OBSERVATIONS ON THE NUTRIENT STATUS IN AIR POLLUTED URBAN FOREST STANDS

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INTRODUCTION

Air pollution induced changes in urban forest stands can be related to the direct air pollution effects and changes in soil conditions. Soil conditions are especially important when discussing the possible air pollution effects on the whole forest ecosystem and particularly the soil layer and ground vegetation, which are normally protected by the snow cover in winter and are not so susceptible to the direct effects as coniferous trees. The environment of a chemical processing plant producing mixed type fertilizers has been found to be problematical with an increasing fertilizing effect on the surroundings. The fertilizing effect is mainly due to overfertilization with nitrogen compounds in the form of NO_x pollution and ammonium. The nitrogen contents of plants and soil have earlier been

studied by HAVAS 1971 and HUTTUNEN 1975.

The surroundings of a fertilizer plant were selected as the site for studying magnesium, calcium and potassium. These nutrients have been found to increase the environmental tolerance of plants when the nutrient status relationships are optimal for plant growth (TRESHOW 1970). In the fertilizing experiments taking into account air pollution some positive effects of fertilization have also been found (BJÖRKMAN 1972, OLSZOWSKI 1976). The over fertilization with nitrogen compounds in the surroundings of a fertilizer plant has been found to have detrimental effects on the water economy and wintering of coniferous trees (HUTTUNEN et al. 1980). Changes related to fertilization have also been found by HUTTUNEN 1975.

MATERIAL AND METHODS

The nutrient economy of the humus layer was monitored around fertilizer industry in Oulu during the years 1975 and 1976 by measuring monthly (during the vegetational period) the pH, K, Ca and Mg contents of the humus layer. The sample areas I—IV are presented in figure 1. Nutrient analyses were made on the leaves of *Vaccinium vitis-idaea*, *Vaccinium myrtillus* and *Empetrum nigrum* coll. Additional analyses were made on samples collected during the years 1972 and 1973. The pH of the humus layer was measured from a water solution (1:3). The kation solution was

made with ammonium acetate (pH 7). Ca and Mg were measured in a 1 % LaCl₃-solution. The amounts of dissolved nutrients were calculated as mg per liter of fresh humus soil. The dry ash analysis of plant samples was made by burning one gram of ower-dried and ground plant material for 2 h at 500°C and by dissolving the ash in 20 % HCl. The nutrients were measured by the AASH method (equipment HITACHI) and the results were calculated as percentage of dry weight (ALLEN et al. 1974).

