RESPONSE OF TEN PROVENANCES OF WHITE SPRUCE SEEDLINGS TO VARIABLE CONCENTRATION OF CALCIUM IN THE NUTRIENT MEDIUM

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The range of white spruce *(Picea glauca* (Moench) Voss) extends across North America and from Idaho, Michigan and Massachusetts north to the tree line. It grows on soils of widely different origins and with many types of underlying substrata The species has been found growing on soils which range in pH from 4.5 to 8.4 (U.S.D.A. 1965).

In Ontario white spruce usually grows on soils overlying the granitic rock of the Canadian Shield. However, in some localities south of the Shield it grows on soils derived from limestone over limestone bedrock. It seems reasonable to suppose that ecotypes may have developed which are adapted to these contrasting soil conditions since edaphic ecotypes have been reported for a few other species (Hiesey and Milner, 1965), It was the purpose of this experiment to test for such ecotypes.

Five provenances from granitic sites on the Canadian Shield and five from limestone sites just south of the Shield (fig, 1) were grown in a growth chamber for 113 days, The rooting medium was Perlite and the nutrient solution was of a standard type except that calcium ion content (supplied as $CaCl_2.6H_2O$) was 1, 8, 64 or 512 parts per million (ppm), a logarithmic progression. Eight to 64 ppm is thought to cover the optimum range.

The results are illustrated in figures 2 to 5, The points represent individual provenances and are based on means of eight to 14 seedlings, The curves are averages for the granitic and limestone groups The performance of individual provenances is quite variable but the curves show some trends.

Figure 2 shows the rate of mortality in relation to calcium concentration, There was a substantial increase with calcium concentration, especially between the two highest concentrations, but there was no significant effect due to provenance groups. The surviving seedlings in the high calcium were yellowish with some seedlings turning brown.

Figure 3 shows the top oven-dry weight. There was little or no evidence of deficiency in the one ppm treatment but the highest concentration was detrimental, especially to the granitic provenances, The pattern for root oven-dry weight was very similar but more emphatic (fig. 4). The top:root ratios based on oven-dry weight are unsatisfactorily high in all treatments (fig. 5). However, they are highest in the high calcium, with the granitic provenances showing the poorest ratios.

Thus, there is some evidence for the existence of genetic differences in the response of the two provenance groups to calcium concentration. There are other possible differences between granitic and limestone soils in addition to the availability or excess of calcium ions. One such factor is pH which when low favors the uptake of iron and phosphorus (Rorison, 1960). In this experiment pH was quite acid, between 4,2 and 5.0 in all treatments. Therefore, if pH favored any of the provenances it would likely be the ones from the granitic sites.

In this experiment the concentration of chloride ion was double the concentration of calcium ion and probably had some detrimental effects. However, it is not clear why one provenance group should show more resistance to the toxic effects of chloride

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ion than the other. It is therefore believed that the interaction between the 64 and 512 ppm treatments was due mainly to the effect of calcium ion. The nature of this effect is not known but it may be due to an antagonism between calcium and potassium and possibly phosphorus (Rorison, 1960).

The lack of pronounced deficiency symptoms in the one ppm treatment was thought to be due to impurities entering the system which were sufficient to meet the require ments of all seedlings.

