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phosphorus, zinc, manganese and copper, can also limit the plants' ability to take up and use the iron.

Manganese—Likewise, the amount of manganese available to plants is not reflected in the amount of manganese available in the soil. Soil pH, cation exchange capacity, organic matter content, drainage, temperature, soil compaction and microbial activity all limit availability of manganese. Even fertilizer packages of iron with sulfur and nitrogen were found to induce manganese deficiency. They caused growth without necessary additional manganese to fuel such processes as hydrolysis, metabolism of organic acids and oxidation reduction that produced spindly, yellow plants.

Occasionally, too much manganese can be as bad as too little. In acid or poorly-drained soils, manganese becomes extremely available and blocks out the uptake of other vital nutrients.

Zinc—Zinc deficiency can be determined through soil and tissue tests. Muck soils and some western, Florida and Michigan soils are naturally deficient in zinc. High soil pH and removing topsoil can also cause zinc deficiency. Unbalanced applications of phosphorus can intensify zinc deficiencies. Uptake of zinc can be more limited when soils are cold and wet during the early part of the growing season.

Others—Other micronutrient deficiencies are less spectacular in their symptoms and are not as often corrected.

Symptoms of boron deficiency can be

SYMPTOMS OF SOME NUTRIENT DEFICIENCIES

<u>Nutrient</u>	<u>Symptom</u>
IRON	Yellowing of the interveinal area of young leaves. On turf, the chlorosis is not uniform, but often appears in irregular patches.
MANGANESE	First signalled by interveinal chlorosis. As deficiency becomes more severe, leaves get brown spots and developing leaves often drop off.
ZINC	Interveinal chlorotic striping, a thin purple margin around leaf edge. For ornamentals, narrowed or reduced leaf size and internodal spacing, giving the plant a "witch's broom" appearance.
COPPER	Can cause newer leaves to die before unrolling. Older leaves may appear limp or turn gray.

confused with other deficiencies and can be more difficult to correct. Researchers have documented boron scarcity in most of the East and Midwest and in some parts of the Northwest. This lack often shows up as reduced plant quality rather than lack of growth.

Organic and very sandy soils are most likely to have copper deficiencies. Problems are fairly localized and can often be diagnosed by soil tests.

Only a small amount of molybdenum is needed for nitrogen fixation and nitrate reduction in plants. Availability may be

limited primarily in acid soils; therefore, pH can be a good indicator of a potential problem. Tissue analysis can also diagnose a scarcity. Although turfgrass scientists recognize the element's importance, little else is known about its effects.

Recent research indicates very few cases where overapplication of micronutrients can pose a problem. Balance is most important. Look for a micronutrient package that contains not only iron and manganese, but also magnesium and—depending on soil tests—zinc, copper, boron and molybdenum.

Treating soils for dangerous contamination**Pesticide spills, battery acid, oil and gasoline leaks can be cleaned up with specially-treated rocks.**

by James E. Guyette
Contributing Editor

■ A new technology may allow landscape managers, golf course superintendents and institutional groundskeepers to treat lead-contaminated soils more cost-effectively.

The discovery involves covering the affected soil with finely ground phosphate rocks. Research indicates that the phos-

phate rocks reduce the amount of water-soluble lead in contaminated soil by 57 percent to 100 percent.

For the landscape industry, this could drastically reduce the costs faced by business managers being forced to purify soils tainted by pesticide spills or previous power equipment maintenance activities that resulted in petroleum products soaking into the ground or leaking gasoline storage tanks. The process also will work on battery acid leaks.

In addition to cleaning their own company headquarters' yards, landscape managers may also find economic opportunities in helping other business owners clean polluted grounds.

"A combination of leaded paint and gasoline has caused soils in some urban areas to be very high in lead," explains Dr. Terry Logan, professor of natural resources and director of the Environmental Science Graduate Program at Ohio State University. The U.S. Environmental Protection Agency and the University of Florida are also participating in the project.

"We envision using our treatment and then covering the surface with a couple inches of clean soil and then planting vegetation," Logan predicts.