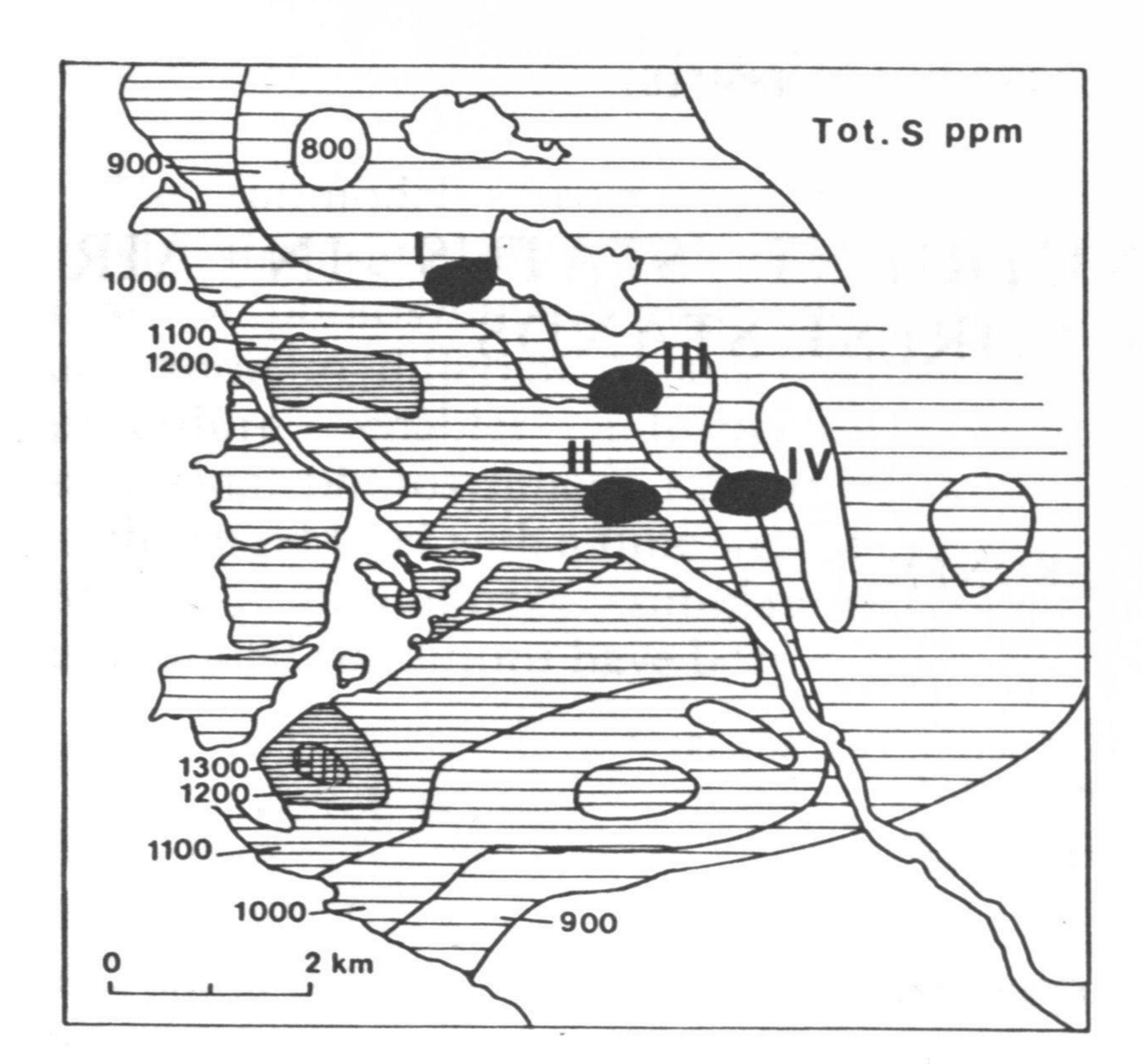


Fig. 1. Sample areas around industrial site I-IV. The mean annual distribution of sulphur compounds is also presented in the map.

RESULTS AND DISCUSSION

The hydrogen ion concentration of the soil magnesium and calcium concentrations was of the calcium concentrations was 96-945 mg 1⁻¹. A positive correlation between the calcium and hydrogen ion concentrations was observed (fig. 2). The variation of the magnesium concentrations was 11-197 mg 1⁻¹ and that of potassium 18-587 mg 1⁻¹. A distinct positive correlation between the

samples varied by approximately one pH unit observable throughout the vegetational during the vegetational period. The variation period (fig. 3). A dependence of the potassium concentration on the magnesium and calcium concentrations was only observable during the spring.

The calcium, magnesium and potassium present in the emission of airborne fertilizer dust brought about an increase of the nutrient content of the surface top soil humus

