Effect of sewage sludge on some physical and chemical characteristics of sandy soils and plant growth

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The agricultural sector has to increase food production through vertical and horizontal extension programs. Sandy soils reclamation is the hop in increasing the agriculture production and subsequently overcoming the deficiency in food requirement.The additions of organic matter play an important role in improving physical and chemical properties of sandy soils and consequently their productivity. In other words, to maintain a good level of fertility, the soils need periodical addition of organic materials. Almost of the solid sewage sludge consists of organic materials, therefore, it is expected to be an important source of organic matter for humus supply and acts as a soil conditioner. In addition, it contains large amounts of calcium compared with the other soilconditioners.This work aimed to study the effect of sewage sludge application rates and it's lime addition on some physical and chemical soil characteristics, plant growth and nutrients uptake by wheat and corn plants.Two consequent field experiments were conducted during the winter and summer seasons 1997-1998 at Abou Rawash Sanitary Station farm 26 km Cairo — Alexandria Desert Road, Giza Governorate. The soil is classified as " Entisol Psamments". The field was divided into 36 square plots (16 m2) and 2 m apart included 12 treatments. The treatments were: 4 rates of sludge (0, 2.5, 5 and 10°/0w/w) enriched with 3 levels of lime (0, 2.5 and 5%,„„A„). These treatments were applied before planting wheat and repeated before corn using three replicates. The study involved completely randomized block design. The obtained data could be summarized in the following:119a. Soil physical characteristics:1. Sofl bL1k (density and total porosity:-Bulk density (BD) decreased with increasing sludge application rate and the opposite was true for total porosity (TP) relative to the control.-The highest BD (1.71 g.cm-3) and lowest TP (35.47%) were obtained in thecontrol.- The lowest BD (1.44 g cm-3) and highest TP (44.66%) were achievedusing 10% sludge enriched with 5% lime treatment after corn plants.-Significant differences (at the 5% level) were noticed in both BD and TP between any two-sludge treatments.2. Soil water retention:-Soil moisture content at WHC, FC, WP and AW increased with increasing sludge rates (%) and the rates could be written in descending order: 10>5>2.5>0 according to their positive effect on soil moisture content.-Increasing sludge rate 0- 10% increased moisture content (`)/0,/„) in soil at WHC, FC, WP and AW, 35.7-46.2, 10.3-24.5, 2.6-8.3; 7.7-16.3, after wheat and 36.7-45.6, 10.1-25.7, 2.5-7.1; 7.6-15.6 after corn, respectively.-Differences in soil moisture between any two sludge rates were significant (at the 5% level) with few exception regardless of the crop and lime level. - The treatments 10% sludge enriched with 2.5% or 5% lime could berecommended for increasing AW in sandy soil.2. Soil hydraulic conductivity and infiltration rate:- Hydraulic conductivity (HC) increased with increasing sludge rate and could be arranged in the following ascending orders: 2.5<5<0<10 and5<10<2.5<0 after wheat and corn, respectively.- Increasing lime addition 0 — 5% decreased HC 39.62- 37.35 and 40.0138.21 cm h-1 after wheat and corn, respectively.-According to lime addition (%), the negative and significant effects at 5%level on HC could be written in the following descending order: 0>2.5>5 %regardless of growth plant.-The treatment 10% sludge enriched 5% lime, which reduced HO by 5% inthe average is recommended.120-Increasing application rate of sludge and its lime content has a depressedeffect on water intake rate (IR).- The change in IR in

