

## EFFECTS OF MUNICIPAL SOLID WASTE COMPOST ON SOILS CROPPED WITH TOMATO AND SUNFLOWER IN ROTATION WITH DURUM WHEAT

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### Abstract

The trial, still in progress on the experimental farm of the Institute, was carried out in a silty-clay soil (Typic chromoxerert) on two rotations: tomato – durum wheat, and sunflower – durum wheat. On a randomized block design with three replications, these crops were submitted to different fertilisation treatments: mineral nitrogen, at 100 kg N/ha for sunflower and durum wheat, and 140 kg N/ha for tomato; organic fertilisation, with compost obtained from municipal solid waste (MSW) by selected collecting, corresponding to the aforesaid doses; control unfertilised. On soil samples collected from each plot, organic C (total, extractable and humified), mineral N, available P, exchangeable K and heavy metals contents were determined. The results obtained show low variations of organic C (total and other fractions) and of all soil humification parameters examined. No accumulation of heavy metals was found during the trial period. The results showed that the supply to sunflower and tomato of agronomic doses of MSW-compost was well tolerated by these crops and did not result in negative effects on chemical or physical soil properties, while the addition of biomass to the soil increased its organic matter content.

Additional Keywords: TOC, TEC, humification parameters, heavy metals, tomato, sunflower.

### Introduction

The addition of organic matter to soil (crop residues, MSW-compost, manure, etc.) attenuates the degradation process of soil native organic matter, because fresh material is attacked more easily by the micro-organisms, and it contributes to safeguarding the ecosystem from irreversible variations in the soil organic pool, determined by intensive cropping systems and by agronomic techniques (Shiralipour *et al.*, 1992; Ferri *et al.*, 1995). The role of organic matter is very important; in fact, its high content in the soil influences physical properties; assures a good value of cation exchange capacity; reduces the mobility of nutrients in soil solution, preventing the loss of useful substances by means of the action of enzymes; avoids the pollution of water table; improves soil porosity; helps the chemical stabilization of structure; reduces the processes of soil erosion and increases the micro-organisms and enzymatic activity. On the other hand, the recycling of municipal solid waste in the farm-land soil (Basile, 1995; Pinamonti, 1997; Benedetti and Sequi, 1998) could resolve, at least partly, the problems resulting from the disposal of this biomass and from its environmental impact.

Several studies (De Bertoldi *et al.*, 1987; Businelli *et al.*, 1998; Goldberg Federico *et al.*, 1991) have reported very positive results through the use of MSW-compost. However, its accumulation in the soil could result, in time, in pollution from organic and inorganic substances. The presence of heavy metals represents a limiting factor of the compost quality and of its use in agriculture, also because the concentration in heavy metals changes in function of the starting residues, of geographical differences, of crops and seasonal fluctuations (Giusquiani *et al.*, 1992).

### Materials and Methods

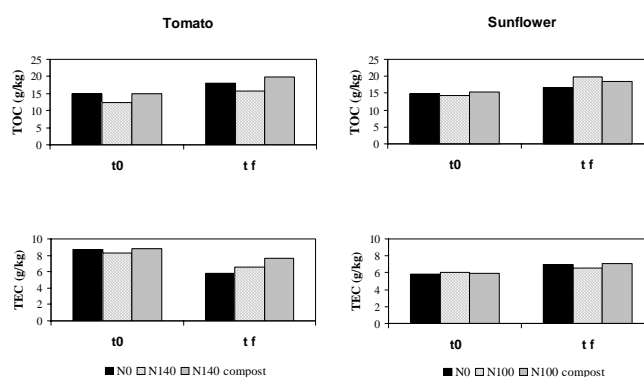
On a silty-clay soil (Typic chromoxerert, Soil Taxonomy - USDA) of Apulian Tavoliere tomato and sunflower have been cropped in a two-year rotation with durum wheat. The first two crops were fertilised with ammonium nitrate and MSW-compost, applied at a rate corresponding to the 0 and the 100 % of the N requirement of tomato and sunflower in the trial environment. MSW-compost has been annually applied to the depth of 30-40 cm about one month before tomato transplantation and sunflower seeding. The fertilisation treatments for sunflower were the following: N100com = organic fertilisation with compost at 100 kg N/ha, corresponding to 55 q/ha of MSW-compost (at sowing-time); N100min = mineral fertilisation at 100 kg N/ha, about 3 q/ha of NH<sub>4</sub>NO<sub>3</sub> (half at the sowing, half as a top dressing); N0 = control not fertilised. For tomato the following doses were used: N140com = organic fertilisation with compost at 140 kg N/ha, corresponding to 77 q/ha of MSW-compost (at the sowing); N140min = mineral fertilisation at 140 kg N/ha, about 4.2 q/ha of NH<sub>4</sub>NO<sub>3</sub> (half at the sowing, half as a top dressing); N0 = control not fertilised. The following durum wheat crop received 50 and 100 kg N/ha as a top dressing fertilisation.

