Effect of Sewage Sludge Compost Application on Ammonium-Nitrogen and Nitrate-Nitrogen Contents of an Olive Grove Soil

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Abstract: The objective of this work was to study the effect of sewage sludge compost on ammonia and nitrate accumulation in the olive-grove soil. This study has been conducted since 1998. To evaluate sewage sludge compost on soil-grove four treatments were set up in a clay loam soil in Seseña (Toledo, Spain). Every experiment was replicated four times. The applied treatments were sewage sludge compost (SSC), sewage sludge compost plus urea (SSC+U), urea (U) and a control (C). Two treatments have provided more $N\text{-}NH_4^+$ and $N\text{-}NO_3^-$ content: U and SSC+U. Thus, results suggest that sewage sludge compost is a fertilizer of slow mineralization for olive grove soil.
Keywords: Olea europaea, organic amendment, organic fertilizer, soil conservation

1 Introduction

One of the most problems of agricultural soils is the decrease on the content of their organic matter, mainly in arid and semiarid regions. Alternative compounds to the traditional manures are sewage sludge compost and municipal solid wastes once do not exit adverse effects.

Sewage sludge compost may be utilized on agricultural land as a source of nutrients and as an organic amendment for the improvement of soil physical properties. Sewage sludge compost contains every nutrient for plants growth, especially N and P. This use of sewage sludge compost has, indeed, another advantage, it avoids the accumulation of sewage sludge in the environment. (García, C, 1991)

So, the objective of this work was to study the effect of sewage sludge compost on ammonia and nitrate accumulation in the olive-grove soil.

2 Materials and methods

This study has been conducted since 1998. To evaluate sewage sludge compost on soil-grove four treatments were set up in a clay loam soil in Seseña (Toledo, Spain). Every experiment was replicated four times. The applied treatments were sewage sludge compost (SSC), sewage sludge compost plus urea (SSC+U), urea (U) and a control (C). Treatments and its doses appear in Table 1.

Table 1 Characteristics of the treatments

Treatments	Doses
SSC	16.000 kg of sewage sludge compost./Ha
SSC + U	250 kg of urea./Ha + 8.000 kg of sewage sludge compost./Ha
U	500 kg. of urea /Ha
C	------

Prior to the compost application, soil analysis of the experimental plots was carried out. The results show (Table 2) that the soil is poor in organic matter; has a low ratio C/N, salts content are insignificant and the available P has a correct level. (Junta de Extremadura, 1992)

Table 2 Characteristics of the soils

Depth (cm)	0—15	15—30
pH (1:2.5)	7.9	8.0
Electrical conductivity (1:5) dS· m^{-1}(25°C)	2.1	2.2
N total (%)	0.08	0.06
Organic Matter (%)	1.2	1.03
Available P (mg P/kg)	15.1	7.0
Texture (USDA)	Clay loam	

The compost used in all the tests was obtained from wastewater treatment plants of Madrid. All the treatments were placed on the soil between the rows of the trees and incorporated by means of harrowing in spring in 1998, 1999 and 2000. The characteristics of the sewage sludge compost are presented in Table 3 and Table 4 (AOAC, 1995; APHA, AWWA, WPCF, 1992).

Table 3 Composition of the sewage sludge compost used in the trials

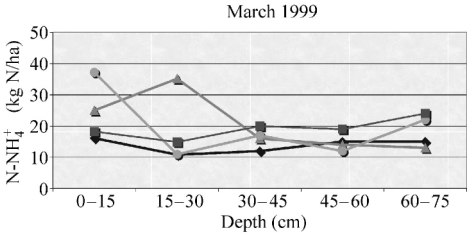
Humidity (%)	Organic Matter (%)	Oxidable Carbon (%)	N (%)	P_2O_5 (%)	K_2O (%)	CaO (%)	E.C dS/m	pH
17.5	35	12.5	2.1	1.4	0.4	5.9	4.05	8.2

Table 4 Heavy metals on sewage sludge compost (mg/kg)

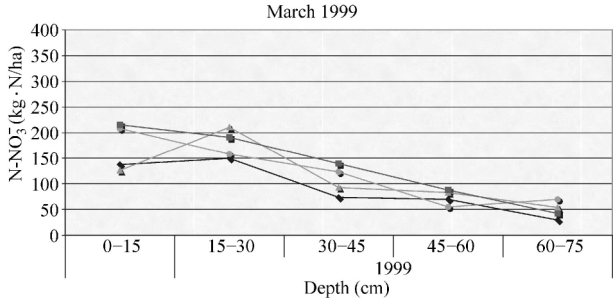
	Pb	Cd	Ni	Cr	Cu	Zn
Seseña	122	<3	48	233	268	1428
UE Limit	1200	40	400	1500	1750	4000

In March, July and October soil samples were collected. Five depths were studied: 0cm—15cm; 15cm—30cm; 30cm—45cm; 45cm—60cm and 60cm—75cm.

