



Improving productivity and sustainability of black truffle plantations by microbiological handling of the rhizosphere

Introduction

Black truffle production is an expanding crop in Catalonia with high economical potential, especially in agricultural areas with low productivity. In this sense, black truffle cultivation is often developed on poor soils, with low production yields and where trees present nutritional deficiencies and serious phytosanitary problems. Another problem to be solved in truffle culture is crop irregularity, possibly due to suboptimal production conditions, both in the nursery and in the field. As a major difference from the cultivation of trees for biomass or for the cultivation of fruits, in this case we work with a much more complex interaction between the tree and the rhizosphere or interface zone between the root of the plant and the soil. However, the increase of monospecific plantations (generally holm oaks) can cause an increase in certain diseases and pests that decrease the production of truffles. Management of the rhizosphere can contribute to the general improvement of plant vigor and its tolerance to biotic factors without the need to use phytosanitary products. In this project we evaluated the capacity of different organic substances and rhizobacteria, some isolated from wild truffle areas described by Vilanova et al (2013) with the intention of improving the biotic and abiotic conditions of the rhizosphere, considering the presence and availability of nutrients, Development of the vegetative phase of truffle mycelium, vigor of the tree (nutritional status) and control of pathogens. The follow-up of the fungus response will be carried out in collaboration with IRTA, using the technology and results of the innovative pilot project, financed by the Department of Agriculture of the Generalitat de Catalunya in 2013 (File No. 56700362013). These techniques are based on quantitative PCR and allow us to determine the mycelium biomass of a fungal species, in this case *Tuber melanosporum*, in a soil sample (Parladé et al. 2013). The monitoring of the vigor of the tree will be carried out through foliar nutrient analysis. In order to correlate the bacterial activity generated in the rhizospheric soil by the introduction of bacterial strains and the effects on the plant and the fungus, initial and final counts of viable aerial mesophiles will be carried out by means of isolating in the appropriate selective media.

Lessons learned

The application of the different rizobacteria, organic compounds, and combinations of treatments in the first and second year of experimentation did not present effects on the concentration of *Tuber melanosporum* mycelium in the substrate of the plants produced in nursery. The treatments used, in isolation or combined, have no effect on a young plant growing in the nursery. The conditions of the nursery (substrate, irrigation, fertilization) and the fact of incorporating a can concentration of spores of the mycorrhizal fungus to obtain the mycorrhization of the plants are sufficiently developed, and the application of this compounds in the phase of Nursery does not represent any detectable improvement. In the plot of Granollers we find comparable results. None of the applied treatments, separately or in combination, have increased the concentration of truffle mycelium in the soil surrounding the treated plants. In a plot already established for years and that is already producing truffles, the incorporation of rizobacterial and organic compounds has no stimulating effect on the development of mycelium fungus. A plot established more than 12 years ago, the fungal composition of the rhizosphere of plants is sufficiently stabilized to be able to significantly modify the equilibrium established with contributions such as those proposed. In the case of Batea's newly established plot in which the treated plants had an age of 3 years, the effects of the incorporation of rizobacteria such as *Bacillus liqueniformis* or *Pseudomonas fluorescens*, as well as the incorporation of organic compounds of different origins, had a stimulating effect on the development of *Tuber melanosporum* mycelium. In young plants, in the phase of settling in their place of definitive plantation, with strong biotic and abiotic competition of the environment, the application of these products if it confers a positive effect on the development of the mycelium of truffle. In conclusion, the application of these products in young plantations in the phase of establishment would be recommended, and it would not be necessary in the phase of production of mycorrhizal plant in nursery or in plantations already adult in phase of production. In view of the results obtained, it can also be concluded that combinations of rizobacteria and organic compounds did not present the expected summation effect in a principle. The hypothesis that the combination of treatments with stimulating effects on the development of truffle mycelium would have a better behavior than the components separately has not been confirmed. More studies would be needed to design, with more data, these possible combinations. On the other hand, combinations of treatments, especially those that contained organic compounds, have had an effect on the bacterial populations of the soils of both plantations. And also, the fungus in the case of the Granollers plantation, consisting of adult plants in production. It is described in the literature that these bacteria can have a positive effect on the development of the plant, and indirectly on the production of truffles. The future monitoring of these parcels would allow to verify it. At the time, to continue collecting data from these experiments, would allow it to determine if the effects of the treatment persist in time or the need to repeat them periodically during the first phases of planting establishments should be considered. With regard to the improvement of the collection and accumulation of nutrients in plants, in all cases the detected effects were not consistent and did not allow to detect a treatment that was efficient in improving the content of nutrients in the plants. There are not enough data to extract solid conclusions.

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Further information

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