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The Effect of Sewage Sludge on the Emergence and Seedling Growth in Cucumber

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Abstract: This study was carried out as a pot experiment in the growth chamber in order to investigate the effects of sewage sludge on the emergence and seedling quality of cucumber (*Cucumis sativus* L.). Seedling growing media consisted of soil, manure and pumice in the rate of 2:2:1. The manure part of the growing media was changed proportionally with sewage sludge. 0, 25, 50, 75 and 100% of 100 g of manure in 250 g of growing media were replaced with sewage sludge. No additional nutrient was applied to the treatments. The effect of sewage sludge on the time and percentage of emergence, hypocotyls length, cotyledon width and length, true leaf emergence time, shoot and root length, fresh and dry weight of shoot and root, leaf number and area were observed. It was determined that sewage sludge had a positive effect on the emergence and seedling growth of cucumber.

Key words: Sewage sludge, cucumber, seedling growth

Kentsel Arıtma Çamurunun Hıyarda Çıkış ve Fide Gelişimi Üzerine Etkisi

Özet: Araştırma hıyarda (*Cucumis sativus* L.) çıkış ve fide kalitesine kentsel arıtma çamurunun etkilerini ortaya koyabilmek amacıyla iklim odasında saksı denemesi şeklinde yürütülmüştür. 2:2:1 oranında bahçe toprağı, yanmış çiftlik gübresi ve pomza ile hazırlanan 250 g'lık tohum ekim harcında 100 g'lık çiftlik gübresine (kontrol) ikame dozlarda%25, %50, %75 ve %100 oranlarında kentsel arıtma çamuru kullanılmıştır. Uygulamalarda ek besin elementi takviyesi yapılmamıştır. Uygulamaların çıkış oranı ve süresi, hipokotil uzunluğu, kotiledon genişlik ve uzunluğu, gerçek yaprak çıkış süresi, sürgün ve kök boyu, sürgün ve kök yaş ve kuru ağırlıkları ile yaprak sayı ve alanına etkileri gözlenmiştir. Araştırma sonucunda kentsel arıtma çamurunun hıyarda çıkış ve fide kalitesine olumlu etki yaptığı saptanmıştır.

Anahtar kelimeler: Kentsel arıtma çamuru, hıyar, fide gelişimi

Introduction

The waste materials increased by the heavy growth in industry and urbanization and their storage problem appeared. The use of these materials in agriculture seems to be a solution and thus it will be profitable and provide an environmental protection. In agriculture, the use of industrial waste such as beer factory sludge (Kütük and Çaycı, 2000), oil plant sludge (Anaç et al., 1993), yarn, paper or cellulose factories sludge (Taşatar and Haktanır, 2000) and municipal waste such as garbage (Aydın et al., 2000) and sewage sludge (Reed et al., 1991; Arcak et al.,2000b; Bozkurt et al., 2000; Garvanska, 2000) have been on the agenda for a long time. Sewage sludge is the most used waste materials for improving soil condition. Sewage sludge is preferred because it has high amount of organic matter and it is easily available. Organic matter in sewage sludge affects the water holding capacity, nutrient availability and soil fertility positively by improving the physical and chemical features of soil (Arcak et al., 2000b).

Sewage sludge is a kind of sediment matters obtained by processing sewage. It is possible to use sewage sludge as a fertilizer in agriculture because of its high organic matter content and adequate nitrogen and phosphorus contents (Arcak et al. 2000b; Bozkurt et al., 2000; Ünsal and Ok, 2000). On the other hand, heavy metal content and parasitical organisms are the negative characteristics of sewage sludge (McBride, 1995; Arcak et al., 2000a;. 2000b). However, the heavy metal content of sewage sludge might be very variable depending on its origin and processing applications (Reed et al., 1991; Ataman and Arcak, 2000). There might be an increase in the heavy metal content of sewage sludge with a heavy industry nearby the urban areas. In addition, the plant species, pH and organic matter content of soil become effective in the uptake of heavy metals by plants. Alkaline and high lime contents of soil might help to reduce heavy metal toxicity (Bozkurt et al., 2000). Insoluble part of organic matter (e.g. humic acid) also reduces the uptake of some heavy metals (McBride, 1995).