Ammonium-nitrogen (NH_4^+-N) and nitrate-nitrogen (NO_3^--N) content in soil samples were analysed by stem distillation. (Bremner J.M., 1965)



(a)



(b)

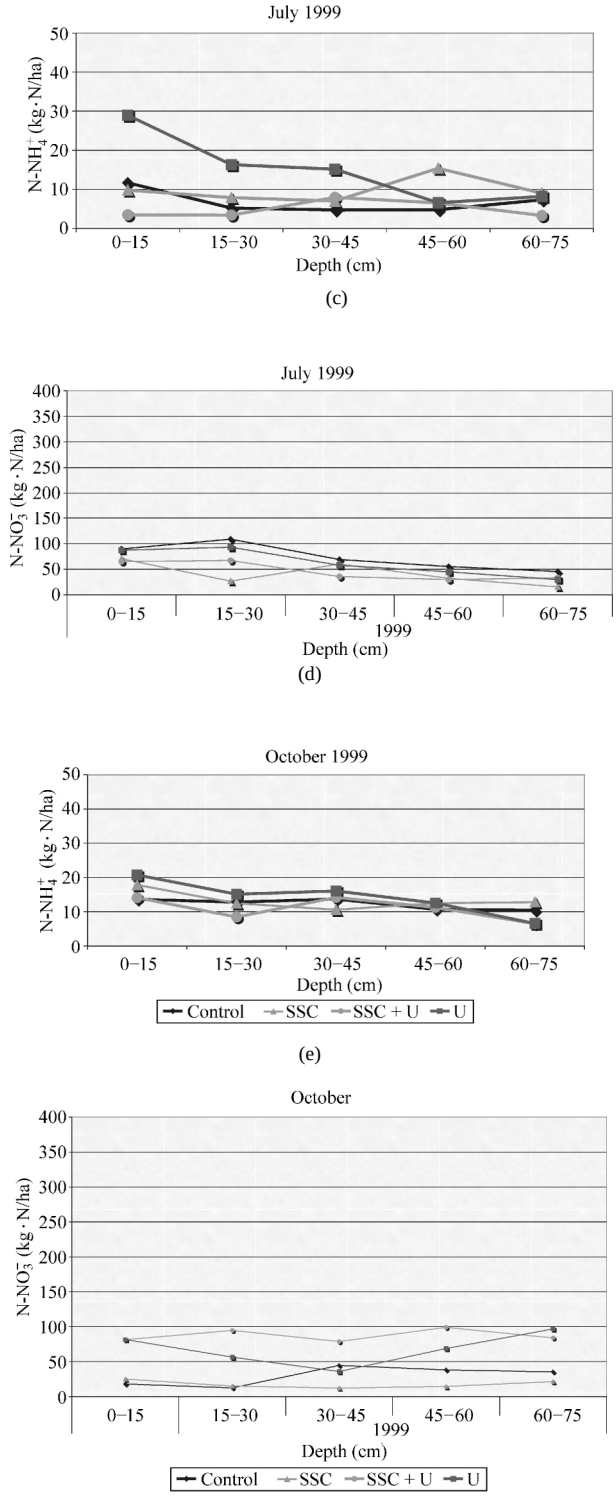
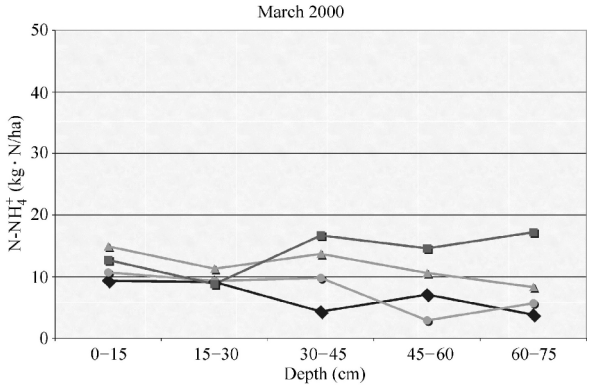
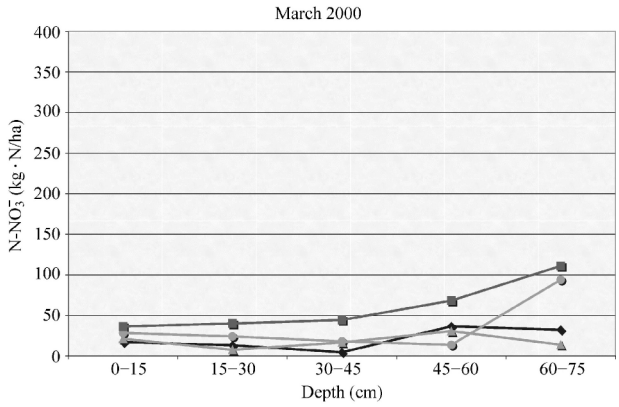


