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Biosolids: Are These Residuals All the Same? [1]

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Florida's increasing population, together with urbanization, is generating a large amount of organic waste from industrial, animal and human sources. A substantial portion of the general public opposes land application of wastes due to fears of adverse environmental degradation. Reasons cited include potential soil contamination, groundwater pollution, the potential threat to human and animal health due to the presence of pathogens and insects, and foul odors.

Currently, most U.S. biosolids (the solid material left as a result of wastewater treatment) are considered fit for land application. A 1988-1989 USEPA national survey of sewage treatment facilities determined that 70% of the wastewater residuals met the criteria for Exceptional Quality (EQ) with regard to heavy metal concentration. In 1993, the USEPA established a set of standards for 10 trace metals in biosolids and compost as a protective measure for public health and safety. The maximum allowable concentrations, in ppm, are: arsenic (AS) 41, cadmium (Cd) 39, chromium (Cr) 1200, copper (Cu) 1500, lead (Pb) 300, mercury (Hg) 17, molybdenum (Mo) 18, nickel (Ni) 420, selenium (Se) 36, and zinc (Zn) 2800.

Application of organic wastes like biosolids to agricultural land provides several benefits, including:

1. reduction of the chemical fertilizer requirement, since biosolids are sources of many plant nutrients;
2. improvement of soil chemical properties by increasing the nutrient pool, promoting an increase in pH of acid soils, and increasing soil buffering capacity;
3. improvement of soil physical properties, such as structure and particle aggregation, aeration and drainage, and water retention;
4. enhancement of biological properties by increasing microbial communities and soil fauna and contributing to disease suppression.

The overall benefit of adding organic material to soils is increased soil productivity and improved plant nutrition and yields. Potential adverse environmental effects of organic wastes applied to soils include soil and water degradation and toxicity of metals to plants, with subsequent movement through the food chain.

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Biosolids application does not necessarily replace inorganic fertilization, although many biosolids compare favorably with commercial fertilizers with respect to some nutrients. Most biosolids contain micronutrients in a natural organically-chelated form. Nevertheless, organic wastes lack the proper balance of nutrients necessary to fully meet crop requirements, They can, however, be used in conjunction with fertilizers to reduce chemical fertilizer inputs.

Most of the nutrients in biosolids are not readily plant-available, so they are often considered as organic slow-release fertilizers for agricultural crops. The metals are generally immobile and have low water solubility. Consequently, there is not much movement of metals in soils, unless surface erosion is considerable or the soil pH is highly acidic. In Florida, biosolids use may be a beneficial source of nutrients compared with inorganic fertilizers that tend to leach readily in sandy soils, especially when a heavy rain follows application.

A vast proportion of Florida's agricultural production occurs in the vicinity of urban populations. These agricultural sites could potentially receive municipal biosolids application. There are several types of municipal biosolids available for land application in Florida, and they can vary widely in moisture content: a) Fresh Materials--2-6% solids; b) De-watered materials--18-35% solids; and c) Pelletized (granular), like Milorganite and Granulite organic fertilizers--more than 90% solids.

Are these residuals all the same? When and how should the various types be applied to land? What characteristics should we be looking for?

Usually, biosolids are applied to land based on potentially available nitrogen and the nitrogen requirement of the particular crop. However, other elements present in the biosolids (particularly phosphorus) should be taken into consideration when they are land-applied. Another key consideration is the type of soil and its texture, pH, and nutrient composition.

The stabilization process used to treat wastewater significantly alters the nutrient composition of the resulting biosolids. The rate of nutrient release, or mineralization, is also affected by the process. Mineralization values ranging from 41 to 50% of the organic N from aerobically-digested sewage sludge and 23 to 41% of the organic N from anaerobically-digested sludge have been reported during the initial crop season. Mineralization rates of approximately 40%, 15%, and 8% have also been estimated for waste-activated sludge, anaerobically-digested sludge, and composted sludge, respectively.

There are two main types of biosolids produced in Florida based on the stabilization process: a) lime-stabilized, and b) stabilized by other processes (chemical, physical, or biological). Most biologically stabilized materials undergo an aerobic (with oxygen) or an anaerobic (without oxygen) digestion process. The typical compositions of lime-stabilized and anaerobically-digested biosolids are shown in Table 1. After considering the characteristics of the biosolids and the soil-cropping system receiving the material (e.g. citrus, sugarcane, or pastures), some basic guidelines should be kept in mind for land application.

For a citrus grove that has been receiving alkaline irrigation water and/or has been limed to obtain a soil pH of 6.5 to 7.0, a lime stabilized material could possibly induce a micronutrient deficiency, since this type of material normally has a pH greater than 12. However, if the crop is pasture grass, which is often under-fertilized and under-limed, lime stabilized biosolids would bring a nutritional benefit, as well as a pH increase over the long term, and enhance overall soil characteristics.

Lime stabilized biosolids contain lower N, P, and metal concentrations, but higher Ca concentration than digested biosolids, because of the large amount of lime added to the material. The economic value of different types of biosolids for different crops are discussed elsewhere. (See Fact Sheet SS-AGR-168 Assessing Economic Value of Biosolids).

Therefore, "are these residuals all the same?" As indicated in Table 1, one major difference may be the pH or lime content. The high lime content or pH of a residual may render it unsuited for repeated applications in a citrus grove, but it may be perfectly adequate for a pasture that has not been limed for many years. For proper utilization of biosolids in Florida, knowledge of the biosolids' composition, the soil where the material is to be applied, and the crop receiving the it, are absolutely necessary, so that adequate types and rates are applied in an environmentally safe manner.

Table 1. Selected characteristics of two types of municipal biosolids.

	Type of Biosolids	
Characteristic	**Anaerobically Digested**	**Lime Stabilized**
Solids (%)	25	25
Nitrogen (%)	5.6	3.8
Phosphorus (%)	2.2	1.0
Potassium (%)	0.2	0.4
Copper (ppm)	566	236
Molybdenum (ppm)	23	5
Zinc (ppm)	1484	321
Arsenic (ppm)	4	1
Cadmium (ppm)	11	4
Chromium (ppm)	91	10
Lead (ppm)	195	17
Nickel (ppm)	59	33
Mercury (ppm)	2	2
Selenium (ppm)	3	1
pH	8	12