lems regarding HCO_3^-.

Toxic Elements. Certain ions that are present in a water can be directly toxic to plants. Ions in a water that may be toxic to plants include Na^+, Cl^- (chloride), and B^{3+} (boron). Boron is needed for normal growth in very small quantities. Injury can occur to plants if that level is exceeded. Boron can injure lemon trees and American elms when levels in soil water are 0.5 ppm (see Table 6).

Summary. Ions that are in a water will affect the health and vigor of landscape plants. High levels of dissolved salts cause plant stress while high levels of Na^+ and HCO_3^- affect soil structure. Other ions like B^{3+} can be directly toxic to plants. Routinely test a water that is used to care for plants. The results of water testing can make a difference in your plant care practices.

Table 5. Data necessary to calculate pHc and SAR_{adj}.

Total meq L^{-1}	$pK_2 - pK_c$	pCa^{2+}	$pHCO_3^-$
0.1	---	4.30	4.00
0.5	2.11	3.60	3.30
1	2.13	3.30	3.00
2	2.16	3.00	2.70
4	2.20	2.70	2.40
6	2.23	2.52	2.22
8	2.25	2.40	2.10
10	2.27	2.30	2.00
15	2.32	2.12	1.82
20	2.35	2.00	1.70
25	2.38	1.90	1.60
30	2.40	1.82	1.52
35	2.42	1.76	1.46
40	2.44	1.70	1.40
50	2.47	1.60	1.30

Sample calculation: assume water contains 2.0 meq Ca^{2+} per liter, 1.0 meq Mg^{2+} per liter, 3.0 meq Na^+ per liter, and 5.0 meq HCO_3^- per liter. The total cation concentration is 6 meq per liter. Therefore, $pK_2 - pK_c = 2.23$. The value of pCa^{2+} at 2 meq per liter equals 3.00 and the value of $pHCO_3^-$ at 5.0 meq per liter equals 2.31. The pHc is the sum of these values, or 7.54. The SAR = 2.45. The $SAR_{adj} = 2.45[1+(8.4 - pHc)] = 4.56$.

Table 6. Approximate boron tolerance limits of select grasses and landscape plants.

Sensitive < 0.5 ppm	Sensitive 0.5-1.0 ppm	Semi-sensitive 1.0-2.0 ppm	Semi-tolerant 2.0-4.0 ppm
Oregon Grape	Persimmon	Gladiolus	Bottlebrush
Photinia	Grapefruit	Olive	Date Palm
Xylosma	Avacado	Sweetpea	Carnation
Thorny Elaeagnus	Cherry	Blue Dracaena	California Poppy
Laurustinus	English Walnut	Sunflower	Japanese Boxwood
Wax-leaf Privit	Apple	Marigold	Oleander
Pineapple Guava	Zinnia	Poinsettia	Chinese Hibiscus
Spindle Tree	Pansy	China Aster	Sweetpea
Chinese Holly	Violet	Gardenia	Kentucky Bluegrass
Juniper	Larkspur	Southern Yew	
American Elm	Glossy Abelia	Brush Cherry	**Tolerant 4.0-8.0 ppm**
Yellow Sage	Geranium	Ceniza	
Lemon	Rosemary	Blue Dracaena	Indian Hawthorne
Blackberry	Orange		Natal Plum
			Oxalis
			Purple Vetch

SOIL: the source of turf life

The savvy landscape manager knows soil is a medium to support ornamental plant life, a vital component of the ecosystem.

by John Fech, Ph.D.,
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■ To some, it's nothing more than "dirt" that sticks to their shoes when wet. Others think of soil as something to be swept away and discarded or covered. An engineer may view soil as something to be moved during a construction project.

Good, healthy soil is a dynamic living system with many biological, chemical and physical properties. In landscape soils, one of the most important properties that affects plant growth and vigor is aeration.

Aeration is a measure of the rate at which oxygen is able to move through the soil to the plant roots.

Oxygen movement depends on the soil water content. A well aerated soil is composed of about 50 percent solids, 25 percent water and 25 percent air spaces or voids (Fig. 1). Soils which have less than 25 percent air spaces are considered compacted and limit root growth to some degree.

Compaction can be caused by foot and vehicle traffic, soil texture and maintenance procedures conducted on the site such as irrigation, fertilization and mowing. Heavily trafficked areas are subject to compaction, and the turfgrass growing in compacted sites usually becomes thin and non-vigorous (Fig. 2).

Soils most likely to be compacted are those with a heavy clay content. The percentage of clay, sand and silt in a given soil combine to form the soil's texture. A soil testing laboratory can make the most accurate assessment of a soil's texture. Once the percentage of each component is calculated, soil texture is determined by using a textural triangle (Fig. 3). The

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three sides of the triangle represent increasing or decreasing percentages of sand, silt and clay. By drawing lines through the known percentages, a soil texture classification can be made. A loam is an ideal combination of the three.