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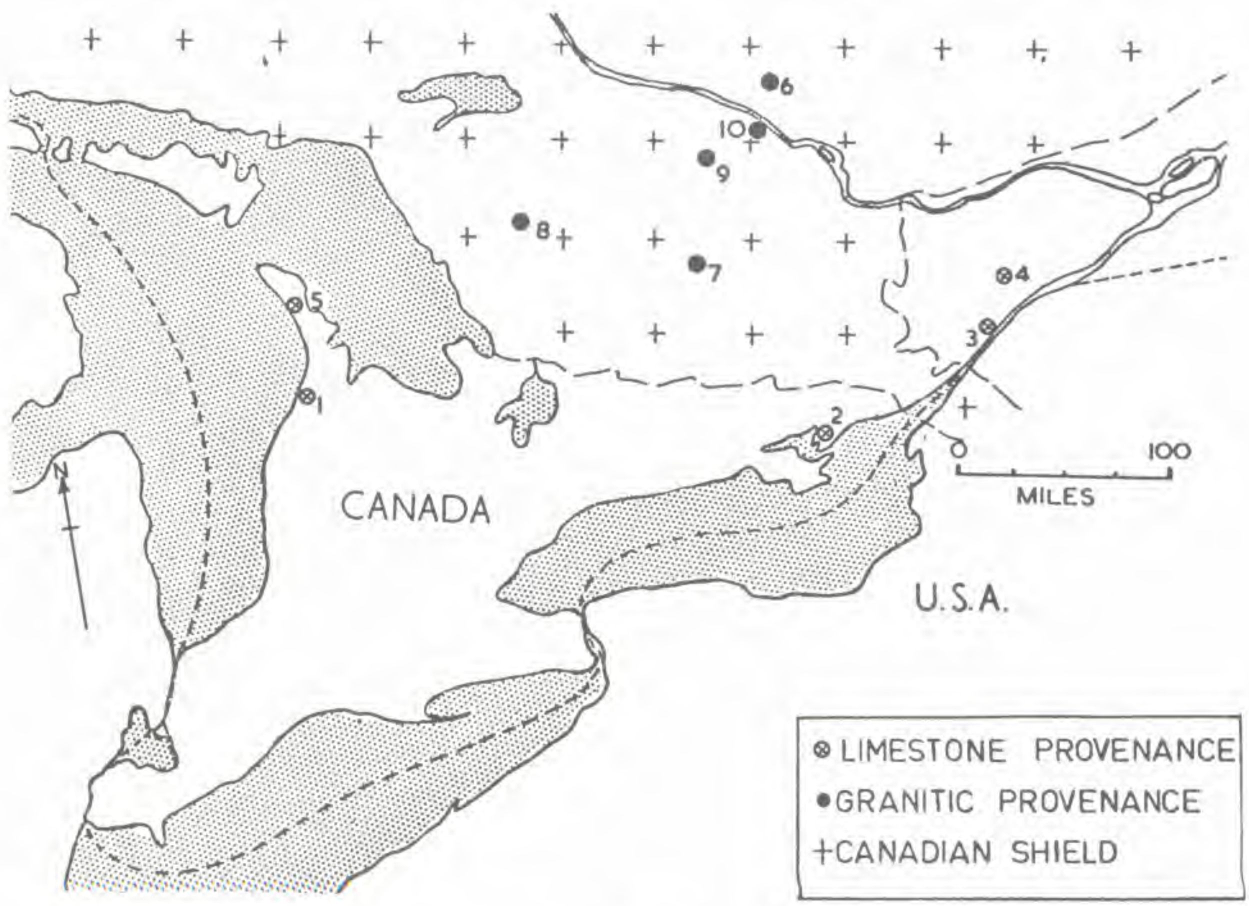

Figure 1.--Location of white spruce provenances.

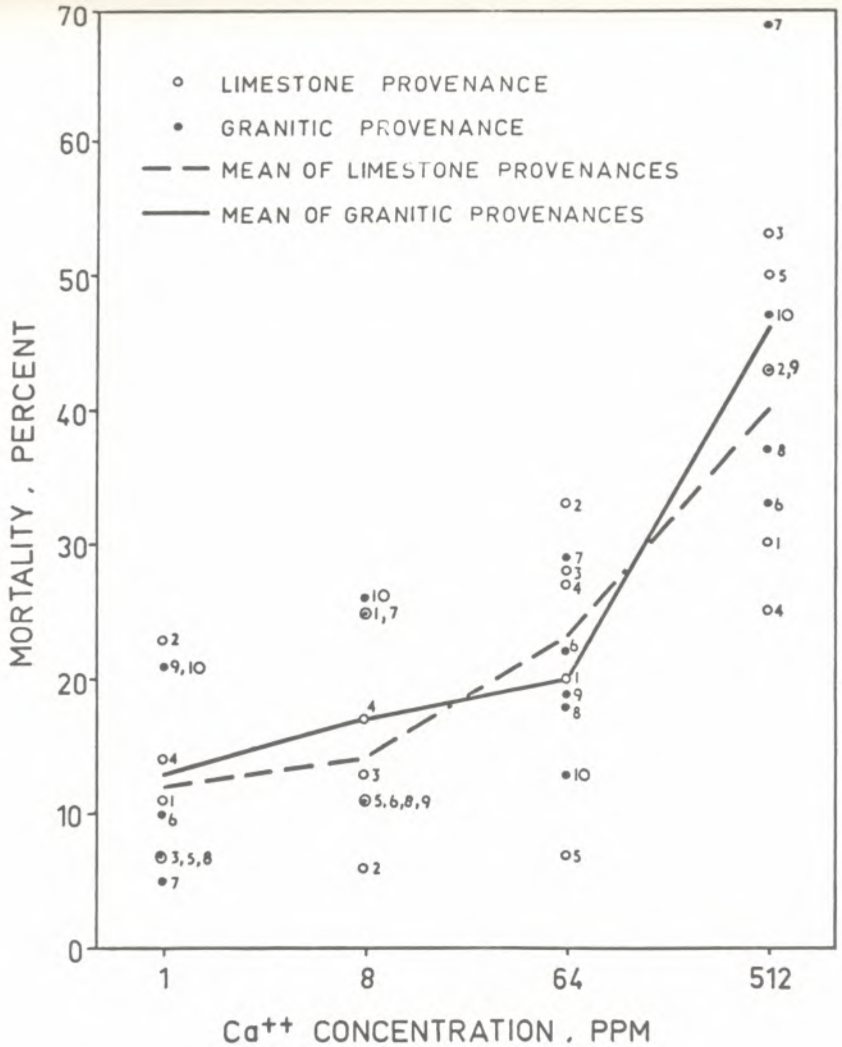

Figure 2.--Percent mortality for the various concentrations of Ca++.

