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Novel copper nanoparticles for the control of olive foliar and fruit diseases

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Introduction

Peacock spot caused by *Spilocaea oleagina* and anthracnose caused by *Colletotrichum* spp., are the most important foliar and fruit diseases of olive, respectively. Applications of copper-based fungicides constitute the main control measures for these pathogens. However, replacement of copper – based fungicides with more eco-friendly alternative control strategies is a priority.

Aim

This study was performed to investigate the efficacy of 5 novel Nano-copper (Cu-NPs) formulations against these 2 major olive diseases.

Materials and Methods

- Five copper nanoparticles and two copper commercial products were evaluated (Table 1).
- The efficacy of Cu-NPs against *Spilocaea oleagina* was evaluated on 1-year-old olive trees (cv. Chalkidikis) under controlled environmental conditions in a plant growth chamber, while the efficacy against *Colletotrichum* spp. was evaluated on olive trees of the same cultivar located in an orchard in the area of Thessaloniki. In both cases, plants were inoculated 2 days after Cu-formulations application.
- *Spilocea oleagina* inoculation*:* Plants were sprayed to run-off with a conidial suspension. After inoculation, inoculated and control plants were covered with a plastic bag, incubated in a growth chamber at 23 ± 2°C for 48 h in the dark, and then transferred to the plant growth chamber at 19°C for 3 months. The percentage of latent infections on leaves was estimated following the sodium hydroxide method (Civantos, 1999).
- *Colletotrichum acutatum* inoculation: Plants were sprayed to run-off with a conidial suspension at full bloom (BBCH 65) stage (Sanz-Cortes et al.,2002). After inoculation, inoculated and control clusters were covered with a plastic bag for 24h. Evaluation of the efficacy of Cu-NPs products against the olive anthracnose disease was estimated measuring two factors. a) The number of infected inflorescences was determined 7 days after inoculation. Inflorescences were incubated in closed plastic containers (100% RH) and placed in a growth chamber (23 ± 2°C) for 5 days (Figure 1). b) The number of fruits (about 50% of final size) with latent infections of *Colletotrichum acutatum* was determined using the herbicide 1,1′-Ethylene-2,2′-bipyridyldiylium dibromide (Diquat) method (Moral *et al.*, 2009) (Figure 1).

Table 1. Copper-based formulations used in this study.

Copper based formulations		
Copper-based formulation name	**Application Dose (μg ml^{-1})**	**Manufacturer**
111_CN_S2_X1	240	Plin Nanotechnology
110_CN_S4_X1	240	Plin Nanotechnology
109_CC_S4_X2	240	Plin Nanotechnology
112_CN_S1_X1	240	Plin Nanotechnology
108_CN_S1_X1	240	Plin Nanotechnology
Nordox	240	K & N Efthimiadis
Kocide	240	K & N Efthimiadis

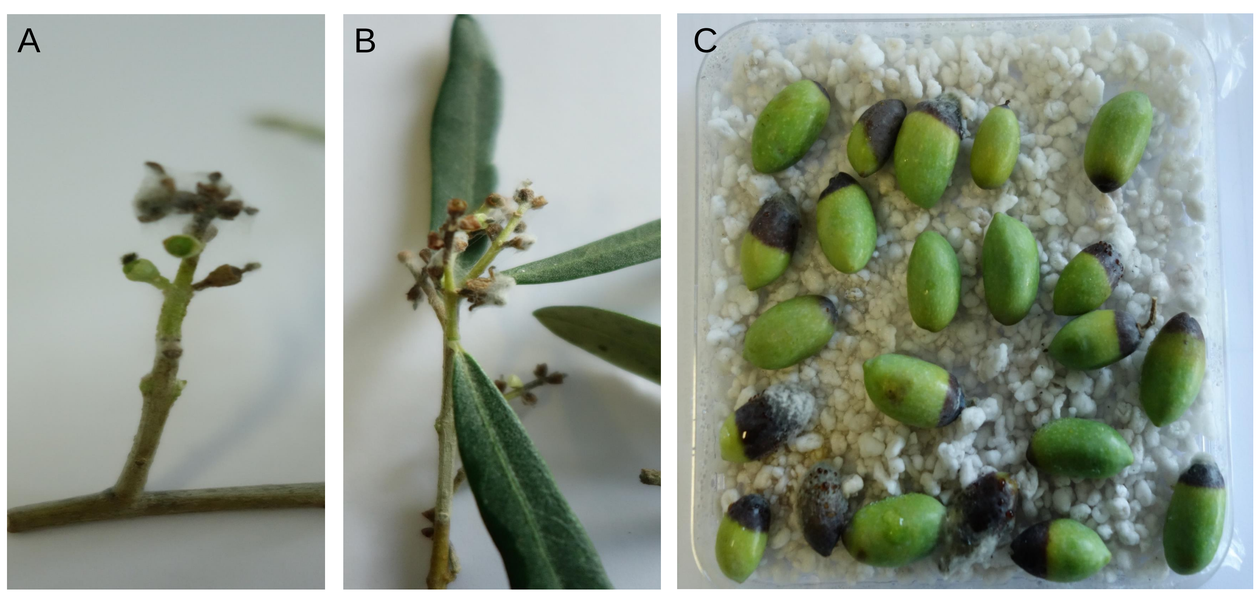

Figure 1. (A), (B) Presence of *Colletotrichum acutatum* on olive flowers 7 days after inoculation and **(C)** appearance of latent infections on fruits.

