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The use of green waste compost in peat-based potting mixtures: Fertilization and suppressiveness against soilborne diseases

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Abstract

Twelve commercially produced Dutch green waste composts were evaluated for their suitability to replace 20% (v/v) peat substrate in the cultivation of ornamentals. Salt concentrations were determined in water extracts of the composts and disease suppressive effects were assessed against various soilborne diseases. The Cl-concentration of the compost extract appeared to be the limiting factor for use of the composts in potting mixtures. The Cl-concentrations in 7 and 1 composts, respectively, were too high to replace 20% of peat for growing salt sensitive and moderately salt sensitive plants, according to guidelines set for these groups of plants. The suppressive effects of the composts were tested in peat-based potting mixtures using three bioassays: *Phytophthora cinnamomi*—lupin, *Cylindrocladium spathiphylli*—*Spathiphyllum* and *Rhizoctonia solani* AG2-1—cauliflower. Disease levels in compost-amended mixtures were compared with the non-amended controls. None of the composts induced suppressiveness against *P. cinnamomi*; 3 and 9 composts significantly induced suppressiveness against *C. spathiphylli* and *R. solani*, respectively. No significant disease enhancement was observed in any of the bioassays. The pH of the potting mixture showed a negative correlation with suppression of the *Rhizoctonia* disease ($R^2 = 0.56$). The effect of pH (pH 4–6) on suppression of *R. solani* and *P. cinnamomi* was further studied in non-amended peat. Disease suppression of *R. solani* in cauliflower decreased with increasing pH in two different kinds of peat, while there was no effect on *P. cinnamomi*. The suppressive effect of 3 composts was assessed in two experiments against *Fusarium* wilt in *Cyclamen persicum* (caused by *F. oxysporum* f. sp. *cyclamini*) and *Begonia eliator* (caused by *F. foetens*) under near-commercial conditions. None of the composts had a significant effect on *Fusarium* wilt in *Cyclamen*. Two and 3 composts significantly induced suppressiveness against *Fusarium* wilt in *Begonia* in the first and second experiments, respectively. No significant differences were observed in growth characteristics between *Begonia* plants grown in compost-amended and non-amended potting mixture in both experiments. In the second experiment, *Cyclamen* plants grown in compost-amended potting mixture had significant lower number of flowers than plants grown in non-amended potting mixture, which may have been due to lower concentrations of N in the compost-amended potting mixtures. In conclusion, most composts of the origin and composition tested can replace 20% peat in potting mixtures for moderately salt sensitive and salt tolerant plants. Amendment of these composts can contribute to control of *Fusarium* wilt in *Begonia* plants.

Keywords: *Begonia*; *Cyclamen*; *Cylindrocladium*; *Phytophthora*; *Rhizoctonia*; *Spathiphyllum*; Suppression

1. Introduction

Peat is the most common ingredient of potting mixtures in Europe. In several European countries, the policy is to decrease the use of peat in potting mixtures to preserve peat bogs as nature areas. Thus, alternatives are needed for potting mixture substrates. Composts have been suggested as an alternative and could replace part of the peat in a potting mixture. However, composts that are immature or have not been well prepared may be toxic to plants and even well-prepared composts may negatively affect plant growth due to high salt concentrations (Hoitink and Fahy, 1986). Salt concentrations that negatively affect plant growth or quality varies among plant species (Arnold Bik and Boertje, 1975; Kipp et al., 2000). Ornamentals

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are relatively salt sensitive and especially to high concentrations of Na and Cl. For many ornamentals grown in pots, the upper limit for Na and Cl has been set at 2.5 mmol/L in the 1:1.5 volume extract (Kipp et al., 2000). As a consequence, the salt content of many composts greatly determines the amount of peat that can be replaced in the cultivation of ornamentals.

In the Netherlands, three main types of composts are being produced: composts made from vegetable, fruit, and garden (VFG) waste (i.e., organic household waste), spent mushroom compost and compost made from green waste (i.e., waste mainly originating from gardens and parks, and to a large extent consisting of woody materials). The first two types of composts generally have a high salt content which will limit their application in potting mixture except if they are wet-sieved but this method is not applied at a commercial scale (Veeken et al., 2005). Compost made from green waste is generally low in salt content and can be considered an appropriate substrate for potting mixture in many peat-based cultivations without wet-sieving. In the present study green waste compost was, therefore, evaluated as potting mixture substrate.

