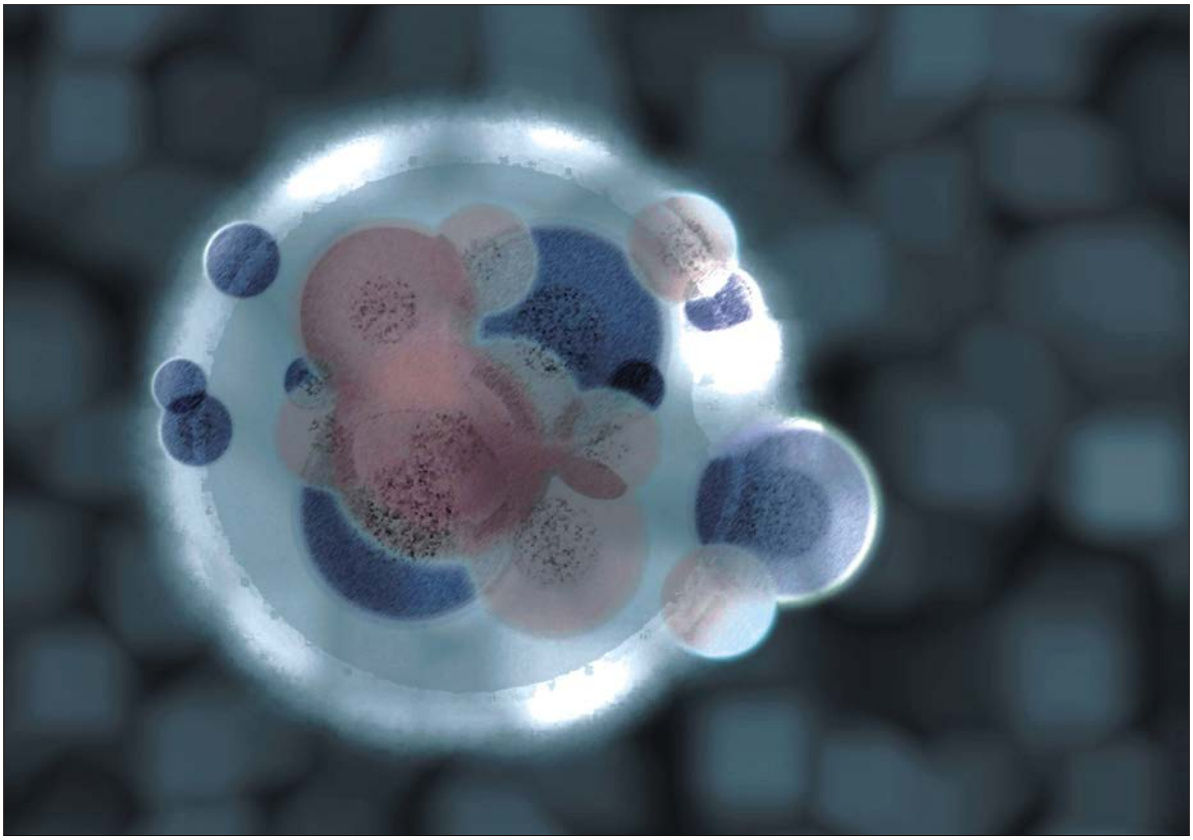

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Effect of Sewage Sludge on the Growth of Maize Crop

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Abstract: Sewage sludge application had significantly effected all parameters of maize crop except germination percentage. Maximum Shoot length, Number of leaves per plant, Leaf area, Plant height, Root length, Shoot dry weight and Root dry weight of maize crop were obtained where sewage sludge was applied at 10-30 ton ha^{-1}. It was recommended that application of sewage sludge at the rate of 20 or 30 ton ha^{-1} will have favorable effect on the maize crop under the agro-climatic conditions of D.I. Khan.

Key words: Sewage sludge, maize crop

Introduction

Sewage sludge is the solid by-product of domestic and/or industrial waste-water-treatment plants which has been spread on the land for decades, and its use will likely increase in the future. The product Milorganite, a dried sludge has been used widely in North America since 1927.

There are many reports from all over the world that Sewage Sludge material can be effectively used as a source of fertilizer for crop yield and for improving physical and chemical properties of soils (Subbiah and Ramulu, 1980; Benmouffok, 1994). Korentajer (1991) reported increased supply of major plant nutrients particularly N and P, along with some of the essential micronutrient (e.g. Zn, Cu, Mo and Mn) and improvement in the soil physical properties with the application of sewage sludge.

Ford *et al.* (1993) conducted an experiment on the effect of sewage sludge on soil properties and crop growth. After four years of testing no harmful effects on the chemical or microbiological constituents were found in the crop material or soil from test plots, the soil physical properties were improved and crop yield was increased.

Christodoulakis and Margaris (1996) conducted an experiment in which maize was pot-grown in nutrient deficient sandy soil. Sewage sludge application promoted growth in maize, compared with the application of traditional fertilizer. Plant height in maize increased by 77% in the sludge treated pots compared with 25% in plants treated with chemical fertilizers.