Results

- The calculation of flower infection revealed that the most effective copper nanoparticle against *Colletotrichum acutatum* was 110_CN_S4_X1 with a control efficacy value of 61.03% (Figure 2).
- The measurement of latent infections on olive fruits caused by *C. acutatum* showed that three copper nanoparticles (110_CN_S4_X1, 109_CC_S4_X2, 112_CN_S1_X1) were the most effective with control efficacy values ranging from 60.4 to 71.7%. On the contrary, the two copper commercial products Kocide and Nordox had control efficacy values of 33.9 and 43.4%, respectively (Figure 3).
- In addition, three copper nanoparticles (110_CN_S4_X1, 109_CC_S4_X2, 108_CN_S1_X1) showed the highest control efficacy against *Spilocaea oleagina,* with control efficacy values ranging from 60 to 67.5%. On the other hand, Kocide and Nordox showed the lowest control efficacy, with control values of 35 and 50%, respectively (Figure 4).

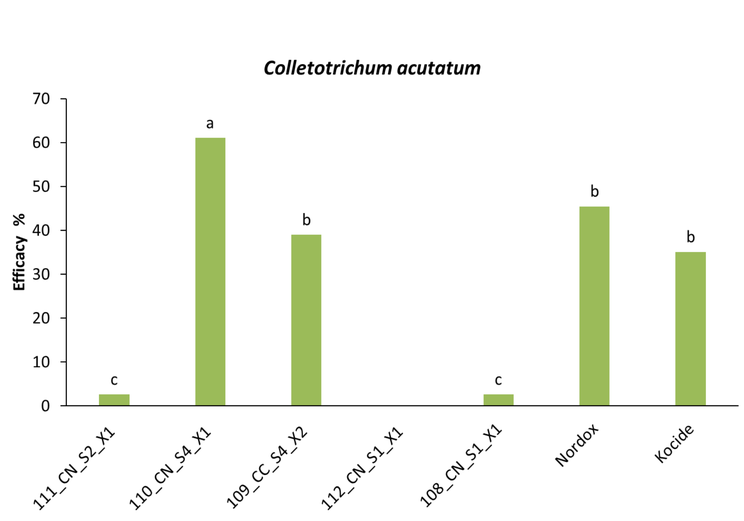

Figure 2. Control efficacy (%) of copper-based formulation treatments against *C. acutatum* after measurement of flower infection.

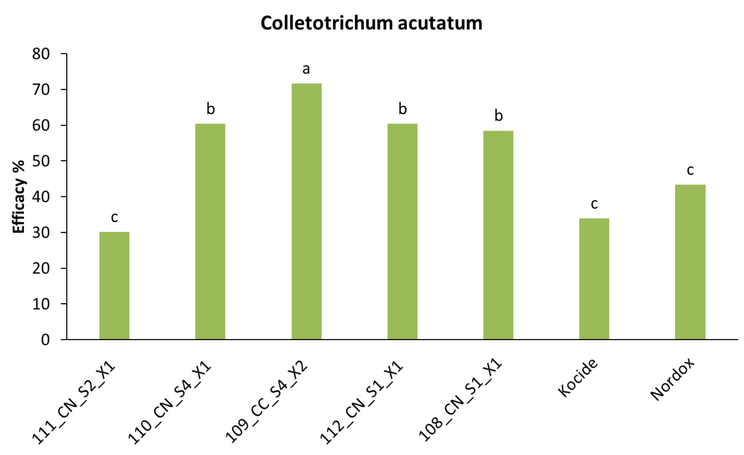

Figure 3. Control efficacy (%) of copper-based formulation treatments against *C. acutatum* after measurement of latent infections on olive fruits.

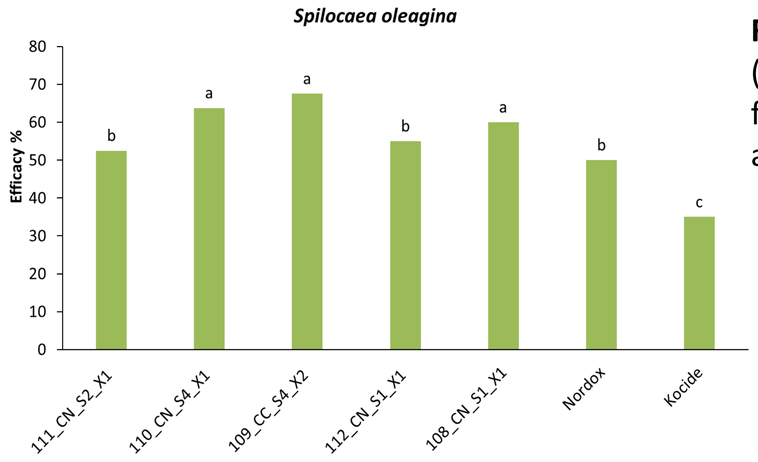

Figure 4. Control efficacy (%) of copper-based formulation treatments against *S. oleagina*.

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