GREEN DEVELOPMENT: WASTE WATER OR GREEN WATER?

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Abstract:
Pollution of surface and groundwater is mostly land based and caused by agricultural overspill and waste materials carried by wind. Agricultural activities are affected very adversely if the resources are not managed properly. Moreover, reduction in biodiversity of flora and fauna, production capabilities of polluted waterways and aquatic ecosystems are the problems created by poor resource management. In modern science there is tremendous development in the concern to study the effective use of different categories of lands and availability of improved land practices for a successful future.
The aim of this work is to give a brief overview about of the effect of sewage sludge on some physiological parameters of plant seedlings. Sewage sludge is an unwanted and inevitable by-product of wastewater treatment management in several industrial processes. Sedimentation – both before and after wastewater bio-treatment – produces sewage sludge. An increasing volume of wastewater is produced by the development of the industry and agriculture, and as a concomitant of the improvement of human life.
The examined sewage sludge originated from Alkaloida Chemicals Co. Ltd (Eastern Hungary). The sewage sludge contains plenty of essential elements (e.g. Ca, K, and P). But, its aluminum and chrome contents also are considerable. The dry matter accumulation and relative chlorophyll content were measured. The flexibility of plant responses depends on composition, origin of examined wastes.

Keywords: crop nutrition, industrial side – products, sewage sludge

Introduction

The improvement of sewage sludge management is a key objective for the development of an integrated strategy for wastewater management. Sewage sludge has been already utilized in agricultural and horticultural applications for several years as it represents an alternative source of nutrients for plant growth (Logan and Harrison, 1995). In domestic wastewater, microorganisms originate from human excrete in household, commercial and hospital sewage. Combined sewage contains street and storm runoff, and these carry microorganisms from soils and animal dropping. Each of these sources contains a vast number and variety of microorganisms (Hansen et al., 2003).
So, the question is: microorganisms or element content of sewage sludge has or has not advantageous effect on plant growth? The aim of this study was to examine the effect of sterilized and non-sterilized sewages sludge on the some basic plant physiological parameters.

Materials and methods

Sunflower seeds *(Helianthus annus L. cvs. Arena)* were used in the experiments. The seeds were sterilized with 18% hydrogen peroxide, and then washed in distilled water. After that, they were germinated on moistened filter paper at 25°C.

The seedlings were transferred to a continuously aerated nutrient solution of the following composition: 2.0 mM $Ca(NO_3)_2$, 0.7 mM K_2SO_4, 0.5 mM $MgSO_4$, 0.1 mM KH_2PO_4, 0.1 mM KCl, 1μM H_3BO_3, 1μM $MnSO_4$, 10 μM $ZnSO_4$, 0.25 μM $CuSO_4$, 0.01 μM $(NH_4)_6Mo_7O_{24}$. Iron was added to the nutrient solution as Fe(III)-EDTA at a concentration of 10 μM. Effect of sterilized and non-sterilized sewage sludge was examined in 2g dm^{-3} and 4g dm^{-3} quantities. The sewage sludge was sterilized on 121 ^oC for 20 minutes.

The seedlings, 12 for each treatment, were grown under controlled environmental conditions (light/dark regime 10/14 h at 24/20 ^oC, relative humidity of 65–70% and a photosynthetic photon flux of 300 μmol m^{-2} s^{-1}) in controlled environmental room.

The element contents of materials were determined using an OPTIMA 3300DV ICP-OA Spectrophotometer. The relative chlorophyll contents of the 1st leaves of the sunflower were measured by Chlorophyll Meter, SPAD - 502 (Minolta). The number of repetitions was 60 on the 10th, 13th and 15th days of treatments.

The dry weight of shoots and roots were measured at the end of experiments with the use of thermal gravimetric analysis, after drying at 85 C° for 48 h.

The sewage sludge originated from ALKALOIDA Chemicals Co. Ltd., Eastern-Hungary.

Results and discussion

The examined sewage sludge contains plenty of essential elements (e.g. Ca, Fe, K and P) but its toxic elements concentration (e.g. Al, Cr, Ni and Pb) are also considerable (Table 1).

Table 1. Contents of some measured elements in the sewage sludge (mg kg^{-1})

Toxic elements				Essential elements			
Al	Cr	Ni	Pb	Ca	Fe	K	P
17,349	41.3	24.5	70.1	123,988	21,098	2,878	21,289

The elements can influence the growth of root and shoot depending on the accumulation efficiency. The dry matter content of shoots and roots of sunflower were also measured during the experiments. Table 2 shows the results of dry matter accumulation.