Water retention—Each component (sand, silt and clay) varies in its capacity to retain nutrients and water. Clay has the greatest retention capacity.

Sands tend to drain quite readily, and silty soils range from intermediate to slow draining.

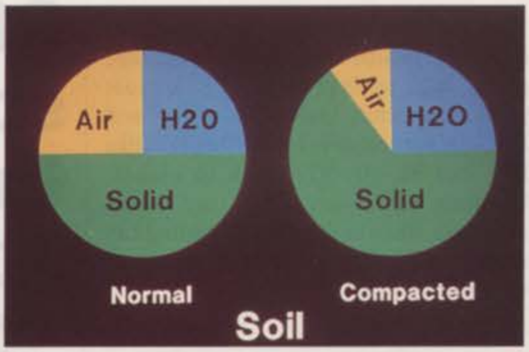

Fig. 1—A well aerated soil is composed of about 50 percent solids, 25 percent water and 25 percent air spaces or voids.

Fig. 2—For a very small fee, soil labs will test your soil and tell you its components so you can make fertility determinations.

Soil drainage and water/nutrient retention is a function of particle size and surface area. Clays and loams have much greater surface area than sands. In fact, the surface area increases 1000 times per unit weight as the particles decrease in size from very coarse sand to clay.

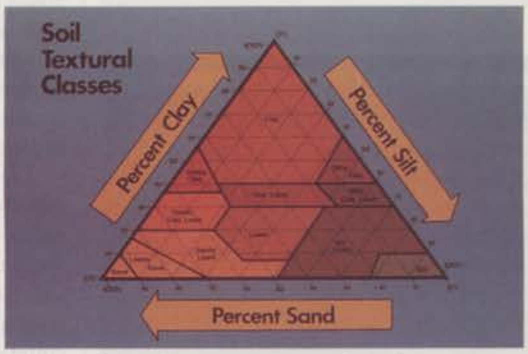

Fig. 3—Once the percentage of each component is calculated, soil texture is determined by using a textural triangle.

The effect of decreasing particle size can be related to a deck of playing cards, which has a small amount of surface area exposed. However, when the deck is subdivided into each card, surface area increases greatly. Chemical and physical reactions in the soil relating to nutrient and water holding capacity and availability occur at the particle surface. Therefore, the greater the surface area, the greater the nutrient and water-holding capacity.

An ideal soil profile is depicted in Fig. 4. In general, the "A" horizon is rich in organic matter and water/nutrient holding capacity. At least 12 inches of "A" horizon is desirable to support turf and tree growth. In many recently disturbed soils (as in new housing developments, shopping malls), little or no "A" horizon exists. Instead, a thin layer of "A'" covers extensive depths of "B" and "C" horizons, which have poorer rooting properties.

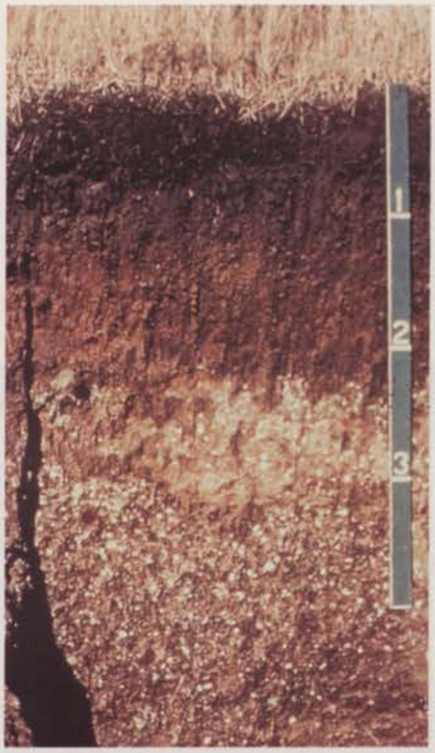

Fig. 4—At least 12 inches of rich organic matter ('A' horizon) is desirable to support turf and tree growth.

pH a factor—Relative soil acidity—or pH— is another major property. Soils with a pH of 7 are neutral, with a balance of positive and negative ions. Most ornamental plants and turfgrasses grow well in slightly acid soils that have a pH between 6 and 7. The pH of a soil has a major effect on nutrient availability. Alkaline soils above 8, and acid soils below 5.5 tend to "tie up" certain nutrients and make them unavailable. The classic example of this is pin oak chlorosis.

When diagnosing plant disorders, remember to consider the soil as a potential cause of the decline. The old adage, "out of sight, out of mind" applies to soils. Half of the plant is growing in the soil below, and can't be seen. Examination of the physical and chemical properties of soil through soil testing and root system observations can go a long way toward diagnosing a suspected plant problem.

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