

Testing the Fertilizer Effect of Compost Produced by Anaerobic Fermentation of Sewage Sludge

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Abstract

The compost tested in this study resulted from the anaerobic fermentation process of sewage sludge with cereal straw. Processing and post-treatment were made by Biotechnological Research Centre within INCD ECOIND from Bucharest. Experimental program included testing the effect of fertilizer in quantities of 25 t, 50 t and 100 t compost / ha on the production of soya beans. It was also investigated the influence of the combination of fertilization with compost and inorganic fertilization with levels of 200 kg, respectively, 400 kg NPK / ha. Was analyzed the following productivity indicators: plant density, number of floors of pods, number and weight of pods and total beans production, in full ripening stage. In the case of fertilization only with composted sludge, production of peas and beans was higher in variants with 50 t / ha and 100 t / ha (2095 kg and 1990 kg grain / ha). Therefore, doubling the amount of compost does not provide corresponding increase yields of soybeans. Combining organic and inorganic fertilization determine a proportional production increase only for the total biomass production. The tested compost is a good organic fertilizer and the amount that provides the greatest soybeans production is 50 t / ha.

Keywords: compost, fertilization, production, sewage sludge, soybean

1. Introduction

In agriculture, using compost has direct effects on crops production and indirect effects on the development and preservation of soil fertility. In this sense, it increase the amount of humus, improve soil physical characteristics such as increasing the pore volume between soil granules, water storage capacity, improve aeration and an increased structural stability plus a higher resistance to degradation factors.

Meanwhile, the administration of well mineralized compost have favourable effects on some chemical properties (pH neutralization, increasing the capacity to absorb nutrients from soil, increasing the biodisponibility of macro-and micronutrients for plants) and on soil biology, in

sense of stimulating the development of microorganisms and actinomycetes [1].

Application of municipal sludge on agricultural land in a sustainable strategy began from the moment of identifying characteristics of this material in terms of organic carbon content and other nutrients. Many studies have demonstrated the benefits of municipal sludge used as fertilizer to enrich soil with organic carbon, increasing ion exchange capacity of soil, in improving physical characteristics, in increasing the amount of N and P, in increasing the harvests of different cultures. [2, 3, 4, 6, 7, 9]

Municipal sludge can also contain certain ingredients that can be used to increase and diversify biocoenosis to increased activity of soil microorganisms [8].

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2. Materials and methods

The fertilizing effect of sewage sludge from the urban stations, composting and anaerobic stabilized at ECOIND Bucuresti was tested on soybean (*Glycine max*). Condor variety was chosen, part of the second group of maturity. Condor variety plants reach maturity at a height of approx. 110-115 cm and have a high resistance to fall.

In the experimental model were followed: testing the effect of different levels of fertilizer quantity of compost on crop productivity of soybean grain, testing the effect of different levels of compost fertilizer compared with inorganic fertilization and testing the effect of different levels of compost fertilizer associated with inorganic fertilization

The experiment was bifactorial type, the two experimental factors were:

- a factor: organic fertilization with anaerobic stabilized sludge, composted on cellulosic support of canes of Grape Vine in the research centre's of ECOIND Bucharest
- b factor: mineral fertilization with inorganic fertilizers such as NPK complex (15:15:15)

Quantitative levels of the two experimental factors were:

- a factor - four gradations (versions):
 - a1 – control
 - a2 - 25 t composted sludge / ha
 - a3 - 50 t composted sludge / ha
 - a4 - 100 t composted sludge / ha

- b factor - three gradations (versions):

- b1 – control
- b2 - 200 NPK / ha
- b3 - 400 NPK / ha

The 12 resulting experimental variants were held in the experimental block in three repetitions, as shown in Table 1.

The experimental location was the experimental campus of discipline of Ecology and Environment Protection of the Faculty of Animal Science and Biotechnology.

Experimental plot had an area of 2 m² (2 x 1). In the experimental plot, soybeans were planted on two rows with an interval between rows of 0.5 m, both between the lines of the parcel to be considered and among adjacent parcels. Between repetitions, as outside, have been provided paths for movement and protection in width of 1 m.

The quantity of sown soybean was 200 kg per hectare, returning 40 g grain per experimental plot. Sowing was made on 12 of May and the first seeds started to rise after 20 of May. Were used unbacterized grains.

Analysis of compost fertilizer effect on soybean crop grown for grain was researched based on the following attributes and indicators: plant density (number of plants per row and experimental plot), number of floors (place of clamping the pods), number and weight of pods, production of grain. Harvesting pods was carried out at full ripening stage.

