

SOIL AERATION

—essential for
maximum plant growth



Sunflowers grown under various per cent oxygen treatments.

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Soil aeration is an important factor in crop production. For maximum production, optimum levels of soil oxygen must be maintained as well as plant nutrient and water supplies. Experiments are being continued to learn more about the relationships between soil aeration and plant growth and to provide information leading to management for the highest production.

Oxygen must be supplied to plant roots at a rate supporting maximum respiration or the plant may suffer. A cooperative project between the Department of Irrigation and Soil Science at Los Angeles and the Department of Soils and Plant Nutrition at Riverside was initiated to investigate more completely how the oxygen supply affects various phases of plant growth and to improve methods of measuring the oxygen status (soil aeration) of a soil.

Under natural conditions, soil aeration is poor when there is too much water in the soil and/or compaction of the soil. However, in an experiment to study soil aeration, it is undesirable to modify the soil oxygen by modification of the soil water content or soil packing. The differences in plant growth might be caused by the actual water content or soil compaction—thus masking the effects of aeration.

A successful method used to vary the soil oxygen supply without producing material differences in soil water or compaction was to mix air with nitrogen gas, thus lowering the percentage of oxygen in the air which is then passed over the soil surface. Plants were grown in containers so that the major portion of the shoot

could be sealed off from the gas mixture. Plants could then be grown in containers which had identical soil water content and soil compaction while differing in soil oxygen because of the amount of oxygen at the soil surface. The shoots, except for a small part of the stem, were out in natural conditions for all treatments.

The platinum microelectrode technique was used to measure the oxygen status within the soil. This technique consists of placing a platinum wire (which would represent a plant root) into the soil and setting up an electrical system of which the platinum wire is one electrode. Under specific conditions, the magnitude of the current which flows is proportional to the rate at which oxygen arrives at the platinum wire. The maximum rate that oxygen can be supplied to the plant root can then be calculated from the electrical current which is measured. The result is expressed as the oxygen diffusion rate.

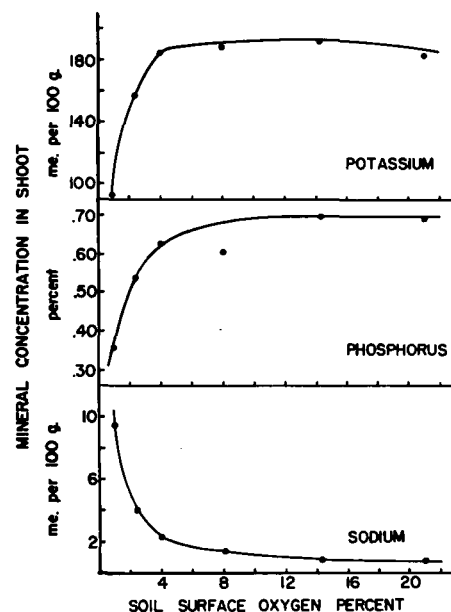
The photograph of sunflower plants showing the relative growth under different soil oxygen levels indicates that shoot growth can be materially decreased by having poor soil aeration. Another difference between plants shown in the photograph is the condition of the lower leaves. Under the lowest oxygen level, the lower leaves of the plants are severely wilted. The lower leaves of the plants under the 8 per cent oxygen treatment show definite signs of wilting and the leaves of the plants under 15 per cent treatment show no signs of wilting. Wilting is not always restricted to the lower leaves.

The fact that one of the symptoms of poor aeration is wilting of the leaves points out a very practical problem which very likely could occur. Suppose that a

plant is growing under conditions of poor soil aeration and shows signs of wilting on a hot dry day. If no measurement is made of either the soil moisture condition or the soil aeration condition, the plant might be thought to be suffering from insufficient water. Adding more water to the soil, however, would make the soil aeration condition even worse. It is important to recognize that plants will wilt from poor aeration as well as from low soil moisture (which is the usual reason).

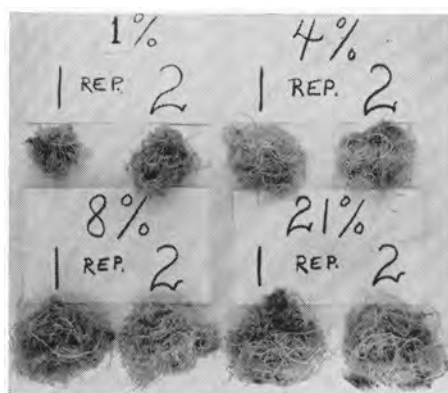
Root growth is very sensitive to the oxygen supply, as indicated in the photograph of roots from plants grown under the various oxygen treatments. The root

CONCENTRATION OF POTASSIUM, PHOSPHORUS, AND SODIUM IN SHOOTS OF SUNFLOWERS GROWN UNDER VARIOUS PER CENT OXYGEN TREATMENTS.



size shown under the 1 per cent treatment is somewhat misleading because the plants were allowed to become established before treatments were applied. Very little, if any, root growth occurred under the 1 per cent oxygen treatment.

