Agricultural use of city refuse compost

I. Effect on growth and chemical composition of plants

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Key words: City refuse compost, ryegrass, heavy metals, soil pollution, plant nutrition, phytotoxicity

Abstract

In the present study, an attempt was made to better understand the effect of city refuse compost on the growth and chemical composition of a test crop (*Lolium hybridum* var. Ariki). A greenhouse pot experiment was conducted on three soils: Cambisols (Cmd), Leptosols (Ps) and Fluvisols (J). Each soil received four rates of city refuse compost (0, 20, 50 and 80 t/ha) and the effects were compared with NPK commercial fertilizer alone and complemented with compost (50 t/ha). Test plants were harvested at regular intervals after seed emergence.

The application of city refuse compost has promoted a positive influence on crop test. Yields were significantly (*p* < 0.05) increased with amount of compost applied, in different soils. Concentration of N, P, K, Ca and Na in plant tissue increased with application of compost. The urban compost did not bring about significant (*p* < 0.05) changes in the concentration of Cr, Fe, Mn, Ni and Cd. Concerning Zn and Cu, the results showed that the city refuse compost tend to increase in the plant concentration in relation to the control. However, levels of every heavy metals analysed were within normal ranges and no toxicity problems were encountered.

However, the application of city refuse compost at high rates and eventually in a strongly acid soils makes possible the potential pollution of soils and the risk of contamination of plants and food chain by heavy metals and for that reason it is necessary to define codes of practice for city waste utilization.

Introduction

Recycling wastes in agriculture has become one of the feasible ways of disposal method and according to waste characteristics can produce valuable soil amendments. However, since heavy metal content in waste materials is often higher than in soil, application rates have to be carefully controlled, to avoid the possible accumulation of toxic metals in agriculture soils and a potential phytotoxicity to crops.

Some research on the effects of the application of urban compost to arable soils has been reported in the literature over the past ten years. However, research reports have produced many conflicting results in part probably due to the complexity of materials used (compost, soils and plants).

The results obtained from the application of compost to soil are quite variable but, generally, it has been proven that urban compost increases crop production. On the other hand, it has been shown that, in general, the heavy metal accumulation in plant also occurs.

In Portugal, the application of urban wastes in arable land is at the beginning, and so these studies are most suitable to advise the farmers about the rates to be applied in different soils and the Institutions about the necessity to define codes of practice for city waste utilization.

The purpose of this study is to investigate the response of ryegrass to application of urban compost. The objectives of this study were to:

1. Determine the effects of the rate of compost on the yield and on the chemical composition of a test plant (*Lolium hybridum*) and compare these effects with those when a commercial fertilizer, alone or combined with compost are used.
2. Determine the contribution of the heavy metals (Cd, Cr, Cu, Fe, Mn, Ni & Zn) to plant tissue through application of compost to three soils.

Materials and methods

A greenhouse experiment was conducted on three soils to determine the effect of city refuse compost on the growth and chemical composition of a test plant (Lolium hybridum cv. Ariki). Surface soil samples (0–20 cm) were collected in fields near Castelo Branco (Portugal). According to the FAO Classification the soils were Cambisols (CMd), Leptosols (LPs) and Fluvisols (J) and according to the Portugal Classification CMd correspond to a Pg soil, LPs to an Ex and J to a Sbl soil. Urban compost was obtained from the Lisbon Municipal Waste Composting Plant. Some analytical characteristics of these soils and the compost are reported in Table 1.

Compost and soils were air-dried and sieved at 2 mm. Pots were filled with about 15 Kg of soil and the compost was added and thoroughly mixed. The treatments included four rates of compost: 0 (T0), 20 (T3), 50 (T4) and 80 (T5) metric tons/ha. An N,P,K fertilizer treatment alone (T1) and combined with 50 tons/ha (T2), provided according to the usual agricultural practices, were also included for comparison.

Ryegrass seed (3 g/pot) was sown in March 1990 and harvested at different times each week at 40, 70 and 100 days after emergence. Tensiometers were installed to monitor the soil moisture regime in pots that were maintained at about 70% of water-holding capacity (WHC).

The experimental design was a randomized complete block with three replications.

After each cutting the plant tissue were washed with distilled water and oven dried at 65 °C and dry weights recorded. Soil samples were collected after final harvest, sieved to 2 mm and retained for analysis.

Organic C was determined after potassium dichromate oxidation; total-N by the Kjeldhal procedure and N-NH₄ and N-NO₃ by a steam distillation method. pH was determined by a potenciometric method. The amount of heavy metals in compost and soils were determined by aqua regia extraction with reflux and measured by atomic absorption. The extractable metals were determined on 0.5 M ammonium acetate + EDTA at pH 4.65. Total metals in plant tissue was determined by atomic absorption spectrophotometer after acid digestion (HNO₃-HClO₄).

Fig. 1. Effects of urban compost treatment on dry-matter yields of ryegrass in CMd soil.

The data from the experiment were analysed using analysis of variance (ANOVA). Least significant differences (LSD) values were computed for each characteristics found significant at (p < 0.05). Some data were analysed using the regression procedures. Homogeneity of variance was evaluated with Bartlett’s test.

Results and discussion

Effects of compost on dry-matter yields

The beneficial effects of city refuse compost were evident as indicated by large yield increases in plants grown on compost amended soils as compared with unamended soils (Fig. 1).

In the first cuttings yields was, generally, greater (p < 0.05) in the soils which received mineral fertilizer, alone or combined with compost than in soils receiving compost and those unamended. This fact can be attributed almost entirely to a greater amount of N supplied by the fertilizer to plants as reflected by the higher N concentration undern plants grown in this treatment (Fig. 2).

However, after the first cutting the yields in soils of treatment T1 declined dramatically and the practically identical dry-matter yields of T1 and T0 suggest that N supplied by the fertilizer had been exhausted. Low plant N concentration supports this reasoning (Fig. 2). Higher total dry-matter yields with compost treatment could be attributed to a higher level of avaible N, P, K and Ca in those treatments (Mesquita Dos Santos, 1993). On the other hand, the increased yields likely resulted from improvements of soil properties.