Table 1. Explanations on test plot and the combination of experimental factors

Experimental plot code	Experimental factors code	Explanations
1	a ₁ b ₁	Control variant, completely unfertilized
2	a ₁ b ₂	Control variant, mineral fertilized with 200 kg / ha
3	a ₁ b ₃	Control variant, mineral fertilized with 400 kg / ha
4	a ₂ b ₁	Fertilized variant with 25 t composted sludge / ha
5	a ₂ b ₂	Fertilized variant with 25 t composted sludge / ha and 200 kg / ha
6	a ₂ b ₃	Fertilized variant with 25 t composted sludge / ha and 400 kg / ha
7	a ₃ b ₁	Fertilized variant with 50 t composted sludge / ha
8	a ₃ b ₂	Fertilized variant with 50 t composted sludge / ha and 200 kg / ha
9	a ₃ b ₃	Fertilized variant with 50 t composted sludge / ha and 400 kg / ha
10	a ₄ b ₁	Fertilized variant with 100 t composted sludge / ha
11	a ₄ b ₂	Fertilized variant with 100 t composted sludge / ha and 200 kg / ha
12	a ₄ b ₃	Fertilized variant with 100 t composted sludge / ha and 400 kg / ha

3. Results and discussion

Experimental data were recorded and processed on each of the 12 experimental plot of a repetition,

and finally average values were calculated and processed.

Summary of these results is presented in Table 2. From Table 2 can be shown that the number of plants per experimental plot was 60 soybean plants, with an approximately equal distribution in each of the two lines. Therefore per hectare were a total of 300,000 plants, a figure which represents the normal range for growing technological soybean for grain.

Regarding the number of floors, meaning that place on the stalk where pods fructify, was found that it varied between 12 and 16, with an average of 14 -15 floors on plant. Number of floors has been correlated with plant height that ranged from 90-100 cm to 120-130 cm.

Table 2. Results of grain production

Variant code	Plants total number	Average number of floors per plant	Pods total number	Gross production (g)	Grain production (g)	Grain production per plant (g)	Grain production per ha (kg)
a ₁ b ₁	60	13.6	1267	606.50	418	6.96	2090
a ₁ b ₂	60	13.3	1617	783.54	588	9.80	2940
a ₁ b ₃	60	14.6	1652	869.20	580	9.66	2900
a ₂ b ₁	60	13	1429	785.95	348	5.80	1740
a ₂ b ₂	60	13	1165	588.73	374	6.23	1870
a ₂ b ₃	60	14	1298	593.67	358	5.97	1790
a ₃ b ₁	60	12.6	1187	523.33	419	6.98	2095
a ₃ b ₂	60	13	1219	591.62	440	7.33	2200
a ₃ b ₃	60	13	1450	700.13	488	8.13	2440
a ₄ b ₁	60	13.6	1361	632.45	398	6.63	1990
a ₄ b ₂	60	15.6	1757	728.71	545	9.08	2725
a ₄ b ₃	60	14	1279	791.11	530	8.83	2650

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The analysis of crops

• At composted sludge fertilization

Regarding the gross production, meaning weight of pods with beans, there is an oscillating trend. Compared to the fully fertilized variant (a₁b₁) was achieved a production increase only in variants fertilized with 25 t per ha (a₂b₁) and 100 tonnes per hectare (a₄b₁), in value of 180 g and 26 g. At variant fertilized with 50 t compost per ha (a₃b₁) the gross production is lower than that obtained on control.

Total production of grains, considered as average production per plant or average production per

hectare, mark out best the effect of compost used as fertilizer.

The presented data indicates that the lowest production of 5.80 g grains per plant and respectively 1740 kg per ha, were obtained from variant fertilized with 25 t per ha (a₂b₁). The control (a₁b₁) and, respectively, variant fertilized with 50 t per ha (a₃b₁), obtained practically the same production (2090 kg to 2095 kg per ha). For version with the highest level of organic fertilization of 100 tonnes composted sludge per hectare (a₄b₁) was obtained a yield of 6.63 g of soy beans per plant, respectively, 1990 kg per hectare. These values are lower than yields obtained by control or variant fertilized with a quantity of only 50 tonnes per ha.

• At the complementary fertilization of compost and chemical fertilizer such as NPK (15:15:15)

At this type of fertilization, there is a direct relationship between gross production and the combination of soil fertilization. Thus, for all variants, the addition of the complex brings an increase of gross production in directly proportional relation to the administered amount. This proportionality is no longer kept for grain production. This means that the gross production of biomass, consisting of pods and beans, do not

always get a large production of grain. Even if gross production is more consistent as biomass, because of the greater weight and number of pods, the number of grains obtained per pod, and their weight, has lower values.

