FRIDAY MORNING SESSION

October 18, 1968

WALTER KRAUSE: Our subject material this morning is the chemical relationships of rooting media and water quality. Moderator and participant in our program this morning is Dr. Andrew Leiser. Dr. Leiser.

MODERATOR LEISER: Thank you, Walter. This panel was put on the program by the program committee because it seemed rather an exciting new look at a phase of propagation which has been overlooked for many years. I will start out by giving a short review of some of the chemical effects of the rooting medium on root initiation and growth.

INFLUENCE OF CALCIUM SATURATION OF SPHAGNUM PEAT ON THE ROOTING OF SOME WOODY PLANTS

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INTRODUCTION

Research in plant propagation in the past 35-40 years has been dominated by uses of auxins (11) and mist (13). L. H. Bailey, in the 1920 edition of his classic Nursery Manual, gave scant attention to the role of the rooting medium in the process of root initiation. Little attention has been given to the chemical nature of the rooting medium. An early study by Hitchcock et. al. (4,5) found that rooting was affected by pH of the medium. Laurie and Chadwick (6) reported differences in rooting between peat, peat-sand and sand media. Media influenced percentage rooting, number and length of roots and in certain species, position of roots on the stem. Although the media differed in a number of properties, quantitative measurements were not given. More recently Raabe and Vlamis (10) showed the effects of sodium-calcium ratios of peats on rooting of chrysanthemum. Paul and Smith (9) studied rooting of chrysanthemum in peats of varying exchangeable calcium-hydrogen content. The study reported here is on the effects of exchangeable calcium and hydrogen on the rooting of five broad-leaved woody species.

MATERIALS AND METHODS

Preparation of peats:

A British Columbia sphagnum peat was treated with $Ca(OH)_2$ to saturate the exchange sites with calcium. Following

[1]Given by A. T. Leiser at the 1968 meeting of the Western Region, International Plant Propagators Society

leaching, the peat was dried. Another peat sample leached with distilled water was prepared as a hydrogen-peat. These two peats were blended to give peats of approximately 0, 10, 20, 30, 40, 60, 80 and 100% calcium saturation. These peats were wetted and packed uniformly into flats. After cuttings were planted, moisture content was maintained by weighing to bring the flats to their initial weights.

Table 1 Exchangeable ion percentages, soluble calcium and pH of calcium peat-untreated peat blends

% Calcium peat	Cation saturation - %		Soluble calcium* and hydrogen*	
	$Ca^{3}+$	H+	$Ca^{3}+$-me/l	pH
0	2.7	94.6	.124	4.38
10	11.3	86.0	.48	4.40
20	19.9	77.4	-	4.67
30	28.5	68.8	-	4.75
40	36.0	61.3	0.80	5.09
60	54.2	43.1	0.93	5.60
80	71.4	25.9	-	5.91
100	88.5	11.5	1.49	7.00

*Determined in solution expressed from peats moistened to 528% gravimetric moisture content

Cutting preparation and planting:

Terminal cuttings, three to four inches in length, of *Rhododendron* (*Azalea*) 'Red Wing', *Euonymus fortunei* 'Colorata', *Hebe salicifolia, Osmanthus heterophyllus* 'Illicifolius' and *Pyracantha* 'Santa Cruz Prostrate' were taken. Basal leaves were stripped, and cuttings were sorted into eight uniform lots of 50. Cuttings were dipped in methyl mercury hydroxide (Panogen, at 5 drops per gallon), dipped in 4000 ppm IBA (50-50 water-ethanol) solution and planted on October 12.

Flats were placed in an outdoor bottom-heated propagating bench covered with polyethylene film. Temperature of the peat was maintained at 65-70°F.

Cuttings were examined periodically and those with more than one cm. of total root length were harvested. Those with less than one cm. were replanted. This was done to separate effects of media on time of root initiation and growth. Data on root numbers and root length were taken on the following dates: Azalea, November 21 and December 14; euonymus, November 3, 14 and 22; hebe, November 4, 19 and 22; osmanthus, November 28 and December 15; pyacantha, November 13, 14 and 22.

Properties of the media:

The hydrogen ion content of the untreated peat was found to be 139 milliequivalents per 100g by titration to pH 7. Total exchange capacity was 144 meq. per 100g peat determined by the ammonium acetate method. The discrepancy was due to small amounts of Ca and Mg in the peat. Only trace levels of Na and K were present.

The calcium peat contained 130 meq of exchangeable Ca and, therefore, complete Ca saturation was not obtained. Instead of the theoretical values of 0, 10, 20, 30, 40, 60, 80 and 100% Ca saturation actual values were, respectively, 2.7, 11.3, 19.9, 28.5, 36.0, 54.2, 71.4 and 88.5 (See Table I.)

Air-filled porosity, density and moisture content of all peats were thought to be optimum.

RESULTS

Data taken were cumulative percentage rooting at each harvest, mean number of roots per cutting (R/C) and mean root length (RL). Results were similar at the several harvests so for simplicity, data from the first harvest only are discussed here. Total root length per cutting derived from R/C x RL has been used occasionally to make comparisons.

There were marked rooting responses to treatment in euonymus hebe and pyracantha with lesser responses in azalea and minimal response in osmanthus. The medium giving optimum rooting varied with species. The principal trends are reported by species.

