ISSN print: 1224-5984
ISSN online: 2248-3942

Rom Biotechnol Lett. 2022; 27(2): 3389-3397
doi: 10.25083/rbl/27.2/3389.3397

**Received for publication: January.10, 2022**
**Accepted: May, 02,2022**

*Original paper*

# Study of use sewage sludge compost as fertilizer on the sandy soil in a plum orchard

**IRINA TITIRICĂ[1], MILICA DIMA[1]*, GEORGETA TEMOCICO[2], CLAUDIA NICOLA[3]**

[1]Dăbuleni Research-Development Station for Plant Cultivation on Sandy Soil, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
[3]Research Institute for Fruit Growing Pitesti-Maracineni, Romania

## Abstract

To the Research and Development Station for Plants Culture on Sands, Dăbuleni, in the period 2020-2021, in a plum orchard, different doses of compost were applied obtained from sludge resulting from the processing of domestic wastewater. Soil analyzes, in the second year after the application of compost, showed an improvement in the content of nitrogen, phosphorus and potassium, with higher values at doses of 60-80t / ha compost. Organic carbon showed values between 0.13% in the control version and 0.69% in the fertilized variant with 80t / ha compost. Regarding the soil reaction, a slight reduction of pH was observed with increasing amount of compost. The results obtained regarding the heavy metals in the soil showed increases in all the analyzed elements, with the increase of the amount of compost, but the values obtained do not exceed the maximum allowed limits in EU countries. The highest values were determined to dose of 60t / ha of compost, at which the manganese content increased from 180 mg to 414 mg, copper from 10.1 mg to 43.9 mg, and zinc from 15.6 mg to 39.3 mg. These results lead to the premise of the careful use of composts obtained from sludge resulting from the processing of domestic wastewater as fertilizer in the orchards.

## Keywords

urban sludge, sandy soils, heavy metals

**To cite this article:** TITIRICĂ I, DIMA M, TEMOCICO G, NICOLA C. Study of use sewage sludge compost as fertilizer on the sandy soil in a plum orchard. *Rom Biotechnol Lett.* 2022; 27(2): 3389-3397 DOI: 10.25083/rbl/27.2/3389.3397

*Corresponding author: Milica Dima, milicadima@yahoo.com

## Introduction

The use in agriculture of the sludge resulting from the processing of domestic wastewater is one of the methods of their release and a form of enhancement of their content in organic matter and nutrients. Many studies have been published on the beneficial effects of changes in sewage sludge on crop production and the physical and chemical properties of the soil. The addition of sludge to the soil is known to improve the physical properties of the soil, increasing water content, increasing water retention, increased aggregation, soil increased aeration, higher permeability, increasing water infiltration and decreasing surface crust (HUSSEIN [12]). The application of sewage sludge by mixing it with the 30 cm soil layer has proven to be effective in improving the physical, chemical and fertility proprieties of the soil. Also, the use of residual sludge as organic manure is considered as a necessary source of nutrients for plants (HUSSEIN [12]).

Some studies reported that the application of sewage sludge decreased soil pH and increased the quantity of total soluble salts, organic carbon and soil cation exchange capacity (ANTOLIN & al., [2]). They also found that the application of sewage sludge increased the content of heavy metals extractable from the soil (Cd, Cu, Mn, Pd and Zn) and increased the N-NH4 + content from the soil.

MENDOZA & al., [18] reported that organic and extractable matter increased with the addition of sludge to the soil, while soil pH decreased.

Globally, researches on the application of sludge composts to fruit trees is much more numerous, and the results obtained argue for their use in agriculture. The application of sludge (biosolids) over several years in apricot (*Prunus armeniaca* L.) plantations, on sandy soils, did not lead to a reduction in fruit production, although fruit ripening was generally delayed, but the percentage of ripened fruit at the same time was higher at higher biosolids doses. Although the C and N content of the soil has increased with the long-term application of biosolids, it is recommended prudence on its negative effect on fruit production (GARY & al., [11]). Researches conducted by ANGIN (& al., [1]) in a cherry plantation showed that the application of sewage sludge not only improved the chemical properties of the soil, but also led to an increase in nutrient content of cherry leaves. The application of sewage sludge has increased the content of heavy metals in the soil. However, the critical values were not exceeded and was not reflected in the heavy metal content of the leaves. The most effective application rate was 7.5 kg per tree. Studies should be continued to evaluate the effects of residual sludge on trees throughout the growing season, as well as on the parameters of vegetative growth, yield and fruit quality.

