Effects of Potassium Deficiency on Photosynthesis, Respiration and the Utilization of Photosynthetic Reductant by Mature Bean Leaves

J. L. Ozbun, R. J. Volk, and W. A. Jackson

IN a previous communication (5), the effects of K deficiency on gas-exchange processes of immature bean leaves were presented. The rates of CO₂ release and O₂ uptake per unit leaf surface area were accelerated by K deficiency both in light and in darkness, whereas photosynthetic O₂ release and CO₂ uptake were depressed. Since the growth of K-deficient leaves ceased soon after the deficiency was initiated, normal leaves of comparable age were considerably larger. It is possible that exposure of leaves to K stress during their development initiates cellular alterations which are quite dissimilar to those which occur if the stress is imposed after cellular maturity is attained. As a consequence, a differential effect of K stress on the respiratory and photosynthetic processes of developing and mature leaves might be expected. This concept was examined in the present investigation by determining the effects of progressive K deficiency on the gas exchange of mature leaves and by comparing these effects with those reported for immature leaves (5).

METHODS

Excised leaves of Phaseolus vulgaris L., variety ‘Kentucky Wonder 191’, were used as the experimental material. The plants were provided daily with 16 hours of light at 1200 ft.-c. intensity, 1 foot above the containers. Temperature of the growth chamber was 24° C. during the light period and 18° C. during the dark period. Seeds were germinated in vermiculite, and uniform plants were selected and transplanted into pots containing quartz sand. The plants were supplied with a complete Hoagland solution (1) until the terminal leaflet of the first (basal) trifoliate was fully expanded or mature (25 days). Thereafter, the plants were watered either with a normal Hoagland solution, in which case the plants are referred to as normal, or with a similar solution devoid of K, the plants being referred to as K-deficient. Since K was added as KCl (5 meq./l.), the normal plants received an additional Cl as well.

At selected intervals (plant age in days: 30, 33, 36, 39, 42, 47, 51) the first (basal) trifoliate leaflets from normal and K-deficient plants were excised for experimental use. The terminal leaflet of the trifoliate served for measurement of gas-exchange rates, and the lateral leaflets were analyzed for chlorophyll, K, and carbohydrate as in the previous report (5). In each experiment a comparison was made of a normal and a K-deficient leaf of the same chronological age. Gas-exchange rates were determined first in darkness, then at 160 ft.-c. and finally at 1500 ft.-c. light intensity.