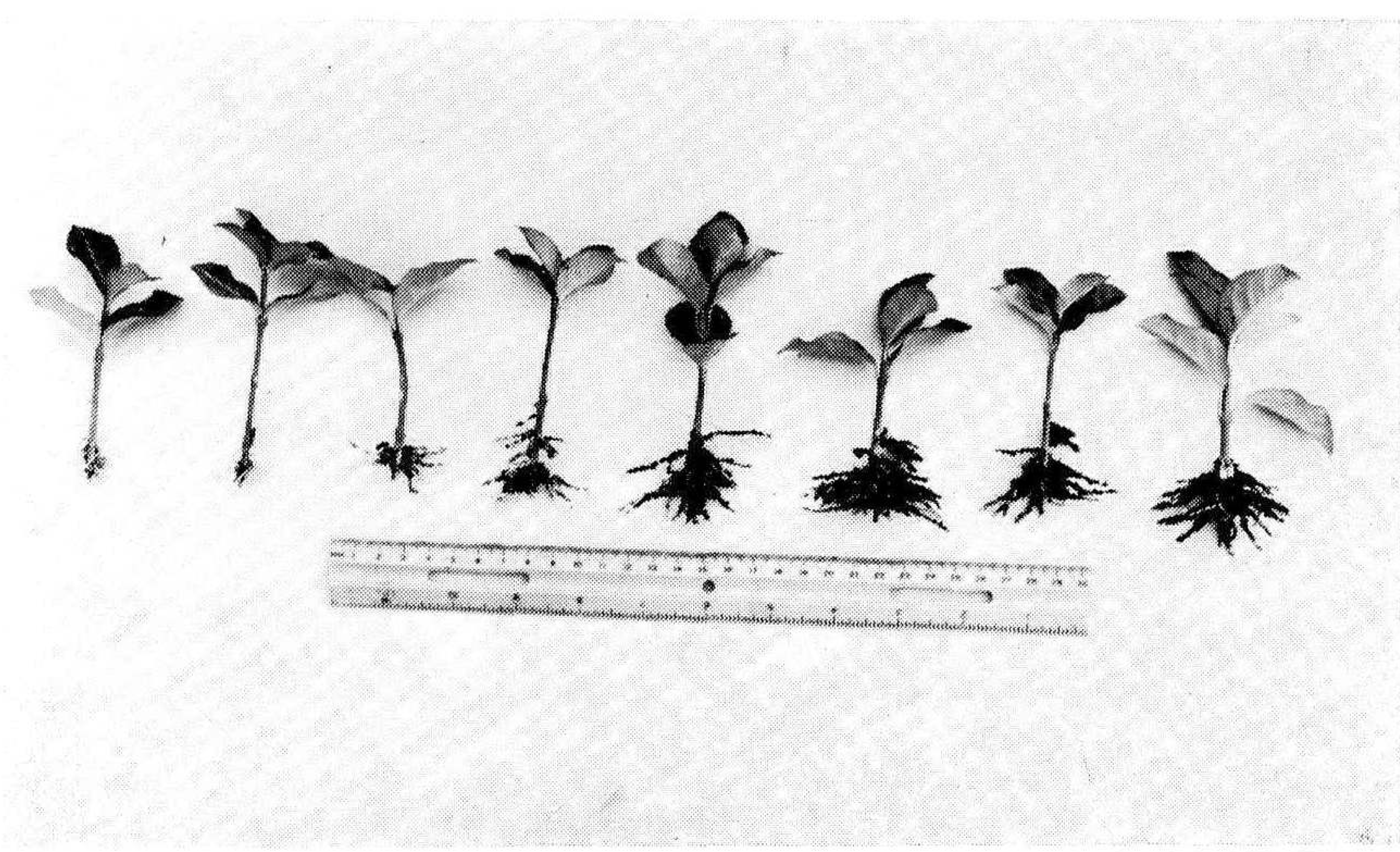


Fig. 1. Euonymus cuttings after 22 days rooting in peats of different Ca content and pH. Treatments from left to right were: 2.7, 11.3, 19.9, 28.5, 36.0, 54.2, 71.4, and 88.5% exchangeable Ca.

Euonymus fortunei 'Colorata': Rooting percentages were 58-79% for the five lowest Ca levels and 88-96% for the three highest Ca levels at the first harvest. The second harvest gave 82% rooting for the 2.7% Ca and was 90% or greater for the seven other treatments. This had increased at the final harvest to 88% and 98-100% respectively.

Mean root length increased from 0.5 cm at 2.7% Ca to ca. 2.0 cm at 19.9 Ca and then remained fairly constant to the highest (88.5%) Ca level. (See Fig. 1, 3).

Mean number of roots per cutting declined from 23 at 2.7 Ca to 11 at 11.3 Ca and then steadily increased with increasing Ca.

