Composition of Soil Atmospheres

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42-1 INTRODUCTION

The term soil atmosphere (or soil air) has been defined as "the gaseous phase of the soil, being that volume not occupied by solid or liquid" (SSSA, 1979). It was originally used to refer to the gaseous phase in soil under field conditions, but its meaning has been broadened in recent literature to include atmospheres above soil samples incubated in sealed bottles under laboratory conditions and atmospheres under chambers placed over soils under field conditions. The broader meaning has been adopted here.

The composition of soil atmospheres is usually significantly different from that of air (Table 42-1) because numerous gases are produced and consumed by soil processes. The process leading to the greatest production and consumption of gases in soils is aerobic respiration by plant roots and microorganisms, which produces carbon dioxide (CO₂) and consumes oxygen (O₂). Other soil processes lead to production or consumption of hydrogen (H₂), organic gases such as methane (CH₄) and ethylene (C₂H₄), nitrogenous gases such as dinitrogen (N₂), nitrous oxide (N₂O), nitric oxide (NO), nitrogen dioxide (NO₂), ammonia (NH₃), and volatile amines, and sulfur gases such as hydrogen sulfide (H₂S), dimethyl sulfide (CH₃SCH₃), dimethyl disulfide (CH₃SSCH₃), methyl mercaptan (CH₃SH), carbon disulfide (CS₂), and carbonyl sulfide (COS).

Analyses of soil atmosphere were initially performed largely to study soil aeration (i.e., the exchange of gases between soil and air) and its effect on the growth of plants. Some plants have roots with adequate internal aeration for growth in soils that are poorly aerated, but most agriculturally important plants require good soil aeration for optimum root growth. A favorable soil atmosphere for root growth has traditionally been defined in terms of O₂ and CO₂ concentrations, but there is now evidence to suggest that the concentrations of other gases (e.g., C₂H₄) may have a significant influence on plant growth.

Although early soil research involving gas analysis was performed largely to study soil aeration, most recent research has been designed to...