Keeping in view the importance of sewage sludge in Agriculture, the experiment was conducted in order to study its influence on Maize crop under the Agro-climatic condition of D.I. Khan.

Materials and Methods

The research work was carried out at the Faculty of Agriculture, Gomal University, D.I.Khan during the year 1998-1999. The sewage sludge was collected from sewerage channel (Drains) of Gomal University in plastic bags and was transferred to the laboratory. It was then air dried, ground and passed through a 4 mm sieve. To study the effect of sewage sludge on maize crop, pot culture experiment was carried out under field conditions. Plastic pots of the size $34 \times 34 \times 34$ cm^3 with 20 kg of air dried soil were used and the experiment was arranged in a randomized complete block design. The soil sample was collected from 0-20 cm depth from the Faculty of Agriculture Farm area and it was air dried at room temperature and then passed through a 2 mm sieve. The sewage sludge material was added to the soil at the rate of 0, 10, 20, 30, 40 and 50 ton ha^{-1}. Similarly, treatments having basal dose of NPK (120:90:35 kg ha^{-1}) and FYM (35 ton ha^{-1}) were also included in the experiment in order to compare their results with the sewage sludge. The soil without sludge and inorganic fertilizer was used as a control. Each treatment was replicated thrice. All cultural and agronomic practices were followed throughout the experiment. Maize seeds were sown on 23 July 1998. The sowing was done with dibbling method. During the harvest, the following different parameters of maize crop were measured and recorded.

1. Germination %
2. Shoot length (cm)
3. Number of Leaves per Plant
4. Leaf Area (cm^2)
5. Plant Height (cm)
6. Root length (cm)
7. Shoot dry weight (g)
8. Root dry weight (g)

The data obtained were statistically analyzed by the method of Steel and Torrie (1980).

Results and Discussion

Germination Percentage: Data pertaining to germination % are presented in Table 1. As evident from the table, maximum values of germination % age (7.00) were recorded in SW10, SW20, NPK, FYM, SW30 and SW40 treatments while the minimum values were recorded in control and SW50 (6.00). However, the result of all the treatments were statistically non-significant to each other. The results indicated that application of sewage sludge at the rate of 10-40 ton ha^{-1} have a favorable effect, but as the amount is increased it leaves an adverse effect on the germination of maize crop.

These results are in line with those reported by Shahnaz and Sheikh (1980) who observed a decrease in % germination (%) when the levels of sludge application were increased.

Table 1: Germination Percentage and Shoot length as effected by various amounts of sewage sludge

	Mean	
Treatments	Germination (%)	Shoot Length
Control	6.00 A	42.33 F
NPK	7.00 A	45.00 D
FYM	7.00 A	44.33 D
Sewage Sludge 10t ha^{-1} (SW10)	7.00 A	52.00 B
Sewage Sludge 20t ha^{-1} (SW20)	7.00 A	55.00 A
Sewage Sludge 30t ha^{-1} (SW30)	7.00 A	52.67 B
Sewage Sludge 40t ha^{-1} (SW40)	7.00 A	49.00 BC
Sewage Sludge 50t ha^{-1} (SW50)	6.00 A	46.33 CD

Means followed by different letters are significantly different at 5% level of probability

Shoot Length: The data in Table 1 showed that maximum shoot length of 55.00 cm was recorded in SW20 followed by SW30 (52.67 cm) and SW10 (52.00 cm), while minimum shoot length was noted in control treatment which was 42.33 cm. The data also indicated that sludge application beyond 30 ton ha^{-1} had a negative effect on the shoot length as there was a spontaneous decrease in shoot length at SW40 and SW50.

These finding are similar to those of the Mahasan *et al.* (1989) who obtained higher vegetative yield of maize when sewage sludge was incorporated to the surface layer of soil.

Number of Leaves Per Plant: Data pertaining to number of leaves per plant as effected by different levels of sewage sludge are presented in Table 2. It is evident from the table that sewage sludge had a significant effect on the number of leaves per plant. Maximum number of leaves per plant were obtained in case of NPK treatment (14.00), followed by SW10 (13.00), SW20 (13.00) and SW30 (11.67), while minimum number of leaves per plant were noted in SW50, and SW40 (7.00).

The result of NPK, SW10 and SW20 were statistically at par with each other at 5 % level of probability. It is evident from the results that addition of sewage sludge at the rate of 10-20 ton ha^{-1} had a positive effect on the number of leaves per plant. The result coincide with those reported earlier.

Leaf Area: Data pertaining to leaf area as effected by sewage sludge are presented in Table 2. It shows that SW10, SW20 and SW30 had a significant effect on leaf area of maize crop. Maximum leaf area (78.25) was recorded in SW20 followed by SW10 (76.00) and

SW30 (75.33), while minimum leaf area (50.00) was observed in control treatment. The results indicated that treatments receiving 10, 20 and 30 ton ha^{-1} of sewage sludge increased the leaf area while higher levels of sewage sludge had negative effect on the leaf area of the maize crop. The results are in line with those reported by Pietz *et al.* (1982) who observed a decline in leaf area with higher rates of sludge application.

