**Acid Rain**

Normal, unpolluted rain would contain almost pure

water (H2O) in which there would be dissolved some

carbon dioxide (CO2), some ammonia (NH3) originating

from organic matter and existing in water as NH+

4,

and varying but small amounts of cations (Ca2+, Mg2+,

K+, and Na+) and anions (Cl2, SO4

22). Although the pH

of pure water is a neutral pH 7.0, the pH of normal,

“unpolluted” rain is usually pH 5.6; in other words, rain

is already acidic. Such rain, however, is considered

normal, and only when the pH of rain or snow is below

pH 5.6 is it considered acidic (acid rain).

**Acid rain** is the result of human activities, primarily

the combustion of fossil fuels (oil, coal, and natural gas)

and the smelting of sulfide ores. These activities release

large quantities of sulfur and nitrogen oxides in the

atmosphere, which when in contact with atmospheric

moisture are converted to two of the strongest acids

known (sulfuric and nitric) and fall to the ground in

rain, snow, and fog. The pH of rain and snow over large

regions of the world ranges from pH 4.0 to 4.5, which

is from 5 to 30 times more acid than the lowest pH (pH

5.6) expected for unpolluted areas. The lowest rain pH

values reported so far (pH 2.4 in Scotland, pH 1.5 in

West Virginia, and pH 1.7 in Los Angeles) are more

acidic than vinegar (pH 3.0) and lemon juice (pH 2.2).

It is estimated that about 70% of the acid in acid rain

is sulfuric acid, with nitric acid contributing about 30%.

In addition to sulfur contained in the acids carried in the

rain, it is believed that an approximately equal amount

of sulfur reaches all surfaces through dry deposition of

particulate sulfur. In humid or wet weather, this sulfur

is also oxidized to sulfuric acid.

Acid rain exerts a variety of influences by greatly

increasing the solubility of all kinds of molecules and by

directly (through the low pH and the toxicity of the

SO4

2- and NO-

3 ions) or indirectly (through the dissolved

molecules) affecting many forms of life. The

adverse effects of acid rain on the microorganisms,

plants, and fishes of rivers and lakes have been well

documented. The effects of acid rain on crop plants have

been more difficult to document. Experiments in which

acidic rain (pH 3.0) was applied to plants showed that,

under some conditions, treated leaves developed pits,

spots, and curling and that treated plants, with or

without symptoms, sometimes showed reductions in

dry weight. Also, more seeds of some plant species germinated

when the soil in which they were planted

received acid rain than when it did not, whereas the

opposite was observed for other species. Experiments

conducted to determine the effect of acid rain on the initiation

and development of plant diseases have shown

that in some diseases, such as *Cronartium fusiforme* rust

of oak, only 14% as many telia formed under acid (pH

3.0) rain treatment than under a pH 6.0 rain treatment

and that beans treated with acidic rain (pH 3.2) had

only 34% as many nematode egg masses than they did

under a pH 6.0 rain treatment. However, a bacterial

disease (halo blight) and the rust disease of bean were

sometimes more severe and others milder with the acidic

rain than with the pH 6.0 rain. In general, although

some evidence exists that acid rain causes variable

amounts of damage to at least some plants, consistent

quantitative data are still insufficient to determine the

extent of such damage on various crops in the areas

where they occur.