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Effects of Drinking Water Treatment Sludge on Crop Quality of *Zea mays L.*

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ABSTRACT

This research was conducted to evaluate effects of drinking water treatment sludge on crop quality. In this trial *Zea mays L.* (pioneer 32 w 86) was used, and the research was planned according to random blocks sampling design with three replicates. Increased amount of sludge, as of 0, 1, 2, 3, 4 t da^{-1}, was applied on blocks. *Zea mays L.* seeds were sewed between rows within a distance of 65 cm, and on rows within a distance of 25 cm. Blocks were irrigated to stimulate germination during dry conditions. When the numbers of leaves were reached 8, 10 kg da^{-1} of N fertilizer was applied. Plant length, first corncob height, corncob length, corncob diameter and number of corncob were observed and measured using randomly selected 10 plants from each block. As a result, the highest plant length, 206.97 cm, was found on blocks of control. The lowest plant length 189.76 cm was found on blocks with 1 t da^{-1}. The highest first corncob height, 85.62 cm, was found on blocks with 1 t da^{-1} sludge applied. The lowest first corncob height, 82.09 cm, was found on blocks with 4 t da^{-1} sludge applied. Average of the highest corncob number 1.23 was found on blocks with 4 t da^{-1} sludge applied. Average of the lowest corncob number 1.03 was found on blocks with 1 t da^{-1} sludge applied. The highest corncob length 22.08 cm was found on blocks with 2 t da^{-1} sludge applied. The lowest corncob length 19.94 cm was found on blocks with 3 t da^{-1} sludge applied. The highest corncob diameter 4.15 cm was found on blocks with 0 t da^{-1} sludge applied. The lowest corncob diameter 3.86 cm was found on blocks with 1 t da^{-1} sludge applied.

Key Words: Water Treatment Sludge, *Zea mays L*, Soil

INTRODUCTION

Plant Corn (*Zea mays L.* 2n=20) has a great importance in the World and in Turkey to produce sufficient amount of plant based proteins, economically. In addition, corn production also supports animal based protein production. Starch, Glucose and corn oil produced from corn kernels are sources for industrial raw materials. Turkey is ranked as the 7th place in corn production based on 585.000 ha growing area, 2.5 million ton yr^{-1} corn production and 425 kg ha^{-1} corn kernel production (Süzer, 2005). Areas used for corn production have been increased due to their usage for silage. The best variety of corn for silage should have some properties like long height, higher leaf number and leaf ratio, high corncob weight and less stem diameter (Anonymous, 2005). Suitable fertilizer and soil amendment use are important for high quality corn production and earliness. Recently, application of water treatment sludge on farm soils has been widely used. Use of water treatment sludge in agriculture is becoming beneficial for plant nutrition, and aids getting rid of recovery material like sludge of treatment facilities (Kocaer et al., 2003). The quality of sludge is important if being used for agricultural purposes. Farmers and related authorities should be encouraged to use sludge of domestic

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and food industries on agricultural purposes. Decision making should be used according to regulations (Kocaer and Başkaya, 2001). During the process of water treatment facilities, treated water was release to environment and bulk amount of sludge has been stocked. Discarding the treatment sludge has been problem economically and environmentally. Current methodology for discarding sludge is inefficient. Hence, development of new methods is inevitable. For more than 20 years, discarding sludge by application on agricultural lands has been accepted as an economic way. But, the quality of sludge measured by its pH, EC, heavy metal and toxic substances content was limits its application on agricultural areas (Topçuoğlu et al., 2003).

In this research, effects of drinking water treatment sludge on corn plant and some properties of corncob were investigated. To eliminate edge effects, plants on edges were discarded.

MATERIAL and METHODS

This trial was conducted in the field of Arslanbey Vocational School, Kocaeli University, in 2005. In the study Corn variety Pioneer 32 W 86 was used. This variety has been used as silage and cips industry due to its long length. Texture components of soil used in this trial were 37.53% sand, 25.07% clay and 37.40% silt. Total carbonate was 2.05%, pH was 7.3 and $ECx10^3$ was 0.13 mS cm^{-1}. Organic matter content of trial soil was 5.59% and nitrogen content was 0.28 %. Trial was conducted based on the random blocks sampling design with three replicates. Increased amount of sludge, as of 0, 1, 2, 3, 4 t da^{-1}, was applied on blocks. Sludge applied on blocks was supplied from Kocaeli city drinking water treatment facilities. This facility has 480.000 m^3 day^{-1} and minimum 300.000 m^3 day^{-1} water treatment capacity. The main technology used in water treatment systems contain filters, clarifiers and flock blankets. Heavy metal contents of sludge were measured by Laboratory of Chemistry and Environmental Institute, TUBITAK. Based on the heavy metal content of sludge, measured in Lab., concentration level of heavy metal contents were among the ranges allowed by Soil Contamination and Control Regulations, appendix I-B: Allowable limits of heavy metal concentrations in stabilized treatment sludge used in soils (Anonymous, 2005). *Zea mays L.* seeds were sewed between rows, each block having 4 rows, within a distance of 65 cm, and on rows within a distance of 25 cm. Blocks were irrigated to stimulate germination during dry conditions. For germination and for early growing periods, until plants were reaching the length of 40-50 cm, sprinkler irrigation, and when plants were taller for sprinkler irrigation, furrow irrigation were applied. When the numbers of leaves were reached 8, 10 kg da^{-1} of N fertilizer was applied. In addition, soils between rows and on rows were cultivated with hoe. Ten plants were randomly selected, and observations and measurements were conducted with selected plants. Plant length (distance between soil surface and node which corn tassel occurred), first corncob height (distance between soil surface and node which firs corncob occurred), corncob length, corncob diameter and number of corncob for each plant were measured and determined.