MEHMET (& al., [17]), after a study on the apple species, showed that the application of sewage sludge in installments of 0, 10, 20, 40 and 60 kg / tree for four years, led to an increase in the production of fruits, annual growth, and leaves content in N, Mg, Fe, Mn, Zn and Cu at the end of the study. The results indicated that the repeated application of sludge in apple plantations did not cause toxicity to leaves and fruits. However, long-term application of sludge can lead to the accumulation of Zn, Cu and Ni in the soil and plant.

The high content of organic matter and the amount of residual sludge nutrients are a guarantee of agronomic benefits. At the same time, the use of sludge from wastewater makes possible reusing the organic waste and has many advantages. There is insufficient organic matter in agricultural soil, a serious problem in areas with a Mediterranean climate where high summer temperatures promote high annual mineralization of organic matter (ANTOLIN & al., [2]). Turkey's agricultural lands, especially the eastern ones, the soils of the Anatolian region are generally low content in organic matter. Therefore, these soils favor the application of sewage sludge as an organic amendment and the provision of nutrients for these soils with a relatively low risk of pollution (BOZKURT & al., [5]). An increase in soil organic matter and other nutrients after the application of sewage sludge has been observed by other researchers (BROFAS G., & al., [6], GARCIA-GILL[9]).

The use of sewage sludge improves soil structure by increasing the stability of aggregates, which leads to improve water retention capacity, aeration and reduction erosion (SORT & al., [25]), BARGEZAR., & al., [4]). Similarly, many researches have shown the beneficial effects of applying sewage sludge on production to different crops (VIATOR & al., [28], BARBOSA & al., [3]., Korboulewsky [15]., MATA- GONZALES[16]).

PINAMONTI & al., [22] tested the compost of sludge in different apple orchards. The resulted data showed that the sludge can be used for soil fertilization without any short/ medium term danger to the environment or crops. NEILSEN & al., [20], they initiated an experiment to evaluate the effects of municipal biosolid on an 8-year-old plantation. The application of biosolid often increased in the leaves the concentration of Zn, Cu and Mn, but the increases were modest.

At the national level, researches have been carried out in fruit growing on the use of compost from sludge. For fruit trees are relevant the researches undertaken by SUMEDREA & al., [27], and NICOLA & al., [21], on the apple species, which showed that the application of the same amounts of manure and sludge per volume of planting substrate at 0-30 cm compared to the depth of 0-60 cm did not show a significant difference in tree growth. At the same application rates, manure induced a more intense and earlier growth of annual shoots and cross-section of tree trunks compared to urban sludge. Also, in the apple orchard, IANCU & al., [13], showed that the use of sludge as a fertilizer in agriculture prevents environmental pollution, which is mainly caused by some infestations of pathogens or the high content of chemicals above the maximum limits admitted by law. SMITH, & al., [24] shows that the long-term accumulation of heavy metals in the soil is an important concern, as they can have important consequences on the quality of the human food chain, plant toxicity and soil microbial processes and, once applied, have long-lasting effects in the ground.

In the present study was evaluated the sandy soil chemical compounds after use of urban sludge as fertilizer in a plum orchard.

## Materials and Methods

### Study area

The study was conducted in a plum experimental plot of the Research and Development Station for Plants Culture on Sands, Dăbuleni. The orchard was established in 2014 year, with Stanley cultivar. The experimental plot was located at 43 80 60 N and 24 05 97 East on a sandy soil poor in nitrogen (0.02-0.06%), medium to well supplied with phosphorus 24-107 ppm) and low supplied with exchangeable potassium (15-38ppm). The organic carbon content was low (0.07-0.49%), characteristic of sandy soils, and the soil reaction was moderately acidic to neutral ($pH_{H2O}$ = 6.36-7.10). To evaluated the effect of urban sludge compost as fertilizer, in 2020 year in the first decade of April, a single factor experiment was designed (five experimental variants with four replicates) the experimental factors with the following graduations: V1=0 tons/hectar; V2=20 tons/hectar; V3=40 tons/hectar; V4 = 60 tons/hectar; V5=80 tons/hectar (t/ha) of urban sludge compost obtained at the Mioveni wastewater treatment plant applied as fertilizer, the doses was mixing to the 30 cm soil depth. The compost was applied in compliance with the Environmental Acquis ([*** 29, 30, 31]).

