Table 1. Elongation, number of flowers and days to flowering under a 12 hr and 15 hr photoperiod of untreated and 0.3 mg ancymidol drench treated plants of *Clerodendrum thomsoniae.*

Treatment Variable	Greenhouse 12 hr^z	Greenhouse 15 hr	Growth chamber 12 hr	Growth chamber 15 hr
Untreated				
Elongation (cm)^y	21.1^x	22.3	19.8	24.1
No. of flowers	14.2	0.0	15.3	0.0
Days to flowering	65.2	68.2	66.5	63.8
Ancymidol-treated				
Elongation (cm)	11.9	12.3	10.4	11.8
No. of flowers	76.5	6.0	78.3	5.8
Days to flowering	68.4	67.0	67.4	66.4

^{z}Plants were grown under 12 hr photoperiod in May and 15 hr photoperiod in August in the greenhouse.

^{y}Time of ancymidol treatment to termination of experiment.

^{x}Mean (10 plants per treatment).

of development of the former.

These anatomical studies showed that ancymidol stimulated axillary shoot development which produced flowers. Ancymidol-treated plants are more floriferous which enhances their use for commercial, flowering potted plant production. The effect of ancymidol on shoot retardation was evident for about 1 year.

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Effect of pH on Foliar Absorption of Rubidium Compounds by Chrysanthemum[1]

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Abstract. **Foliar absorption of RbCl, $RbNO_3$ and Rb_2SO_4 by *Chrysanthemum morifolium* Ramat. cv. Giant No. 4 Indianapolis White was greatest at pH 2, at which there was considerable leaf damage, but changed little at pH 3-10. Absorption of RbCl was greater than $RbNO_3$ or Rb_2SO_4 regardless of pH. Absorption of Rb and phosphate as Rb phosphate was minimal at pH 3-6, but was greatly increased at pH 7-10. These results may be explained by the degree of drying and crystallization of the applied compounds on the leaf surface.**

Many workers have studied factors affecting the foliar absorption of K and Rb compounds (4, 10), which are assumed to behave similarly. Meyer and Boodley (5) found foliar applications of K citrate more effective than K_2SO_4 for increasing the K level in chrysanthemum, but not as effective as root applications. Page et al. (6) suggested that 3-4 sprays per year of 0.5 M KNO_3 were sufficient to maintain adequate K levels in citrus leaves.

The cuticle is considered the main barrier to foliar applied compounds (2), and the permeability of isolated cuticles may change with pH (4, 9). Reed and Tukey (8) found that pH of the treating solution greatly affected the absorption of P compounds by intact leaves. This work was conducted to explore the effect of the pH of the treating solution on foliar absorption of Rb compounds.

Materials and Methods

Cuttings of 'Giant No. 4 Indianapolis White' chrysanthemum were rooted and grown in No. 4 quartz sand flooded periodically with Hoagland's nutrient solution as described previously (8). The plants were placed in a controlled environment growth chamber 24 hr prior to treatment, and maintained at a 21°C day-night temperature, 40-50% relative humidity, and a 16-hr photoperiod of 44 $nEs^{-1}cm^{-2}$ (400-700 nm).

Dosing solutions of 25 mM RbCl, $RbNO_3$ and Rb_2SO_4 were labeled with 0.2 μCi ^{86}RbCl (0.5-10 Ci/g Rb) per 20 μl of dosing solution, and adjusted to the appropriate pH by titration with HCl or RbOH. The solutions were unbuffered since solution properties of the treating solution have a profound effect on foliar absorption of phosphates (8), and buffers such as acetate affect the absorption of Rb and phosphate differentially (7). Dosing solutions of 25 mM Rb phosphate were

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double-labeled with 1.0 μCi $H_3{}^{33}PO_4$ (carrier-free) and 0.2 μCi^{86}RbCl per 20 μl of dosing solution; Rb phosphate served as a buffer.

Five plants for each experimental variable tested were treated with 20 μl of the dosing solution applied to the center of the third expanded leaf from the apical cluster. After a 48-hr absorption period the treated area of the leaf was removed with a 1-cm cork borer and discarded. The remainder of the plant was prepared for assay of radioactivity by ashing and dissolving in dilute acid as previously described (8). All experiments were repeated at least twice.