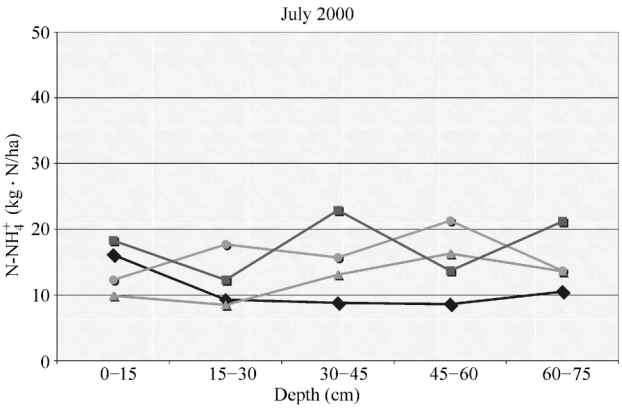
Fig. 1 N-NH_4^+ and N- NO_3^- content in soils during 1999


March 2000
N-NH4+ (kg · N/ha)
50
40
30
20
10
0
0–15
15–30
30–45
45–60
60–75
Depth (cm)

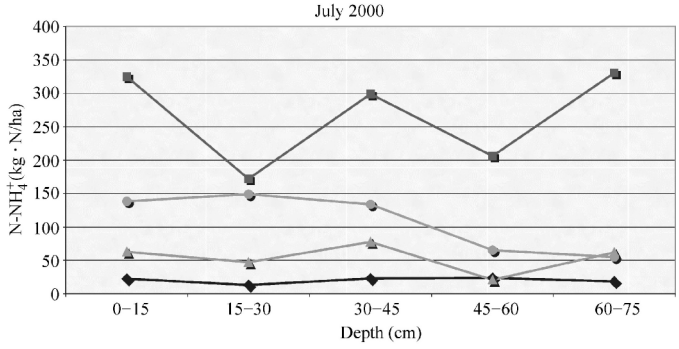
(a)


March 2000
N-NO3 (kg · N/ha)
400
350
300
250
200
150
100
50
0
0–15
15–30
30–45
45–60
60–75
Depth (cm)

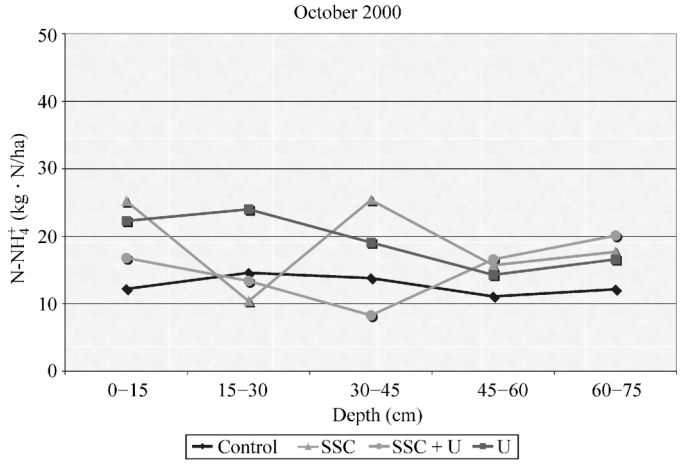
(b)


July 2000
N-NH4+ (kg · N/ha)
50
40
30
20
10
0
0–15
15–30
30–45
45–60
60–75
Depth (cm)