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When the sewage sludge with no heavy metal problem was used, the heavy metal uptake of plants increased in parallel to the amount of given sewage sludge, however, stayed below the allowed limits (Kırımhan et al., 1983; Berthet et al., 1989; Reed et al., 1991; Bozkurt et al., 2000; Garvanska, 2000). On the other hand, there is some concern about the excessive and long-term application of sewage sludge (McBride, 1995).

There is not enough work on the use of sewage sludge only during seedling period. Falahi-Ardakani et al. (1988) compared different seedling growing media combinations consisted of peat moss, perlite and vermiculite with sewage sludge for tomato and lettuce seedlings. They obtained marketable seedlings of these vegetable species on the seedling growing media of equal amount of sewage sludge, peat moss and vermiculite with a little supplemental nitrogen fertilizer. They did not find any toxic level of heavy metals in the seedlings.

This study was carried out to investigate the effect of sewage sludge on the emergence and seedling quality in cucumber. Sewage sludge might be utilized economically by using it only in the seedling growing media. In addition, the use of sewage sludge only in the seedling period will decrease the amount of applied sewage sludge significantly. Therefore, concerns about the large amount of application of sewage sludge might be minimized.

Materials and Methods

This study was carried out as a pot experiment in the growth chamber of Horticulture Department of The University of Yüzüncü Yıl. During the experiment, the growth chamber was illuminated approximately 14 hours per day with the light source of 10,000 lux. The minimal and maximum weekly temperature of growth chamber are seen in Table 1.

Table 1. The minimal and maximum weekly temperature of growth chamber .

Weeks	Average Minimal Temparature (^oC)	Average Maximum Temperature (^oC)
1. Week	21.0	28.3
2. Week	22.3	31.9
3. Week	21.4	28.0
4. Week	21.4	26.6

The Beith Alpha cucumber variety was used as a plant material. The standard seedling growing media composed of two parts of manure and soil, and one part of pumice. Sewage sludge (SS) was obtained from the wastewater treatment plant of The Yüzüncü Yıl University. Some characteristics of sewage sludge are seen in Table 2.

When the allowed limits for heavy metals (Mn, Zn, Cu, Co, Ni, Cr, and Cd) is considered, the sewage sludge used in this experiment can be used in agricultural activities and there will be no danger for its heavy metal content (Schachtschabel et al., 1989).

Table 2. Some characteristics of sewage sludge (Bozkurt et al., 2000)

Sewage sludge	
Organic matter, %	25.0
pH (1:1 water)	6.06
Total N, %	1.30
Total P, %	0.59
Beneficial P, ppm	561
Total K, %	0.41
Total Ca, %	1.72
Total Mg, %	1.76
Total Fe, %	1.86
Total Zn, %	0.19
Total Mn, ppm	402
Total Cu, ppm	74
Total Co, ppm	13.2
Total Ni, ppm	12
Total Cr, ppm	51
Total Cd, ppm	0.73

The study was designed as randomized design with three replications and lasted for 4 weeks. There were five pots in each three replications, and 250 g of growing media was used in each pot. The control consisted of 100 g of manure and no sewage sludge. In the other applications, 25, 50, 75 and 100 % of manure in the growing media were changed with sewage sludge. The proportion of sewage sludge in the applications became 0 (control), 10, 20, 30 and 40 %. No supplemental nutrient was applied to the applications.

Emergence percentage and time, true leaf emergence time, hypocotyls length, cotyledon width and length were measured with a compass in the first week of the study. Shoot and root length, shoot and root fresh and dry weight, stem diameter, leaf number and area of all plants were measured at the end of the study. Plant samples were dried in a hot oven at 60 ^oC until the constant weight. Dry and fresh samples were weighted with a digital scale. Root and shoot length were measured with a ruler. Total leaf area of all samples were determined with a planimeter.

Results and Discussions

The effect of sewage sludge on the emergence and seedling quality of cucumber are shown in Table 2.

Emergence percentage of the control (0 % SS) application with no sewage sludge was found at the lowest level (93.33%) while those of other applications were 100%. There was no significant difference among the applications for emergence time and hypocotyls length. The control had the lowest cotyledon length (21.86 mm) and width (12.07 mm). Application of 30% SS had the largest cotyledons with 28.85 mm length and 16.71 mm width and was followed by other applications

of 40, 20, and 10% SS. True leaf emergence time of control was also the latest (12.2 days) while other applications emerged 1 or 2 days earlier than the control.

