NEWS & VIEWS

A regional newsletter published by the Potash & Phosphate Institute (PPI) and the Potash & Phosphate Institute of Canada (PPIC)

September 1997 **Multi-Region**

Fertilizers as Part of Our Environment

QUESTIONS AND CONCERNS about heavy metals in fertilizers and amendments have been highlighted recently by the news media under titles such as "Fear in the Fields." The issues are complex and can be confusing. None-the-less, acting from a perspective of fact-based-knowledge will serve us best…both consumers and fertilizer producers. Most fertilizer materials (more than 97 percent) are manufactured from naturally occurring air or mineral deposits with the specific purpose of providing needed nutrients to growing plants. Where other nutrients (often micronutrients) are required, they are sometimes added from less conventional sources not originally intended for fertilizer use. Some of these materials may contain small amounts of heavy metal contaminants. These heavy metals occur in all nutrient sources whether organic or inorganic, since heavy metals are part of our natural environment.

Heavy Metals in the Environment

All soils contain small amounts of heavy metals. A portion of the total is available for absorption by plants and could be, therefore, ultimately consumed by animals and humans. Generally, the concentration of heavy metals is lowest in the southeastern U.S. and highest in the Midwest, West and Northern Great Plains. Concentration is related to the weathering of naturally occuring rocks and minerals; weathering is fastest in warm, humid regions.

Table 1 shows the concentration of heavy metals, in parts per million (ppm), in soils from various regions of the U.S.

Zinc (Zn) and copper (Cu) are essential nutrients for plants and must be present in the soil in an available form for plants to grow and reproduce. They are applied as fertilizers when soils are deficient. Nickel (Ni) is an essential nutrient for some plants, but has not been found to be deficient in production situations. Lead (Pb) and cadmium (Cd) are not required by plants, but are easily absorbed by some plants if available.

The total content of metals in soil is not nearly as important as is the concentration of metals available for absorption

Table 1. Typical average concentration and range in county averages of heavy metals (ppm) in surface soils from selected regions in the U.S.

	Pacific Northwest		Northern Great Plains		Central Great Plains		Southeast	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Cadmium	0.3	0.08-0.64	0.36	0.16-0.64	0.12	0.04-0.32	0.08	0.02-0.16
Zinc	83	20-143	64	40-183	41	10-143	16	1-40
Copper	34	10-80	21	10-40	9	5-20	8	1-40
Nickel	38	20-80	25	10-80	19	10-40	10	2-40
Lead	9	3-20	10	3-20	18	10-30	9	3-20

Source: G.G.S. Holmgren et al. 1993. Cadmium, Lead, Zinc, Copper, and Nickel in Agricultural Soils of the U.S.A. J. of Environ. Qual. 22:335-348

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by plants. The availability of metals in soils generally decreases with increasing pH, with increasing clay content, and with decreasing organic matter levels. Although western soils may have higher total metal content than other regions, availability is reduced by their typically higher pH and lower organic matter content.

Waste or Resource?

Industrial by-products are sometimes used as nutrient sources in some fertilizers, primarily for their micronutrient content, and have been since the 1950s. The idea has been to utilize a resource and produce less expensive products. Properly managed, monitored and regulated this practice should not be a problem, but rather another example of utilizing a resource to its fullest.

The U.S. Food & Drug Administration monitors for chemical contaminants in the U.S. food supply. Metals are followed under a program known as the Total Diet Study (or the Market Basket Study). The objective is to estimate the dietary intake of pesticides, industrial chemicals, toxic elements, radionuclides, and essential minerals. Values obtained for metals are compared to provisional tolerable daily intake (PTDI) levels, above which chronic poisoning in humans may occur. Monitoring began in the 1960s. Since the mid-1970s the trend in dietary consumption of arsenic (As), Cd and Pb has actually been downward, not upward. And, importantly, the average values have been substantially below PTDI levels. Lead consumption has historically been the highest, reflecting its greater natural abundance in soil and atmospheric deposition resulting from the use of leaded gasoline.

Cadmium Focus

There is evidence that Cd is slowly building up in some soils. This is of concern because Cd is not essential to plants or animals, and at higher levels can be toxic. There are several possible sources of buildup including atmospheric deposition, sewage sludges, animal manures and phosphate fertilizers. Maximum total recommended concentrations in soils are somewhat arbitrary and range between 0.5 and 5 ppm in some countries where such levels have been set. There are no regulations or recommendations for acceptable levels of soil Cd in the U.S. or Canada at this time. However, Canada does regulate how much Cd can be added to soils through biosolids and fertilizers.

About 50 percent of the total Cd input to agricultural soils in many European countries is from airborne sources. Deposition is greatest around cities and industrial sites. In the U.S., deposition amounts to less than a gram (0.002 pounds) per acre per year in most areas.

Sewage sludges contain varying amounts of Cd, from a few ppm to several thousand ppm. Applying sludges containing the higher quantities of Cd may lead to contamination. Although local situations deserve careful management, land receiving sludge is a very small portion of total agricultural land.

Phosphate fertilizers contain Cd because most of the Cd which occurs naturally in phosphate rock carries through in the manufacturing process. Cadmium in rock phosphate ore ranges from about 1.0 to 100 ppm. For wet-process phosphoric acid, about two-thirds of the Cd continues through to the finished products. It is important to note that the total content of the incidental Cd is very small in the finished phosphate product (from 0.0001 to 0.01 percent) when compared to the level of the desired plant nutrient (often 25 to 46 percent P_2O_5). Several countries, particularly in Europe, are imposing regulations on the Cd content of phosphorus (P) fertilizers and are suggesting that others do the same. However, it is questionable whether this kind of regulation is justifiable or effective since many factors—soil pH, moisture content, variety, etc.—affect how much Cd might be absorbed by plants.

Restricting Cd content of P fertilizers is only one of the options that might be considered. In the Northern Great Plains region, using current fertilization practices, estimates are that it would take hundreds of years to double natural background Cd levels, and then they would still be *well* below maximum acceptable concentrations for agricultural lands. Western rock phosphate ore contains relatively higher concentrations of Cd, but it is still unclear whether it will be most beneficial to remove Cd in the manufacturing process or to employ alternative management strategies to minimize its potential entrance into the food chain.

Studies Continue

The California Department of Food and Agriculture (CDFA) is completing a study of three heavy metals…Pb, As and Cd. The study, entitled Heavy Metal Assessment Project, is reviewing how these metals move in soil, water and air, as well as their agronomic impact related to food production. The study is being conducted with the full support of the California Fertilizer Association and will potentially provide guidelines for the industry. It is due for release soon.

Information is presently being gathered by many university, government and industry sources. Specifics can be obtained by contacting your local agricultural university, state/provincial agricultural agencies, or fertilizer association. ■

Reference number 97138