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Compost based ecological growing media according EU eco-label requirements

Noelia López-López, Adolfo López-Fabal *

Departamento de Producción Vegetal, Universidad de Santiago de Compostela, Escuela Politécnica Superior, Campus Universitario s/n, 27002 Lugo, Spain

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ABSTRACT

Green compost is seen as one of the best solutions for peat replacement in growing media and for increasing their sustainability. However, the poor quality of many composts has restricted their use as substrate components. The EU Ecolabel may be awarded to products and services that have a reduced environmental impact throughout their life cycle. It is voluntary and ensures certain aspects of the origin and quality. The primary aim of this work was to obtain a gorse compost-based substrate fulfilling the requirements for award of the eco-label.

Forest biomass consisting mainly of gorse was composted in dynamic piles with or without irrigation (I) at the beginning and with or without addition of 5% v/v poultry manure (PM). There were thus four different composting treatments that were designated PM0I, PM5I, PM5 and PM0. Temperature, moisture, pH and the C/N ratio of the composting biomass were monitored over a period of nearly 10 months. The resulting composts were characterized in physical, chemical and biological terms, and evaluated for compliance with the requirements of the European Union eco-label for growing media. All composts were found to be mature, stable and pathogen-free. All of them were suitable for use as growing media, exhibiting a high aeration and drainage capacity, little water retention and adequate level of available nutrients. In general they also met the requirements of the EU eco-label, although not all were weed seed-free, which was possibly the sole unfulfilled EU eco-label requirement.

1. Introduction

Whether alone or in mixtures, peat is the substrate most commonly used in horticulture to grow seedlings and soilless plants. But quality peat is a scarce resource in southern Europe, where there is a significant soilless crop production sector. Peat must therefore be imported from northern and central Europe and recently has become more expensive (Ribeiro et al., 2007), but resort to low cost products involves problems of quality and heterogeneity. In addition, peat is a very slowly renewable natural resource and its exploitation entails C emissions which could greatly influence climate change (Boldrin et al., 2010), so environmental pressure against its extraction has risen.

In response to these concerns and the need for efficient recycling of wastes, the EU Commission (2006) has established the ecological criteria for the award of the Community's eco-label to growing media. The EU Ecolabel is a voluntary scheme promoting environmental excellence which can be trusted. It may be awarded to products and services that have a reduced environmental impact throughout their life cycle, from the extraction of raw material through to production, use and disposal. To apply for the European Eco-label the products have to meet requirements for raw materials, hazardous substances, contaminants, nutrient loadings, product performance and product safety.

A growing media shall only be considered for the award of the eco-label if it does not contain peat and its organic matter content is derived from the processing and/or re-use of waste. In the organic constituents content of heavy metals (Zn, Cu, Ni, Cd, Pb, Hg and Cr) is limited, and also other hazardous substances (Mo, Se, As and F) for products containing materials from industrial processes. Products have to show low level of primary pathogens (absence of salmonella and helminth ova and *Escherichia coli* <MPN g^{-1}) and of viable weed seed/propagules (<2 units L^{-1}). Besides, growing media must not adversely affect plant emergence or subsequent growth and its electrical conductivity must not exceed 1.5 $dS\,m^{-1}$.

Although it will not be the sole solution, green compost has an important role to play in peat replacement or the transition to sustainable growing media. However some users of growing media have never had confidence in the use of green compost and others have had their confidence in its use dented through past use of poor quality compost (Knight, 2012). Lack of uniformity, less-than-optimal physical properties, high salinity, low pH, occasional

* Corresponding author.
E-mail address: adolfo.lopez@usc.es (A. López-Fabal).

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phytotoxicity and threats as human or plant pathogens are the most frequent constraints of green compost to be used as growing media component (Raviv, 2013). Therefore quality assurance is key to promote the inclusion of compost in substrates and progress in reducing the use of peat.

The literature abounds with studies on the potential of various types of compost as growing media and nutrient sources (Fiasconaro et al., 2015; Papafotiou et al., 2004) the best among which might fulfil the EU eco-label requirements. However, none of the 63 substrates currently holding the eco-label consists solely of compost; also, pine bark-based substrates aside, those containing any compost account for less than 10% of all (EU Commission, 2015).

Organic residues successfully used as growing media include compost from green waste such as pruning (Aleandri et al., 2015; Benito et al., 2005; Morales-Corts et al., 2014) or forestry cleaning residues (Ribeiro et al., 2007). Galicia, a region in NW Spain, has a number of forest areas abounding with scrub bush largely consisting of gorse (*Ulex europaeus* L.). Although gorse originated in central and western Europe, and the British Isles, it is also present in North America, New Zealand and Australia, where it was introduced as an ornamental plant and now occupies large areas and is considered a highly invasive species. It is therefore a material available in good quantities around the world. The aim of this work was to obtain a gorse compost-based substrate fulfilling the requirements for award of the European Union eco-label.