### Soil sampling and laboratory analysis

In the study period 2020-2021, for evaluated the soil chemical characteristics the following determinations were made: total nitrogen by Kjeldahl method (KJELDAHL [14]); the extractable phosphorus (P-AL) by Egner - Riem Domingo method, by which phosphates are extracted from the soil sample with a solution of acetate - ammonium lactate at pH - 5.75, and the extracted phosphate anion is determined calorimetrically as - molybdenum blue; the changeable potassium (K-AL) by Egner-Riem Domingo method which the hydrogen and ammonium ions of the extraction solution replace by exchange the potassium ions in exchangeable form from the soil sample which are thus passed into the solution (EGNER & al.[8]). The potassium dosing in the solution thus obtained is done by flame emission photometry; the organic carbon by the method of wet oxidation and titrimetric dosing (gogoasa modification); the soil pH by the potentiometric method; the determination of the content of heavy metals in the soil, before the application of the compost and after the application was performed at National Research and Development Institute for Soil Science, Agrochemistry and Environment Bucharest. The geoaccumulation index of heavy metal in soil ($I_{geo}$) was calculated after formula: $I_{geo} = \log_2 (C_n / 1.5 x B_n)$ (MULER [19]) where $C_n$ is the measured concentration of the element in sewage sludge (mg/kg ) and $B_n$ is the geochemical background value in soil. The constant value 1.5 is introduced for better analysis of the natural variability of the content of the chosen substance in the environment.

### Vegetable material sampling and laboratory analysis

After the administration of the compost, during the period of intense growth of the shoots, leaves samples were collected to determine the nitrogen, phosphorus and potassium content of the plants. The chemical content in the leaves during the period of intense growth of shoots was evaluated by the following methods: the total nitrogen by the Kjeldahl method; the total phosphorus by the colorimetric method; the total potassium by method of dosing by flame emission photometry.

### Statistical analyses

The obtained results were statistically analyzed using the analysis of variance (ANOVA). Means were compared using Duncan`s multiple range test at 0.05 probability levels.

## Results and discussion

### The chemical composition of the soil before the application of the sewage sludge compost

The results obtained regarding the chemical composition of the soil before the application of the sewage sludge compost used as fertilizer, show that soil is poorly provisioned in total nitrogen (0.03%), also the average soil content in

Table 1. Chemical composition of the soil in the plum, before applying the compost

| Dose of compost applied (t/ha) | Depth (cm) | Total nitrogen content Nt (%) | Extractable phosphorus (ppm) | Exchangeable potassium (ppm) | Organic carbon (%) | pH |
|---|---|---|---|---|---|---|
| V1-0 | 0-30 | 0.04 | 62 | 38 | 0.38 | 6.66 |
| | 30-60 | 0.05 | 53 | 26 | 0.21 | 6.36 |
| | 60-90 | 0.03 | 40 | 20 | 0.18 | 6.70 |
| V2-20 | 0-30 | 0.06 | 65 | 26 | 0.46 | 6.56 |
| | 30-60 | 0.01 | 52 | 20 | 0.35 | 7.00 |
| | 60-90 | 0.02 | 46 | 20 | 0.43 | 6.87 |
| V3-40 | 0-30 | 0.04 | 46 | 26 | 0.41 | 6.87 |
| | 30-60 | 0.02 | 24 | 15 | 0.07 | 7.10 |
| | 60-90 | 0.02 | 34 | 15 | 0.21 | 6.86 |
| V4-60 | 0-30 | 0.02 | 73 | 32 | 0.07 | 6.96 |
| | 30-60 | 0.04 | 77 | 26 | 0.21 | 7.00 |
| | 60-90 | 0.03 | 62 | 20 | 0.42 | 6.95 |
| V5-80 | 0-30 | 0.04 | 82 | 20 | 0.49 | 6.87 |
| | 30-60 | 0.03 | 72 | 20 | 0.21 | 6.80 |
| | 60-90 | 0.02 | 107 | 20 | 0.17 | 6.76 |
| Average | | 0.03 | 87 | 20 | 0.29 | 6.81 |

Table 2. Analysis of heavy metals and microelements (mg/kg dry soil) from sandy to plum soil

| Depth (cm) | Cd | Cu | Co | Mn | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| 0-30 | 0.066 | 10.1 | 4.03 | 180 | 7.50 | 6.12 | 15.6 |
| 30-60 | 0.043 | 8.56 | 3.13 | 147 | 7.78 | 5.47 | 14.6 |
| **Normal limits after Order 756/1997** | **1-3** | **20-100** | **15-30** | **900** | **20-75** | **20-50** | **100-300** |

phosphorus (87 ppm), potassium (20 ppm) is normal after RĂUȚA & CHIRIAC [23] the organic carbon content was low (0,29 %) (Table 1). The heavy metals content before sewage sludge compost applied in plum orchard was under the normal limits after Order 756/1997 (Table 2).