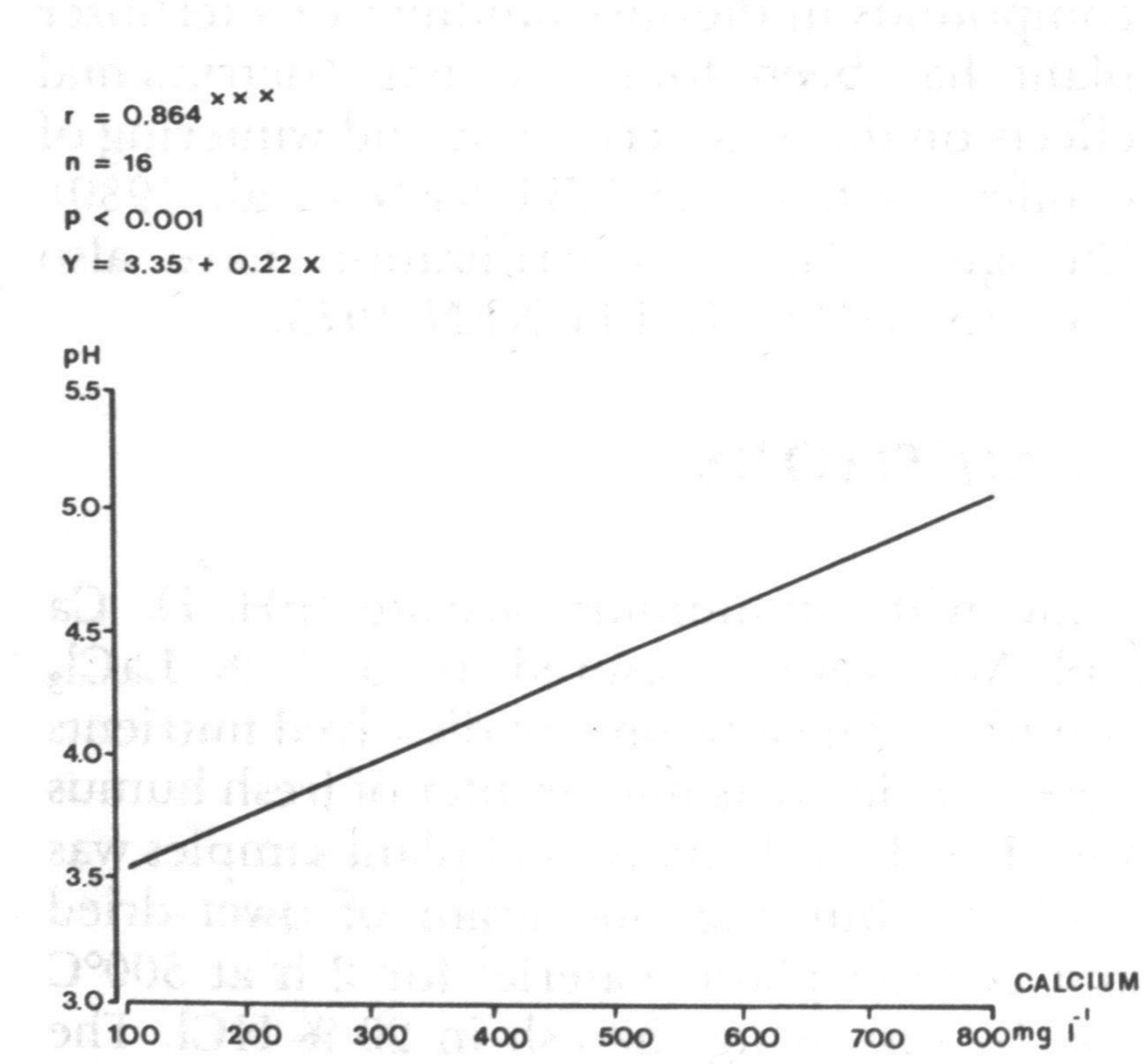
