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Oregon State University Fertilizer Guide for

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FERTILIZING WITH SEWAGE SLUDGE

SEWAGE SLUDGE AS A FERTILIZER FOR AGRICULTURAL LAND

Sewage sludge contains plant nutrients and is a valuable fertilizer material. It has been applied to agricultural land for many years, however, poor management or disposal practices raise environmental concerns. As with other agricultural chemicals and soil amendments, appropriate application rates are important.

RESTRICTIONS AND GUIDELINES FOR THE APPLICATION OF SLUDGE

Details of guidelines for sludge application are outlined in "Oregon State Department of Environmental Quality Guidelines for Land Application of Wastewater and Sludge, 1981."

Permits for the application of sludge to agricultural land are issued to wastewater treatment plants by the Oregon Department of Environmental Quality (DEQ). The treatment plant provides sludge analyses and maintains a log of the amount of sludge applied to approved sites. No permit is required for an individual accepting sludge for land application.

Analyses include total nitrogen (N), ammonium nitrogen ($\text{NH}_4\text{-N}$), phosphorus (P), potassium (K), acidity (pH), and the heavy metals lead (Pb), zinc (Zn), copper (Cu), nickel (Ni), and cadmium (Cd). These analyses serve as a guide for determining application rates of sludge. Where sludge is applied at or below agronomic rates (based on crop N requirements) no monitoring other than the sludge analysis and a record of the amount sludge applied is required.

A DEQ representative evaluates the suitability of land for sludge application based on soil characteristics such as landscape and drainage features which in some cases may limit the season and/or method of application to prevent surface or groundwater contamination.

Some crops such as leafy vegetables and root crops may accumulate undesirable amounts of Cd or other heavy metals. Where these crops are grown the soil should have a pH of 6.5 or above before sludge application. This higher pH limits the uptake of Cd by crops. This may require liming of acid soil. Many crops such as small grains, pasture and forages do not readily accumulate metals. However, if a sludge has a high metal content or repeated use of sludge leads to large applications of metals then soil pH adjustment may also be required for these crops.

Crops grown for direct human consumption usually require a waiting period of 18 months between sludge application and planting. The waiting

period may be waived if the sludge has been heat treated or subjected to other processes which destroy all pathogenic organisms. No waiting time restrictions exist for crops not grown for direct human consumption such as small grains and mint. Time of application is also of less concern with pasture and forage crops. Animals should not be allowed to graze fields for one month after sludge is applied. This is particularly true for dairies, where animal contact or direct ingestion of sludge could result in milk contamination. It is recommended that sludge be applied soon after the cutting of a hay or forage crop or after an individual pasture has been grazed.

FERTILIZER VALUE OF SLUDGE

Annual application rates of sludge to cropland are usually determined by crop needs for N. Total application over a period of years may be limited by cumulative amounts of heavy metals such as Cd. Soil tests should be used as a basis for estimating crop nutrient requirements and sludge application rates. Crop Fertilizer Guides and soil test information are available from your County Agent.

The nutrient and trace element content of sewage sludges in Oregon varies considerably so that sludge application rates must be based on the analysis of the sludge to be used.

Nitrogen in sewage sludge exists in both the readily and slowly available forms. Mineral N ($\text{NH}_4\text{-N} + \text{NO}_3\text{-N}$) is readily available to plants and about 15% of the organic N is converted to plant available forms during the year of application.

Calculation of Sludge Application Rate Based on Crop N Requirement

The sludge application rate can be calculated using the following equation:

$$G = \frac{120,000 N}{S(85M + 15T)}$$

where:

- G = gallons of sludge/A
- N = amount of N required by crop (lbs N/A)
- S = % solids in wet sludge
- M = % mineral N in dry sludge
- = % $\text{NH}_4\text{-N}$ + % $\text{NO}_3\text{-N}$
- T = % total N in dry sludge

Example:

N requirement of crop	N - 150 lbs/A
Sludge contains 4% solids	S = 4
% mineral N in solids	M = 2
% total N in solids	T = 5

$$G = \frac{120,000 \text{ N}}{S(85M + 15T)} = \frac{(120,000)(150)}{[(85)(2) + (15)(5)]}$$

$$= 18,400 \text{ gallons sludge/A}$$

When feasible, sewage sludge should be injected into the soil, or if surface applied, immediately plowed down or followed by sprinkler irrigation to reduce loss of N through volatilization of ammonia (NH₃).

