**Use of Mineralization Kinetics to estimate the Agricultural Value of a Compost incorporated in Vineyard in Luxembourg.**

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Abstract & Key words:

Several rates of compost have been applied to a vineyard in Luxembourg in 1997 and 1998. The compost was produced from organic wastes and green refuse from an intermunicipality treatment center.

The agricultural value of compost has been estimated by laboratory mineralization kinetics to provide information on the availability of mineral nitrogen produced with this organic fertilizer. The evaluation of the kinetic mineralization was realized for different places of the field in which same dose of compost was incorporated. Mineralization rates were measured annually to estimate the cumulative effect of compost.

The research revealed that a second compost incorporation doubled the quantities of nitrogen mineralized after 91 days of incubation compared with a single incorporation.

A significant spatial variation was observed in the experimental field where the mineralization was different in each of the plots with 60 T compost $ha^{-1}year^{-1}$. The nitrogen mineralization rate was correlated with the soil organic matter. Another approach showed that the soil organic matter was also correlated with the vineyard yield: after two years, vineyard yield was mainly influenced by the amount of soil organic matter, whereas the dose of compost applied had no impact.

biowaste and greenwaste compost ; laboratory incubations; Luxembourg, N mineralization; spatial variations; soil organic matter; vineyards.

## Introduction

A research on the use of compost in Luxembourg has been conducted since 1997. This research was prompted by two factors. Firstly, with the increasing amounts of organic waste being produced, it is increasingly important to use the composting process. Secondly, vineyard soils have been subject to a gradual degradation by the exclusive use of chemical fertilizers (loss of organic matter, erosion). Riva (1973) and Ballif (1990) showed that compost application has an impact on this gradual degradation.

The purpose of this paper was to assess the agricultural value of the compost made from organic wastes and green refuse to evaluate the capacity of compost for providing mineral N for the vines. Composted products may be characterized by physical or chemical determination, but this is only a descriptive approach and it cannot provide information on the behavior of the organic material in the soil or on the use of mineral elements by crops. Field experiments (Lemaire, 1989; Limbourg, 1992) can also indicate effects of organic materials under real conditions, but these methods are time-consuming, expensive and sometimes gives little information on kinetic aspects (Cheneby and Nicolardot, 1992).

A simpler way of assessing the availability of elements of the organic matter mineralization is use of mineralization kinetic tests in the laboratory (Castellanos & Pratt, 1981; Aoyama, 1985 and Leclerc and al., 1986). The principle is in a soil and/or organic matter incubation under optimum temperature and moisture conditions. This method, usually used to estimate N mineralization of composted manure (Hébert and al, 1991; N'Dayegamiye and al, 1997), is relatively easy and inexpensive. A large number of samples can be tested quickly. The results are correlated with in situ behavior of materials (Recous, 1994; Houot and al., 1994).

## Materials and Methods

The organic material was a mixed compost of organic wastes and green refuse (1/3 organic wastes; 2/3 green refuse). A turned windrow with no forced aeration system was used. The mixture was then composted for 12 weeks. At the end of the process, compost maturity was determined with the Rottegrad test (Methodenbuch zur Analyse von Kompost, 1994), based on profile temperature. Physical and chemical determinations were made at the laboratory of the Administration de l'Environnement in Luxembourg (pH: 7.5; dry matter: 57 %, organic-C: 20 %; total-N: 1.7 %; C/N: 11.76).

In spring 1997, compost experiments were established in one vineyard localized on "the Moselle" in Luxembourg. The site has been planted about 8 years previously to Rivaner grapes (*Vitis vinifera*). The soil was characterized as a sandy soil with 61-71 % sand, 19-21 % clay, 9-17 % silt and a pH of 6.7-7.2 in the surface horizon ( 0-20cm ).

The experimental field was divided into four identical blocks. Each block was separated into small plots with different fertilization treatments: annual applications of 30, 40, 50 and 60 Tons compost per hectare and per year applied uniformly to the soil surface and a control with no compost.

Soil samples were taken in each of the four replicated plots with applications of 60 T compost $ha^{-1}$ $year^{-1}$: P1 (plot n°-1 localized in block n°-1), P2 (plot n°-2 in block 2), P3 (plot n°-3 in block n°-3) and P4 (plot n°-4 in block n°-4). Samples were taken in the first layer between 0 and 20 cm, sieved (< 5 mm) and stored at 4 °C before being incubated.

To study nitrogen mineralization, soil with compost was incubated in 50 ml polystyrene vials which was disposed in 2-liter jars (eight vials per jar) (Cheneby et al. 1994). Two polystyrene vials were also placed in the 2-liter jars: one with water to maintain optimal humidity and another with NaOH to trap $CO_2$.

Control soil (without compost) was incubated under similar conditions. All treatments were made with four replicates. Soil moisture was regularly controlled (80 % of the water holding capacity) and the jars were incubated at 28°C during all the experiment.

Nitrogen mineralization was measured at different sampling dates : 0, 7, 14, 21, 28, 56, 84 and 112 days. The mineral N ($NH_4^+$+ $NO_2^-$+ $NO_3^-$) was extracted with 0.5 M KCl and measured by colorimetry by flow analysis and spectrometric detection.