## The influence of compost application on plum leaves chemicals characteristic

The values of the total nitrogen content from plum leaves, after fertilization in the plantation, divided the 5 fertilization variants into 3 statistical classes. The differences registered between the fertilization variants are between 5.50-12.3%. The highest values of leaf content in total nitrogen and potassium were recorded in plants of variant V5, respectively 80t compost/ha in 2020 year and in 2021 year the highest value were registered on V4 variant. In our case, the differences between the total nitrogen values in leaf registered in first and in the second year were between 0.42% - 9.1%. Regarding the phosphorus content of the leaves, the highest value was registered for fertilized plants with a dose of 20t/ha (0.33%) in 2020 year and in the second year, 2021 the highest value was registered on V5 variant (0.44%). The

Table 3. The influence of compost application on the nitrogen, phosphorus and potassium content of the plum leaves in 2020-2021 year

| Dose of compost applied (t/ha) | Total nitrogen (%) | | Total phosphorus (%) | | Total potassium (%) | |
|---|---|---|---|---|---|---|
| | 2020 | 2021 | 2020 | 2021 | 2020 | 2021 |
| V1- 0 | 2.06 c* | 1.96 e | 0.26 b | 0.24 d | 2.05 d | 1.38 e |
| V2-20 | 2.05 c | 2.23 d | 0.33 a | 0.29 c | 2.19 cd | 1.87 d |
| V3-40 | 2.18 b | 2.40 b | 0.25 b | 0.37 b | 2.28 c | 1.99 c |
| V4-60 | 2.23 b | 2.80 a | 0.29 ab | 0.39 b | 2.71 b | 2.79 b |
| V5-80 | 2.35 a | 2.36 c | 0.29 ab | 0.44 a | 2.92 a | 2.96 a |

*Different letters indicate significant differences for the probability $P \leq 0.05$ according to Duncan's multiple range test.

Table 4. The chemical composition of sandy soil profile, in plum orchard after compost application, 2021 year

| Dose of compost applied (t/ha) | Depth (cm) | Total nitrogen (%) | Extractable phosphorus (ppm) | Exchangeable potassium (ppm) | Organic carbon (%) | pH |
|---|---|---|---|---|---|---|
| V1-0 | 0-30 | 0.04 c | 53gh | 32 i | 0.35 i | 6.70 ab |
| | 30-60 | 0.03 c | 51 h | 38 h | 0.49 g | 6.60 b |
| | 60-90 | 0.03 c | 47 i | 36 h | 0.13 k | 6.62 b |
| V2-20 | 0-30 | 0.04 c | 66 e | 32 i | 0.63 c | 6.29 c |
| | 30-60 | 0.04 c | 59 f | 42 g | 0.35 i | 6.95 a |
| | 60-90 | 0.03 c | 52 h | 30 i | 0.24 j | 6.70 ab |
| V3-40 | 0-30 | 0.05 bc | 66 e | 32 i | 0.58 d | 6.54 bc |
| | 30-60 | 0.05 bc | 76 cd | 45 f | 0.66 b | 6.64 b |
| | 60-90 | 0.03 c | 64 e | 50 e | 0.55 e | 6.48 bc |
| V4-60 | 0-30 | 0.07 bc | 78 c | 38 h | 0.70 a | 6.51 bc |
| | 30-60 | 0.06 bc | 86 b | 57 d | 0.60 d | 6.66 b |
| | 60-90 | 0.04 bc | 56 fg | 63 c | 0.45 h | 6.57 b |
| V5-80 | 0-30 | 0.10 a | 74 d | 57 d | 0.69 a | 6.48 bc |
| | 30-60 | 0.07 bc | 96 a | 77 b | 0.57 de | 6.77 ab |
| | 60-90 | 0.06 bc | 73 d | 84 a | 0.52 f | 6.65 b |

*Different letters indicate significant differences for the probability P≤0.05 according to Duncan's multiple range test.

differences assured statistically, in the case of the phosphorus content in the leaves, vary between 12.1-21.2%, and between 17.2%-44.5% in 2021 (table 3). The values recorded to the potassium leaves content showed the highest value in the study period on the V5 variant (2.92 % in 2020 year, and 2.96 in 2021year) (table 3).

## The influence of compost application on the chemical characteristics of sandy soil profile, in plum orchard.

The total nitrogen content of the soil after sewage sludge compost applied as fertilizer in the plum orchard, presented in table 4, was between 0.03% for the control variant (V1) and 0.10% for the V5 (80t/ha). That show, an increase of total nitrogen with differences between the studied variants till 30%. The differences between the analyzed variants are statistically assured, the same situation is with the content of extractable phosphorus and exchangeable potassium were the differences between V1 variant and the other studied variants rise progressively with the sewage sludge compost dose till 47%.