A plant which has poor root growth has its feeding zone restricted. The effect of soil aeration on the nutrition of a plant is reflected by the data presented in the graphs. Under low oxygen treatments, the concentration of potassium and phosphorus in the plant shoot is decreased. Conversely, sodium accumulated in high concentrations in the shoot of a plant growing under low soil oxygen. High concentrations of sodium in the leaves of certain fruit trees have been observed in



Roots of sunflowers grown under various per cent oxygen treatments.

the field following extremely wet winters. This may possibly be associated with a poor soil aeration condition which resulted from high soil moisture conditions.

The oxygen diffusion rates were measured by the platinum microelectrode technique for this and other experiments associated with soil aeration. As a general guide, a measured diffusion rate of 40×10^{-8} gm cm⁻² min⁻¹ or greater indicates that soil oxygen is sufficient to maintain optimum plant growth. Values less than 40 signify that soil aeration should be improved. If the diffusion rate is less than 20×10^{-8} , roots will not grow in that area.

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BRIEFS

short reports on current agricultural research.

BOVINE EMPHYSEMA STUDIED IN CATTLE

A newly recognized disease of cattle in California, called acute pulmonary emphysema or bovine asthma, is being investigated at Davis. Considered one of the most important diseases of cattle in the western United States, it appears to be increasing in incidence. It is usually limited to cattle three years or older, and beef herds are affected mainly. The disease is seasonal, usually involving animals in September or October. Pulmonary emphysema follows a drastic change in feed, usually a change from short, dry, overgrazed range pasture to irrigated, improved meadow pasture containing good regrowth of forage. It also occurs in cattle brought into feedlots.

Cattle become sick in 4 to 10 days after moving to better forage. The disease runs a rapid course, usually 1 to 2 days, but animals that recover from the acute condition sometimes develop chronic manifestations. The number of sick cattle in an outbreak varies greatly from year to year. Death occurs in 5 to 35 per cent of the sick animals.

Affected cattle are depressed, standing with head lowered and extended, and

have a difficult time breathing. Expiration is usually accompanied by a short grunt. Cattle have normal or slightly elevated temperature, diarrhea or constipation, and normal appetite and milk secretion until late in the disease. Post-mortem examination reveals marked gaseous distention of the lungs.

The cause of pulmonary emphysema is unknown. Suggested causes include toxins of bacterial origin, or anaphylaxis following absorption of foreign proteins from the feed. Treatment of sick animals has been unsuccessful, but prevention is sometimes obtained by feeding hay or straw before moving cattle to lush pasture.

Because of the increasing importance of pulmonary emphysema to cattlemen, efforts are being made to discover the cause of the condition. Following recognition of the disease in California a year ago, it has been analyzed clinically and pathologically. Certain infectious agents have been eliminated from consideration, and critical experimental investigations are now under way.—*J. E. Moulton, School of Veterinary Medicine, Dept. of Pathology, U.C., Davis.*

SEED TRANSMISSION OF AVOCADO SUN-BLOTCH

Only one virus disease of avocado is presently known. This disease, called "sun blotch" because its symptoms were originally attributed to sunburning, is not known to be transmissible other than by tissue grafts and through seeds. Most seedlings grown from avocado trees infected and showing symptoms of the sun-blotch virus disease are healthy and virus-free, but an occasional seedling becomes infected through seed transmission of the virus and develops characteristic symptoms.

Some infected, but symptomless, trees have been discovered which produce seedlings—all or nearly all of which are symptomless carriers of the virus. No seedlings of the latter type have developed sun-blotch symptoms and they are unaffected when reinoculated, but when used as rootstocks they bring about infection of the scion top. The capacity to transmit virus through seeds to all or nearly all seedlings

is passed on from one seedling generation to another.

Virus-free avocado seedlings experimentally inoculated with sun-blotch virus develop characteristic symptoms of the disease but later some of them produce symptomless shoots, which eventually make up the major part of the tree. Seeds from fruits produced on a recovered limb produced seedlings which were symptomless carriers of the virus. This suggests the origin of trees which regularly produce diseased seedlings—some of which are known to have been used as rootstock parents by nurserymen and to have been responsible for a high percentage of disease in the nursery. These findings make it clear that the rootstock (seed) parent tree as well as the budwood parent source must be indexed for sun blotch to insure freedom from the disease.—*J. M. Wallace and R. J. Drake, Dept. of Plant Pathology, Riverside.*