## Results and Discussion

For a given sampling date, the results are the sum of the $NH_4^+$-N + $NO_3^-$-N present in the soil minus the mineral N present in the treatment at the beginning of incubation.

Figure 1 compared the amount of nitrogen mineralized after one and twice applications of 60 T compost $ha^{-1}year^{-1}$.

After the second compost incorporation in plots P.1 and P.4, the amount of nitrogen mineralized increased. For example, in P.4, 19 mg mineral N were mineralized after the first incorporation, compared to 40 mg mineral N after the second incorporation after 105 days of incubation. The results are similar for P.1. The amount of nitrogen mineralized was significantly higher after a second compost application than after a single application: the quantities doubled from the first year to the second. This result is a combination of the pursuit of compost mineralization during the first year and the mineralization in the second year.

The rate of N mineralization was significantly higher during the first 28 days of the second year of compost application than after the first one. For example, in P.4, 1.07 mg N was mineralized per day after the second compost incorporation compared to 0.36 mg N mineralized per day after the first compost incorporation.

Figure 1:

Organic-N mineralization ($NH_4^+$+$NO_3^-$) after one and two incorporations of 60 T compost $ha^{-1}$ $year^{-1}$ (the coefficients of variation are less than 10 %)

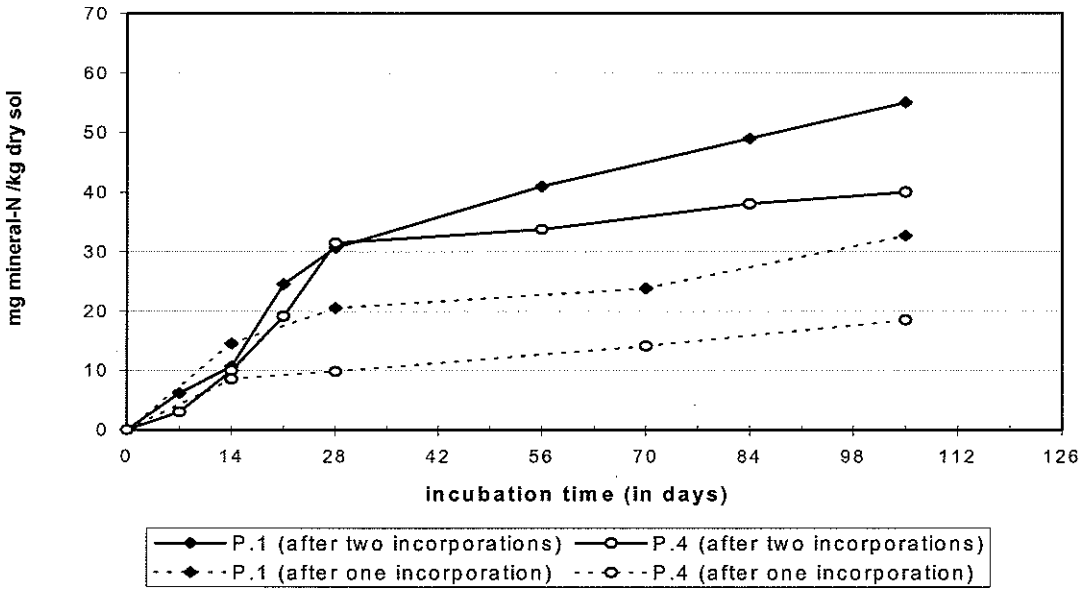
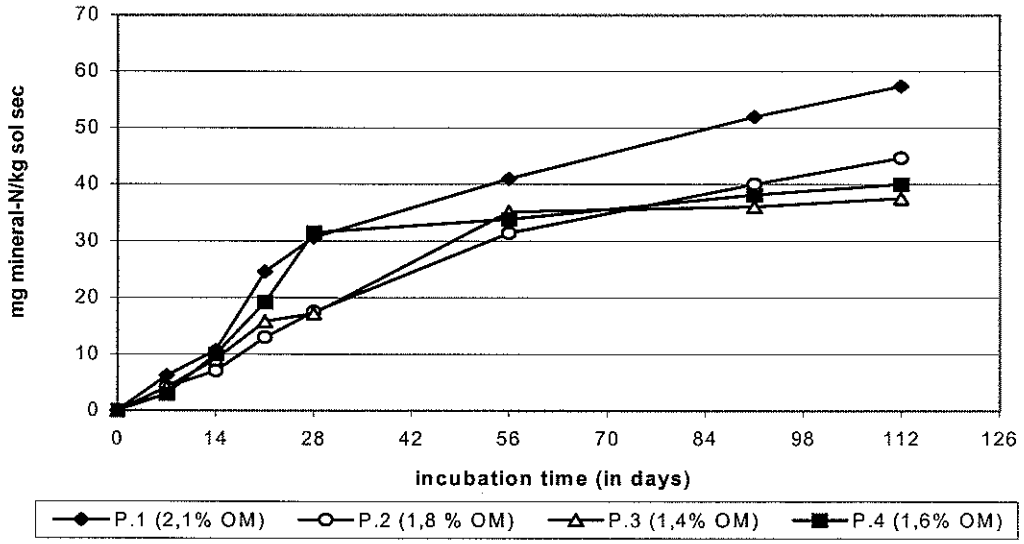



Figure 2:

Organic-N mineralization ($NH_4^+$+$NO_3^-$) after incorporation of 60 T compost $ha^{-1}$ $year^{-1}$ in four different places of the experimental field. (the coefficients of variation are less than 10 %)



There was significant spatial variation in the vineyard soils.