The organic carbon showed values between 0.13% in the depth of 60-90 cm for the control variant (V1) and 0.69% in the depth of 0-30 cm for the variant fertilized with 80 t/ha compost (V5). As for the soil reaction, a slight decrease in pH can be observed with increasing amount of compost (table 4).

Between the amount of nitrogen in the compost and the content of total nitrogen, extractable phosphorus and exchangeable potassium in the soil, polynomial correlations were established, given by second degree equations, with significant correlation factors. Nitrogen and potassium (average content per profile 0-90cm) accumulate in the soil with increasing amount of compost, and phosphorus increases with increasing of nitrogen content in compost to the nitrogen values in compost of 1000 kg/ha (Figure 2 1).

In the second year after sewage sludge compost applied used as fertilizer in plum orchard, the heavy metals soil content show for five from seven elements analyzed the highest content in the v4 variant, on the deeep 0-30 cm, with differences between 30.4 and 2.2% (table 5). Also, the highest value in soil cobalt content was recorded on V4 variant to the depth 60-90 cm. In case of soil nickel content the highest values (20.7 mg/kg) was recorded on variant V5, on 30-90cm depth. For all the havy metals analyzed, the differences between the fertilizer variants applied, were ensured from a statistical point of view (Table 5).

The geoaccumulation index according to MULER [19] cited by DÍAZ-DE-ALBA & al.[7], is associated with a qualitative scale of pollution status: $I_{geo} < 0$ indicates practically unpolluted status; $I_{geo}$ = 0–1 denotes unpolluted to moderately polluted status; $I_{geo}$ = 1–2 is moderately polluted status; $I_{geo}$ = 2–3 represents moderately to strongly polluted status; Igeo = 3–4 is strongly polluted status; $I_{geo}$ = 4–5 is strongly to extremely strong polluted status; and Igeo > 5 is extremely polluted status. In our study, after $I_{geo}$ was calculated for all seven metals studied, for Cd heavy metal, the sandy soil was high polluted on V4 and moderate polluted on others studied variants. For the other heavy metals analyzed after $I_{geo}$ calculated the soil was characterized as no polluted (table 6).

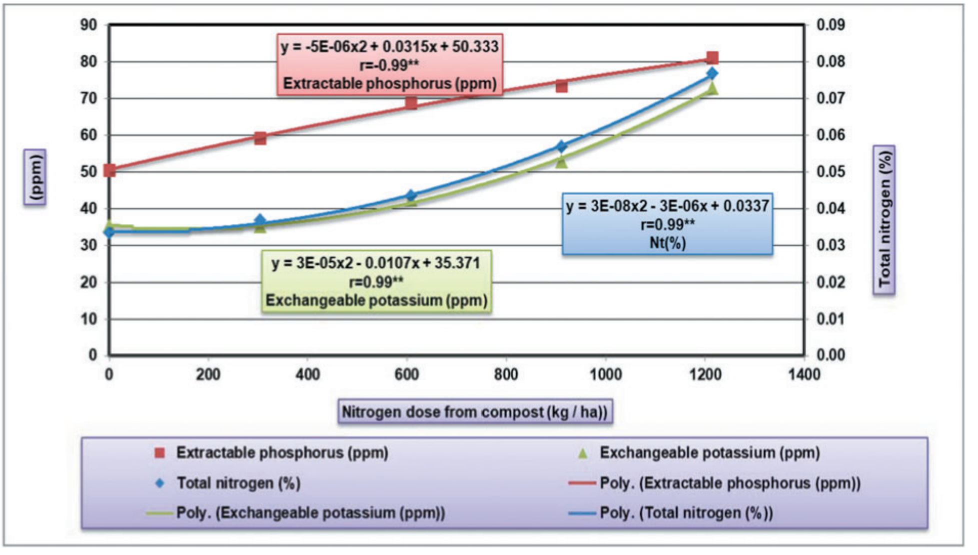


Figure 1. Correlation between the amount of nitrogen in the compost and the content of total nitrogen, extractable phosphorus and exchangeable potassium in the soil for the plum species, 2021

The results obtained by NICOLA & PARASCHIV [19], in an apple orchard, show that in the first year after sludge compost applied the soil contamination with Cd, Pb, Zn appeared to a dose of 60t/ha, versus to the second year after compost applied, when the pollution moderately was identify to a dose of 40 t/ha compost. So, they show that heavy metals are trapped in soluble compounds and are made available with changing environmental conditions.