Application of P and K

When the sludge application rate is based on crop N requirement, adequate P for the crop is usually also applied. The amount of K supplied in sludge is usually considerably less than the amount of P. The availability of nutrients such as P and K in sewage sludge is comparable to the availability of these nutrients in chemical fertilizers. Where the sludge application does not provide sufficient P or K additional P or K fertilizer should be applied.

Application of P and K

Phosphate (P₂O₅) and potash (K₂O) applied in sewage sludge may be calculated as follows:

$$P_2O_5 = G \times S \times P \times .00191$$

$$K_2O = G \times S \times K \times .00104$$

G = gallons of sludge
 S = percent solids in sludge
 P = percent P in dry sludge
 K = percent K in dry sludge

Example:

Gallons of sludge applied G = 18,400 gals
 % solids in sludge S = 4%
 % P in dry sludge P = 1.5%
 % K in dry sludge K = 0.5%

$$P_2O_5 = 18,400 \text{ gals.} \times 4\% \text{ solids} \times 1.5\% \text{ P} \times .00191$$

$$= 211 \text{ lbs } P_2O_5$$

$$K_2O = 18,400 \text{ gals} \times 4\% \text{ solids} \times 0.5\% \text{ K} \times .00104$$

$$= 38 \text{ lbs } K_2O$$

Other Plant Nutrients

Sludge applications which supply adequate available N for crop production will usually supply sufficient sulfur for the crops. Sludge often contains significant amounts of calcium, zinc, copper and iron and sometimes significant levels of magnesium, boron, and manganese are present.

Total Amount of Allowable Cadmium

The rate at which sewage sludge is applied can be limited by the amount of Cd it contains. The allowable cumulative Cd application is related to the cation exchange capacity (CEC) of the soil as indicated in Table 1.

As Oregon sewage sludges usually contain little Cd these limits on Cd application do not place serious restrictions on the application of sludge to cropland in Oregon.

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Some of the information is based on experiments conducted by T. L. Jackson, V. V. Volk, and D. D. Hemphill, Jr., OSU Agricultural Experiment Station.

Table 1. Total amount of Cd allowed on agricultural land.

Soil Cation Exchange Capacity (CEC)		
-----meq/100 g soil-----		
0 - 5	5 - 15	> 15
Maximum Amount of Cd - lbs/A		
5	10	20

Calculating Cd Application

Cadmium applied in sewage sludge can be calculated as follows:

$$C_A = \frac{0.0833 \text{ GSC}}{1,000,000}$$

C = lbs/A of applied Cd
 G_A = gallons of sludge
 S = percent solids in sludge
 C = ppm Cd in dry sludge

Example:

Gallons of sludge applied G = 18,400 gals
 % solids in sludge S = 4%
 ppm Cd in dry sludge C = 25

Cadmium applied

$$C_A = \frac{0.0833 \times 18,400 \text{ gals} \times 4\% \text{ solids} \times 25 \text{ ppm Cd}}{1,000,000}$$

$$= 0.153 \text{ lbs Cd/A.}$$

Using this sludge at 18,400 gals/A on a soil with a CEC of 10 meq/100 g it would take 10 ÷ 0.153 = 65 years to apply the maximum allowable amount of 10 lbs/A Cd.

Crops

Perennial grasses: Good crops for sludge application; yields of grass grown on sludge treated soils have equaled or exceeded those with equal rates of available N from chemical fertilizer. Sludge applications can be made throughout most of the year and frequently supply all needed nutrients.

Small grains: Good crops for sludge application; yields of grain on sludge treated soils have equaled those from chemical fertilizers after the second year of sludge application.

Row crops: Sludge fertilization of many row crops for direct human consumption requires a lag time of 18 months between application of the sludge and planting of the crop. A few crops such as processed vegetables and sweet corn may be safely and effectively grown without a lag time.

Other Publications on the Use of Sewage Sludge:

1. Land Application of Sewage Sludge. OSU Extension Service Fact Sheet No. 249.
2. Land Application of Treated Sewage Sludge: Guidelines for Communities and Farm Operators. OSU Extension Service Special Report No. 449.
3. Applications of Sludges and Wastewaters on Agricultural Land. U.S. Environmental Protection Agency. MCD-35. March 1978.