EVALUATION OF A COMPOST OBTAINED FROM SOLID PHASE OF PIG SLURRY AND FORESTRY WASTES AS A SUBSTRATE FOR SEEDLINGS PRODUCTION

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ABSTRACT

A solid phase of pig slurry - forestry waste compost was evaluated as a substrate component for the production of tomato and lettuce seedlings. Four different substrates were tested: compost (100C), peat based substrate (control), a mixture of 50% compost and 50% peat substrate (50C) and a mixture of 75% compost and 25% peat substrate (75C). Increasing the percentage of the compost on the substrate led to an increase of pH values from 6.3 (control) to 6.9 (100C), value that for an organic substrate may lead to a reduction of micronutrients availability. No significant differences were found for electrical conductivity, anticipating that no salinity problems are expected. Results have proven that physical properties of the 4 substrates did not constitute a limiting factor for plant growth. Germination and growth of lettuce seedlings were not affected by the substrate, contrasting with tomato seedlings that had a worst performance on control. Increasing compost percentage on substrate also increased nitrogen (N) and magnesium (Mg) concentration in plant tissues. On the contrary, potassium (K) and manganese (Mn) concentration was reduced. Results from the study suggest that the compost studied is a good alternative to peat for the production of vegetable seedlings, although supplemental potassium fertilization has to be considered.

INTRODUCTION

In Southern Europe peat is widely used as the main substrate component for the production of seedlings in containers. However, peat is imported from Northern and Central Europe and recently has become more expensive and its properties more variable. So, it is important to look for good quality and local available low cost substitutes of peat. Furthermore, the need to recycle wastes and the increasing environmental pressures against peat extraction has lead to an increasing interest on the feasibility of substituting peat by composted organic wastes. A number of potential alternatives have been identified (Cull, 1981; Morel et al., 2000; Abad et al., 2001), and composts obtained from different organic materials have proved to be very promising (Verdonck, 1988; Reis et al., 1995; Garcia-Gomez et al., 2002). However, the use of compost as substrate can cause some problems namely as a consequence of its high salt contents (Ribeiro et al., 2000; Castillo et al., 2004) and unsuitable water retention properties (Ribeiro et al., 1999). The objective of this study was to evaluate the suitability of a composted material obtained from solid phase of pig slurry and forestry wastes as a substrate or component for seedlings production, using tomato and lettuce as indicator crops.

MATERIAL AND METHODS

A solid phase of pig slurry - forestry waste compost (1:3 by volume), was mixed with sphagnum peat based substrate at rates equivalent to 50, 75 and 100% compost (by volume). A control treatment consisting of a commercial sphagnum peat based substrate was used. Substrates pH, electrical conductivity (EC), N, P, K, Ca and Mg were determined in the water extract 1:6 by volume, according to Johnson (1980). Physical properties of the mixtures: available water (AW), air capacity (AC), total porosity (TP) and bulk density (BD) as defined by Boot and Verdonck (1972), were measured according to Verdonck and Gabriëls (1992).

A completely randomised greenhouse experiment, with 4 replications, and 45 plants per replication was carried out. Seedling, in cells-trays with 17 cm^3 filled with the 4 substrates, was performed in May 2003. Lettuce was harvested after 5 weeks and tomato after 6 weeks. Shoot and root material was dried at 65 ºC for 48 h, grounded through a 1 mm screen and samples were taken up for chemical analysis. Nitrogen was determined by the Kjeldahl method. After a hydrochloric digestion of the ash, phosphorus was determined by the vanadomolybdo-phosphoric yellow colour and all the other nutrients were determined by atomic absorption spectrophotometry.

Data were subjected to ANOVA analysis. In every table, means followed by the same letters, in the same column, do not differ at $p \leq 0.05$ by the LSD test.

RESULTS AND DISCUSSION

Physical properties of the substrate were significantly affected by compost percentage in the mixtures (table 1). The compost increased substrate bulk density (BD) from 0.10 (control) to 0.31 g cm^{-3} (100% C), and decreased total porosity (TP) and available water (AW). However the values obtained for the 4 substrates are within the acceptable range for a seedling substrate (Bragg and Chambers, 1988; Verdonck and Gabriëls, 1988). The presence of compost did not affect electrical conductivity (EC) in different treatments. However, compost additions significantly increased substrate pH values, which can affect the availability of micronutrients. Yet, the presence of compost significantly increased nitrogen (N), calcium (Ca) and magnesium (Mg) availability while reducing phosphorus (P) and potassium (K) (table 1).

Table 1. *Some substrate properties.*

Treat.	BD g cm^{-3}	AW %,v v^{-1}	AC %,v v^{-1}	TP %,v v^{-1}	pH	EC mS.cm^{-1}	N mg L^{-1}	P mg L^{-1}	K mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}
Control	0.10*a*	50.9*c*	7.7*a*	93.7*a*	6.3*d*	0.26*a*	62*c*	127*a*	310*a*	101*c*	41*d*
50%C	0.23*b*	48.7*cb*	7.7*a*	87,2*b*	6.7*c*	0.28*a*	116*c*	90*b*	174*b*	155*b*	74*c*
75%C	0.26*b*	46.2*b*	7.2*a*	86.1*b*	6.8*b*	0.27*a*	128*b*	78*c*	120*c*	158*b*	83*b*
100%C	0.31*c*	40.0*a*	8.4*a*	83.6*c*	6.9*a*	0.27*a*	152*a*	68*d*	80*d*	170*a*	95*a*

In each column, means followed by the same letter are not significantly different p ≤ 0.05.