Data of the research were evaluated statistically using SPSS program.

RESULTS

Some chemical properties of Water Treatment Sludge, and effects of increased amount of sludge applied to soil on some quality properties of corn plant were given in Table1 and Table 2.

Table 1. Some chemical properties of water treatment sludge.

pH (1:2.5)	EC dS m^{-1} (1:2.5)	Organic Matter (%)	$CaCO_3$ (%)	N (%)	Available P mg kg^{-1}	Available K mg kg^{-1}
8.03	1.88	24	4.33	1.63	265	1089

Table 2. Effects of increased amount of sludge applied on some quality properties of corn plant.

Sludge doses applied (t da^{-1})	Plant length (cm)	First corncob height (cm)	Number of corncob for each plant	Corncob length (cm)	Corncob diameter (cm)
Control	206.97	83.10	1.06	20.5	4.15
1	189.76	85.62	1.03	20.4	3.86
2	208.80	84.22	1.10	22.08	4.04
3	190.76	85.28	1.10	19.94	3.92
4	195.23	82.09	1.23	21.21	4.03

Effects of sludge doses on plant length were given in Fig.1. As of the average value of replicates, plant lengths varied between 189.76 cm and 208.80 cm. Average plant length was 206.97 cm for control blocks. There is no important trend found between sludge applications, statistically. There are no steady changes observed on plant length due to the increased amount of sludge applications.

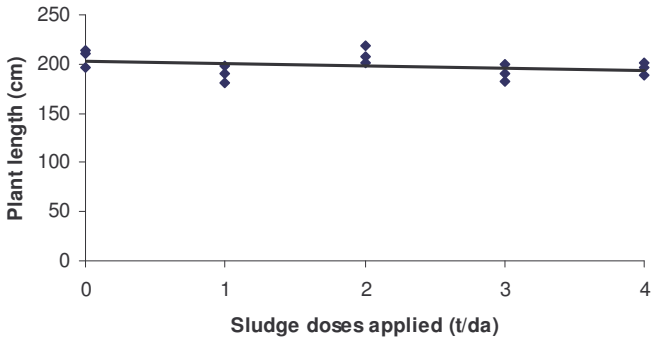

Figure 1. Effects of water treatment sludge doses on plant length.

Effects of increase amount of sludge doses on first corncob height of corn plant were given in Fig. 2. First corncob heights were increased with doses 1t da^{-1}, 2 t da^{-1} and 3 t da^{-1} sludge applied, and

decreased with dose of 4 t da^{-1} sludge applied compared to control treatment. The highest value 85.62 cm and lowest value 82.09 were found for the treatments 1 t da^{-1} and 4 t da^{-1} sludge applications, orderly. However, there is no significance was found among treatment blocks, statistically.

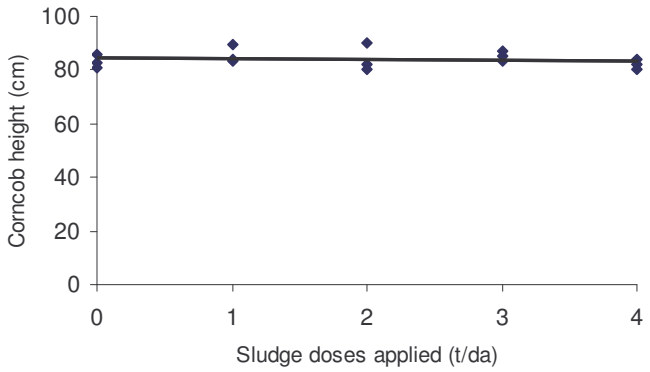

Figure 2. Effects of water treatment sludge doses on first corncob height of corn plant.

Effects of increase amount of sludge doses on corncob number of corn plant were given in Fig. 3. Although, there is significant relations found between sludge doses and corncob number, evaluation of Fig. 3 showed that highest number 1.23 and lowest number 1.03 were found on blocks where 4 t da^{-1} and 1 t da^{-1} of water treatment sludge applied, accordingly.