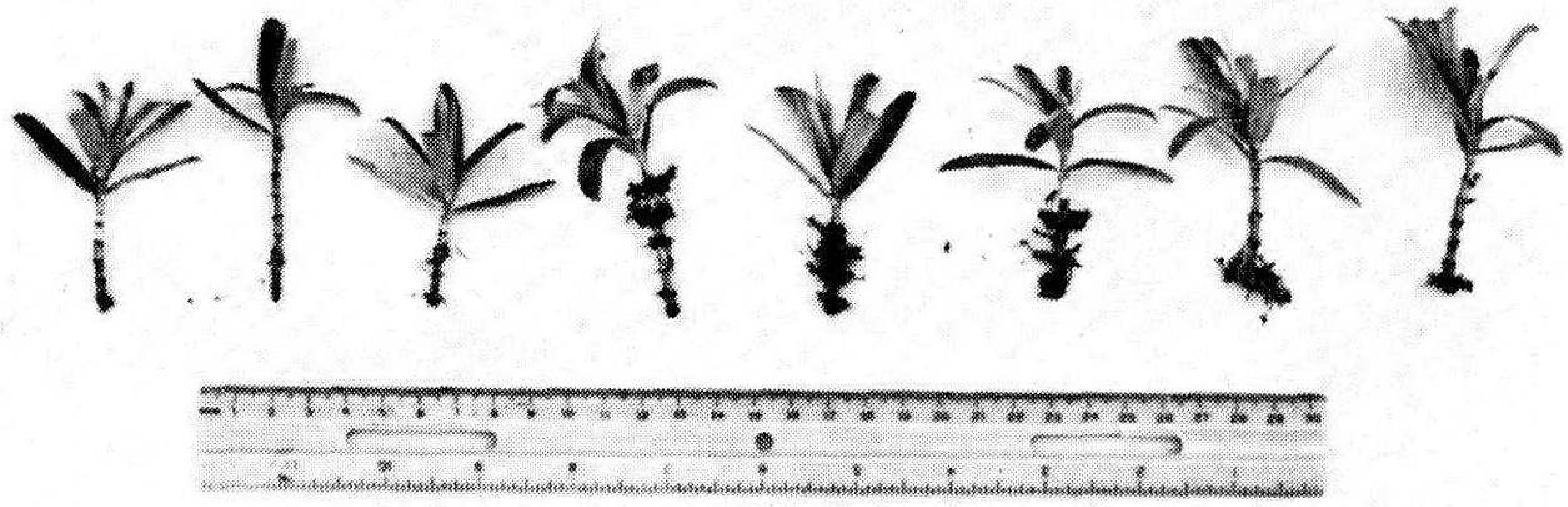


Fig. 2. Hebe cuttings after 22 days rooting in peats of different Ca content and pH. Treatments from left to right were: 2.7, 11.3, 19.9, 28.5, 36.0, 54.2, 71.4, and 88.5% exchangeable Ca.

Hebe salicifolia: Rooting percentages were 0 for the two lowest calcium levels and averaged 75% for the other treatments at the first harvest. These percentages increased in the second harvest to 5 and 90% and in the third harvest to 9 and 95% respectively. Data in Figure 4 show R/C and RL for the second harvest of the 2.7 and 11.3% Ca treatments (dashed lines) because there was no rooting at the first harvest.

Response curves for RL and R/C were dissimilar (Fig. 4). RL increased steadily from 0 to 71.4% Ca. R/C reached a maximum at 36-54.2% Ca and declined to low values at 11.3 and 88.5% Ca. Total root length per cutting (R/C x RL) showed a broad plateau between Ca levels of 36% and 71.4% Ca.

Distribution of roots on the cuttings was strongly affected by treatment (Fig. 2, Fig. 5). Rooting at the base of