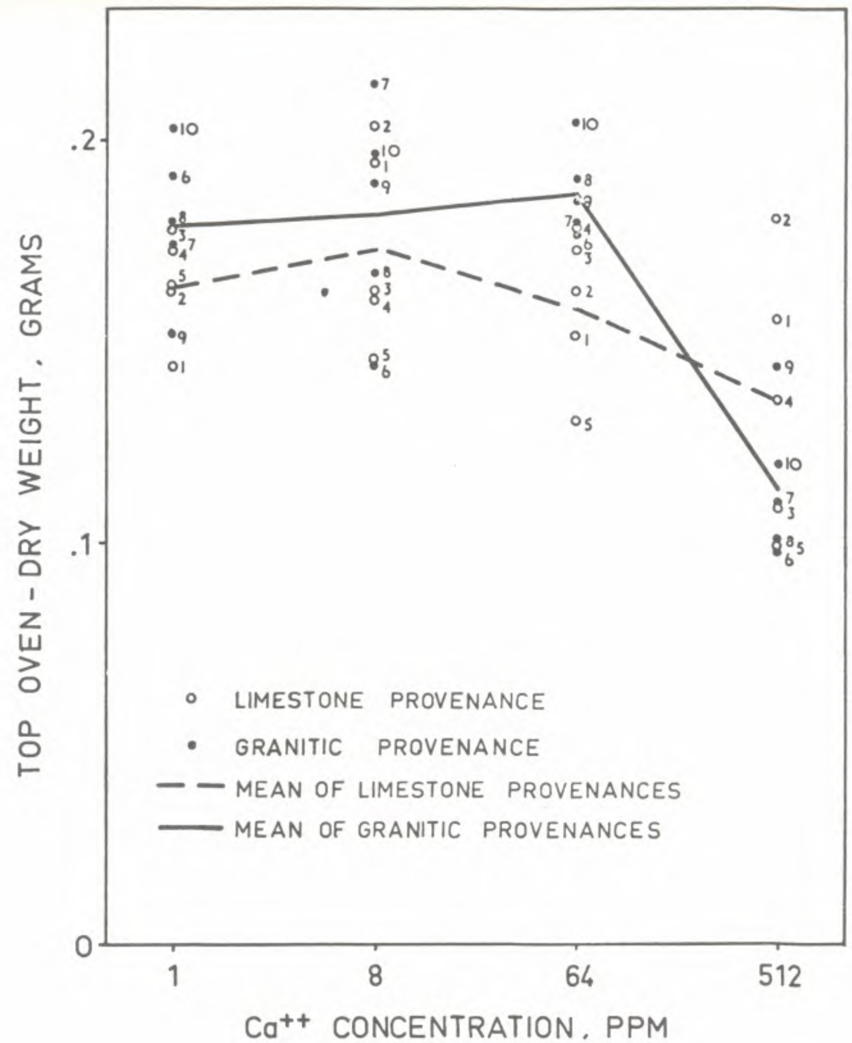

Figure 3.--Top oven-dry weight per seedling for the various concentrations of Ca++.