In whatever way, after the studies made by ANTOLIN & al.[2], IANCU & al. [13], Bozkurt & al.[15], ANGIN & al. [1] long-term application of sludge compost can lead to the accumulation of Zn, Cu and Ni in the soil and in plant, also.

Table 5. The sandy soil heavy metals content (mg/kg dry soil) in the second year after the application of the urban sluge as fertilizer

| Dose of compost applied (t/ha) | Depth (cm) | Cd (mg/kg) | Cu (mg/kg) | Co (mg/kg) | Mn (mg/kg) | Ni (mg/kg) | Pb (mg/kg) | Zn (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| V1-0 | 0-30 | 0.066 e | 10.01i | 4.03 b | 180 l | 7.50 i | 6.12 b | 15.6 j |
| | 30-60 | 0.043 g | 8.56 k | 3.13 c | 147 n | 7.78 i | 5.47 d | 14.6 k |
| | 60-90 | 0.035 h | 5.36 e | 2.15 d | 120 o | 7.80 i | 4.32e | 13.82 l |
| V2-20 | 0-30 | 0.064 e | 39.8 b | n.d** | 316 f | 6.67 j | 4.41e | 23.2 f |
| | 30-60 | n.d** | 23.8 e | n.d** | 250 k | 9.40 g | 3.11g | 18.6 h |
| | 60-90 | 0.081 d | 8.9 jk | 3.01 c | 306 h | 11.6 f | 4.97d | 31.8 b |
| V3-40 | 0-30 | n.d** | 24.0 e | 1.63 c | 323 e | 7.83 i | 5.71c | 24.9 e |
| | 30-60 | n.d** | 21.3 f | 1.55 e | 274 j | 8.95 h | 4.43e | 20.7 g |
| | 60-90 | n.d** | 13.9 h | 3.02 c | 175 m | 12.9 e | 4.01 f | 13.6 e |
| V4-60 | 0-30 | 0.201a | 43.9 a | 1.51 e | 414 a | 17.6 b | 6.63a | 39.3 a |
| | 30-60 | 0.118 b | 25.8 d | 3.07 c | 352 b | 17.7 b | 6.42ab | 30.1 c |
| | 60-90 | n.d** | 9.7 ij | 4.21 a | 297 i | 17.1 c | 3.27g | 16.9 i |
| V5-80 | 0-30 | 0.091 c | 33.5 e | n.d** | 346 c | 15.7 d | 4.59 e | 26.4 d |
| | 30-60 | 0.088 c | 19.3 g | 1.48 e | 311 g | 20.7 a | 4.24ef | 26.3 d |
| | 60-90 | 0.056 f | 14.5 h | 2.23 d | 332 a | 20.7 a | 3.35g | 26.8 d |

*Different letters indicate significant differences for the probability P≤0.05 according to Duncan's multiple range test; n.d** - not detected

Table 6. The degree of sandy soil heavy metals pollution in the second year after the application of the urban sludge compost as fertilizer

| Dose of compost applied (t/ha) | The analized metal | Heavy metal content of fertilized soil (mg/kg) | Havy metal content of compost (mg/kg of d.m) | The Igeo index | Degree of heavy metal pollution in the soil |
|---|---|---|---|---|---|
| V1=0 | Cd | 0.066 | | | |
| | Cu | 10.1 | | | |
| | Co | 4.03 | | | |
| | Mn | 180 | | | |
| | Ni | 7.50 | | | |
| | Pb | 6.12 | | | |
| | Zn | 15.6 | | | |
| V2=20 | Cd | 0.064 | 1.04 | 1.0 | moderate pollution |
| | Cu | 39.8 | 72.36 | 0.0 | pollution no |
| | Co | 0.021 | 38.75 | 0.0 | pollution no |
| | Mn | 316 | 446.14 | 0.0 | pollution no |
| | Ni | 6.67 | 29.53 | 0.2 | pollution no |
| | Pb | 4.41 | 32.21 | 0.3 | pollution no |
| | Zn | 23.2 | 557.0 | 0.1 | pollution no |
| V3=40 | Cd | 0.091 | | 2.0 | moderate pollution |
| | Cu | 24.0 | | 0.1 | pollution no |
| | Co | 1.63 | | 0.8 | pollution no |
| | Mn | 323 | | 0.0 | pollution no |
| | Ni | 7.83 | | 0.2 | pollution no |
| | Pb | 5.71 | | 0.2 | pollution no |
| | Zn | 24.9 | | 0.1 | pollution no |
| V4=60 | Cd | 0.201 | | 3.2 | high pollution |
| | Cu | 43.9 | | 0.0 | pollution no |
| | Co | 1.51 | | 0.8 | pollution no |
| | Mn | 414 | | 0.0 | pollution no |
| | Ni | 17.6 | | 0.1 | pollution no |
| | Pb | 6.63 | | 0.2 | pollution no |
| | Zn | 39.3 | | 0.1 | pollution no |
| V5=80 | Cd | 0.091 | | 2.3 | moderate pollution |
| | Cu | 33.5 | | 0.0 | pollution no |
| | Co | 0.001 | | 0.0 | pollution no |
| | Mn | 346 | | 1.2 | moderatte pollution |
| | Ni | 15.7 | | 0.1 | pollution no |
| | Pb | 4.59 | | 0.3 | pollution no |
| | Zn | 26.4 | | 0.1 | pollution no |