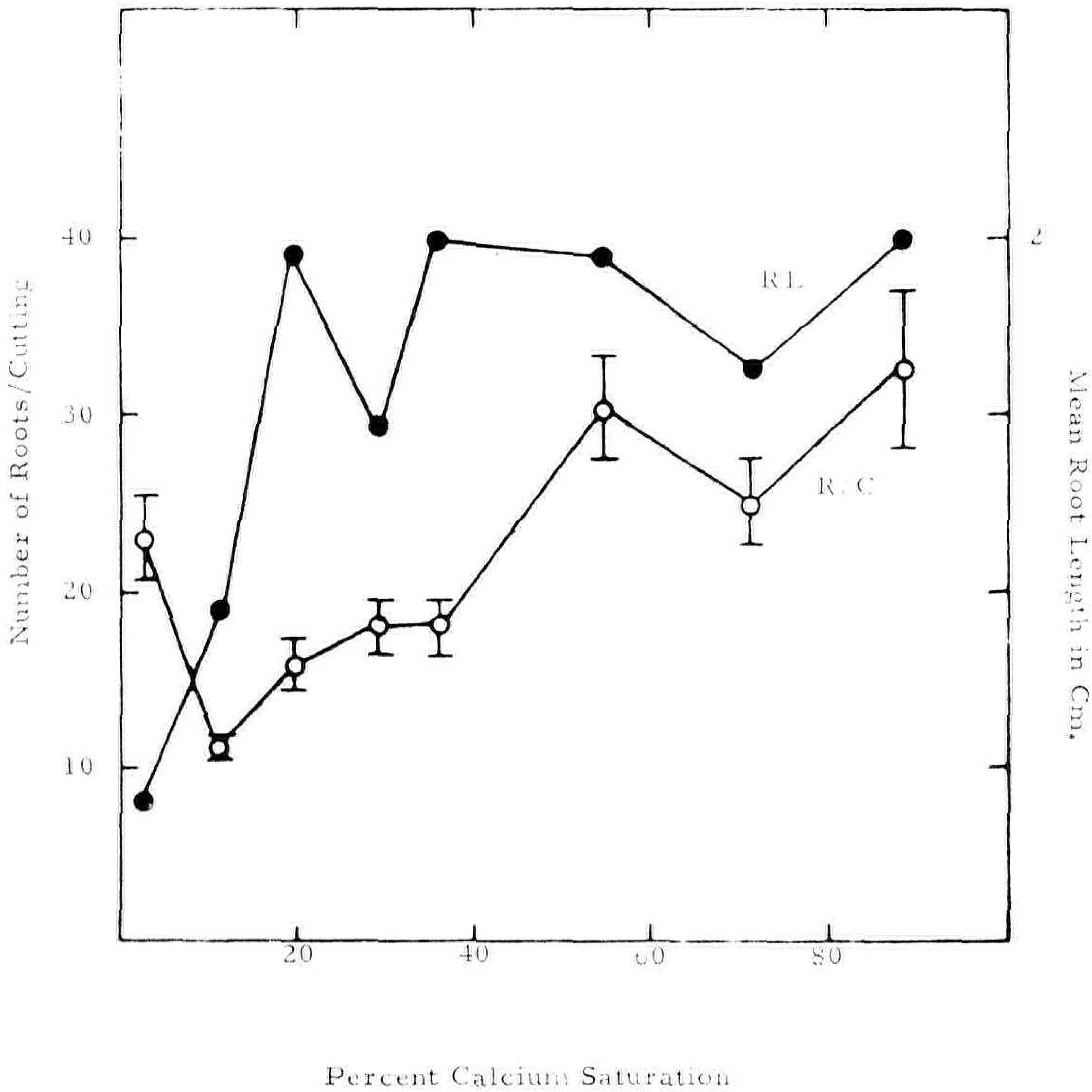


Fig. 3. Mean number of roots per cutting and mean root length for euonymus in relation to exchangeable Ca percentage of sphagnum peat.

the cuttings was inhibited at low and promoted at high Ca, while the opposite was true for the upper part of the stem. Laurie and Chadwick (6) reported somewhat similar effects of rooting media on the position of roots, especially in *Forsythia intermedia, Hydrangea paniculata* 'Grandiflora', *Kerria japonica, Philadelphus coronarius* and some species of *Viburnum*. In Chadwick's experiments, rooting occurred at the stem bases in sand-peat medium but occurred all along the stems in sand. Whether this was caused by chemical or physical properties of the medium cannot be determined, because both changed. Chadwick (personal communication, 1968) noted that the sand used in his experiments had a high calcium carbonate content. In the present study chemical properties were responsible because physical properties remained constant.

Pyracantha 'Santa Cruz Prostrate': Rooting percentages were 0-42 after 25 days and 0-74 after 36 days. No rooting had taken place at 2.7% Ca. After 44 days, 64-80% rooting had occurred in the 11.3-88.5% Ca treatments but the 2.7% treatment had only 6% of cuttings rooted.

Fig. 6 shows that RL approached its maximum at 28.5% Ca and then remained fairly constant. Root number was rather uniform in all treatments. The dashed line in Fig. 6 represents data taken at the third harvest for the 2.7% Ca treatment. In this species, browning of the stem was affected by Ca level: at the first harvest 35 stems were discolored in the 2.7% treatment, 8-9 in the 11.3 and 19.9% treatments, and 2 in the 71.4 and 88.5% Ca levels. Good rooting took place between 28.5 and 88.5% Ca, indicating a wide range of satisfactory rooting conditions.

Rhododendron (*Azalea*) 'Red Wing': Rooting at 40 days varied between 60 and 70% for the 2.7-54.2% Ca treatments and fell to 40% at the two highest Ca treatments. At 63 days rooting varied between 80 and 100% with lowest percentages at the three highest levels. Some browning of root tips occurred at the 2.7 and 11.3% Ca levels and browning of stem tips was present in all treatments but was most severe at the 2.7% Ca.

