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Substitution of peat for municipal solid waste- and sewage sludge-based composts in nursery growing media: Effects on growth and nutrition of the native shrub *Pistacia lentiscus* L.

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Abstract

In this study, the effect of a partial substitution of peat for compost on the growth and nutrition of a native shrub (*Pistacia lentiscus* L.) was tested. Composts were prepared from pruning and municipal solid wastes or pruning waste and sewage sludge. For preparing growing media each compost was added at a rate of 40%, fresh pine bark at 20% or 40% and peat at 20%, 40% or 60%. Aqueous extracts from the substrates did not impair germination of cress (germination bioassay). In relation to plants growing in peat-based substrate (used as a control), plants of the compost-based substrates reached better growth and nutrition, especially when using the sewage sludge-based compost, and the P uptake was notably enhanced. The concentrations of trace elements were far lower than the ranges considered phytotoxic for vascular plants. Detrimental effect derived from using fresh pine bark was not observed.

Keywords: Nursery substrates; Peat; Composts; Native shrub propagation; Plant nutrition

1. Introduction

Most nurseries in the world have based for many years their growing media on peat. However, peat is obtained from wetlands, which are being rapidly depleted, causing environmental concerns that have lead to many individual countries to limit the extent of peat mining, and prices are increasing as a result. Research on peat alternatives is of great interest in the future (Ingelmo et al., 1998; Guerrero et al., 2002; Chong, 2005; Wilson et al., 2006). In this context, different authors have suggested that some organic materials such as well-composted municipal solid waste and biosolid composts could be feasible materials for a partial peat substitution (Bugbee, 2002; Guerrero et al., 2002). The increasing interest in waste recycling is another cause to advocate the recycling and use of organic wastes and composts as soil or potting amendments; it could be one of the most attractive methods of solving the problem of waste disposal.

The combination of peat and compost in growing media is synergistic; peat often enhances aeration and water retention and compost or other additives improves the fertilizing capacity of a substrate. In addition, organic by-products and composts tend to have porosity and aeration properties comparable to those of bark or peat and, as such are ideal substitutes in propagating media (Chong, 2005).

Because the physical and chemical properties of waste and compost-based media may shift with time and source (Hicklenton et al., 2001; Hernandez-Apaolaza et al., 2005), these substrates should always be tested for local conditions. Except perhaps for bark, the use of waste by-products in nursery substrates is not well defined or scientifically documented (Chong, 2005). Organic wastes and waste-derived composts frequently have a high salt content, which may be the most important criterion that limits the potential use of organic wastes and composts in plant propagation (Chong, 2005). Other constraints for use

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include possible presence of contaminants (trace elements, organic chemicals, glass), potential phytotoxicity (immaturity and/or salt level, pH) and differences in species responses.

Government and commercial peat policies support and encourage the use of sustainable peat alternatives; these alternatives need to satisfy the relevant technical requirements and be readily available in sufficient quantities at reasonable cost. In efforts to use organic waste materials, composts have been utilized to successfully grow a wide range of crops including bedding annuals, perennials, sods, vegetables, woody shrubs and trees, and foliage plants. However, few studies have addressed the use of composts for containerized native shrub production (Wilson et al., 2006). Revegetation and afforestation programs for abandoned and degraded lands, encouraged recently by EU (Murillo et al., 2005), frequently make a pressure on nurseries for a massive young plant availability. Facilities for low-cost substrates other than peat-based media would be thus desirable for this purpose.

The aim of this study was to evaluate the effects of peat substitution by other alternatives, such as municipal solid waste compost, sewage sludge compost and pine bark, on growth and nutrition of the low growing Mediterranean shrub *Pistacia lentiscus* L.

2. Methods

2.1. Growing media preparation

Seven growing media were tested (Table 1). The commercial growing media used routinely at nursery was used as control (substrate C: peat H 1–3 von Post, particle size <20 mm, enriched with slow release fertilizer 16-18-19 at a rate of 0.8 kg m^{-3}). This substrate incorporates both black and white peats.

The compost-based substrates were prepared by mixing 40% of compost S or M, 0–20–40% of fresh pine bark and 20–40–60% of white sphagnum peat. Ratios of each component in each substrate are shown in Table 1.

Pine bark was incorporated to substrates because negative properties of composts, such as heterogeneity, high salinity or high content of contaminants, can be minimized (Raviv et al., 1986). In Spanish nurseries, bark is also one of the most usual substrates for forestry plant production (Guerrero et al., 2002). Commercial pine bark (from Badajoz, SW Spain) of particle size greater than 10 cm was grinded to particle size lesser than 10 mm before incorporating it to substrates.

Coarse white Sphagnum peat (from Finland, H 1-6 von Post, particle size <25 mm, and without added fertilizer) was used to counteract the little particle size of the composts used and to prevent high pH due to compost.

Compost S was produced in the composting facilities of the Seville city waste water plant treatment by composting a mixture of sewage sludge from the same plant and pruning waste from Seville gardens. The ratio sludge:pruning waste for composting was 1:3 v/v. Before composting, pruning waste was grinded to fragments between 2 and 15 cm. Compost M was produced in the municipal solid waste composting plant at Mijas (Málaga, SE Spain) using a mixture of unsorted municipal solid waste (particle size <8 cm) and garden pruning wastes (2–15 cm) from the same place. A ratio of 1:1.5 v/v municipal solid waste:pruning waste was used in this case. The turned windrow aerated-pile method was applied for both composts, using triangular windrows of 5.5 m width and 2.5 m height. Turning was applied to the windrows every 15 days during the active composting period (three months). After this period, both composts followed a further period of maturity (3 months). Both composts S and M were sieved to pass a 10 mm and 4 mm sieve, respectively, and compost M was also air-cleaned (to separate plastic films) and destoned (to eliminate glass) for the growing media preparation. The characterization of the raw materials is shown in Table 2. Both composts showed an optimal degree of maturity according to their C:N ratio ⩽12 (Bernal et al., 1998).

2.2. Plant species

The plant species used to evaluate the suitability of the growing media was *Pistacia lentiscus* L. (Anacardiaceae), a low-growing shrub widely distributed in the Mediterranean area (see Zohary, 1952, for more details about taxonomy and distribution). This species is an evergreen, sclerophyllous, dioceous woody shrub, up to 3 or 4 m height

Table 1
Composition of the growing media

Growing media	Formulation
C	100% Peat (commercial substrate)
S40	40% Compost S + 60% peat
M40	40% Compost M + 60% peat
S40B20	40% Compost S + 20% B + 40% peat
S40B40	40% Compost S + 40% B + 20% peat
M40B20	40% Compost M + 20% B + 40% peat
M40B40	40% Compost M + 40% B + 20% peat

Percentage of each component on a volume basis.
S: sewage sludge-based compost.
M: municipal solid waste-based compost.
B: pine bark.

Table 2
Analysis of the raw materials used in the preparation of the growing media

	pH 1:5 v/v	EC 1:5 v/v (dS m^{-1})	OM (g kg^{-1})	N (g kg^{-1})	C/N
Compost S	6.93	3.23	333	20.3	8.2
Compost M	6.96	1.59	278	15.2	9.1
Pine bark	5.62	0.08	962	2.4	200
White peat	3.54	0.04	959	7.8	61.8

EC: electrical conductivity.
OM: organic matter.