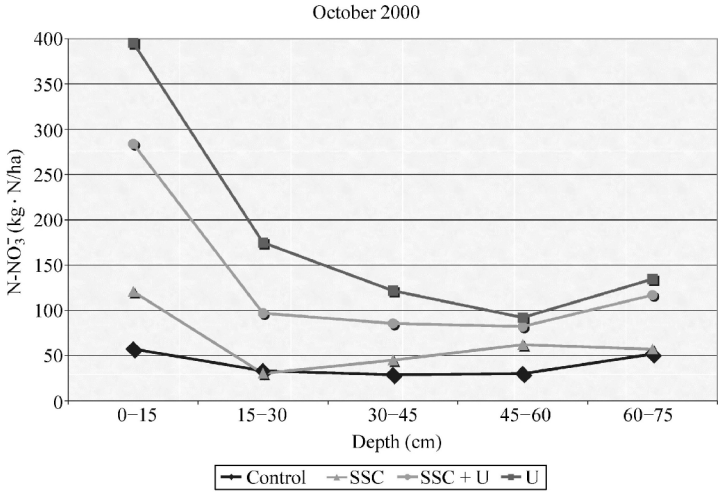
(c)


July 2000
N-NH4+ (kg · N/ha)
400
350
300
250
200
150
100
50
0
0–15
15–30
30–45
45–60
60–75
Depth (cm)

(d)

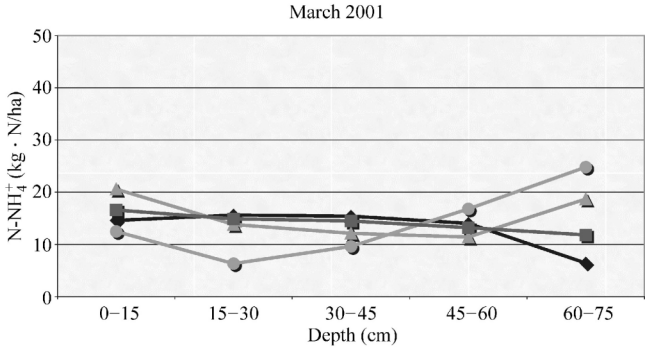


(e)

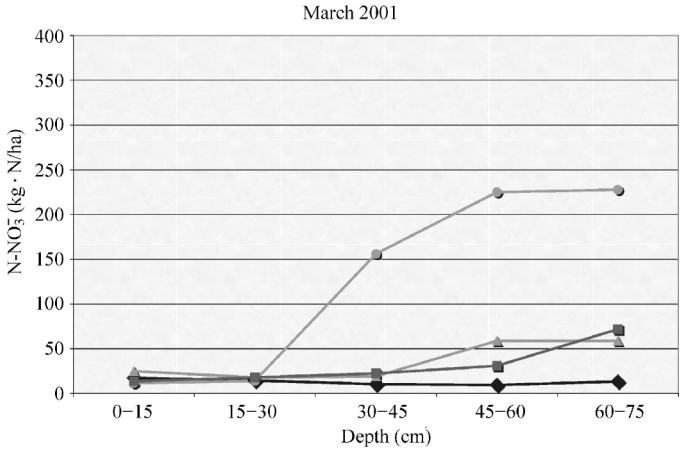


(f)

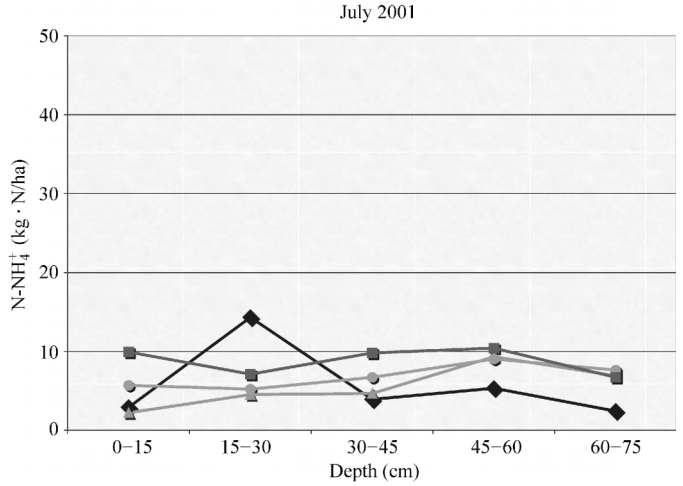
Fig.2 N-NH_4^+ and N-NO_3 content in soils during 2000



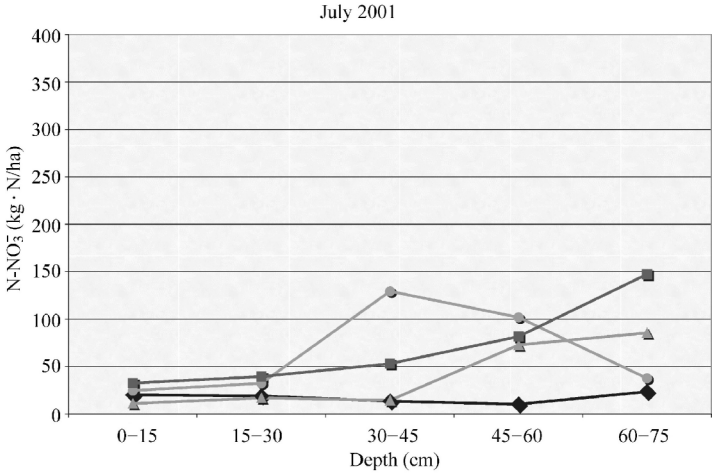
(a)