Combats heavy metals—The technology, which has been patented by OSU

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and the EPA, can also be used to treat soil contaminated by other heavy metals, such as zinc, aluminum, cadmium and possibly uranium. Lead is viewed as the primary health risk because it is especially harmful to young children.

With the process, lead-contaminated soil is covered with ground phosphate rocks on a ratio of two parts phosphate to one part lead. (To be most effective, the lead content has to be measured ahead of time.) In most cases, the phosphate can be applied to the surface just like fertilizer.

One application is likely to do the job, according to Logan, unless the soil has an extremely high concentration of lead.

For alkaline soils, like those found in the West, an application of liquid phosphate, such as the type found at landscape supply centers, may be the best technique, says Logan.

Using phosphate rocks to treat lead-contaminated soil is different from conventional technologies because it focuses

on managing the lead where it is. Other treatments seek to remove the lead from

The technology could drastically reduce the costs faced by business managers who are being forced to purify soils.

the soil, which can rob it of important nutrients, Logan points out.

"We took a different approach and focused on managing the lead where it is, which is much more cost-effective and eliminates the need to store the contaminated soil in a landfill or to incinerate it," Logan explains.

"Using this technology will cost hundreds of dollars to treat an acre of contaminated soil compared to thousands or tens of thousands of dollars to treat with any other technology," he reports.

The project began five years ago, and now trials are on tap for urban and rural sites, according to Logan. "Since phosphorous is a fertilizer, we were concerned that crops growing in the soil would take out the phosphorous, and the lead would be soluble and able to move into the groundwater and be absorbed by the crops," he recalls. "But as long as there is an excess of phosphorous, that shouldn't be a problem," Logan adds.

"Another important thing we found was that it worked regardless of what the source of the lead was, including soluble forms of lead, mineral forms, or even leaky batteries."

Phosphate is abundant and easy to mine. "The key to this technology is that it doesn't use another synthetic, man-made chemical," Logan says. "It uses a natural product that we know and understand well to treat a very serious problem in a cost-effective manner."

These herbaceous plants are best for shady spots

■ Much of the gardening world hungers for the cooling pleasures of shade trees in their landscape. The rest of the world regrets they cannot plant many of the sun-loving plants which will not thrive in their shady landscapes.

Here are a few favorite plants for various levels of shade.

Ajuga

- A spreading member of the mint family; can be showy when bright blue flowers appear;
- has many uses as a background groundcover.

Astilbe

- Feathery flower spikes rise above the dark green dissected foliage. Astilbes give an airy look to garden borders. If flowers are deadheaded, the blooming period will be lengthened.

Begonia

- These plants range from the widely popular wax begonia bedding plant to an exotic range of fancy hybrid tuberous begonias.

Climbing hydrangea

- A wonderful climbing vine for along garden walls. This vine with glossy

green foliage and fine, fragrant blooms takes years to develop, but it's well worth the wait.

Coleus

- This edging and window-box plant has a wild range of foliar colors and patterns, which seem almost incongruous with its preference for shade;
- blue flowers are not a key characteristic.

Columbine

- Airy blossoms which come in many colors have attractive spurs as a feature;
- excellent for naturalized areas;
- may bring the columbine leaf miner insect.

Daylilly

- More and more varieties are available each year;
- will bush out if they are cut back somewhat at transplanting. New Guinea impatiens can tolerate less shade than the standard impatiens varieties.

Lily of the Valley

- Very aromatic, white bell-like flowers;
- multiply and spread over large areas quickly.

Lilyturf (Liriope)

- Grasslike leaves make this an excellent border plant or groundcover for small areas.

Primrose

- Easy spring flowers provide the promise of summer warmth with heady aroma;
- will bloom in chilly spring temperatures.

Vinca minor

- Also known as creeping myrtle;
- a standby groundcover with lavender flowers;
- remains evenly green throughout the year.

Violet

- An attractive range of plants with mostly heart-shaped leaves;
- attractive in clumps, but can be cultivated to serve as a groundcover.

—Source: Jim Chatfield, writing in the Northeast Ohio Forum of the Professional Grounds Management Society.