For single-labeled samples, a sample aliquot was evaporated to dryness on a planchet and assayed for radioactivity using a Nuclear-Chicago Model D47 thin window gas flow counter. The net count rate obtained was corrected for background and coincidence loss; self absorption was not significant. For double-labeled samples, a sample aliquot was added to a 20-ml low K glass liquid scintillation vial to which was added 10 ml of scintillation solution containing a 1:1 ratio of Triton X-100 and toluene with 5 g/liter PPO and 0.1 g/liter POPPOP (1). The samples were counted in a Beckman LS-350 liquid scintillation counter. The net count rate was corrected for background, and the contribution of each isotope to the total counts observed in the sample was determined by the use of quench correction curves and simultaneous equations (3). The amount of activity recovered in the non-treated parts of the plant was compared to the amount applied to the leaf, and the results were expressed as percent absorbed.

Results

Absorption of RbCl, $RbNO_3$, and Rb_2SO_4 was greatest at pH 2 (Fig. 1), at which there was severe leaf damage in the treated area. There were no differences in absorption at higher

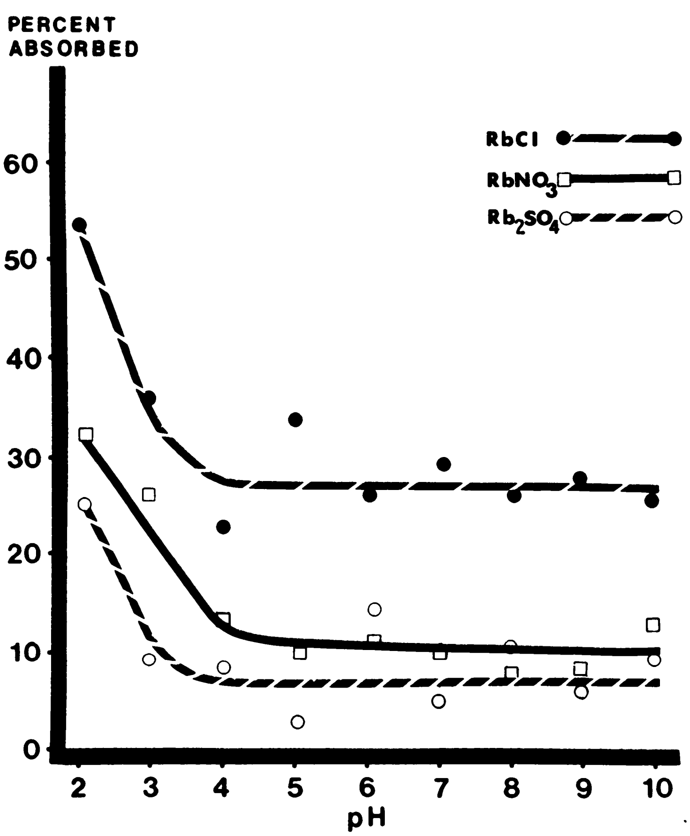
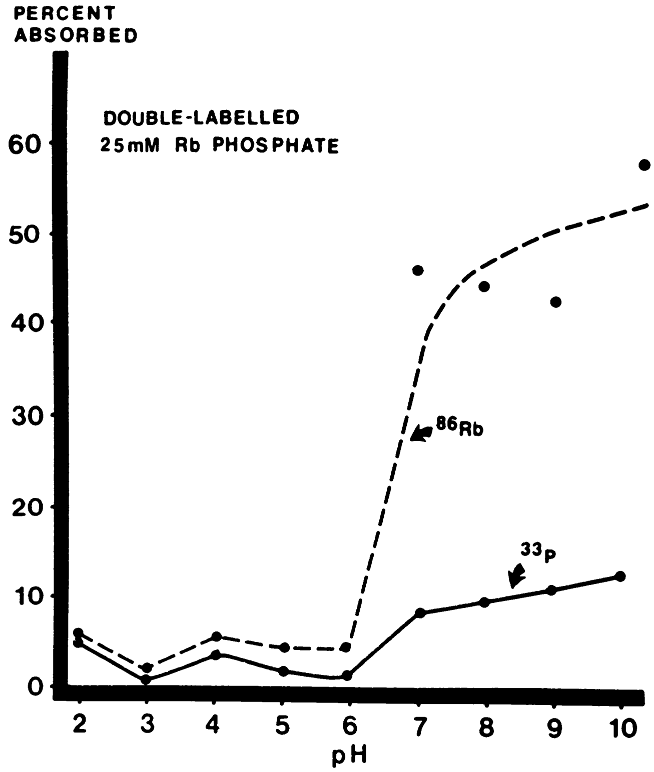


Fig. 1. Effect of pH and anion on foliar absorption of ^{86}Rb by chrysanthemum.