response to sludge rate and its lime addition was quitesimilar to that of HC.-IR values varied from 34.5-43.0, 35.0-42.0 cm h-1 after wheat and corn,respectively.4.Aggregation and aggregate stability:Increasing sludge rate (0-10%) and its lime addition (0 to 5%) has positive effect on water stability aggregate index (WSI).-The increase in WSI ranged 24-331 and 27-388% relative to the control under wheat and corn plants, respectively, according to sludge rates andits lime addition.-There is a positive linear effect of sludge rate and its lime addition on WSI. The values of WSI under corn exceeded that under wheat in the similartreatments.5. Soil resistance:-Soil resistance (SR) decreased with increasing sludge rate at all used lime content after both crops.-Negative and significant effects at 5% level due to increasing sludge rate enriched with different addition of lime (0-5%) on SR were noticed. Increased lime addition of sludge increased SR relative to the control up tothe depth of 10 cm.- SR increased with increasing soil depth and this increase was sharp in the layer 0-5 cm then it became gradually small and nil up to 20 cm.- The maximum and minimum total SR (0-20 cm) were 720 N cm-2 (in control plots) and 500 N cm-2 (10% sludge enriched with 5%), respectively, after wheat. After corn, the values were 695 N cm-2 in control plots and 450 N cm-2 under unlimed 10% sludge after corn.b. Yield, water use efficiency and seed index:1. Yield:-Increasing sludge rate from 0 to 5% increased the grain yields of bothwheat and corn.12!- In the absence of lime, 10 % sludge caused a marked decrease in yield forboth crops.-The maximum and minimum yield (2040, 945 Kg fed-1) for wheat and(2424, 2068 Kg fed-1) for corn were obtained with 10% sludge enriched with 2.5% lime and control one, respectively.2. Water use efficiency and seed index:-Water use efficiency (WUE) and seed index took the same trend similar tothat of the yield .- WUE for wheat ranged from 0.53-1.15 Kg Cr1-3 irrigation water using sludge 10% enriched with 0 and 5% lime, respectively.-Corn WUE ranged from 0.73 —1.05 Kg rr1-3 irrigation water in control plotsand 10% sludge containing 5% lime.-Both sludge and its lime addition has a positive effect on WUE for bothcrops.-According to the positive effect of sludge rate on seed index for both wheat and corn, sludge rate could be arranged in the following descendingorder:10 > 5 > 2.5 > 0.c. Soil chemical characteristics (pH, EC, OM and CEC):-Increasing sludge rate and its lime content have a positive significant effect(5%) on soil EC, OM and CEC.-The minimum and maximum EC (0.25, 0.36 dS m-1) and (2.48, 2.37 dS m-') were obtained in the control plot and in the 10% sludge containing 5% lime treatments after both wheat and corn, respectively.-Soil organic matter (SOM) ranged from 0.14-4.73 % and 0.54 — 5.67 %after wheat and corn respectively.-The lowest SOM values occurred in the control plots and the highest onein the 10% sludge containing 5% lime.-The minimum and maximum CEC values (4.10, 4.85 meq per 100g soil)and (17.52, 19.54 meq per 100g soil) were obtained in the control plotsand 10 % sludge containing 5% lime after wheat and corn, respectively.-Concerning soil pH, slight effect for the used treatments was noticed .122d. Liming sludge:-Liming sludge increased sludge EC, pH. soluble K and total P and K and decreased its OM and total N.-Co, Ni and Pb decreased with liming below critical level.-Lime rate 2.5% can be recommended to avoid Co hazardous.e. Co, NI and Pb uptake:-Increasing sludge rate increased Co, Ni and Pb content of shoots and grains for both wheat and corn.-Regard lime addition, its negative and significant (5%) effect on Co, Ni and Pb in both crops.-There were increase in Co, Ni and Pb in soil after wheat and , but there were no consistent trend for that.-The maximum and minimum content of those elements in leaves, grains and soil for both wheat and corn were obtained using 10% unlimed sludge and control plots.-Liming sludge decreased the Tc of Co, Ni and Pb from soil to plant relative to the control.Lime addition to sludge is consider a good method to avoid its potential hazard due to presence of heavy metals and pathogenic. Liming sludge decrease Co, Ni and Pb uptake and their transfer in wheat and corn grains. Sludge rate of 5% enriched with 2.5 % lime is recommended. It improves most of the studied parameters (soil physical and chemical characteristics). It should be prepared and applied in locations faraway from industrial areas and major highways to prolongate the life of soil-plant barrier.