Lime Tolerance in Rhododendron

Amin Chaanin
W. Kordes Söhne, 25365 Klein Offenseth-Sparrieshoop, Germany

INTRODUCTION

High content of lime or bicarbonate (HCO_3^-) in the soil inhibits plant growth in many economically important members of Ericaceae family including *Rhododendron*. Difficulties in cultivation could be reduced by selection of lime-tolerant genotypes. Such plants could increase the market for rhododendrons and have the environmental benefit of reducing the amount of peat used by the horticulture industry for commercial production of these plants.

For the cultivation of large-flowered rhododendron hybrids (elepidote rhododendrons), lime-tolerant rootstocks have been selected at the Institute for Ornamental Plant Breeding in Ahrensburg, Germany (Preil and Ebbinghaus, 1994). For the small-leaved rhododendrons (lepidote rhododendrons) cultivation problems exist still on lime soil. This paper summaries experiments at The Institute for Ornamental Plant Breeding, Ahrensburg, on the development of lime-tolerant rhododendrons, including investigation of the variability of lime tolerance in the genus *Rhododendron* and the selection of genotypes for breeding lime-tolerant rhododendrons with different flower colours.

MATERIALS AND METHODS

Seed from open pollination of 200 rhododendron species and cultivars was collected from a number of botanical gardens and from the natural growing regions (a complete list of tested rhododendron species can be obtained from the author). Seeds were germinated in the greenhouse directly on a peat substrate supplemented with 1 g (control), 5 g or 10 g $CaCO_3$ $litre^{-1}$, respectively, resulting in pH ($CaCl_2$) levels of 4.2, 6.4, and 7.1, respectively (Table 1). In further experiments 10 g $CaCO_3$ $litre^{-1}$ was found to be a toxic level for most rhododendrons (Chaanin and Preil, 1996). Tests were carried out in boxes 20 cm × 15 cm × 5 cm deep. To avoid loss of bicarbonate (HCO_3^-) arising by dissociation of $CaCO_3$ in water during the experiments, these boxes were placed inside water-tight containers. Loss of $CaCO_3$ or HCO_3^- was prevented by the closed culture system used. Each treatment was replicated three times.

For estimating the amount of bicarbonate (HCO_3^-) in the substrates 50 g of the substrate was shaken with 250 ml of distilled water for 15 min. After filtration HCO_3^- was determined by titration with 0.01 M HCl using a pH electrode at pH 4.3 (modified after Boxma, 1972). Measurements of pH were carried out by suspending the substrate in 0.01 M $CaCl_2$ (1 : 2.5, v/v).

Table 1. $CaCO_3$,HCO_3^- ,and pH ($CaCl_2$) of the substrate at the start of lime tolerance screening.

Treatment	$CaCO_3$ (g $litre^{-1}$)	pH (in 0.01 M $CaCl_2$)	HCO_3^- (mg $litre^{-1}$)
Minimum lime	1	4.2	32
Medium lime	5	6.4	814
High lime	10	7.1	1554

RESULTS

As expected the control (minimum lime) plants, growing in a medium with just 1 g $CaCO_3$ $litre^{-1}$, were healthy and grew vigorously. The majority of those growing in 5 g $CaCO_3$ $litre^{-1}$ (medium lime) were stunted in growth beyond the second month with iron chlorosis symptoms in the youngest leaves of most taxa in the trial. On the high lime (10 g $CaCO_3$) substrate, all plants died after 4 months except one progeny of *R. micranthum* and few seedlings of *R. schlippenbachii* and *R. occidentale*.

All seedlings on the minimum lime substrate had roots longer than 5 cm after 4 months. The root growth of most seedlings in the medium lime substrate was stunted, reaching a maximum of 2.4 cm while the roots of most seedlings in the high lime substrate reached a maximum of just 1.7 cm. Roots of lime-stressed seedlings were untypically branched and coloured dark brown.

Rhododendron micranthum was the exception to the above results. In the high-lime substrate the roots of these seedlings grew to 4.2 cm (Table. 2). These roots were healthy, light in colour, and did not show growth deformations. Iron-chlorosis symptoms were not observed on the leaves of these seedlings during the duration of the trial. Shoot growth was not significantly stunted in this species on the medium- nor high-lime substrates.