Figure 2 presents the amount of N mineralized in four plots with 60 T compost $ha^{-1}$ $year^{-1}$ at different locations of the experimental field.

Significant differences were observed: 52 mg N were mineralized for P.1 (organic matter: 2.1 %), 45 mg N mineralized for P.2 (organic matter: 1.8 %), 40 mg N mineralized for P.3 (organic matter: 1.4 %) while 36 mg N were mineralized for P.3 (organic matter: 1.4 %) after 91 days of incubation at 28°C.

Chemical determinations, and in particular initial (before compost applications) soil organic matter, provided information to explain these results. Figure 3 shows the relationship between the initial soil organic matter and the quantities of N mineralized after the first and the second compost incorporation for a period of 91 days of incubation at 28°C.

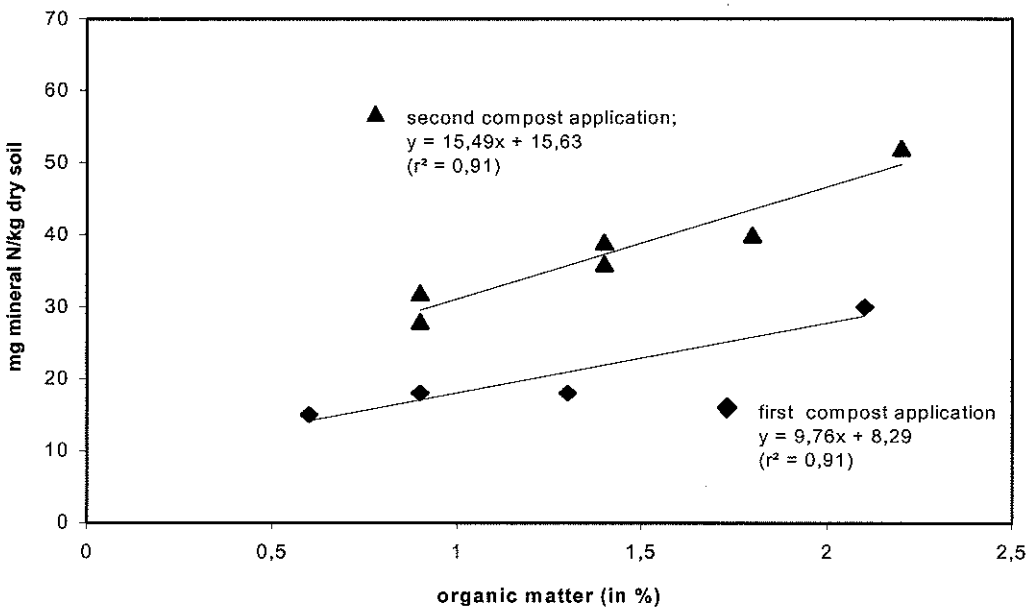
A linear relationship exists between the two parameters: the soil organic matter has a significant influence on the nitrogen mineralization ($r^2$ = 0.91 for the two years). The data suggests that a soil with a very low soil organic matter (<1 %) will have a very low nitrogen mineralization, and vice-versa.

The line showing the second year of application is above the one of the first year in the graph 3. This might be explained by a cumulative effect of the compost: mineralization rates after the second year of application were greater than after the first year.

The slopes of the two straight lines are significantly different: 9.76 for the first compost incorporation compared to 15.49 for the second one. In other words, high organic matter soil will release more nitrogen in the second year than a low organic matter soil. This means that a soil with low organic matter can not mineralize very much nitrogen from compost as we have seen in this study. That is the reason why, in soils with low organic matter, several small doses of compost would be preferable to one large application of compost.

Figure 3:

Linear regression between soil organic matter and quantities of N mineralized after one and two incorporations of different doses of compost



The initial soil organic matter would also be expected to have an influence on the mineralization of the compost incorporated the first year but this can not be show by this graph.

Moreover, initial soil organic matter is a very important parameter because a correlation with the vineyard yield was observed (Weinzaepflen, 1999). But up to now, the different compost treatments do not seem to modify the relationship between initial soil organic matter and vineyard yield (Weinzaepflen, 1999).

The practical recommendations for the use of a given organic material must be adjusted to the soil in which the organic matter is to be incorporated, in particular initial soil organic matter. The organic matter applied for the last two years did not have any effect of the vineyard yield in spite of the considerable amount of compost incorporated. This type of weak relationship at the start of an experiment with organic matter was also observed by Limbourg (1992), Godden and al. (1997) but for different organic matter (manure compost) that the one we use. Their results are not necessarily applicable to our experiment. Consequently, this study will continue and new results will soon complete the present approach.

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