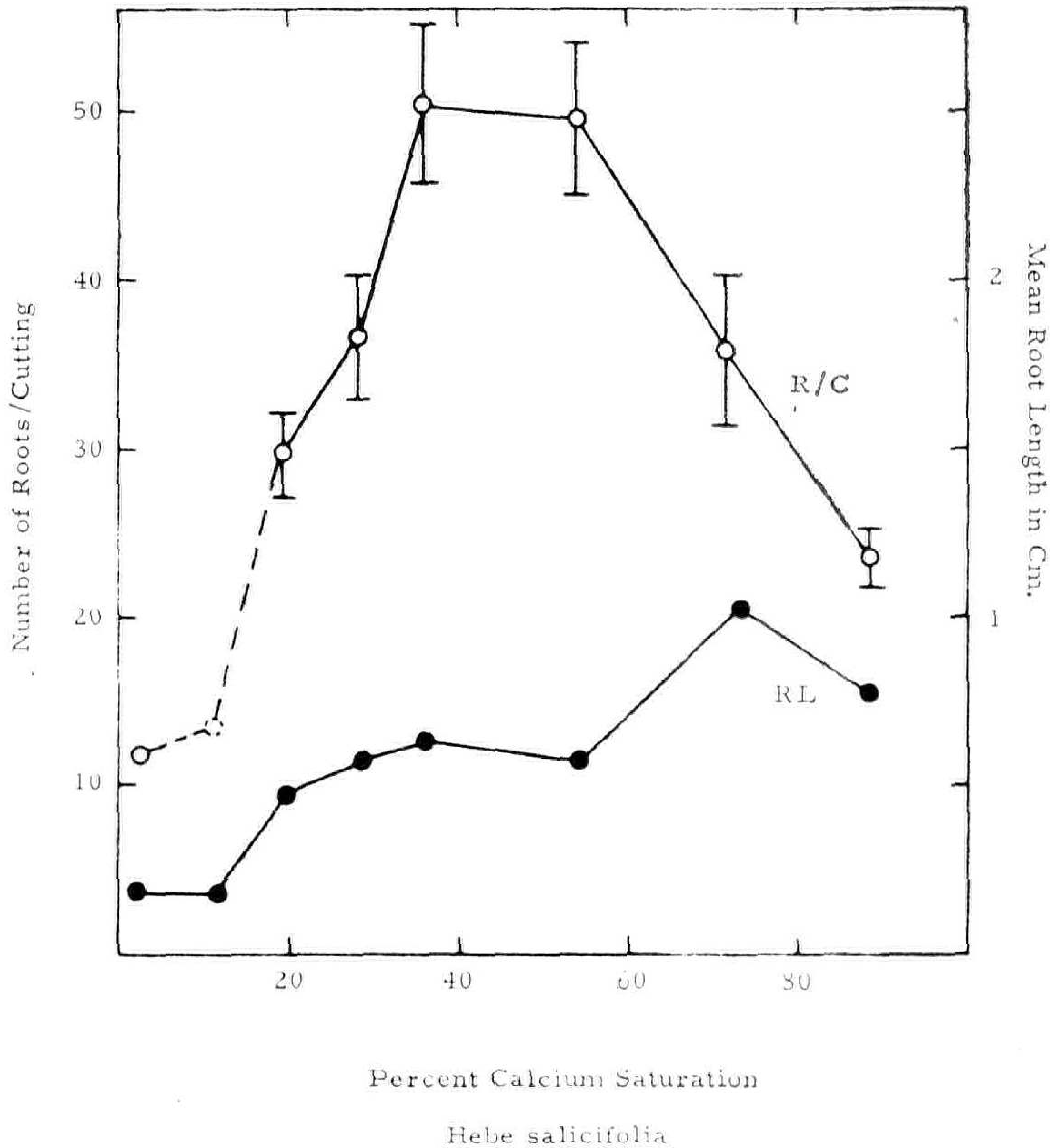
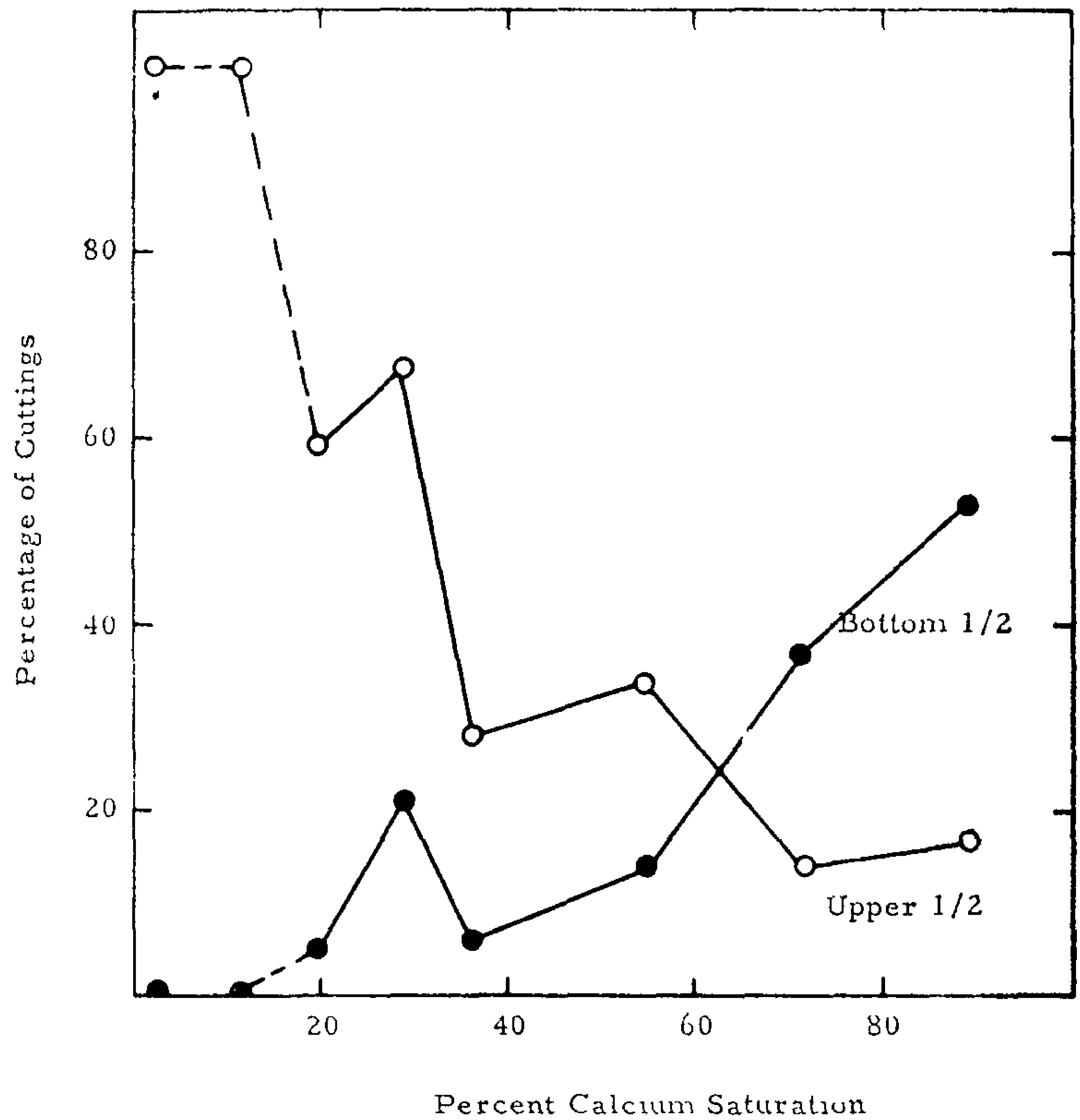


Fig. 4. Mean number of roots per cutting and mean root length for hebe in relation to exchangeable Ca percentage of sphagnum peat.