Compost amendment may be advantageous by increasing the disease suppressive properties of the potting mixture due to an increase in general microbial activity and/or the presence of specific antagonists in the compost (Hoitink and Fahy, 1986; Hoitink and Boehm, 1999). However, suppressiveness of compost may be highly variable and is difficult to predict. Termorshuizen et al. (2006) assessed the suppressiveness of 18 composts from which seven were Dutch green waste composts. These green waste composts significantly increased suppressiveness of peat in a *Rhizoctonia solani* AG21—cauliflower seedling bioassay while they did not show suppressive effects in a *Phytophthora cinnamomi*—lupin assay. Three and seven out of the seven composts had a significant disease suppressive effect against *Cylindrocladium spathiphylli* and *Fusarium oxysporum* f.sp., *lini*, respectively. The results suggest that amendment with Dutch green waste compost may especially be effective against diseases caused by *R. solani* and *F. oxysporum* but not against *P. cinnamomi*. However, disease suppression of *R. solani* was related to the pH of the peat–compost mixture, with lower disease suppression at higher pH-levels. All seven mixtures with Dutch green waste compost had a relatively low pH (<5) and the suppressive effect may disappear by increasing the pH to values that are optimal for most pot plants (pH 5–6). The reported disease suppression against *Fusarium* wilt was studied after addition of compost to a steam-sterilized loamy soil (Termorshuizen et al., 2006). The question remained if green waste composts could also induce suppressiveness in peat substrates against *Fusarium* wilt and could be a useful tool for pot plant growers to control *Fusarium* wilt diseases.

In the present study, the potential of Dutch green waste compost to replace part of the peat in potting mixtures and to suppress soilborne diseases was further studied based on the results of Termorshuizen et al. (2006). Salt concentrations of water extracts from 12 Dutch green waste composts were determined and compared with guidelines for potting mixes set for different groups of ornamentals (Kipp et al., 2000). The suppressive effect of the composts was evaluated against *R. solani* and *P. cinnamomi* in bioassays. The effect of pH on suppression was also determined. Suppressiveness of peat–compost mixtures was assessed against *Fusarium* wilt in *Cyclamen persicum* (caused by *F. oxysporum* f.sp. *cyclamini*) and *Begonia eliator* (caused by *F. foetens*) under near-commercial conditions. Part of the results has been summarized previously (Van der Gaag et al., 2004).

2. Materials and methods

2.1. Collection of composts, chemical and biological characterizations

Twelve green waste composts were collected from five commercial composting sites in the Netherlands (Table 1). The composting sites were selected because they usually produce composts with an organic matter (OM) content above 20% (w/w) which is the required minimum content for compost according to Dutch directives (Aendekerk, 2002). Compost samples were stored at 4 °C for several weeks until they were tested in bioassays for disease suppressiveness as described below. A 2-L sample of each compost was oven-dried at 65 °C and sent to the research partner in Israel for several chemical analyses as described in Termorshuizen et al. (2006). The compost was dry-sieved through openings 5 mm in diameter. The fraction <5 mm was ground and used for further analysis. Organic matter was measured by loss of weight on ignition at 400 °C for 8 h. Carbon and N content were measured using an EA 118 Elemental analyzer (Fisons Instruments, Milan, Italy). Aqueous extracts from the dried composts were prepared by shaking compost in distilled water at a 1:10 (w/w) ratio for 2 h at room temperature. The suspension was centrifuged (12,000 rpm, 30 min) and the supernatant was filtered through Schleicher and Schuell 395 paper filter and subsequently through 0.45-μm membrane filters (Supor, Gelman Laboratory). Dissolved organic carbon (DOC) concentration was determined using a Formacs^{HT} Total Carbon Analyzer (Skalar, NL).

Two litres of fresh compost were sent to the research partner in Wageningen (the Netherlands) for determination of the basal respiration and total biomass. Total biomass was determined using the fumigation extraction method (Joergensen, 1995). Ten grams (dry weight basis) of compost were placed in a glass vial, put in a desiccator lined with wet tissue paper together with a vial with soda lime, a beaker containing 50 mg ethanol-free $CHCl_3$ (chloroform) and a few boiling chips. The desiccator was evacuated until chloroform boiled for 2 min, incubated in the dark at 25 °C for 24 h, followed by removal of the chloroform by sixfold evacuations. The fumigated as well as the unfumigated control samples were transferred to 250 ml bottles for extraction with 100 ml 0.5 M K_2SO_4 for 30 min in an oscillating shaker at 180 rpm and then filtered through a paper filter (Whatman No. 42) for 1 h. Subsequently, the samples were frozen at −20 °C until determination for total organic carbon (DOC).

General microbial activity was characterized by determining basal respiration, i.e. the CO_2-production without addition of