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INFLUENCE OF MSW DERIVED COMPOST ON RHIZOBIUM TRIFOLII AND THE VA MYCORRHIZAL ENDOPHYTE GLOMUS MOSSEAE IN A LOW FERTILITY SOIL

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ABSTRACT

Compost derived from biostabilisation of a mixture of organic biodegradable fraction of municipal solid waste (MSW) and sewage sludge was tested in pots. Increasing amounts of the mixture were added a low fertility soil supporting clover or sorghum growth. The aim of the experiments was to evaluate the effect of the organic amendant on the symbiotic microorganisms Rhizobium trifolii and Glomus mosseae in the inoculated plants. Nodulation efficiency, nitrogen-fixation functionality, VAM infectivity and plant productivity are discussed.

INTRODUCTION

Microbial populations of the soil are influenced to some extent by introducing into the soil organic amendants such as crop residues, animal manures or compost putrescible wastes (Kunc, 1988).

Recently, compost from the organic biodegradable fraction of municipal solid waste (MSW) has become more widely available for agricultural utilisation in Italy (Regione Toscana, 1988).

Nevertheless researches have not been carried out which would allow a satisfactory and complete understanding of the effects, either stimulatory or inhibitory, of MSW derived compost on the different physiological groups of soil microflora.

Most of the literature in this field deals with responses of some free-living soil microorganisms to the addition of MSW derived compost to soils, supporting growth of different crops (Nishio and Kusano, 1981; Nishio, 1983; Pera et al., 1983).

On the other hand, very few studies have been done concerning the influence of this organic amendant on symbiotic microbes such as Rhizobia and vesicular-arbuscolar fungi, which are of great importance in plant productivity (Hepper and Warner, 1983; Giovannetti and Avio, 1984; Guidi et al., 1988).

Before starting a broad soil application of MSW derived compost it is interesting to characterize its early effects, although bigger modifications in soil microbiological properties are only expected after several years of treatment with compost.

In this paper a preliminary four-months pot-scale study is reported, estimating the influence of increasing concentrations of MSW derived compost on both the functionality of Rhizobium trifolii (i.e. nodulation and nitrogen-fixation) in clover and the mycorrhizal infection by Glomus mosseae in clover and sorghum roots.

MATERIALS AND METHODS

MSW derived compost - Compost derived from a mixture of the biodegradable fraction of solid urban waste and municipal sewage sludge was used. Composting was carried out by blowing air in a static pile as described elsewhere (de Bertoldi et al., 1982). Table 1 reports some physico-chemical and biological analyses of this compost.

Soil characteristics - Soil originating from sandy bank of the river Arno near Pisa was used. Table 2 shows its physico-chemical characteristics. In this soil organic matter and mainly nitrogen were present in low levels. Neither Rhizobium sp. nor VA mycorrrhizal endophytes were found in that soil.

Plants - Trifolium pratense and a hybrid sorghum variety (Sorghum vulgare var. Trudan) were cultivated.

Symbiotic microorganisms - For inoculations into the pots the following microorganisms were used: Rhizobium trifolii, strain IMAP 201 (Casella et al., 1984) and Glomus mosseae (Giovannetti et al., 1981).

Experimental design - Plastic pots (3.4 litres) were used in sets of 5 replications for each treatment. Compost was added to the soil at three different doses: 2.5, 5.0 and 10.0% respectively. Table 3 shows the cultivation scheme. The pots were placed in the open in normal wheather for the season. Each pot contained five seeds when clover was the plant tested while only three seeds when sorghum was used.

Procedures for R. trifolii inoculation into pot sets with clover were as previously described (Casella et al., 1981). The experimental soil was mixed with 3.0% crude inoculum of G. mosseae endophyte in clover or sorghum pot sets.

Nodulation by R. trifolii was assessed following the method suggested by Vincent (1970) while nitrogen-fixation was extimated with the acetylene reduction activity (Citernesi et al., 1977).

The percentage of root infected by the VA mycorrhizal fungus G. mosseae was assessed by the gridline intersect method (Giovannetti and Mosse, 1980).

