Use of compost to partially substitute non-renewable growing media and suppress soil-borne pathogens on potted vegetable plants

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Abstract

Composts are expected to suppress plant diseases, according to the type of wastes, the composting process, the chemical and microbiological composition. Suppressive composts are generally applied as soil improvers, while it is necessary to develop specific compost based growing media for applications on potted plants. The aim of this research was to evaluate the suppressiveness of compost/peat growing medium compared to peat. A growing medium made of 20% v/v compost, peat and pumice was tested. Suppressiveness was tested in greenhouse on potted plants against *Pythium ultimum* on cucumber, *Phytophthora nicotianae* and *Fusarium oxysporum* f. sp. *lycopersici* on tomato. Pathogens were mixed into the substrate at 1 g of biomass on wheat kernels L^{-1} 7 days before seeding or with chlamydospores in talc at $1x10^4$ cfu/g of substrate. Seeds of cucumber and tomato were sown into 2 L pots in greenhouse and five pots were used for each treatment. A commercial peat based growing medium was used as control. The number of alive plants and weight of above ground biomass were measured 20-30 days after seeding. Cucumber and tomato biomass significantly increased up to 40-50% with the compost/peat growing medium compared to control. The number of diseased tomato plants in substrates inoculated with *P. nicotianae* was significantly reduced by 40% and the number of diseased cucumber plants by 30% compared to the peat substrate. Fusarium wilt of tomato was reduced by 60% in plants grown with the compost/peat growing medium. The tested growing medium, thanks to its composition based on high quality compost, improved plant development and controlled *Pythium ultimum* on cucumber, *Phytophthora nicotianae* and *Fusarium oxysporum* f. sp. *lycopersici* on tomato. Compost is a valuable component of growing media that can partially substitute non-renewable sources and suppress soilborne pathogens.

Key words: Fusarium wilt, tomato, cucumber, *Pythium*, *Phytophthora*.

INTRODUCTION

Composting is a way to upcycle biowastes into a valuable biofertilizer, called compost. The processes to obtain it have been improved in the last years, and the most recent plants are generally integrated with anaerobic digestion systems and pyrolysis. This circular economy approach further increases the quality of compost, which is a renewable fertilizer, and provides also renewable energy (De Corato et al., 2018).

Composts are expected to suppress plant diseases, according to the type of wastes, the composting process, the chemical and microbiological composition (Hadar, 2011). Variability also depends on the pathosystem, as well as on soil type and conditions, like texture, pH and moisture, and the microbial component of compost also play an important role (Noble and Coventry, 2005).

Suppressive composts are generally applied as soil improvers, mixed to the soil before or at planting, at 5-30 t/ha, according to soil fertility and crop uptake (Pugliese et al., 2015). Maturity, salinity and other chemical parameters are considered less important than organic matter and nutrient content for composts applied as soil improvers or for land reclamation. However, only top-quality composts, fully stable and rich in nutrients, are suitable for applications on potted plants. Good examples of application of compost mixed into peat based growing media are well known since the 1970s, with dosages generally varying from 10-40% v/v of compost for being suppressive (Pane et al., 2011; Pugliese et al., 2015). More difficult is to standardize and industrialize this approach, as well as to develop specific compost based growing media for applications on potted plants, due to possible negative effects such as high pH and salinity and low maturity

The aim of this research was to evaluate the suppressiveness of compost/peat growing medium compared to peat, starting from commercially available products, and demonstrate the possibility of using renewable substrate to substitute peat substrate on potted plants.

MATERIALS AND METHODS

Preparation of trials

The commercially available compost based growing medium “Hortofan”, made with 20% v/v suppressive composts, peat and pumice, and produced by the start-up company AgriNewTech srl in Italy, was compared with peat based growing medium, compost free. The peat used was the same in both substrates.

Suppressiveness was tested in greenhouse on potted plants against *Pythium ultimum* on cucumber, *Phytophthora nicotianae* and *Fusarium oxysporum* f. sp. *lycopersici* on tomato.

Pathogens were mixed into the substrate at 1 g L^{-1} of biomass on wheat kernels 7 days before seeding or with chlamydospores in talc at $1x10^4$ UFC g^{-1} of substrate. Ten seeds of cucumber (cv Marketmore) and tomato (cv Cuor di Bue) were sown into 2 L pots in greenhouse and five pots were used for each treatment. Pots were place in greenhouse, with a randomized experimental block design, daily watered and kept at an optimum temperature for the pathosystems (20-25°C). All trials were carried out twice. Two trials were also carried out with the same method, but without the inoculation of the pathogens, to assess the effect on tomato and cucumber growth.

The number of germinated seedlings was counted 7-10 days after seeding and alive plants and the weight of above ground biomass were measured 20-30 days after seeding. For the Fusarium wilt trial, a disease index from 0 (healthy) to 100 (wilted) was given to tomato plants.

Statistical analysis

Statistical analysis was carried out using SPSS 22.0. After assessing the homogeneity of variances, the data of the two experiments were pooled together for the cucumber and tomato/*P. nicotianae* trials. ANOVA and Tukey's "HSD" post-hoc tests were used, with a significance defined at the $P < 0.05$ level.