Testing the productive effect of composted sludge on a mixture of fodder harvested as green mass revealed a favourable effect of fertilizer levels of 100 t and 250 t compost per ha, with a production increase of 12.2% (version with 100 t per ha) and 43.9% (version with 250 t per ha) compared to control. [5]

The results of testing the effect of fertilizer by using the same type of anaerobic composted sludge, but on an industrial crop such as soybean (*Glycine max*) variety Condor, highlight a reduced influence of organic fertilization on grain production, as can be seen in Figure 1.

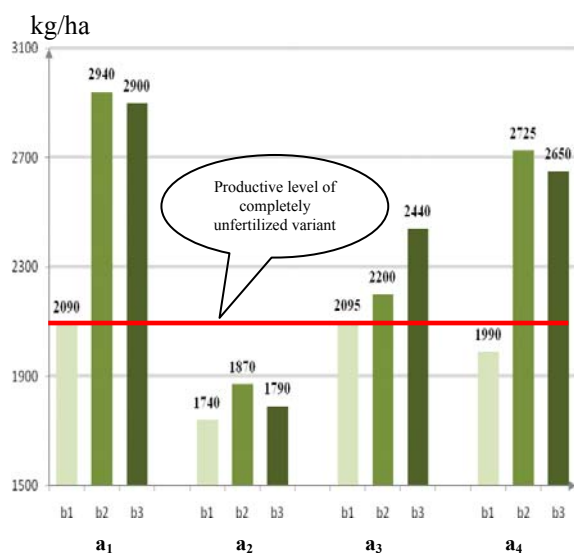


Figure 1. The relationship between the grain production of soybeans and the fertilization level

Thus, variations a₂b₁ (25 tonnes per hectare), a₃b₁ (50 tonnes per ha) and a₄b₁ (100 tonnes per hectare) achieved a grains production similar with control (a₁b₁) or even lower, such as a₂b₁ version. Graphical representation of the values obtained from gross biomass production of pods and grains show up in this case a lower fertilizer effect of administration of composted sludge on soybean culture (Fig. 2).

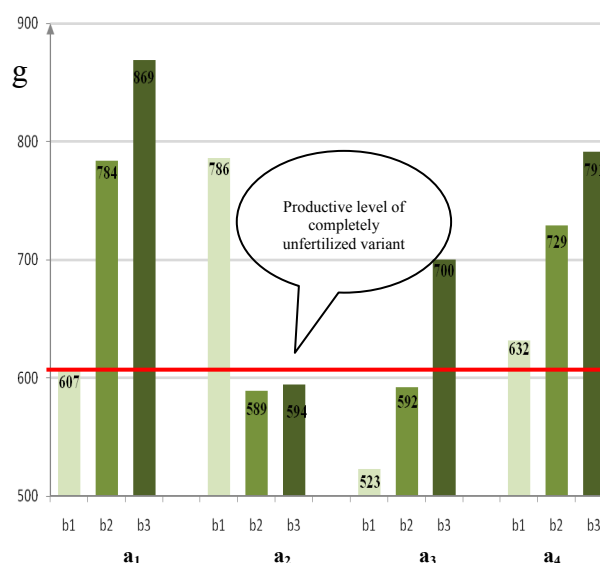


Figure 2. Relationship between gross soybean production (pods + grains) and the fertilization level

Combined administration of composted sludge with complex fertilizer such NPK (15:15:15) does not provide a substantial increase production. Moreover, it is found that on organically fertilized plots (variant a₁), production response is more consistent to complex fertilization. A higher production of pods and grains is obtained at complex fertilization with 400 kg per ha (Fig. 2), but grains production is as large at a fertilization of only 200 complex kg per hectare (Fig. 1).

4. Conclusions

At composted sludge fertilization was registered an oscillating trend of gross production, meaning weight of pods with beans. Compared to the fully fertilized variant (a₁b₁) was achieved a production increase only in variants fertilized with 25 t per ha (a₂b₁) and 100 tonnes per hectare (a₄b₁), in value of 180 g and 26 g. At variant fertilized with 50 t compost per ha (a₃b₁) the gross production is lower than that obtained on control.

At the complementary fertilization of compost and chemical fertilizer such as NPK (15:15:15) there is a direct relationship between gross production and the combination of soil fertilization. Thus, for all variants, the addition of the complex brings an increase of gross production in directly proportional relation to the administered amount. Combined administration of composted sludge with complex fertilizer such NPK (15:15:15) does not provide a substantial increase production.

Moreover, it is found that on organically fertilized plots (variant a₁), production response is more consistent to complex fertilization. A higher production of pods and grains is obtained at complex fertilization with 400 kg per ha, but grains production is as large at a fertilization of only 200 complex kg per hectare.

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