Plants were harvested 4 months after germination. Vegetable biomass was determined by considering only the epigeous portion of the plants.

(w/w, on a dry matter basis)

RESULTS AND DISCUSSION

The effects of increasing MSW derived compost rates in clover and sorghum are reported in Table 3. The addition of this compost to the soil up to 10% on a dry matter basis was not inhibitory to nodulation efficiency and nitrogen-fixation functionality of R. trifolii in clover and for infectivity of G. mosseae both in clover and in sorghum. Data concerning the increase in yield of the tested plants grown in the compost amended pot sets, when compared to the controls, show the generic fertilizing effect of the compost itself. However the highest vegetable biomass production resulted in the pot sets treated both with compost and inocula of the two symbiotic microorganisms. This can be explained by assuming better edaphic conditions for the symbiotic associations in soil amended with compost although there is not evidence of a direct compost stimulation of the symbiotic infections rate in the plants roots.

Anyway further investigations are needed involving the effects of added organic substrates such as compost on the biotic soil component and particularly on the symbiotic plant-microorganisms associations.

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Table 1 - Physico-chemical characteristics and phytotoxicity monitoring analyses of the compost used during this research (% on a dry matter basis)

Moisture	32.73%
pH	7.71
Ash	49.22%
Organic matter	50.77%
Total-N	1.64%
C/N	17.95
Total-P (as P O)	0.53%
Phytotoxicity test (*Lepidium sativum* bioassay)*	negative
* Zucconi *et al.*, 1981	

Table 2 - Main physico-chemical analyses of the river sandy soil used in this work (% on a dry matter basis)

Moisture	2.11 %
pH	8.03
Reaction	Subalkaline
Gravel	0.00 %
Fine soil	100.00 %
Clay	7.00 %
Silt	16.00 %
Sand	75.70 %
Limestone	2.00 %
Organic matter	1.27 %
Total-N	0.081%
Total-P (as P O)	0.046%

Table - Experimental Results

	Soil contents			Clover				Sorghum	
Pot set	Initial total-N % d.w.	Initial total-P % d.w.	Initial organic matter % d.w.	Mycorrhizal root infection %	Nodulation	N_2-fixation	Shoot dry wt. (mg/plant)	Mycorrhizal root infection %	Shoot dry wt. (mg/plant)
S	0.081	0.046	1.27	0	-	-	5.15 a	0	1.50 a
S + R. trifolii	0.081	0.046	1.27	0	+	+	36.10 c		
S + G. mosseae	0.081	0.046	1.27	32.10 a	-	-	26.20 bc	33.10 a	6.85 bc
S + R.t. + G.m.	0.081	0.046	1.27	35.15 a	+	+	45.30 cd		
A	0.120	0.058	2.51	0	-	-	10.10 ab	0	3.20 ab
B	0.159	0.070	3.75	0	-	-	21.20 b	0	5.40 b
C	0.237	0.094	6.22	0	-	-	33.30 bc	0	7.88 bc
A + R. trifolii	0.120	0.058	2.51	0	+	+	39.40 cd		
B + R. trifolii	0.159	0.070	3.75	0	+	+	41.10 cd		
C + R. trifolii	0.237	0.094	6.22	0	+	+	42.20 cd		
A + G. mosseae	0.120	0.058	2.51	36.51 a	-	-	29.10 bc	38.50 a	10.60 c
B + G. mosseae	0.159	0.070	3.75	37.20 a	-	-	30.00 bc	39.10 a	10.80 c
C + G. mosseae	0.237	0.094	6.22	38.20 a	-	-	34.30 c	41.20 a	11.25 c
A + R.t. + G.m.	0.120	0.058	2.51	34.30 a	-	-	51.10 d		
B + R.t. + G.m.	0.159	0.070	3.75	35.20 a	+	+	51.30 d		
C + R.t. + G.m.	0.237	0.094	6.22	38.10 a	+	+	52.40 d		

S = soil; A = soil + 2.5% compost; B = soil + 5.0% compost; C = soil + 10.0% compost. Results in vertical columns followed by the same letter do not differ significantly from each other ($p = 0.01$ as determined by LSD)