Table 2. Effects of sewage sludge on the dry matter accumulation of shoots, roots (g $plant^{-1}$) and shoots/ roots ratio of sunflower seedling

Treatments	Shoots (g $plant^{-1}$)		Roots (g $plant^{-1}$)		Shoot/root	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	0.400	0.02	0.088	0.00	4.54	0.070
Non-ster.(2)	0.421	0.05	0.098	0.02	4.29	0.060
Ster.(2)	0.402	0.03	0.101	0.01	3.98	0.050
Non-ster.(4)	0.381	0.03	0.081	0.00	4.70	0.070
Ster.(4)	0.405	0.03	0.098	0.01	4.13	0.060

In crop production, optimal nutrient supply is usually achieved by the application of fertilizers. In our experiment the dry matter accumulation of shoots increased by 5% and dry matter of roots by 11% in the 2g sewage sludge treatments. When 2g sterilized sewage sludge was examined, the dry matter of roots increased by 14% and the dry matter accumulation of shoots was higher then the control value. The 4g treatment with non-ster. sewage sludge decreased the dry matter accumulation of shoots and roots but when 4g sterilized sewage sludge was applied these values were increased. Differences could be observed between the different amount of sterilized and non-sterilized sewage sludge. The dry matter of shoot was higher when non-sterilized sewage sludge was added to the nutrient solution in the 2g dm^{-3} treatment. The sterilized 2g dm^{-3} treatments increased the dry matter of shoots. The dry matter of shoot and roots also increased in the 4g dm^{-3} sterilized treatment

The ratio of shoot to root growth varies widely between plant species, during ontogenesis of plants, and it strongly modified by external factors. When parts of the shoots are removed, plants tend to compensate this by lower root growth and returning to a ratio characteristic for the species. However, there is some controversy as to whether this reflects functional equilibrium between roots and shoots (Klepper, 1991). The shoot/root ratio was the highest at the 4g dm^{-3} non-sterilized treatment. This value decreased at all other treatments comparison to the control.

The dry matter accumulation is very complicated process. One of the most influencing factor is a photosynthetic activity. So, the relative chlorophyll contents of 1st leaves of sunflower was measured the results are shown in Table 3.

Table 3. Effect of sterilized (ster.) and non-sterilized (non-ster.) sewage sludge on the relative chlorophyll contents of 1st leaves of sunflower (Spad Units)

Treatments	10th day		13th day		15th day	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	36.15	3.22	39.32	3.02	41.76	2.22
Non-ster.(2)	39.22	2.17	51.91	2.78	50.55	3.06
Ster. (2)	41.18	1.81	44.14	2.44	45.62	1.94
Non-ster. (4)	39.45	2.33	43.03	1.69	43.60	2.25
Ster. (4)	41.86	2.59	44.47	2.93	45.45	2.08

The sewage sludge treatments had favorable effect on relative chlorophyll content in all treatments and measuring time. The relative chlorophyll of 1st leaves of sunflower significantly increased on 10th day when sewage sludge was not and was sterilized with small differences. The increasing level was higher at the non-ster. treatment. On the 13th and 15th days the relative chlorophyll content increased significantly, except in the 4g non-ster. treatment. The relative chlorophyll contents also increased at the non-ster. treatment but by lower increase.

The relative chlorophyll content was higher when sterilized sewage sludge was applied than non-sterilized.

Conclusions

Sewage sludge has an advantageous effect on dry matter accumulation of roots and shoots. It is a very important result, because the main product of agriculture is shoots at the fodder crop. The application of non-sterilized and sterilized sewage sludge influences relative chlorophyll contents. Sewage sludge increased the relative chlorophyll contents in the 1st leaves of sunflower on the 10th, 13th and 15th days of examination. The relative chlorophyll content was higher when sterilized sewage sludge was applied than non-sterilized.

Differences could be observed between the different amount of sterilized and non-sterilized sewage sludge. The dry matter of shoot was higher when non-sterilized sewage sludge was added to the nutrient solution in a smaller amount treatment. The sterilized 2g dm^{-3} treatments increased the dry matter of shoots. The dry matter of shoot and roots also increased in the 4g dm^{-3} sterilized treatment. The shoot/root ratio was the highest at the 4g dm^{-3} non-sterilized treatment. This value decreased at all other treatments comparison to the control.

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