

FOLIAR ADSORPTION FACTORS OF PHOSPHOROUS AND RUBIDIUM

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Foliar nutrition can offer a more efficient, economical and rapid method of supplying nutrient material to plants than conventional soil application. There is renewed interest in foliar nutrition due to the current high cost of fertilizer and concerns about environmental pollution by leaching and run-off from ground application. As a result, the Horticultural Research Institute (HRI) is helping to support this valuable research.

Foliar absorption of phosphorous (P) compounds has been studied extensively because smaller quantities of P are easily fixed and thus not available for plant use. Results of experiments studying various P compounds and factors affecting their foliar absorption have been highly variable, however. Despite the potential benefits, supplying P in foliar sprays is not practiced widely. pH of the treating solution, which determines the chemical form of P present in it, is one of the principal factors affecting foliar absorption of P. In addition, pH may alter the permeability of the cuticle, generally considered the foliar absorption rate-limiting barrier.

Work was initiated to better define the effect of pH of the treating solution on foliar absorption of phosphorous and rubidium compounds and to determine the factors affecting foliar absorption with possible adaptation to commercial applications. Absorption was assayed by measuring the amount of radioactive phosphorous or rubidium compounds recovered in the plant after application of a known amount, such as a drop to a leaf.

Results: Research results indicated that absorption of phosphate compounds was greatly affected by pH. Absorption was least at those pH values when salt deposits were formed on the leaf surface, and greatest when salt deposits were not evident. The formation or lack of formation of salt deposits was correlated with the solubility and moisture retention of the predominant phosphate form present in solution. Hence, pH did not directly affect the plant's ability for phosphate absorption, but affected absorption by dictating the phosphate form present in solution and the degree of absorption was determined by properties of the predominant phosphate form present. Maximum phosphate absorption occurred with sodium phosphate at pH 3-6, with potassium and rubidium phosphate at pH 7-10, and with ammonium phosphate at all pH values. Calcium phosphate was not readily absorbed.

Absorption of rubidium (Rb) as Rb phosphate also was greatly affected by pH. It was minimal at pH 3-6, but was greatly increased at pH 7-10. This was due to the same factors that were shown to affect phosphate absorption (e.g. the degree of drying and formation of salt deposits on the leaf). Rubidium was used since it behaves similarly to potassium and serves as a radioactive tracer in the study of the uptake of potassium. Rubidium chlor-

ide (at pH 3-10) was absorbed to a greater degree than Rb sulfate or nitrate.

Urea, one of the most rapidly absorbed and effective compounds used in foliar nutrition, and several similar, chemically related compounds were assayed as to their effect on foliar absorption of Rb and phosphate. All of these substances decreased absorption of both Rb and phosphate, which was attributed to the formation of salt deposits.

These results indicate that dibasic phosphate (K_2HPO_4), monobasic sodium phosphate (NaH_2PO_4) and monobasic or dibasic ammonium phosphate — ($NH_4H_2PO_4$) and [$(NH_4)_2HPO_4$] respectively — are the most useful phosphate forms. Dibasic potassium phosphate and potassium chloride (KCl) are the most useful potassium forms for foliar application to commercial crop plants.

Several additional experiments were conducted in order to determine the effect of 18 commercially available surfactants (wetting agents) on foliar absorption. Only three (AL 825, Ethomid 0/15 and Tween 85) increased phosphate absorption, but all decreased Rb absorption. Of the three surfactants that increased phosphate absorption, only one (AL 825) was not toxic to the foliage, and therefore practically applicable. However, the advantage of increased phosphate absorption must be weighed against the decreased Rb absorption.

Time course studies demonstrated that both Rb and phosphate were rapidly absorbed and translocated throughout the plant, and hence, readily available for use by the plant. Absorption of both Rb and phosphate was not greatly affected by leaf age. This indicates that the data from all previous experiments, using only one leaf at a particular stage of development, are probably indicative of the response of the entire plant.

Absorption of phosphate by a variety of horticultural species varied greatly, ranging from less than 1% to approximately 15%, whereas Rb absorption ranged from less than 1% to approximately 40%. In addition, plants treated with foliar nutrients produced good growth following treatment and tolerated surprisingly high concentrations of nutrients to the foliage.

Summary: In summary, solution pH affected uptake of P and Rb compounds by dictating the chemical form of the compound present in solution. Solubility, moisture retention, and crystallization on the leaf surface were factors determining absorption. Partially as a result of this research, it can be seen that foliar nutrition offers advantages in production of commercial horticultural crops; in landscape maintenance; in more efficient use of fertilizer to reduce pollution of lakes, streams, and ground water supplies; to conserve energy and reduce costs; and is a very rapid means of correcting possible nutrient deficiencies. **WTT**