

Co-inoculation effects of A1 and A2 mating types of *Phytophthora* × *cambivora* and *P. cinnamomi* on *Castanea sativa*.

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INTRODUCTION

Ink disease of chestnut (*Castanea sativa* Mill) caused by the oomycete *Phytophthora* was first described in Portugal and subsequently reported throughout whole Europe. *P. cinnamomi* and *P. ×cambivora* are the most associated oomycetes causing decline, dieback and mortality of chestnut. Although ink disease caused by *P. cinnamomi* is more distributed in Atlantic areas and ink disease caused by *P. ×cambivora* is more prominent in warmer areas of Central Europe, co-occurrence of both pathogens has also been recorded. There are currently no experiments based on co-inoculations with both pathogens and neither with their mating types. This study aims to characterise the development of the disease and its severity as well as to describe the physiological changes of the plants as response to infections of the A2 mating type of *P. cinnamomi*, A1 and A2 mating types of *P. ×cambivora* and the combinations of two of these pathogens.

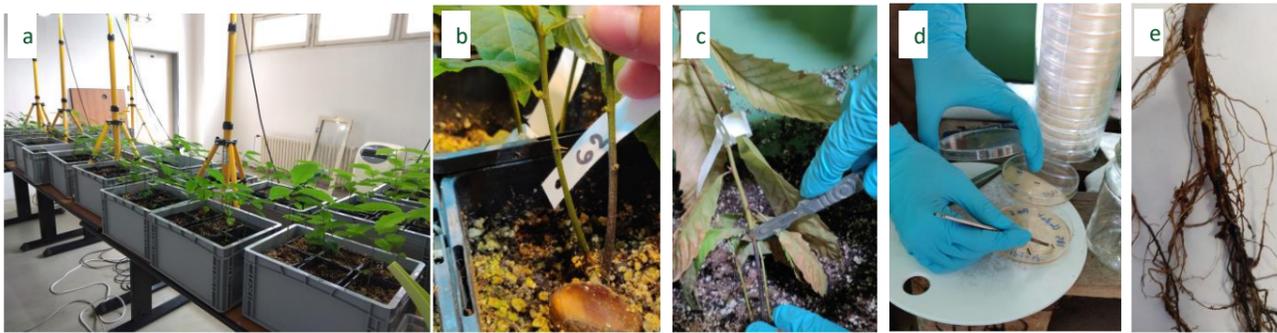


Fig. 1. Methodology: a) chestnut seedlings distribution within the trial, (b) stem lesions developed after inoculation of plants (c) removal of *Phytophthora* infected bark tissue, (d) plating infected tissue on PARPNH-agar selective media and (e) root assessments.

RESULTS

First stem lesions appeared two weeks post-inoculation in the plants inoculated with *P. cinnamomi* A2 and *P. cinnamomi* A2-*P. ×cambivora* A2 and three weeks post-inoculation in the *P. cinnamomi* A2-*P. ×cambivora* A1 treatment. Afterwards all treatments except control produced stem lesions. The highest mortality rates were associated with the *P. cinnamomi* A2, the *P. cinnamomi* A2-*P. ×cambivora* A2 and the *P. cinnamomi* A2-*P. ×cambivora* A1 treatments (Fig. 2a). The percentage of tap root necroses was significantly higher in plants subjected to *P. cinnamomi* A2, *P. cinnamomi* A2-*P. ×cambivora* A2 and *P. cinnamomi* A2-*P. ×cambivora* A1 treatments than in plants in the *P. ×cambivora* A2 and control treatments. Plants inoculated with *P. ×cambivora* A2 had a higher percentage of healthy roots than the *P. cinnamomi* A2-*P. ×cambivora* A1, *P. cinnamomi* A2-*P. ×cambivora* A2 and *P. cinnamomi* A2 treatments.

Physiological measurements of some treatments were not possible after a few weeks post-inoculation due to the high mortality rate. Plants subjected to the *P. cinnamomi* A2, *P. cinnamomi* A2-*P. ×cambivora* A2 and *P. cinnamomi* A2-*P. ×cambivora* A1 treatments showed the lowest values of maximum quantum yield of photosystem II. One month post-inoculation control and *P. ×cambivora* A1-infested plants had generally higher values of NDVI than the combined *P. ×cambivora* A1-*P. ×cambivora* A2 treatment (Fig. 2c). Control plants differed in PRI values from *P. ×cambivora* A1-*P. ×cambivora* A2 and *P. ×cambivora* A2 infected plants (Fig. 2d). In most cases, SIPI and CRI1 did not differ between control and *Phytophthora* treatments. Higher values of net photosynthesis were observed in control, *P. ×cambivora* A2 and *P. ×cambivora* A1-*P. ×cambivora* A2 treatments comparing to the others (Fig. 2e).