Table 2: Number of Leaves per plant and Leaf Area as effected by various amount of sewage sludge

	Mean	
Treatments	Leaves $Plant^{-1}$	Leaf Area
Control	9.00 CD	50.00 B
NPK	14.00 A	64.00 AB
FYM	10.00 BC	65.25 AB
Sewage Sludge 10t ha^{-1} (SW10)	13.00 A	76.00 A
Sewage Sludge 20t ha^{-1} (SW20)	13.00 A	78.25 A
Sewage Sludge 30t ha^{-1} (SW30)	11.67 B	75.33 A
Sewage Sludge 40t ha^{-1} (SW40)	8.00 E	64.00 AB
Sewage Sludge 50t ha^{-1} (SW50)	8.00 E	52.31 B

Means followed by different letters are significantly different at 5% level of probability

Plant Height: Data in Table 3 showed that maximum plant height of 118.00 cm was obtained in case of SW30 treatment, followed by NPK (117.30 cm), SW20 (117.30 cm) and SW10 (116.00 cm) while minimum plant height of 94.00 cm was noted in SW50. The results of SW30, SW20, SW10 and NPK treatments were significantly higher compared to other treatments but were statistically at par with one another.

It is evident from the results that by addition of sewage sludge at the rate of 20-30 ton ha^{-1}, the plant height also increased. But further increase in the levels of sewage sludge had negative effect on the plant height. The results corroborate the findings of Christodoulakis and Margaris (1996).

Table 3: Plant height and Root length as effected by various amount of sewage sludge

	Mean	
Treatments	Plant height	Root length
Control	110.00 B	20.67 C
NPK	117.30 A	23.33 AB
FYM	111.00 B	21.33 BC
Sewage Sludge 10t ha^{-1} (SW10)	116.00 A	23.34 AB
Sewage Sludge 20t ha^{-1} (SW20)	117.30 A	24.00 A
Sewage Sludge 30t ha^{-1} (SW30)	118.00 A	24.00 A
Sewage Sludge 40t ha^{-1} (SW40)	98.33 C	20.33 C
Sewage Sludge 50t ha^{-1} (SW50)	94.00 F	19.33 C

Means followed by different letters are significantly different at 5% level of probability

Root length: Data pertaining to root length as effected by various amount of sewage sludge are presented in Table 3. The data showed that maximum root length was noted in SW20 and SW30 treatments which was followed by SW10 and NPK treatments, while minimum root length was noted in SW50 treatment. The results of SW20 and SW30 were statistically at par with one another but highly significant to SW50, SW40, SW10, FYM, NPK and control treatments. It indicated that by increasing sewage sludge beyond 30 ton ha^{-1} had a negative effect on the root length of maize crop. The results support the findings of Metz *et al.* (1995) who noted a positive effect of sludge on the root development of maize crop.

Shoot dry weight: The data in Table 4 showed that maximum shoot dry weight (6.25 g) was noted in SW20 followed by SW30 (6.00), SW10 (5.58 g) and SW40 (5.42 g) while minimum shoot dry weight (4.50 g) was noted in control treatment. The result of SW20 and SW30 were significantly higher to all the treatments but were non-significant to one another. It indicated that application of sewage sludge at the rate of 20 to 30 ton ha^{-1} had favorable effect on the shoot dry weight of maize crop, while further increase in the rate of sewage sludge application had negative effect on it. The results are in line with those reported by Vitvakon *et al.* (1995).

Table 4: Shoot dry weight and Root dry weight as effected by various amount of sewage sludge

	Mean	
Treatments	Shoot dry Weight	Root dry Weight
Control	4.50 E	1.24 D
NPK	5.33 BCD	1.32 B
FYM	5.00 D	1.26 D
Sewage Sludge 10t ha^{-1} (SW10)	5.58 B	1.29 C
Sewage Sludge 20t ha^{-1} (SW20)	6.25 A	1.47 A
Sewage Sludge 30t ha^{-1} (SW30)	6.00 A	1.46 A
Sewage Sludge 40t ha^{-1} (SW40)	5.42 BC	1.14 E
Sewage Sludge 50t ha^{-1} (SW50)	5.17 CD	1.11 F

Means followed by different letters are significantly different at 5% level of probability

Root dry weight: Data pertaining to root dry weight as effected by various amount of sewage sludge are presented in Table 4. The data showed that maximum root dry weight of 1.47 g was obtained from treatment receiving sewage sludge at the rate of 20 ton ha^{-1}, followed by SW30 and NPK, while minimum root dry weight of 1.11 g was noted in SW50 treatment. The results of SW20 and SW30 were highly significant to all the treatments, but were statistically at par with one another.

It indicated that by increasing sewage sludge beyond 20-30 ton ha^{-1}, there was a decrease in the root dry weight of maize crop. The results are in agreement with that of Vitvakon *et al.* (1995).

From these discussions it could be concluded that sewage sludge application at the rate of 10-30 ton ha^{-1} had a favorable effect on all parameters of maize crop. This shows that sludge application upto 30 ton ha^{-1} could be safely used in order to have profitable yield of maize crop.

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