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Nanoengineered Plant Protection: *Cercospora beticola* Control in Sugar Beet with Encapsulated Phytoextracts

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INTRODUCTION & AIM

Nanotechnology offers promising applications in agriculture, aiming to increase crop production while reducing environmental impact. **Nanocarriers** (NCs) enable the efficient transport of biologically active molecules, minimizing the required amount of bioactive compounds and allowing for controlled release over time. Recently, NCs have been proposed as a key technology for applying agrochemicals. This study presents the results of using **chitosan-based NCs to deliver natural compounds**, specifically extracts of *Rubia tinctorum* and *Uncaria tomentosa*, **for the effective and sustainable control of phytopathogens in horticultural crops**.

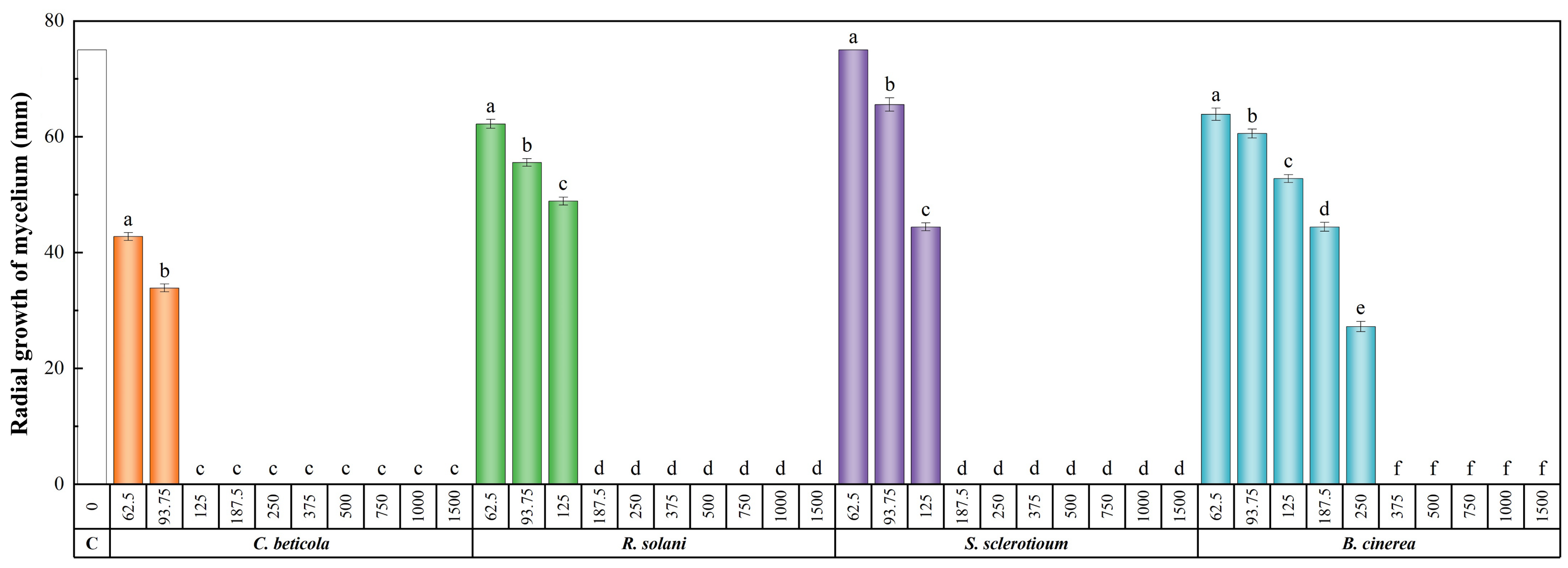
METHODOLOGY

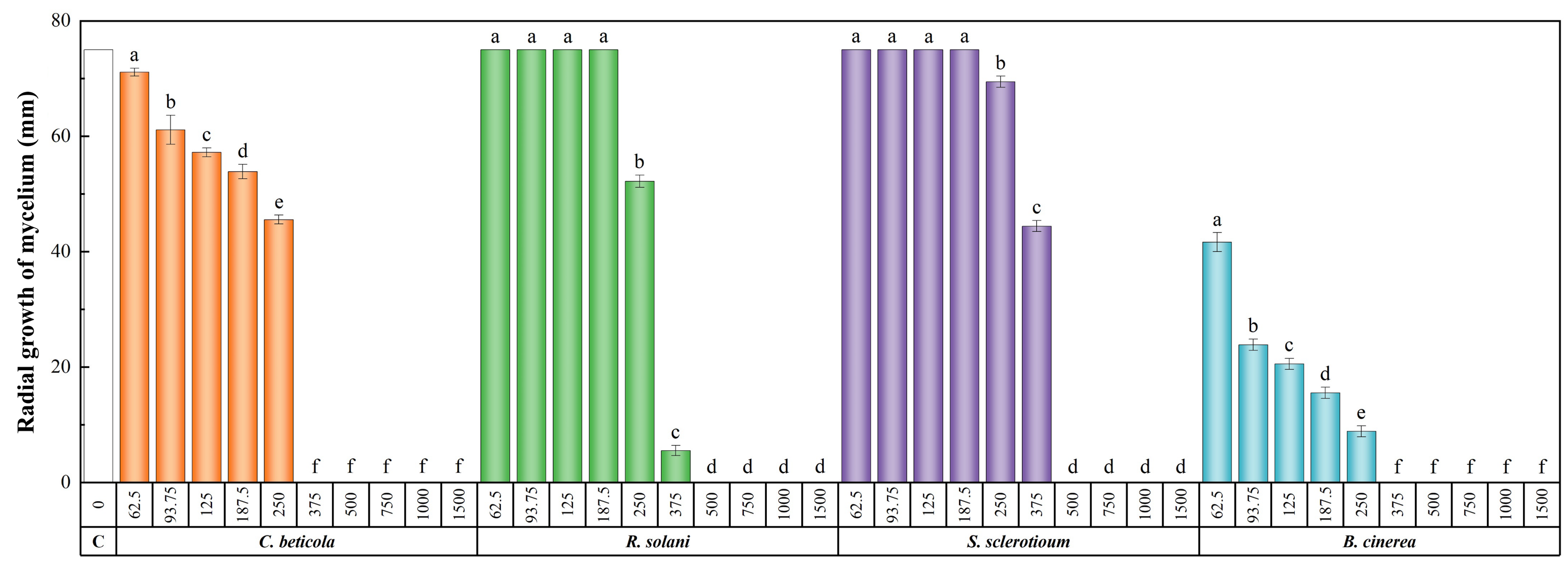
The synthesis of NCs and their characterization is explained in detail in Santiago-Aliste *et al.* (2022, 2023). Their antimicrobial activity was assessed through ***in vitro*** analyses against several horticultural pathogens, including ***Botrytis cinerea***, ***Cercospora beticola***, ***Rhizoctonia solani***, and ***Sclerotinia sclerotiorum***, following the EUCAST guidelines. For ***ex-situ* plant protection assays**, the protocol established by González et al. (2020) was followed. **Field tests** were conducted on sugar beet over a growing season, in AIMCRA's facilities at San Román de Hornija (Valladolid, Spain), with **treatment application through spraying**.