March 2001
400
350
300
250
200
150
100
50
0
N-NO3- (kg · N/ha)
0–15
15–30
30–45
45–60
60–75
Depth (cm)

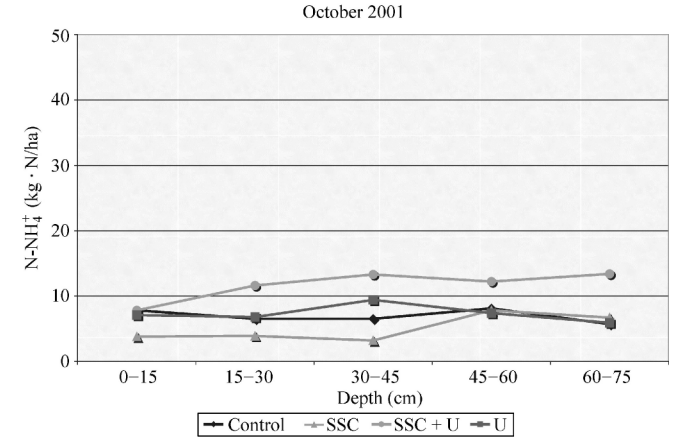
(b)


July 2001
50
40
30
20
10
0
N-NH4+ (kg · N/ha)
0–15
15–30
30–45
45–60
60–75
Depth (cm)

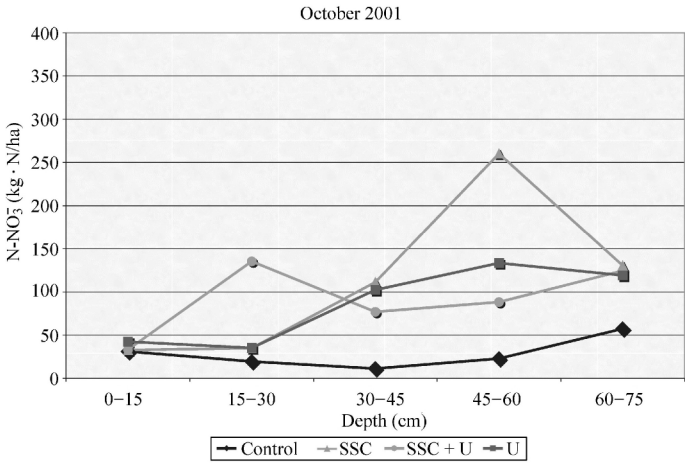
(c)


July 2001
400
350
300
250
200
150
100
50
0
N-NO3- (kg · N/ha)
0–15
15–30
30–45
45–60
60–75
Depth (cm)

(d)



(e)



(f)

Fig.3 N-NH_4^+ and N- NO_3^- content in soils during 2001

3 Resulsts and discussion

3.1 N-NH_4^+

In 1999, in March, in superficial soil, 0 cm —15 cm and 15 cm—30 cm, SSC provided more N-NH_4^+ content to soil. To increase the depth, U was the treatment that provided more N-NH_4^+ content to soil. In July and October the same trend was observed, plots with U treatment had more N-NH_4^+ content.

In 2000, U and SSC treatments provided more N-NH_4^+ and in 2001 more N-NH_4^+ in soils was observed with SSC + U treatment.

3.2 N-NO_3^-

In 1999, in March, more N-NO_3^- was observed than in July and in October at 0 cm—15 cm and 15cm—30cm of depth. However, at 60 cm—75 cm the N-NO_3^- content increased slightly in October with respect to March, due to the N-NO_3^- accumulation and progress of nitrification. U and SSC+C treatments provided more N-NO_3^- content to soil.

In 2000 N-NO_3^- content in soils in march is lower than in July and October. The reason is that application of fertilizers was done after the soil samples were collected. Treatments that provided more N-NO_3^- content were U and SSC + U.

The same trend was observed in 2001.

4 Conclusions

Two treatments have provided more $N\text{-}NH_4^+$ and $N\text{-}NO_3^-$ content: U and SSC+U. Thus, results suggest that sewage sludge compost is a fertilizer of slow mineralization for olive grove soil.

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