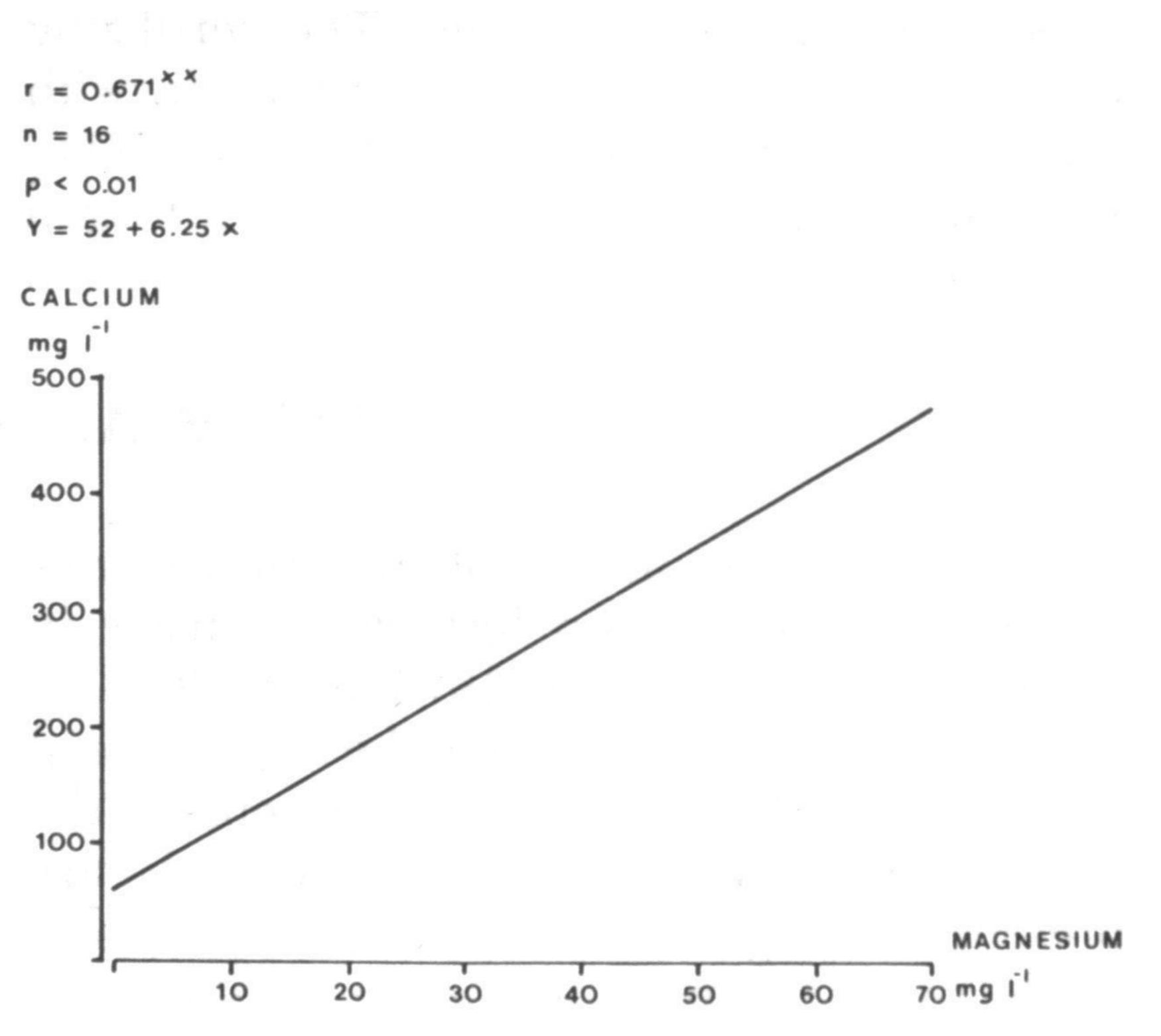