Root distribution on Hebe salicifolia

Fig 5 Percentage of hebe cuttings with roots only on top one half and roots on bottom one half of buried stem as a function of exchangeable Ca percentage

Root length response was erratic (Fig. 7), though a downward trend beyond 54.2% Ca was indicated. R/C increased from 24 at 11.3% Ca to 40 at 71.4% Ca then decreased to 28 at the highest Ca level. Total root length per cutting (RL x R/C) was depressed at the two highest Ca levels, a result that might be expected from the acid-loving character *Ericaceae*. However, it is indeed interesting that this species was capable of rooting quite well over the whole range of Ca concentrations imposed, considering the widely held view that *Ericaceae* are calciphobes. And further, total root length reached a maximum at a Ca saturation of 54.2% Ca! These results though are in agreement of those of Leiser (7) who found severe Ca deficiency symptoms in *Ericaceae* grown in pure peat with distilled water and who also found (8) that *Rhododendron* (florists azaleas) made excellent growth at high Ca levels if free calcium carbonate (lime) was not present.

Osmanthus heterophyllus 'Ilicifolius': Rooting percentages were quite variable and followed no treatment pattern, the averages being 60% at 47 days and 85% at 64 days. RL was lowest at the two low Ca levels, passed through a maximum between 19.9 and 28.5% Ca and was moderately high in the remaining treatments. (See Fig. 8). Roots were brownish at 2.7 and 11.3% Ca but white in all other treatments. R/C differed little between treatments.

DISCUSSION

We can offer no satisfactory explanation for the differences in rooting response found between these species. Of the processes which take place during rooting, only root extension has been shown to be affected by pH and Ca concentrations of the media. Under acid conditions root growth seems to be particularly affected by Ca concentration, as has been shown in solution culture experiments by Arnon (1) and Burstrom (3). As pH is lowered, the Ca concentration required for normal root growth increases. This probably accounts for poor root growth of *E. f.* 'Colorata', *P.* 'Santa Cruz Prostrate'

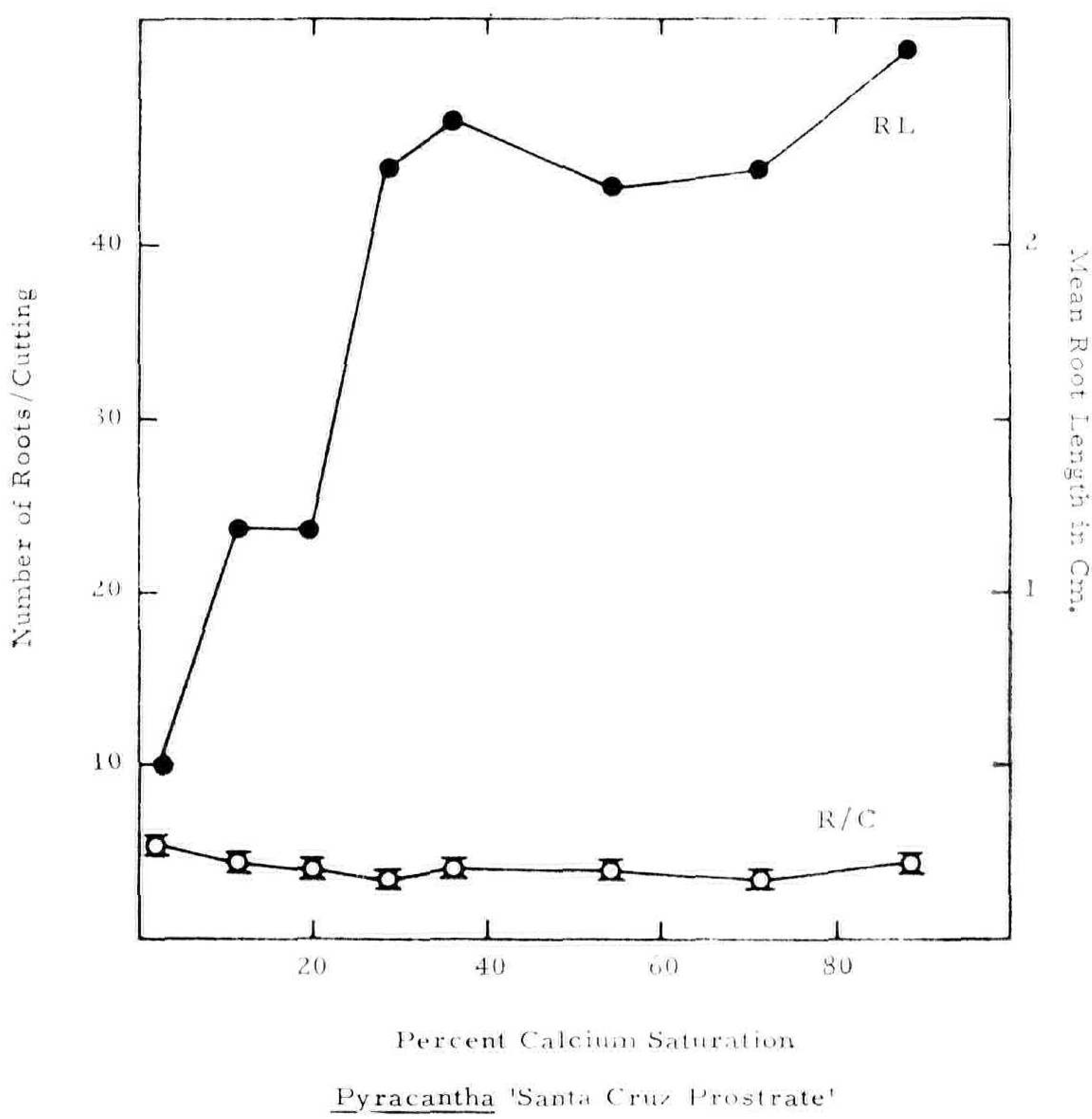


Fig. 6. Mean number of roots per cutting and mean root length for pyracantha in relation to exchangeable Ca percentage of sphagnum peat.