Table 2. Comparison of root and shoot growth (length, in mm) of a selection of the taxa screened for lime tolerance, after 4 months.

	Minimum lime		Medium lime		High lime	
Taxa	Shoot	Root	Shoot	Root	Shoot	Root
canadense	56	50+	2	9	1	2
cumberlandense	33	50+	4	30	1	12
hormophorum	20	50+	4	14	2	15
micranthum	35	50+	15	42	11	42
ponticum	48	50+	3	6	1	2
pseudoyanthinum	25	50+	4	17	1	6
smirnowii	18	50+	2	24	1	5
'Cunningham's White'	25	50+	2	6	1	2
'Gibraltar'	30	50+	4	16	2	9
'Klondyke'	33	50+	5	19	2	5

In a further trial, selected plants of *R. micranthum* were grown in 12-cm plastic pots in substrates containing lime at four different concentrations: 1, 5, 10, or 20 g $CaCO_3$ $litre^{-1}$. In all concentrations the plants grew normally with no signs of damage. Even after 8 months there was no difference between the plants growing in 1 g $CaCO_3$ $litre^{-1}$ and those in 20 g $CaCO_3$ $litre^{-1}$. In the substrate with the highest lime concentration (20 g $CaCO_3$ $litre^{-1}$) the bicarbonate concentration was approximately 3000 mg HCO_3^- $litre^{-1}$ and the pH ($CaCl_2$) was 7.1.

In order to breed lime-tolerant dwarf or small-leaved rhododendrons, crosses were carried out from *R. micranthum* with 53 species or hybrids. Most of these crosses failed to set seed. From the interspecific crosses, few combinations resulted in viable seedlings. One seedling resulted from the cross *R. micranthum* × 'Blaumeise',

11 from *R. micranthum* × *R. impeditum*, and several hundred each from *R. hirsutum* × *R. micranthum* and *R. ferrugineum* × *R. micranthum*. These will be screened for lime tolerance.

DISCUSSION

Rootstocks already selected at the Institute for Ornamental Plant Breeding in Ahrensburg, in cooperation with the INKARHO, can tolerate lime concentrations in soil up to about 400 mg HCO_3^- kg^{-1} soil. However the growth of these plants was strongly inhibited at 600 HCO_3^- (Chaanin and Preil, 1996).

In the trials described in this paper, seedlings of *R. micranthum* were able to tolerate bicarbonate concentrations up to nearly 3000 HCO_3^- $litre^{-1}$ substrate. These plants, therefore, represent a valuable gene source for interspecific crosses for breeding lime-tolerant small-leaved rhododendrons.

There are some disadvantages of this species as a breeding parent. It has small white flowers. It does not hybridize well with other rhododendrons and there are no known hybrids.

Current knowledge about the heredity of lime tolerance in rhododendrons is limited and looking for lime-tolerant seedlings still requires the testing of large populations. Our experience of crossing *R. micranthum* with other rhododendrons has resulted in only limited success. Only in the combinations *R. hirsutum* × *R. micranthum* and *R. ferrugineum* × *R. micranthum* could worthwhile quantities of seedlings be produced. Further screening of these progeny will yield more information about the genetics of lime tolerance in rhododendrons.

Acknowledgements. The author gratefully appreciates the financial support of the INKARHO (Westerstede) and wishes to express his gratitude to Mrs. Julia Westhoff, Rhododendron-Park in Bremen; Mr. Hans Hachmann, Barmstedt and Mr. Johann Wieting, Westerstede-Gießelhorst for supply of seeds.

LITERATURE CITED

Boxma, R. 1972. Bicarbonate as the most important soil factor in lime-induced chlorosis in the Netherlands. Plant and Soil 37:233-243.

Chaanin, A. and **W. Preil.** 1996. Limits for bicarbonate concentrations in rhododendron rootstocks. TASPO-Gartenbaumagazin 5(2):44-46.

Preil, W. and **R. Ebbinghaus.** 1994. Breeding of lime tolerant rhododendron rootstocks. Acta Hort. 364:61-70.