The experimental design was a split-plot with three replications. At the beginning (t<sub>0</sub>) and at the end (t<sub>f</sub>) of each cropping cycle, soil samples were collected from each elementary plot at 0-40 cm depth. On each soil sample, total

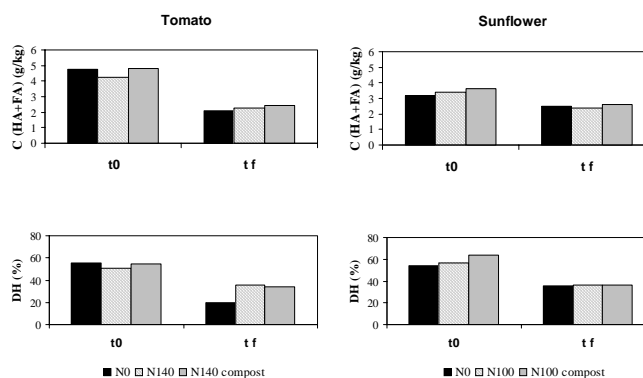
organic carbon (TOC), extractable (TEC) and humified C (HA+FA) (Sequi *et al.*, 1986), mineral N (N-NO<sub>3</sub> + N-NH<sub>4</sub> exchangeable) and heavy metals (Zn, Cu, Ni, Pb, Cd) were determined (MiRAAF, 1994). From these experimental data, the following coefficients have been calculated: degree of humification = DH % = C(HA+FA)/TEC\*100; humification rate = HR % = C(HA+FA)/TOC\*100; carbon organic extract and not humified = NH = TEC - C(HA+FA); humification index = HI = NH/ C(HA+FA). All soil determinations were also performed on the MSW-compost. The compost was obtained by the Cupello engineering (Chieti, Italy) through aerobic transformation of municipal solid waste, collected separately (wet and dry residues).

## Results and Discussion

Figure 1 reports TOC and TEC values related to tomato and sunflower plots; they show that MSW-compost application to the soil results in an increase of TOC in tomato cropped plots higher than that achieved by supplying N140min. The same figure also indicates a less evident effect on organic C of sunflower cropped plots, in which the increases of TOC are lower than those measured in the plots subjected to mineral fertilisation (N100min).



**Figure 1. Effects of crops and fertilising treatments on total organic carbon (TOC) and extractable organic carbon (TEC)**

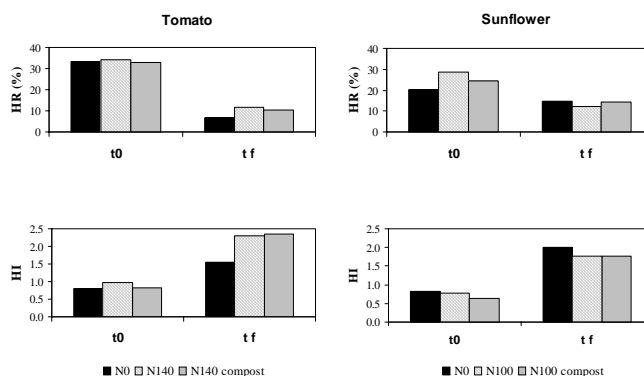


**Figure 2. Effects of crops and fertilising treatments on humified organic carbon [C(HA+FA)] and degree of humification (DH)**

