.4 ppm over the two-year project period, compared to plots treated with 100% copper.
3. In plots where copper application is halved (i.e., 50% copper + 50% Zeo-Biopesticide), a reduction of at least 0.35 ppm/year (or 0.7 ppm over two years) in copper build-up in the topsoil is anticipated, relative to full-copper treatments.

- The combined treatment of 50% copper and 50% Zeo-Biopesticide is expected to effectively control target diseases (e.g., downy mildew, bacterial spot, etc.) with comparable efficacy to conventional full-copper treatments.
- An increase in soil microbial biodiversity is expected across all test sites after two years of applying the project's integrated approach.
- The taste, quality, and marketability of the harvested grapes, tomatoes, and olives will remain unaffected, ensuring that the new method does not compromise product standards.

SOIL COPPER MONITORING PROTOCOL AND ANALYSIS

➢ **Field Sampling Design**

- Experimental fields divided into **homogeneous sampling zones** (Figure 4a)
- Each zone subdivided into **sampling units (~100 m², 10 × 10 m)** (Figure 4b)
- **2 soil core (0–20 cm depth)** collected per sampling unit

➢ **Sampling Campaigns**

- **Year 1 (Baseline)**
  - Collection of soil cores across all units
  - Analysis of:
    1. **Copper (Cu) concentration**
    2. **Particle Size Distribution (PSD)** *(selected samples)*
    3. **Cation Exchange Capacity (CEC)** *(selected samples)*
    4. **Bulk Density (BD)** *(in situ)*
    5. **Soil Organic Matter (SOM)** and **pH**
- **Year 3 (Follow-up)**
  - Same sampling method as Year 1 (same sampling units and soil depth)
  - Re-analysis of: **Cu, SOM, BD and pH**

➢ **Analytical Methods**

- Sample preparation via **Microwave Digestion**
- **ICP-MS** used for Cu and trace
- Laser Granulometer for PSD
- Loss on Ignition for SOM
- $CaCl_2$ extraction for pH
- $BaCl_2$ extraction for CEC

➢ **Outputs**

- **Two spatial distribution maps** (Figure 5) of copper in surface soil (Year 1 vs Year 3)
- Correlation of copper changes with soil properties affecting **Cu mobility and retention**