RESULTS & DISCUSSION

In vitro results:

Mycelial growth inhibition (MIC) values ranged from **187.5 to 375 µg/mL** for **NCs loaded with *R. tinctorum* extracts** and from **187.5 to 500 µg/mL** for those with ***U. tomentosa* extracts**, depending on the pathogen.

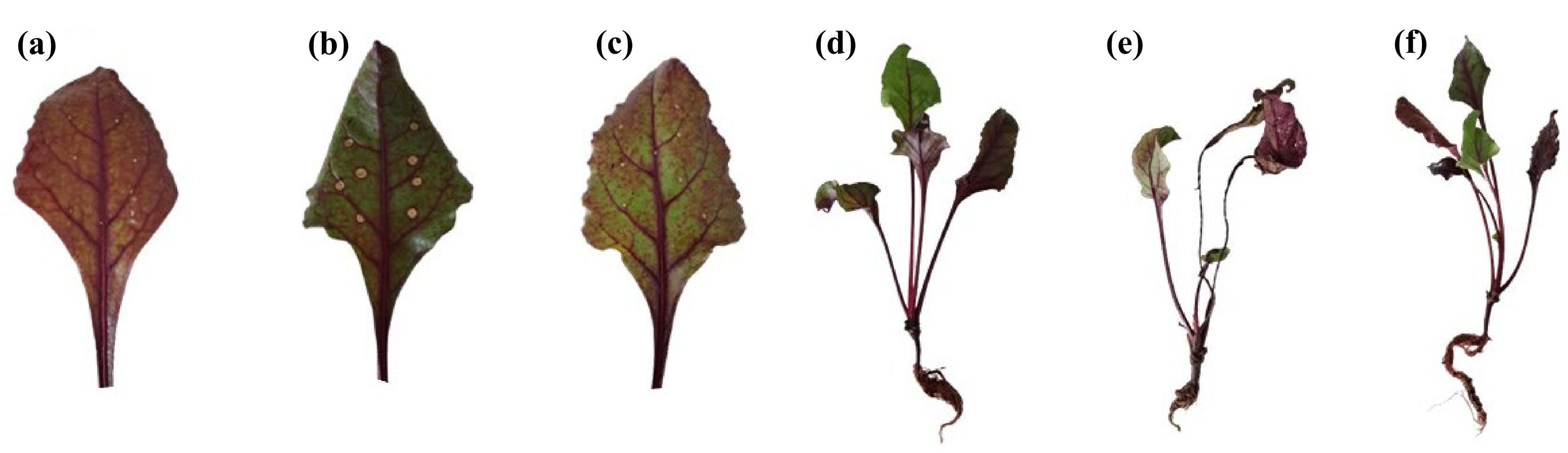




Mycelial growth inhibition achieved with C_3N_4-COS NCs loaded with *R. tinctorum* extract (*left*) or with C_3N_4-COS-HAP NCs loaded with *U. tomentosa* extract (*right*) at concentrations over the 62.5–1500 µg/mL range. Same letters indicate non-significant differences at $p<0.05$. Error bars show standard deviations. 'C' represents the untreated control (fungus growing on PDA medium).

Ex-situ plant protection assays:

Complete plant protection of sugar beet plants artificially inoculated with *C. beticola* and *R. solani* was achieved at **500 µg/mL.**



Plant protection assays against (**a-c**) *C. beticola* and (**d-f**) *R. solani*. (**a**,**d**) Negative control; (**b**,**e**) positive control; (**c**,**f**) treatment with C_3N_4-COS NCs loaded with *R. tinctorum* extract at 500 µg/mL.

Field plant protection assays:

Field tests showed promising results for *C. beticola* control for both treatments at a dose of **500 µg/mL**, with no phytotoxicity signs.

Field application by spraying (*left*); untreated control leaves (*center*); treated leaves (*right*).

CONCLUSION

Chitosan-based nanocarriers loaded with bioactive compounds offer substantial protection of sugar beet against *C. beticola* at a dose of 500 µg/mL. The absence of phytotoxicity and clogging problems during spray application pave the way to towards optimizing the unmanned aerial vehicle (UAV) field application of these treatments.

REFERENCES

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