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Some Effects of Insolation on Mineral Nutrition of Triticum.

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In an earlier investigation of certain crop plants grown on colloidal humus soils, foliar chlorosis attributable to a physiological insufficiency of iron was reported. Insufficiency of mobile iron and concomitant chlorosis were found to be especially marked in plants exposed to strong insolation. The purpose of the investigation herein reported was to determine if changes in sap acidity induced by light were of sufficient magnitude to reduce the iron supply to the point of chlorosis.

Wheat seedlings for this purpose were grown in an acid humus low in iron. A portion of the cultures were treated with 2000 parts per million of powdered calcium carbonate to correct the known acidity of the soil. Seedlings were grown in glazed pots in a greenhouse at 60° C. until 6 weeks old, at which time analyses were begun. The cultures were evenly divided and placed in adjacent benches subjected to different illumination, one being exposed to full insolation and the other shaded from direct afternoon sunlight by a thin, white muslin screen. Entire plants, freed from soil, were employed and the sap extracted under constant pressure from frozen samples of uniform weight. Acidity of freshly expressed sap was determined potentiometrically in duplicate at 25° C.

The initial analyses, made at 4 hour intervals, disclosed a diurnal cycle of sap acidity which reached a maximum in the early morning and fell steadily to a minimum in the late afternoon in all young wheat cultures. There was some fluctuation from day to day in the hour and amount of the maximal and minimal acidity but the rhythmic diurnal rise and fall continued until the end of the experiment, at which time the plants were 12 weeks old. The variation in time and amount of the afternoon minima was, however, consistently greater than the variation in the morning maxima. Hence the diurnal cycle of sap acidity may be graphically represented as a V-shaped curve whose left limb represents the fall from the morning maximum and whose right limb denotes the subsequent nocturnal rise. The steepness of slope is regulated primarily by the hour and level of the afternoon minimum acidity.

The fact that reversals in direction of the acidity gradients occur approximately at those hours of the day marking the diurnal bal-

ance between photosynthetic and respiratory processes within the plant suggest that the light stimulus may be more important than the thermal stimulus of insolation. Though no attempt was made to measure foliar temperatures, spectral composition or thermal energy of the light, it is certain that thermal maxima of the plants were reached much earlier in the afternoons than the maximum pH of the sap. It is very probable, however, that the thermal effect of insolation is in part responsible for the results observed but the precise effect of temperature on sap hydrion concentration remains a subject for further study.

Though illumination appeared uniformly to induce a decrease in sap acidity as described above, differences in light intensity and soil alkalinity exercised considerable influence upon the degree of acidity attained. Limed cultures in the shaded and unshaded sets maintained a lower level of acidity and exhibited a greater fall in sap hydrion concentration in the presence of light than the corresponding untreated cultures. In fact, the pH values for the limed cultures exposed to a light period of maximal insolation on several consecutive days suggest that the period of darkness is too brief for complete acid recovery. Hence acidity falls progressively to a lower level and shows a smaller diurnal fluctuation during protracted periods of intense illumination. Untreated cultures developed chlorosis when strong illumination was used during the normal light period for several days, but the symptoms were less pronounced and less persistent than in alkalinated cultures. Microchemical inspection of chlorotic plants disclosed an abundance of iron in the roots but none in young leaves. Strong insolation thus depressed sap acidity to the point of iron precipitation and ultimate inavailability as evidenced by the chlorotic foliage.

A number of investigators have employed potash with considerable success to correct injury attributable to the use of lime on nutrient deficient soils. To determine the effect of potash in the present instance a dilute solution of KCl was slowly supplied to the limed cultures until potash reached the concentration of 200 parts per million in the soil. The initial effect of this treatment was to stimulate vegetative activity, to raise the general acid level of the sap and to diminish its diurnal fluctuation. Young leaves gradually developed a distinctly green coloration and within 10 days after the initial potash supplement most symptoms of chlorosis had disappeared. The character of response to potash indicates that its influence upon the plants is in part ascribable to increased availability of the salt itself and in part to the resultant increase in tissue fluid acidity which again makes iron available.