RESULTS AND DISCUSSION

Cucumber and tomato above ground biomass significantly increased, respectively, up to 40 and 62% with the compost/peat growing medium compared to control, showing a plant-growth promotion effect (Fig. 1).

The number of diseased tomato plants in the substrates inoculated with *P. nicotianae* was significantly reduced from 5/pot to 0.8/pot (~40% reduction) compared to the control (Fig. 2). Also the number of diseased cucumber plants was reduced from 67% to 34% of plants killed by *P. ultimum* (Fig. 2) compared to the compost free substrate.

Fusarium wilt of tomato was significantly reduced by 50% in plants grown with the compost/peat growing medium compared to those grown with a peat based growing medium used as control, showing a suppressive effect against *F. oxysporum* f. sp. *lycopersici* on tomato (Fig. 3). In the first trial disease index of compost/peat growing medium was 31, compared to 80 in the compost free substrate. In the second trial it was 70, while it was 20 in the peat growing medium.

CONCLUSIONS

The tested compost/peat growing medium, thanks to its composition based on high quality compost, improved plant development and controlled important soil-borne pathogens like *Pythium ultimum* on cucumber, *Phytophthora nicotianae* and *Fusarium oxysporum* f. sp. *lycopersici* on tomato.

Compost is a valuable component of growing media that can partillay substitute non-renewable sources and suppress soil-borne pathogens.

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 633999 "EU-China Lever for IPM Demonstration" (EUCLID).

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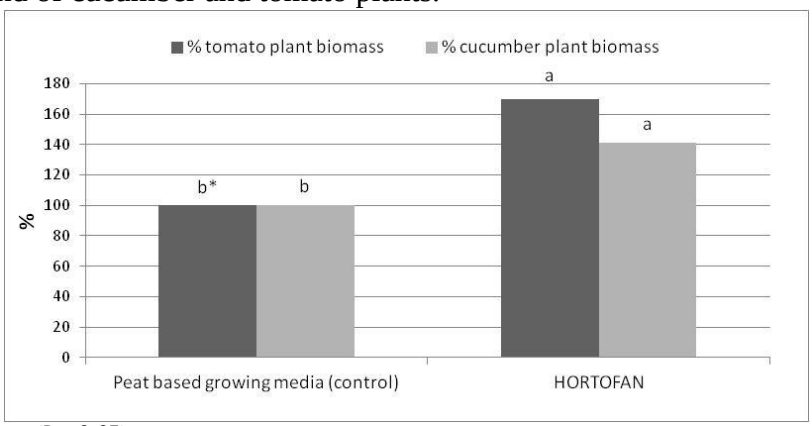
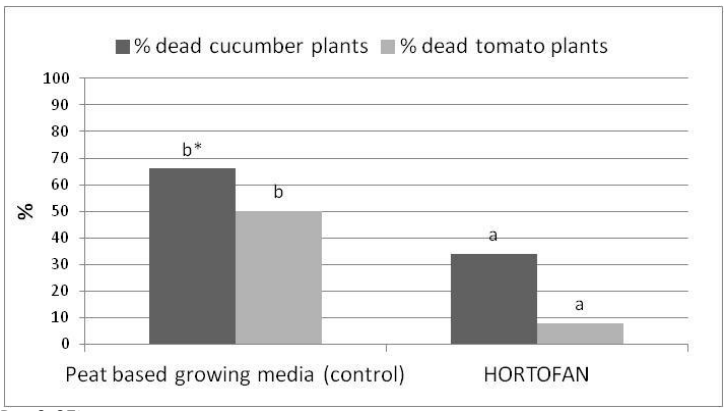
Figures

Fig. 1. Effect of peat based and compost/peat based (Hortofan) growing medium on above ground of cucumber and tomato plants.



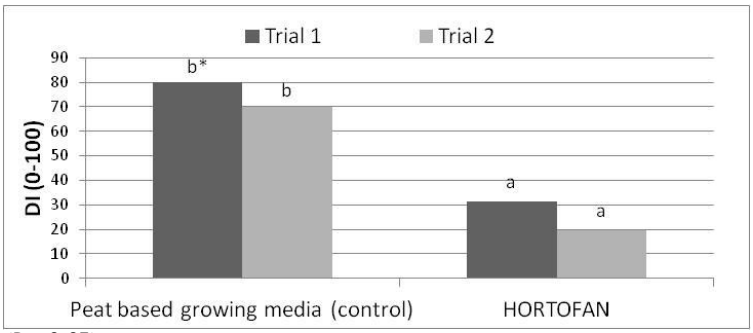
* Tukey's HSD test (P < 0.05).

Fig. 2. Effect of compost/peat growing medium (Hortofan) on the control of *Pythium ultimum* on cucumber and of *Phytophthora nicotianae* on tomato compared to a peat growing medium.



* Tukey's HSD test (P < 0.05)

Fig. 3. Effect of compost/peat growing medium (Hortofan) on the control of *F. oxysporum* f. sp. *lycopersici* on tomato compared to a peat growing medium.



* Tukey's HSD test ($P < 0.05$)