

# Phosphorus deficiency decreases stomatal activity and water use of plants

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It appears that phosphorus deficiency in plants drastically affects the ability of leaf stomata to open universally in all plant species, but in varying degrees. Failure of the stomata to open results in greatly decreased water use, and in elevated leaf temperatures. These studies indicate that the increased temperature is the cause of at least some phosphorus-deficiency symptoms.

**E**ARLIER STUDIES in this laboratory indicated that phosphorus deficiency in tobacco resulted in failure of stomatal opening with the result that transpiration was decreased to one-third, or even less, that of control plants. Further studies indicated that the leaves of phosphorus-deficient plants were routinely around 11°F higher than those of control plants for a considerable portion of the day. Typical phosphorus-deficiency symptoms appear usually after weather conditions result in a very high leaf temperature when the leaf cannot be cooled because of transpiration failure. The phosphorus-deficiency effect seemed to be most pronounced around the center of the tobacco plants. Typical temperature differentials (above ambient air temperatures) for around noon were 6°, 5°, 7°, 8°, 12°, 10°, 9°, 7°, 4°, and 2°F, respectively, for leaves from the top to the base of the plant. The reason for the decreased difference at the top was that phosphorus is translocated from old to new growth and that the new growth, therefore, had less phosphorus deficiency. The cause of the decreased difference at the base of the plant was shading.

The effect of phosphorus deficiency on the mechanism controlling stomatal opening appears to be specific. Data in the table indicate that some other deficiencies do not have effects of the same magni-

tude. With tobacco the decrease in water use was far more drastic than was the growth difference, indicating that the stomatal mechanism required more phosphorus than did growth.

Several other plant species were similarly studied to determine if these observations would be universal for all plant species. Bush bean, corn, tomato, sage brush, and Russian thistle plants were grown in nutrient solutions with and without phosphorus.

Within 10 to 30 days, plants showed at least some decreased growth from phosphorus deficiency. The temperature of leaves of all deficient plants was higher than that of the control plants during periods of sunshine. Temperature differentials were modest for corn (2°F) but higher for other species. Water use per square centimeter of leaf area of corn, however, was decreased about 40 per cent by the phosphorus deficiency. Except for

corn (for which the test is not reliable), kerosene readily penetrated the leaves via open stomata of control plants but did not penetrate those of the phosphorus-deficient plants. There were definite indications that phosphorus deficiency greatly decreases stomatal opening in a wide variety of plants.

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EFFECT OF SOME NUTRIENT DEFICIENCIES ON LEAF TEMPERATURE DIFFERENCES OF TOBACCO (FIFTH AND SIXTH LEAVES FROM TOP)—MEANS OF MEASUREMENTS FOR THREE DIFFERENT DAYS.

Element withheld	Mean °F above air temperature
None	1.4
-P	11.1
-K	5.2
-N	2.7
-Mg	3.6
-Fe	2.5

Golden Cross bantam corn grown with and without phosphorus for 18 days. Those on the left used 40% less water per square centimeter of leaf area than those on the right. Each gram of roots of plants on the right absorbed three times as much water as each gram of those on the left.