At the end of 4-week seedling growth, the stem diameter of 40% SS application was 6.92 mm (80% larger than the control). Shoot length was affected positively by the sewage sludge application while there was no significant difference in root length. The shoot length of 30,40, 10, 20% SS and control applications were 8.95 cm, 8.12 cm, 7.70 cm, 7.23 cm and 6.30 cm, respectively. Fresh weight of shoots and roots were significantly affected by the sewage sludge applications**.** 30 and 40% SS applications had an approximately 66% increase in shoot fresh weight by comparison to control while 10 and 20% SS applications had an approximately 50% increase. The control application had the lowest fresh shoot weight (4.08 g). The fresh root weight of 30, 20, 10% SS and control applications had 4.08 g, 2.55 g, 1.87 g and 0.70 g of fresh root weight, respectively while 40% SS application had the highest fresh root weight (5.20 g). Sewage sludge application had a negative effect on dry root weight (%) while there was no significant effect on shoot dry weight (%). Leaf number and area increased by the application of sewage sludge. The control gave the smallest leaf number (4.00) and area (71. 30 cm^2). 10 and 20% SS applications had approximately one more leaf and 60% more leaf area than the control. 30 and 40% SS applications had approximately two more leaves and 80% more leaf area than the control.

Previous works were concentrated on the effects of sewage sludge on the plant yield. It was seen that sewage sludge improved the plant growth and soil characteristics due to the its high organic matter and adequate nitrogen and phosphorus contents (Kırımhan et al., 1983; Berthet et al., 1989; Reed et al., 1991; Bozkurt et al., 2000; Garvanska, 2000). Falahi-Ardakani et al. (1988) obtained positive results in tomato and lettuce seedlings while they were applying sewage sludge into different growing media combinations. Our results also indicate the positive effect of sewage sludge on emergence and seedling growth in this case in cucumber.

Table 3. The Effect of sewage sludge on some characteristics of cucumber seedlings

Characteristics	Manure (%) + Sewage Sludge (%)					LSD
	40 + 0	30 + 10	20 + 20	10 + 30	0 + 40	
Emergence (%)	93.33 b	100.00 a	100.00 a	100.00 a	100.00 a	4.67*
Emergence Time (Days)	5.68	5.83	5.83	5.96	5.73	n.s.
True Leaf Emergence Time (Days)	12.20 a	11.00 b	10.40 b	10.33 b	10.33 b	0.79**
Hypocotyls Length (mm)	31.14	33.87	32.53	35.17	32.79	n.s.
Cotyledon Length (mm)	21.86 b	26.06 a	26.64 a	28.85 a	28.31 a	3.11**
Cotyledon Width (mm)	12.07 d	14.46 c	15.21 bc	16.71 a	16.12 ab	1.42**
Stem Diameter (mm)	3.85 c	5.13 b	5.52 b	6.03 ab	6.92 a	0.96**
Shoot Length (cm)	6.30 c	7.70 abc	7.23 bc	8.95 a	8.12 ab	1.57**
Root Length (cm)	19.73	26.22	24.22	29.50	29.70	n.s.
Shoot Fresh Weight (g)	4.08 c	8.25 b	7.87 b	12.15 a	11.75 a	1.91**
Root Fresh Weight (g)	0.70 c	1.87 c	2.55 bc	4.08 ab	5.20 a	1.92**
Shoot Dry Weight (%)	7.76	7.90	8.58	8.71	8.85	n.s.
Root Dry Weight (%)	4.43 a	3.73 ab	3.30 ab	2.99 b	2.97 b	1.09**
Leaf Number (per plant)	4.00 c	5.17 b	5.17 b	6.17 a	6.00 a	0.57**
Leaf Area (cm^2)	71.30 c	159.25 b	178.88 b	324.40 a	333.62 a	54.77**

*significant at $p<0.05$ level
** signicant at $p<0.01$ level
n.s:non-significant

Conclusion

The result of this study shows that sewage sludge which contains an allowed heavy metal content (Table 1) has positive effects on cucumber seedling growth (Table 2). Especially, 30% SS might be recommended for cucumber seedling production. On the other hand, we need to determine the heavy metal content of sewage sludge before using it because the amount of heavy metal varies according to the source of sewage sludge. Moreover, different amounts of sewage sludge with the other organic matters and mineral fertilizers can be studied in the other vegetables seedling production in the future experiments.

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