2. Material and methods

2.1. Composting process

Forest scrub was used to obtain four different composts. The shrubs, consisting mainly of 4–5 year's old gorse (*Ulex europaeus* L.) plants, were collected and chopped with a flail forage harvester. An experimental design consisting of two factors at two levels each was used. The two factors were irrigation (I) at the beginning of the process and the addition of 5% (v/v) poultry manure (PM) from an organic egg producing farm. The addition of manure was intended to facilitate the process by lowering the C/N ratio to about 30 at the start, and also to increase nutrient levels in the end-product. A proportion of 5% (v/v) was thought to suffice in order to fulfil both aims while reducing the risk of too high salinity in the composted material. Irrigation was intended to increase moisture and reduce salt contents as far as possible in the starting gorse. Layers of the material 25 cm thick received 175 L m^{-2} of tap water and then were left to drain two days. There were thus four different treatments, namely: PM0I (irrigation without addition of PM), PM5I (irrigation plus addition of PM), PM5 (addition of PM but no irrigation) and PM0 (no irrigation neither PM).

Composting was started in July and followed by maturation. The overall process thus lasted 9 months. Piles were frustoconically shaped and approximately 6 m^3 in volume and 2 m high. They were mechanically turned over about once a month at the beginning and every 2 months later. Moisture was maintained by hose irrigation beginning two weeks after the start of the experiment; and the piles were covered during the periods of increased precipitation. Pile temperature was measured at three different depths (0.2, 0.4 and 0.6 m) by inserting a thermometer through a side of the pile-roughly at the middle of total height- to the centre.

2.2. Laboratory analyses

2.2.1. Analysis of raw materials

The materials examined included the gorse before and after irrigation, and the poultry manure. pH was measured in their saturation extracts and moisture contents by oven drying at 105 °C to a constant weight. The total contents in C, N and S were determined with a LECO TruSpec CHNS autoanalyzer and those in Ca, Mg, Na, K and P by ICP-OES after digestion of finely ground samples of each material with HNO_3 (USEPA, 1995).

2.2.2. Monitoring of the composting process

Samples were periodically obtained from the piles to determine pH, electrical conductivity (EC), moisture content, and total C and N. EC and pH were measured in the saturation extracts, moisture content was determined by oven drying, and total C and N by using the LECO TruSpec CHNS autoanalyzer.

2.2.3. Characterization of the final compost

The obtained composts were fully characterized prior to use as growing media. A representative portion of each compost pile was sieved to 6 mm and transferred to the laboratory for comprehensive physical, chemical, physico–chemical and biological analyses with a view to assessing the potential of the composts for organic agriculture.

2.2.3.1. Physical properties. The specific physical properties determined were the moisture retention curve (De Boodt et al., 1974), total porosity, bulk density, particle density and shrinkage value (EN-13041, 1999), compacted bulk density (EN-13040, 2007) and particle size.

2.2.3.2. Chemical and physico–chemical properties. EC, pH and soluble elements were assessed in both saturation extracts and 1:5 (v/v) extracts (EN-13652, 2001). Also, C and N were determined as described in Section 2.1, and the total content in Ca, Mg, K, P, Cr, Cu, Cd, Pb, Zn, Hg and Ni were determined by ICP-OES after digestion with HNO_3 (USEPA, 1995). The organic matter and ash contents (EN-13039, 1999), and the stability of organic matter (Saña et al., 1989), were also determined.

2.2.3.3. Biological properties. Compost maturity was assessed via the germination bioassay of Emino and Warman (2004) with slight modifications. To this end, 20 lettuce seeds (*Lactuca sativa* var. Reina de Mayo) were sown in Petri dishes between pieces of filter paper moistened with 6 mL of aqueous 1:10 (w/w) extract, using distilled water as control and four repetitions per treatment. The dishes were placed in the dark at 20 °C for 3 days, after which the number of germinated seeds in each was counted and root lengths were measured. The germination index (GI) was calculated as the product of the mean number of germinated seeds by the mean root length, both of them relative to the control (Zucconi et al., 1981).

A germination–growth bioassay was also conducted by using barley (*Hordeum vulgare* var. Scarlet) in accordance with the guidelines of FCQAO (1994). All composts and their 75/25, 50/50 and 25/75% (v/v) mixtures with white sphagnum peat were tested, the peat being used as control (0% compost). Four 450 mL pots per treatment were prepared and 50 seeds sown in each. After 12 days in a growth chamber, the number of germinated seeds was counted and the fresh and dry weight of the aerial part of the plants measured.

Trays containing 1 L of substrate each were allowed to stand under controlled light and temperature conditions for 1 month prior to counting germinated seeds. The amount of microorganisms for which the EU Commission (2006) has set limits in plant growing media (viz. salmonella, helminth eggs and *E. coli*) was also measured.

2.3. Statistical analysis

The two principal components (independent variables) examined were (*a*) wetting of the ground gorse material before piling