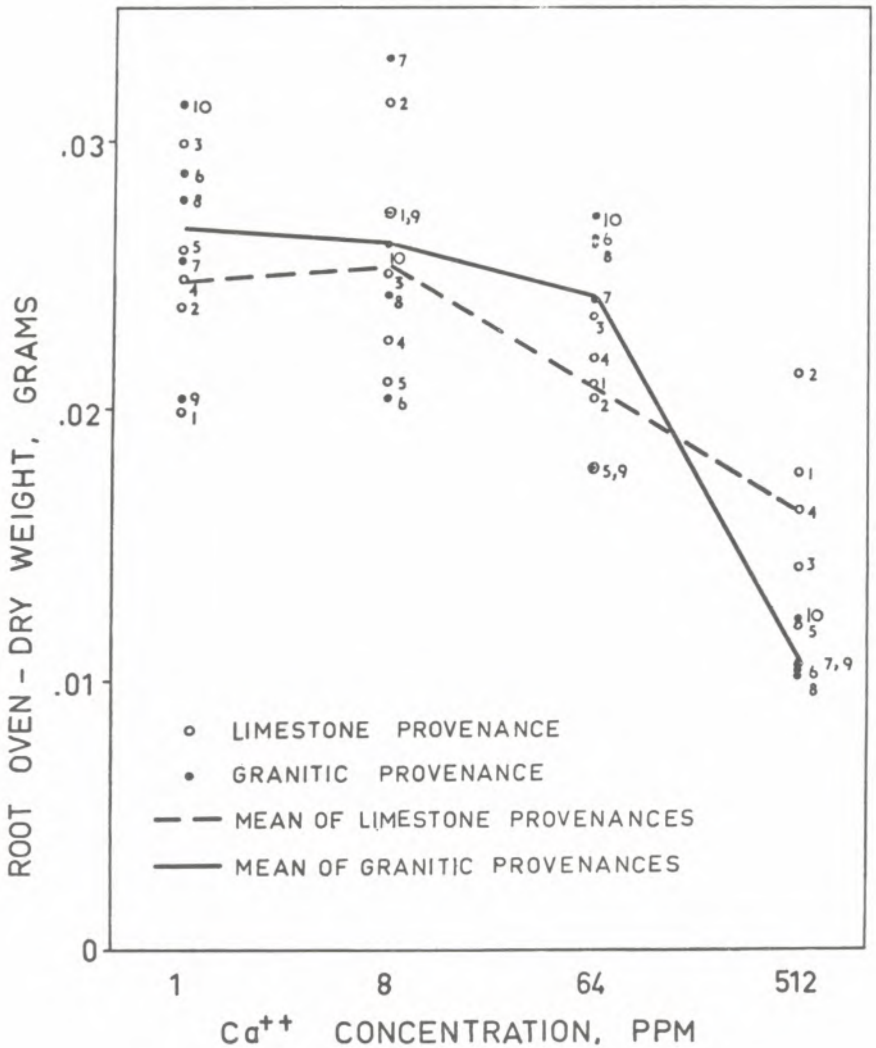

Figure 4.--Root oven-dry weight per seedling for the various concentrations of Ca++.

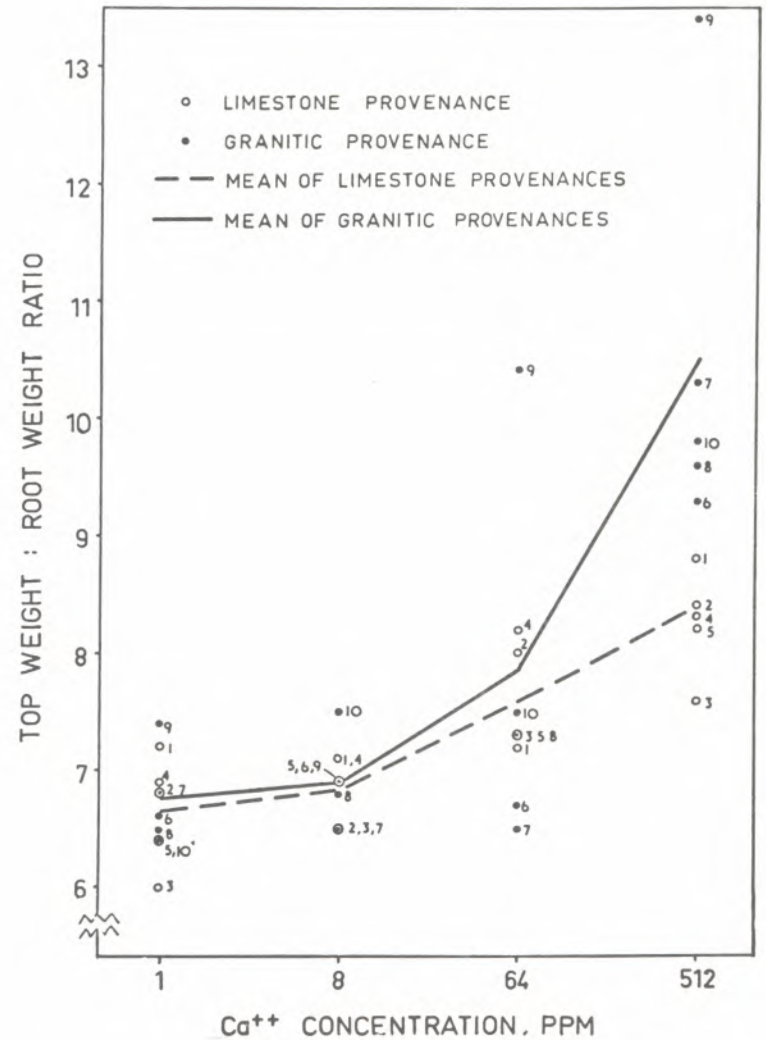

Figure 5.--Top weight:root weight ratio for the various concentrations of Ca++.