Growth of lettuce seedlings was not affected by compost percentages on the substrate, while for tomato seedlings compost increased plant growth for every treatment, when compared with the control substrate (table 2).

Table 2. *Plant growth (data per seedling).*

Treat.	Tomato Shoot dw (mg)	Tomato Root dw (mg)	Tomato n.º leaves per seedling	Lettuce Shoot dw (mg)	Lettuce Root dw (mg)	Lettuce n.º leaves per seedling
Control	102.4*b*	38.1*c*	2*b*	141.9*a*	65.7*a*	4.7*a*
50%C	150.0*a*	57.1*b*	3*a*	132.4*a*	69.1*a*	4.3*a*
75%C	146,7*a*	59.5*b*	3*a*	114.3*a*	63.3*a*	4.0*a*
100%C	168,1*a*	66.7*a*	4*a*	134.8*a*	64.3*a*	4.5*a*

In each column, means followed by the same letter are not significantly different p ≤ 0.05.

Results obtained for nutrient composition of the shoots and roots (table 3 and 4) showed that, in general terms, N and Mg concentration in plant tissues increased as the compost percentage increased in the substrate. Conversely, there was a decrease of K concentration in plant tissues with the increase of compost percentage. These results are consistent with those for nutrients availability in the substrates (table 1).

***Table 3**. Mineral composition of lettuce seedlings.*

Treat	N g kg^{-1}	P g kg^{-1}	K g kg^{-1}	Ca g kg^{-1}	Mg g kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}	Cu mg kg^{-1}
				Shoot				
Control	6.8*d*	11.6*c*	22.0*a*	8.7*a*	1.9*b*	165.6*a*	41.2*b*	10.6*a*
50%C	7.3*c*	11.9*bc*	22.4*a*	8.6*a*	2.5*a*	20.9*b*	53.7*a*	13.3*a*
75%C	7.8*b*	12.1*ab*	21.8*a*	9.4*a*	2.7*a*	24.4*b*	54.9*a*	11.5*a*
100%C	9.5*a*	12.4*a*	17.7*b*	9.8*a*	2.9*a*	22.9*b*	52.9*a*	10.4*a*
				Root				
Control	6.0*b*	12.1*a*	24.5*a*	7.8*a*	5.4*d*	76.7*a*	61.8*a*	11.3*c*
50%C	6.3*b*	13.9*a*	26.2*a*	8.9*a*	5.9*c*	19.4*b*	69.5*a*	22.3*b*
75%C	6.7*b*	13.9*a*	21.8*a*	7.9*a*	6.8*b*	24.3*b*	65.5*a*	21.0*b*
100%C	8.9*a*	14.2*a*	18.0*a*	7.4*a*	7.9*a*	22.7*b*	78.9*a*	29.2*a*

In each column, means followed by the same letter are not significantly different p ≤ 0.05.

Plants grown on compost substrates showed significant low concentrations of manganese (Mn) in their tissues, which is probably a consequence of the diminution of the availability of this micronutrient induced by the higher pH values of these substrates as well as of the presence of humic like compounds in the compost.

***Table 4**. Mineral composition of tomato seedlings.*

Treat	N g kg^{-1}	P g kg^{-1}	K g kg^{-1}	Ca g kg^{-1}	Mg g kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}	Cu mg kg^{-1}
				Shoot				
Control	7.8bc	5.3a	19.2a	19.1b	4.6d	151.9a	59.1a	12.2a
50%C	7.2c	4.4a	15.5b	18.8b	5.6c	34.7b	62.0a	8.9a
75%C	8.3b	5.7a	14.6bc	21.5a	7.0b	31.6b	66.4a	10.7a
100%C	9.2a	6.0a	13.5c	21.4a	8.1a	33.6b	67.6a	11.1a
				Root				
Control	10.9c	9.0b	30.7a	10.6a	6.7c	60.4a	83.1b	18.2c
50%C	11.8bc	10.7a	23.3ab	9.5a	9.3b	10.5b	97.8ab	48.3b
75%C	13.2ab	10.4a	27.4ab	13.3a	10.3a	12.2b	114.9a	57.9a
100%C	14.9a	8.4b	19.8b	11.2a	10.3a	18.1b	118.5a	57.8a

In each column, means followed by the same letter are not significantly different p ≤ 0.05.

CONCLUSIONS

Results obtained show that the compost tested (obtained from solid phase of pig slurry and forestry wastes) can be used as a substrate for tomato and lettuce seedlings production, being an alternative to peat-based substrates usually used.

Despite the differences encountered for physical properties between the control and the 100%C substrate the values obtained for the latter did not constitute a limiting factor for plant growth.

Availability of nitrogen and magnesium in the substrate increased with increasing percentages of compost, while potassium availability decreased. This aspect must be taken into consideration when mineral fertilization planning's are considered The strong reduction on Mn concentration in plant tissues was likely due to the decrease of the availability of this element induced by the higher pH values of these substrates and by the presence of humic substances in the compost.

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