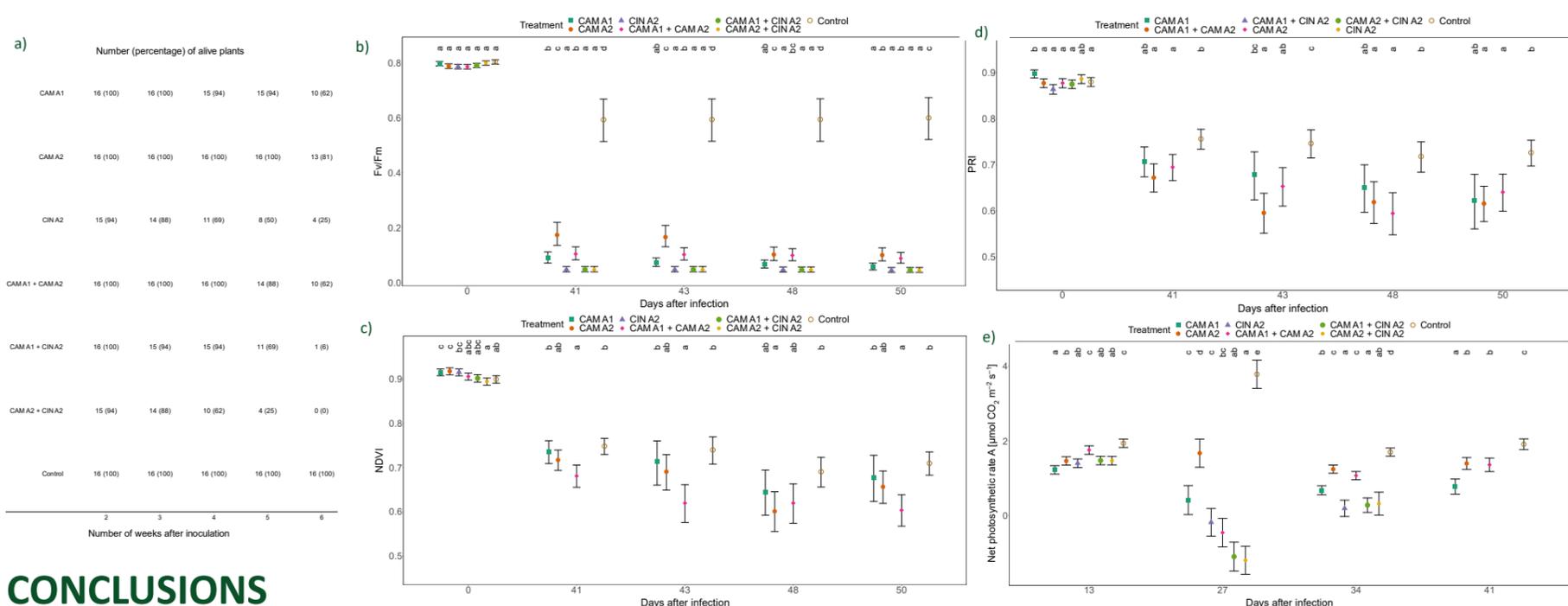


Fig. 2. Differences on the number of alive plants (a) and on the mean values of (b) Fv/Fm, (c) NDVI, (d) PRI and (e) net photosynthetic rate between the inoculation treatments.

CONCLUSIONS

Chestnut was affected by inoculation with *P. ×cambivora* A2, inoculation with *P. ×cambivora* A1, inoculation with *P. cinnamomi* A2, co-inoculation with *P. ×cambivora* A2 and *P. ×cambivora* A1, co-inoculation with *P. ×cambivora* A2 and *P. cinnamomi* A2, co-inoculation with *P. ×cambivora* A1 and *P. cinnamomi* A2 in terms of physiology, below- and aboveground infection symptoms and mortality. Early detections of infections were more obvious after one month trial when measuring chlorophyll fluorescence and net photosynthesis than when measuring spectral reflectance. Mortality rates differed between treatments being *P. cinnamomi* A2 alone and in combination with *P. ×cambivora* the treatments with the highest number of dead plants. Physiological measurements and root biometry as well as infection symptoms showed similarly the higher susceptibility of chestnut to *P. cinnamomi* A2.

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