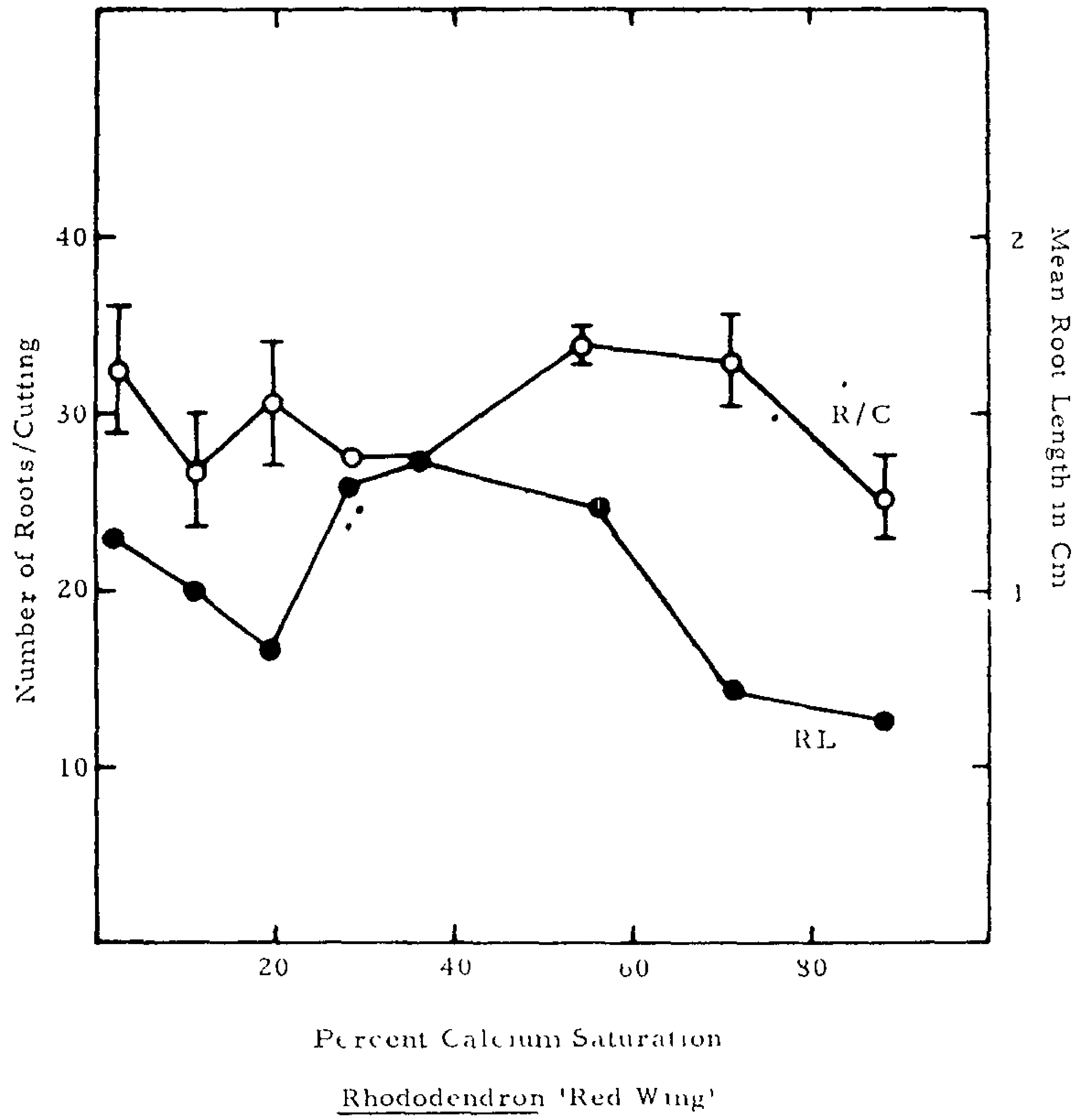


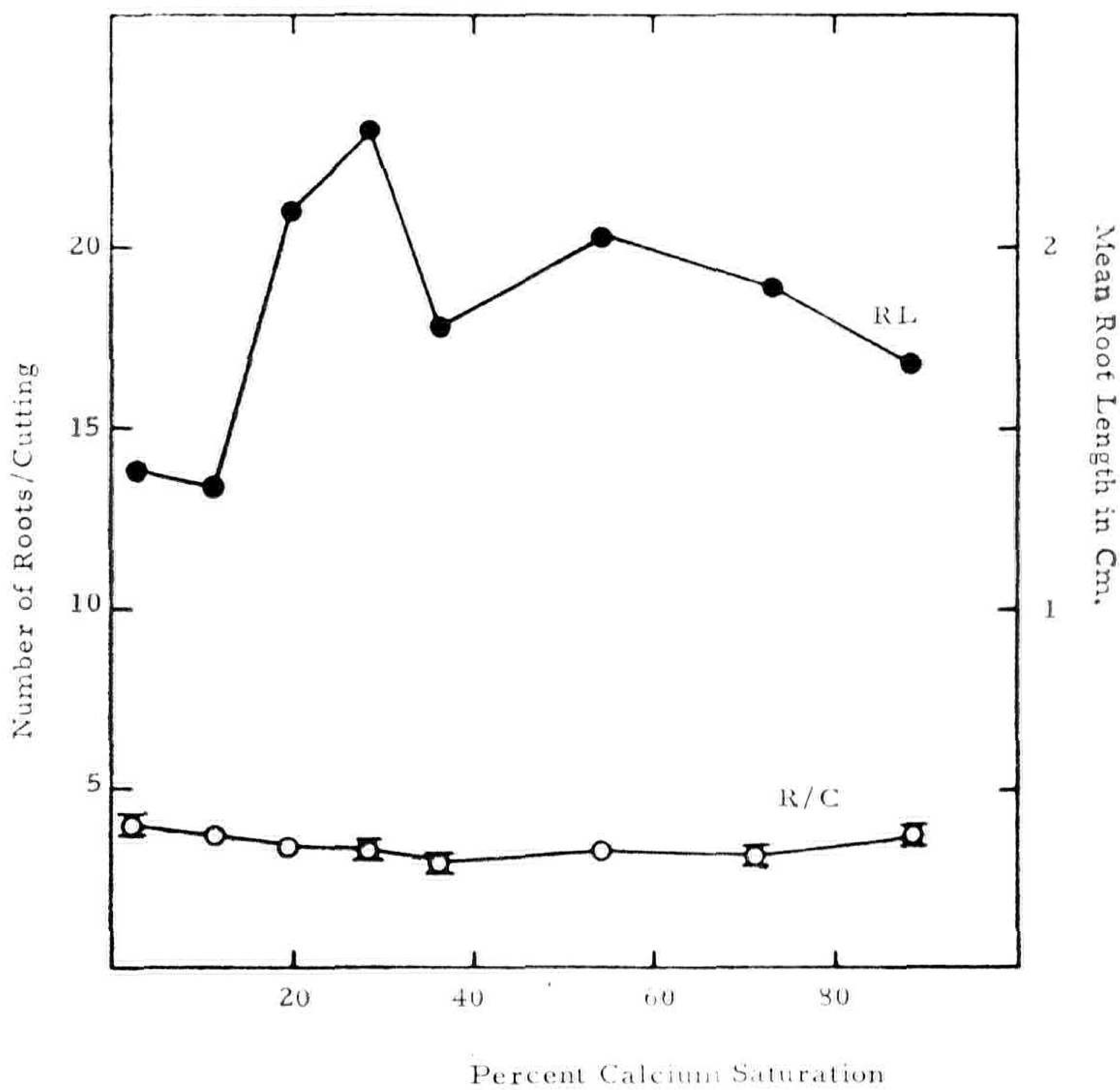
Fig. 7 Mean number of roots per cutting and mean root length for azalea in relation to exchangeable Ca percentage of sphagnum peat.

and *H. salicifolia* at the lower pH values, but the calcium requirements for *R. 'Red Wing'* and *O. h.* 'Ilicifolius' under acid conditions are apparently much less.

At least four other processes take place during rooting, namely expansion and proliferation of cells, organization of primordia, growth of primordia, and emergence. Their dependence upon Ca concentration and pH is difficult to determine and has not been discussed in the literature. In this laboratory we found (unpublished data) that chrysanthemum cuttings, grown in peats of low Ca saturation, lost Ca from the stem in the zone of rooting. This loss was accompanied by an increase in numbers of root initials but an almost complete suppression of root growth. Calcium analyses of stems were not made in the present study, but Ca gains or losses may correspond to particular response patterns — such as the R/C responses of *E. f.* 'Colorata' and *H. salicifolia.*

In these experiments pH and Ca changed simultaneously, and, unlike the situation in a solution experiment, Ca and H could not be examined separately. This is to be expected for systems where an exchanger phase is present. A practical way to assess soils for excess or deficiency levels in ions such as Na or Ca is to use exchangeable