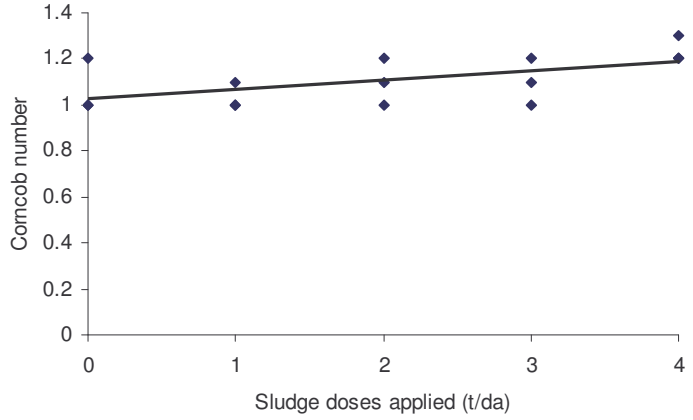

Figure 3. Effects of water treatment sludge doses on corncob number

Effects of sludge doses on corncob length were given in Fig. 4. Evaluation of Fig. 4 showed that the highest corncob length 22.08 cm was found on blocks 2 t da^{-1} of sludge applied, and the lowest corncob length 19.94 cm was found on block 3 t da^{-1} sludge applied on. The value found for control treatment was 20.05 cm. However differences among treatments were not found significant, statistically.

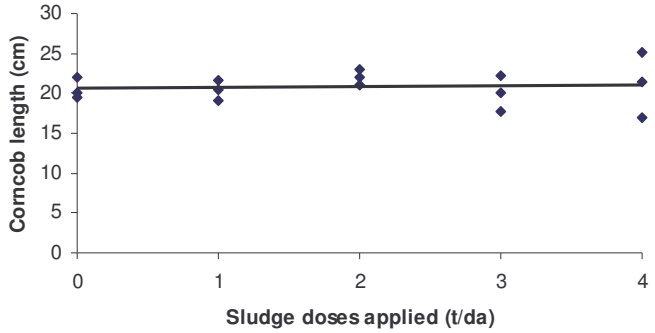

Figure 4. Effects of water treatment sludge doses on corncob length.

In fig. 5, effects of sludge doses on corncob diameter were given. The highest corncob diameter 4.15 cm and the lowest corncob diameter 3.86 were found for control treatment and 1 t da^{-1} sludge application. But there was no significances found among treatments considering corncob diameter.

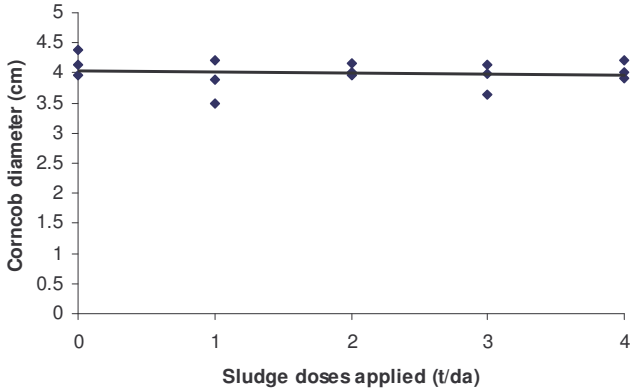

Figure 5. Effects of water treatment sludge doses on corncob diameter.

DISCUSSION and SUGGESTIONS

There are varieties of results of conducted researches related to application of water treatment sludge on soils. The research conducted by Cimrin et al. (2000) was focused on use of municipal treatment sludge in agricultural fields as a phosphorus sources. The results showed that sludge applications increased the phosphorus content of corn pant compared to control while increase in sludge portion in combination of TSP and Sludge decreased the phosphorus content of corn plant. This decrease was found statistically not significant. Topcuoglu et al. concluded that one of the main topics is increase in heavy metal content of tomato plant its mineral content when treatment sludge applied to soil repeatedly. The heavy metal contents were found higher in the second year of the work than the first year of the work (Topçuoğlu et al., 2003). Bozkurt et al. searched effects of sludge application on yield, growth, nutrition content and heavy metal content of apple trees. It is found that

there were no significant differences statistically between the sludge and manure applications and leaf mineral content, and trunk development. They also reported that long time use of sludge repeatedly may cause increase in heavy metal accumulation in soils and in plants more than the limits allowed by regulations (Bozkurt and Yarılgaç, 2003). Sensoy, in his work, observed that there were positive effects of municipal treatment sludge, applied to soil, on emergence and seedling growth of cucumber (Şensoy, 2001). Villaroel et al., stated that phosphorus and heavy metal content of plant increased several times after application of sludge, 8 years repeatedly (Villaroel et al., 1993). In this research, effects of drinking water treatment sludge applied to soil with increased doses on corn plant and some quality properties of corncob were investigated. Based on the results there were no significant quality increases found among sludge treatments. In addition there were no significant differences found, statistically. According to results derived from the research, these suggestions can be made: Organic matter content is become important for application of sludge in agricultural field. Water treatment sludge can be used as soil amendment to increase soil organic matter content. Even heavy metal content of sludge is less than the limit allowed by the regulation; due to the application of sludge repeatedly heavy metal content of soil and plant may be increased for later times. Due to the fact that, sludge should not be used in agricultural fields where plant grown for human demand or food. However, piling sludge on fields as a way of discard has cause environmental problems.

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