# Conclusion

Soil analyzes in the second year after the application of compost to the plum orchard showed an improvement in the content of nitrogen, phosphorus and potassium, with higher values at doses of 60-80 t/ha compost. The organic carbon showed values between 0.13% in the depth of 60-90 cm for the control variant and 0.69% in the depth of 0-30 cm for the variant fertilized with 80 t/ha compost, results that indicate a reduced to middle states. Regarding the soil reaction, a slight reduction of pH was observed with increasing amount of compost.

The results obtained regarding the heavy metals in the soil in the second year after the application of the compost, showed increases to all the analyzed microelements, with the increase of the amount of compost, but the values obtained do not exceed the maximum allowed limits. The highest values were determined at a dose of 60t/ha of compost, for which the manganese content increased from 180 mg to 414 mg, copper from 10.1 mg to 43.9 mg, and zinc from 15.6 mg to 39.3 mg. The values obtained for the analyzed microelements, in the conditions of sandy soils, in the second year from the compost administration lead to the premise of the careful use of composts obtained from sludges resulting from domestic wastewater treatment in orchards. Regarding the analysis of the macroelements in the leaves, the results obtained show that the increase in the amount of compost led to the increase of the content of the three macroelements, both in the first year and in the second year, and the highest values were recorded in fertilized variants with 60 and 80t /ha.

## Acknowledgements

The research from this paper was supported from the project ADER 7.3.10. *Research on the use of compost obtained from sludge resulting from the treatment of domestic wastewater as fertilizer in fruit growing in compliance with the Environmental Acquis*, funded by the Ministry of Agriculture and Rural Development.