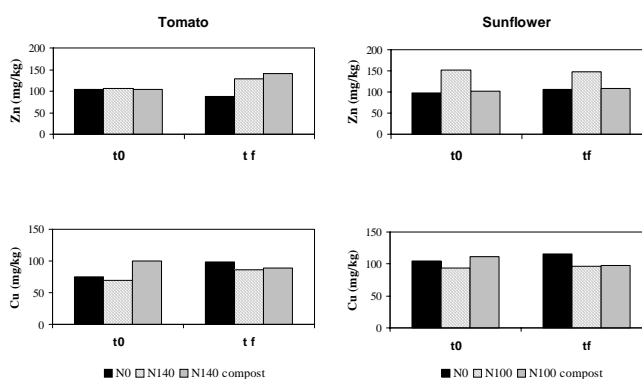
For the TEC in the tomato plots there was no significant decrease between the beginning and the end of the experimental trial, whether using mineral fertilisation, or MSW-compost. On the contrary, the application of MSW-compost (100com) on sunflower allowed an increase of this parameter, so showing a positive change in the soil organic pool, that was enriched of fractions humifiable. Figure 2 shows the seasonal changes of humified C and of the degree of humification (DH). The first parameter indicates a general lowering of values, above all in tomato plots.

A similar trend has been observed in both crops for DH; in particular, in the plots treated with MSW-compost, the addition of organic matter to the soil introduces an organic fraction not humified that, obviously, causes a decrease of DH. Also the humification rate (HR) (Figure 3) recorded in the plots treated with MSW-compost shows a large

decrease in the plots cropped with tomato. The content of fresh organic matter supplied with MSW-compost in these plots would seem, therefore, less humified, in comparison to that in sunflower cropped plots.

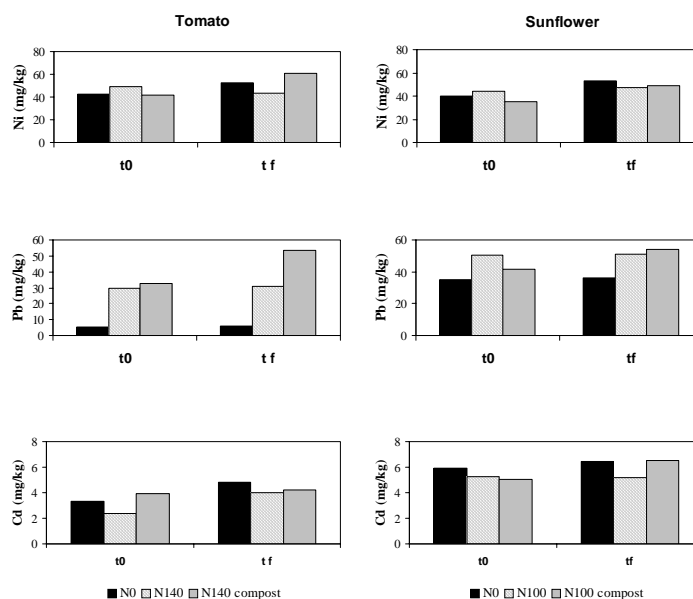


**Figure 3. Effects of crops and fertilising treatments on humification rate (HR) and humification index (HI)**



**Figure 4. Effects of crops and fertilising treatments on soil Zn and Cu contents**

As with previous results, the humification index (HI) (Figure 3) shows a most evident increase in the tomato plots. The Zn accumulation (Figure 4) in the tomato cropped plots, due to MSW-compost addition, has depended from the high amounts of biomass supplied to this crop; on the contrary, in sunflower cropped plots, the Zn accumulation was less evident. Considering that chemical composition of compost could change over the time, Zn variation in the soil must be carefully monitored. The Cu soil content (Figure 4) was not significantly increased with the supply of MSW-compost in any of the tomato or sunflower cropped plots, but it was slightly decreased, while a light Cu accumulation was found in tomato plots with the mineral N treatment. The Ni and Pb soil contents (Figure 5) increased in both crops with the MSW-compost application, above all in tomato. Finally, a similar behaviour was observed for soil Cd content (Figure 5), but only in sunflower plots.



**Figure 5. Effects of crops and fertilising treatments on soil Ni, Pb and Cd contents**

## Conclusions

The results obtained to date indicate that:

1. sunflower and tomato tolerate well the application of MSW-compost;
2. MSW-compost does not cause any negative effects on the soil chemical and physical properties;
3. the addition of biomass to the soil increases the organic matter content and its humification, as shown by the decrease of HR index;
4. the heavy metals brought with the compost do not modify the soil composition, even if the study must continue as to determine the modifications of available fraction. It is clear that these results must be confirmed in the long term, to check the effects on plant-soil system due to the addition of stabilized biomass, whose quality must be improved more and more. The recycling of MSW-compost in the arable soils could resolve the problems associated with the environmental impact of MSW disposal, and in addition contribute to the enrichment of soil organic C, especially in semi-arid conditions of Southern Italy.

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