

Crop Fertilization and Heavy Metal Accumulation in Soils

Trace elements and heavy metals occur naturally in all agricultural soils. Several of them are either essential or beneficial to plants as well as animals. However, they can become toxic if accumulated in excessive amounts. Proper nutrient management and fertilization planning considers both agronomic and environmental outcomes, and, can prevent the potential for such toxicities. Paracelsus, the father of toxicology, observed more than 500 years ago "the dose makes the poison."

In past years, there were reports of heavy metal contamination in fertilizers manufactured from industrial byproducts. This practice of selling contaminated fertilizers is prohibited. Nowadays, more than 97% of the mineral fertilizers used in North America are made from natural sources such as atmospheric gases and deposits of earth minerals. The U.S. Environmental Protection Agency (EPA) has reported that typical rates of heavy metal additions to soils in mineral fertilizers are well below U.S. biosolids annual pollutant loading rates and the Canadian Fertilizer Act limits. Regulatory agencies set careful limits on metal application based on multiple safety factors.

The only heavy metal of practical concern in fertilizer is cadmium (Cd). It occurs naturally in geologic deposits of phosphate rock, the mineral used to make phosphorus (P) fertilizers. During the manufacturing process, much of the Cd in the ore is carried through to the final fertilizer products. Cadmium can also be present in organic fertilizer sources such as biosolids or manure. Further, it can be added to the soil through atmospheric depositions as a result of forest fires, volcanic eruptions, and air pollution due to industrial output.

Sewage sludge from cities can contain elevated concentrations of Cd and this source has caused contamination in some areas. However, biosolids such as sewage sludge are applied to only limited areas and affect a relatively small proportion of agricultural land. Manures can be a concern because more than 90% of the Cd ingested by animals passes into the manure. Also the organic matter in manure helps to solubilize soil Cd, making it more available to plants.

Cadmium accumulation and availability in the soil are affected by several factors in addition to fertilization, including: soil organic matter content, soil pH, crop species grown, and crop rotation. While there should be concern about Cd, adoption of measures that might limit the use of P fertilizers and crop production



It is important that we understand and utilize all our management options in taking the necessary steps to protect public health and the environment.

are not necessary. For example, using a worst-case scenario of applying a P fertilizer source high in Cd, it would take almost a thousand years to reach the EPA cumulative limits in the soil. Other studies show no significant Cd accumulation in soil after more than 100 years of P fertilization. Risk analysis show the Cd in fertilizer poses no threat to human health.

Metals in fertilizers and biosolids are regulated but manures are not. There is growing awareness of the metals applied to cropland in animal manures. Experts are becoming more concerned about copper (Cu) accumulation in soil following application of dairy wastes to fields. Accumulation of both Cu and zinc from swine and poultry manure has caused some states to set limits on their application. These metals are essential plant nutrients, but excessive concentrations can stunt plant growth.

FOR FURTHER READING:

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