## References

1. ANGIN, R. ASLANTAS, M. KOSE, H. KARAKURT, G. OZKAN. Changes in chemical properties of soil and sour cherry as a result of sewage sludge application I. Hort. Sci. Vol. 39, No. 2: 61–66 (2012).
2. ANTOLIN M.C., PASCUAL I., GARCIA C., POLO A., SANHEZ-DIAZ M. Growth yield and solute content of barley in soils treated with sewage sludge under semiarid Mediterranean conditions. *Field Crops Res.* 94, 224 (2005).
3. BARBOSA G.M., FILHO T. Agriculture utilization of sewage sludge: effect on the chemical and physical properties of soils and on the productivity and recovery of degraded areas. *Ciencias Agrarias (Londrina)* 27, 565 (2006).
4. BARGEZAR A.R., YOUSEFI A., DARYASHENAS A. The effect of addition of different amounts and types of organic materials on soil physical properties and yield of wheat. *Plant And Soil 247, 295* (2002).
5. BOZKURT M.A., CIMRIN K.M. The effects of sewage sludge applications on nutrient and heavy metal concentration in a calcareous soil. *Fresen Environ Bull. 12, 1354* (2003).
6. BROFAS G., MICHOPOULAS P., ALIFRAGIS D., Sewage sludge as an amendment for calcareous bauxite mine spoils reclamation. *J. Environ. Qual. 29,811* (2000).
7. DÍAZ-DE-ALBA M., GRANADO-CASTRO M.D., GALINDO-RIAÑOM.D., CASANUEVA-MARENCO M.J. Comprehensive assessment and potential ecological risk of trace element pollution (as, ni, co and cr) in aquatic environmental samples from an industrialized area. *Int. J. Environ. Res. Public Health* , *18*, 7348. https://doi.org/10.3390/ijerph18147348 (2021)
8. EGNER, H., RIEHM, H., DOMINGO, W.R. Untersuchungen über die chemische bodenanalyse als grundlage für die beurteilung des nährstoffzustandes der böden. ii. chemische extractionsmethoden zur phosporund kaliumbestimmung. *Annals Royal Agricultural College, Sweden, 26: 199-215 (1960)*.
9. GARCIA-GILL J.C., PLAZA C., SENESI N., BRUNETTI G., POLO A. Effects of sewage sludge amendment of humic acids and microbiological properties of semiarid mediterranean soil. *Biol. Fertil. Soils* 39, 320 (2004)
10. GARCIA-GILL J.C., PLAZA C., SENESI N., BRUNETTI G., POLO A. Effects of sewage sludge amendment of humic acids and microbiological properties of semiarid mediterranean soil. *Biol. Fertil. Soils 39, 320* (2004).
11. GARY S. BANUELOS, SAJEEMAS PASAKDEE, SHARON E. BENES, CRAIG A. Long-term application of biosolids on apricot production, *Communications in Soil Science and Plant Analysis, 38: 1533-1549* (2007).
12. HUSSEIN A.H.A. Impact of sewage sludge as organic manure on some soil properties, growth, yield and nutrient contents of cucumber crop. *Journal of Applied Sciences, 9: 1401-1411* (2009).
13. IANCU M., SUMEDREA D., DUMITRU M., EUGENIA GAMENT, PREDESCU C., MIHAELA ULMEANU, MIRELA SOCACIU, TOGOE I., TUDOR L. Influence of the urban sludge used as fertilizer on the chemical components of soil and leaves of Idared apple, *Fruit growing research, vol. XXIV, p. 187-195* (2008).
14. KJELDAHL J. New method for the determination of nitrogen. Chemestry News., 48(1240):101-102 (1983).
15. KORBOULEWSKY N., BONIN G., MASSIANI C. Biological and ecophysiological reactions of white wall rocket grown on sewage sludge compost. *Environ Poll. 117, 36* (2002).
16. MATA-GONZÁLEZ, R. SOSEBEE RE. WAN C. Nitrogen in desert grasses as affected by biosolids. their time of application and soil water content. *Arid Land Research and Management; 18(4):385–395* (2004).
17. MEHMET A. B., TARIK Y., AYŞE Y. The use of sewage sludge as an organic matter source in apple trees, *Pol. J. Environ. Stud., 19(2):267–274* (2010).
18. MENDOZA, J., G. TATIANA, C. GABRIELA AND S.M. NILSA. Metal availability and uptake by sorghum plants grown in soils amended with sludge from different treatments. *Chemosphere, 65: 2304-2312* (2006).
19. MULLER G. Index of geoacumulation in sediments of the Rhine River. *GeoJournal, 4, 108-118(1969*).
20. NEILSEN G.H., HOGUE E.J., FORGE T., NEILSEN D., KUCHTA S. Nutritional implications of biosolis

and paper mulch applications in high density apple orchards. *Can J Plant Sci. 87, 551* (2007).

21. NICOLA C., PARASCHIV M. Use of urban sluge compost as fertilizant on apple orchards. *Fruit growing research, vol. XXXVII, p: 103-114. doi10.33045/fgr.v37.2021.15* (2021).
22. PINAMONTI F., STRINGARI G., GASPERI F., ZORZI G. The use of compost: its effects on heavy metal levels in soil and plants. *Resour Conserv Recy. 21, 129* (1997).
23. RAUȚA, C., CHIRIAC A. Metodologia de analiză a plantei pentru evaluarea stării de nutriție minerale. *Ed. Academiei Române de Științe Agricole și Silvice* (1980).
24. SMITH S. R. A critical review of the bioavailability and impacts of heavy metals in municipal solid waste composts compared to sewage sludge, *Environment International 35, 142–156* (2009).
25. SORT X., ALCANIZ J.M. Effects of sewage sludge amendment on soil aggregation. *Land Degrad. Develop.* 10, 3 (1999).
26. STILES W.C. Nitrogen management in orchard. Cap. IV in "Tree Fruit Nutrition". Shortcourse proceedings. *Ed. by Peterson A.B. and Stebens R.G.. Yakima. Washington* (1994).
27. SUMEDREA D. IANCU M. CHITU E. Influence of urban sludge used as fertilizer on Idared apple behavior, *Fruit growing research, vol XXIV, p. 178-186* (2008).
28. VIATOR R.P., KOVAR J.L., HALLMARK W.B, Gypsum and compost effects on sugarcane root growth, yield and plant nutrients. *Agron J. 94, 1332* (2002).
29. ***1999. Council Directive 1999/31/EC of 26 April 199 on the landfill of waste.
30. ***2006 Commission Regulation (EC) No.1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuff (Text with EEA relevance).
31. *** 2008 Commission Regulation (EC) No.834/2007 on organic production and labeling of organic products with regard to organic production, labeling and control.