Fig. 2. The correlation between hydrogen ion and Fig. 3. The positive correlation between the magnesium effect or the industrial site is visible in the high calcium vegetational period. concentrations and the calcium caused increase in the pH of the humus layer.



calcium concentration of soil samples. The fertilizing and calcium concentrations is observable throughout the

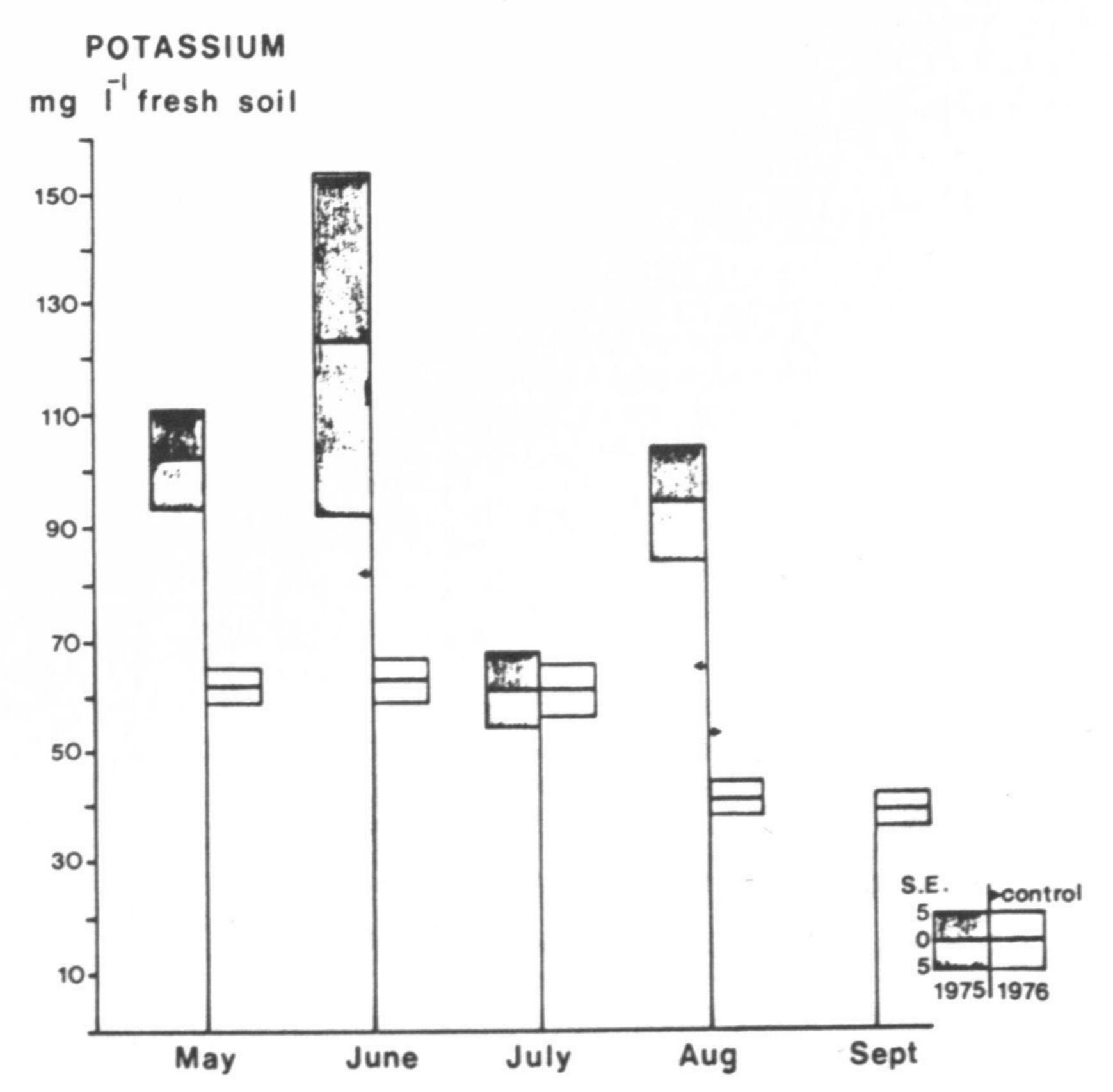


Fig. 4. The potassium contents of the humus samples. The highest amounts were found in June.