ion ratios or exchangeable ion percentages. For example, a soil having 15% exchangeable Na is classified an alkali soil and reclamation is recommended. In Ca-Mg soils exchangeable Ca must be equal to or greater than 20% to prevent Ca deficiency (Vlamis, 1949). Using this approach, these species can be classified in the following way for optimum rooting in Ca-H peats (the figures being percentage Ca saturations):

R. 'Red Wing'	$\leq$ 2.7 to $\leq$ 71.4%
Q. h. 'Ilicifolius'	$\leq$ 2.7 to $\geq$ 88.5%
P. 'Santa Cruz Prostrate'	$\geq$ 28.5%
H. salicifolia	$\geq$ 36 to $\leq$ 71.4%
E. f. 'Colorata'	$\geq$ 54.2%



Osmanthus heterophyllus 'Ilicifolius'

Fig. 8. Mean number of roots per cutting and mean root length for osmanthus in relation to exchangeable Ca percentage of sphagnum peat.

No restrictive values are offered for *O. h.* 'Ilicifolius' because of lack of response within the limits examined, nor for *R.* 'Red Wing' at low Ca saturation. If other ions are involved, such as Na, these values would very likely be altered.

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MODERATOR LEISER: Our next speaker is Dr. Robert Raabe of the Department of Plant Pathology on the Berkeley campus. Dr. Raabe works primarily with diseases of woody plants. His major areas of interest are oak root fungus and verticillium wilt. Although he is primarily a plant pathologist, he is also a very good horticulturist. His subject this morning indicates this interest. Dr. Raabe.