MOLE PERCENT									
H_3PO_4	57	12	1	-	-	-	-	-	-
$H_2PO_4^-$	43	88	99	99	94	62	14	2	0.2
$HPO_4^=$	-	-	-	1	6	38	86	98	99.8
mM Rb	11	22	25	25	27	35	47	50	50

Fig. 2. Effect of pH on foliar absorption of ^{86}Rb^{33}P-phosphate by chrysanthemum.

pH values. Absorption of RbCl was greater than $RbNO_3$ and Rb_2SO_4, regardless of pH (Fig. 1). With $RbNO_3$ and Rb_2SO_4, salt deposits were noted on the leaf surface after drying, whereas with RbCl very little to no salt deposit occurred.

The use of double-labeled Rb phosphate allowed the determination of both Rb and phosphate absorption from the same dosing solution. Absorption of Rb and phosphate (Fig. 2) was very low at pH 2-6, with a sharp rise from pH 6-7, after which absorption leveled off at about 10% for phosphate and 50% for Rb.

The degree of absorption of both Rb and phosphate could be correlated with the occurrence of salt deposits on the leaf surface and the phosphate form present in solution. Salt deposits occurred at pH 3-6, at which monobasic Rb phosphate predominated and absorption was least (Fig. 2). Conversely, no visible salt deposits occurred at pH 8-10 at which dibasic Rb phosphate predominated and absorption was greatest.

Discussion

Reed and Tukey (8) found that pH indirectly affects the absorption of various phosphorus compounds by determining the phosphate salt present in solution; the solubility, degree of drying and crystallization of the predominant phosphate salt on the leaf surface determined the degree of absorption. In the present study the shape of the absorption curve of both Rb and phosphate as Rb phosphate (Fig. 2) and the occurrence of salt deposits were identical to the previously reported absorption of phosphate as K phosphate (8). This indicates that Rb and K affect both absorption and chemical and solution properties of the phosphate anion similarly, and hence the results obtained with Rb are probably indicative of those that would have been obtained with K.

From this it appears that those factors that affect phosphate absorption (solubility, degree of drying and crystallization) also affect Rb absorption. The occurrence of salt deposits on the leaf surface resulted in the decreased absorption of $RbNO_3$ and Rb_2SO_4 (Fig. 1) and of Rb phosphate at low pH (Fig. 2), as compared to the lack of salt deposits and the greater absorption of RbCl (Fig. 1) and of Rb phosphate at high pH (Fig. 2).

Although absorption of RbCl, $RbNO_3$, and Rb_2SO_4 was greatest at pH 2, absorption of Rb phosphate was not. With Rb phosphate there was only slight necrosis of the treated area, whereas with RbCl, $RbNO_3$ and Rb_2SO_4 (Fig. 1) necrosis and greater uptake were observed. The severity of damage by acid solutions has been shown to alter the degree of absorption (10)

As the pH increases the Rb concentration also increases (bottom of Fig. 2). Therefore, the effect of pH on absorption may be due to an effect on the concentration of Rb. However, the greatest increase in the absorption curve occurred between pH 6 and pH 7 (Fig. 2), but this represents only an 8-mM difference in Rb concentration (bottom of Fig. 2). Also, at pH 7.2, only slight differences occurred in the degree of absorption between 25 mM and 50 mM Rb phosphate (7). This suggests that the shape of the Rb absorption curve was not due to concentration differences at different pH values.

McFarlane and Berry (4) found the penetration of KCl, KI, and KNO_3 through isolated apricot leaf cuticles to be greater than penetration of K_2SO_4, and correlated the results with differences in ionic activity. Therefore, the differences between the pH absorption curves of RbCl, $RbNO_3$, and Rb_2SO_4 (Fig. 1) also may be partially due to the effect of the accompanying anion on ionic activity.

Teubner et al. (10) found the absorption of Rb and K phosphate and citrate by beans to be greater at pH 8 than at pH 4, similar to the results in Fig. 2. The chlorides at pH 2 were intermediate in absorption. With all accompnaying anions Rb was absorbed more readily than K.

Permeability of isolated apricot leaf cuticles to K (4) and of isolated dewaxed *Citrus aurantium* leaf cuticles to Na (9) was much greater at a high pH. The cuticles had isoelectric points around 3, and their cation exchange capacity increased with increasing pH (9). Hence, the increased cation permeability at high pH was attributed to the net negative charge and an increase in the concentration of exchangeable cations in the cuticles (9). However, in this study under conditions that allowed drying of the solution on the leaf surface, similar to natural or field conditions, pH affected absorption indirectly by altering solution properties of the applied compound.

From these data, the Rb, and presumably K compounds, most desirable for application to crop plants would be dibasic K phosphate at high pH (7-10) or KCl at any pH (3-10), since both resulted in a high degree of absorption.

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