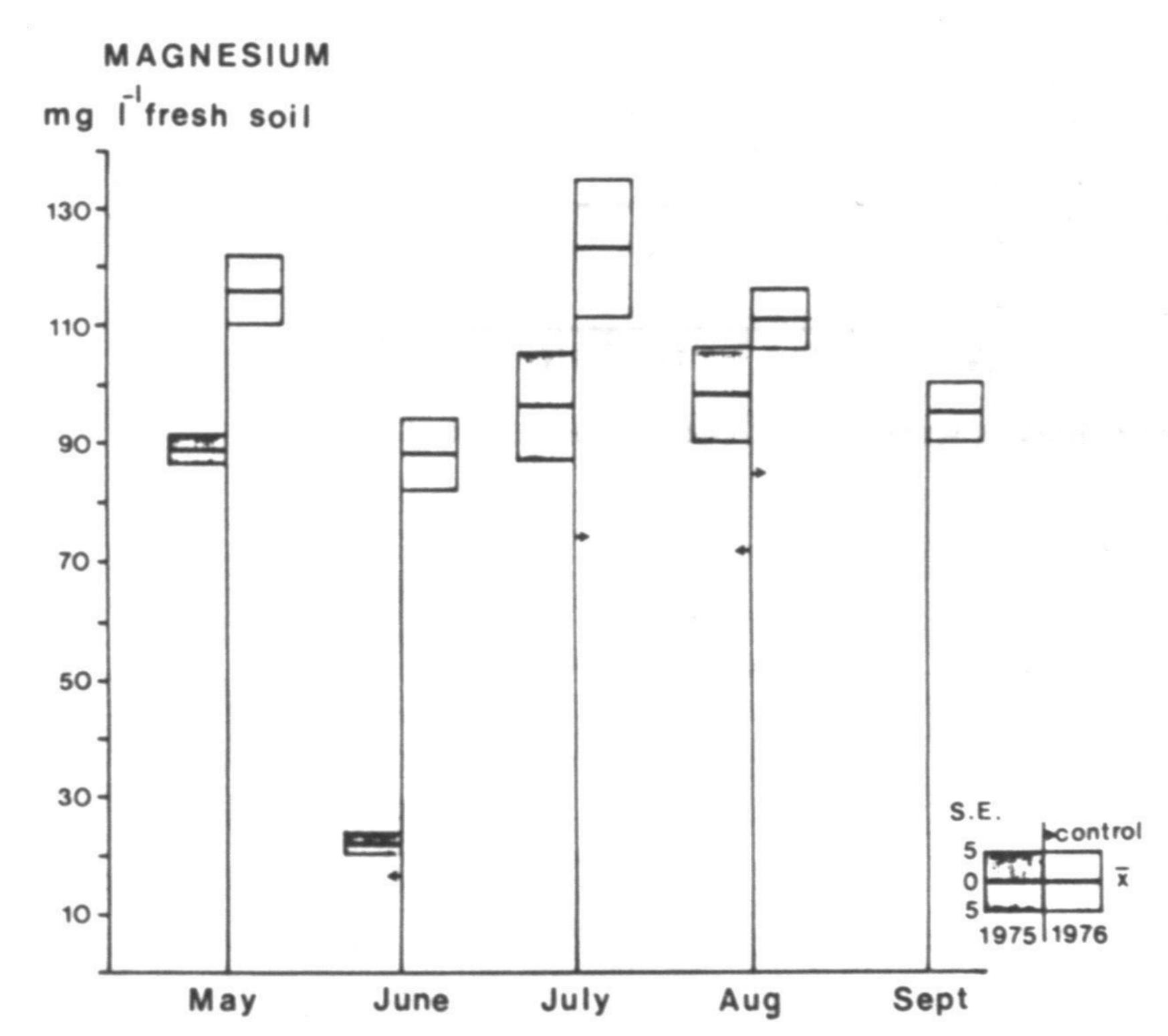


Fig. 5. The magnesium contents of the humus layer. The highest contents were found in July.

compared with the control samples and some occasional high concentrations, e.g. potassium 587 mg 1⁻¹ (figs. 4, 5 and 6).

The nutrient contents of dwarf shrub leaves increased near the industrial site as compared with the controls. The potassium contents of pollutants, e.g. sulphur and fluorine Vaccinium myrtillus and Empetrum nigrum (GUDERIAN 1977). The increase in the coll. were exceptionally high (figs 7, 8 and 9). sulphur content of plant cells is followed by

biological activity between plant and soil in concentration, which can reduce the toxicity o plant communities of boreal coniferous forests are nitrogen, calcium and potassium

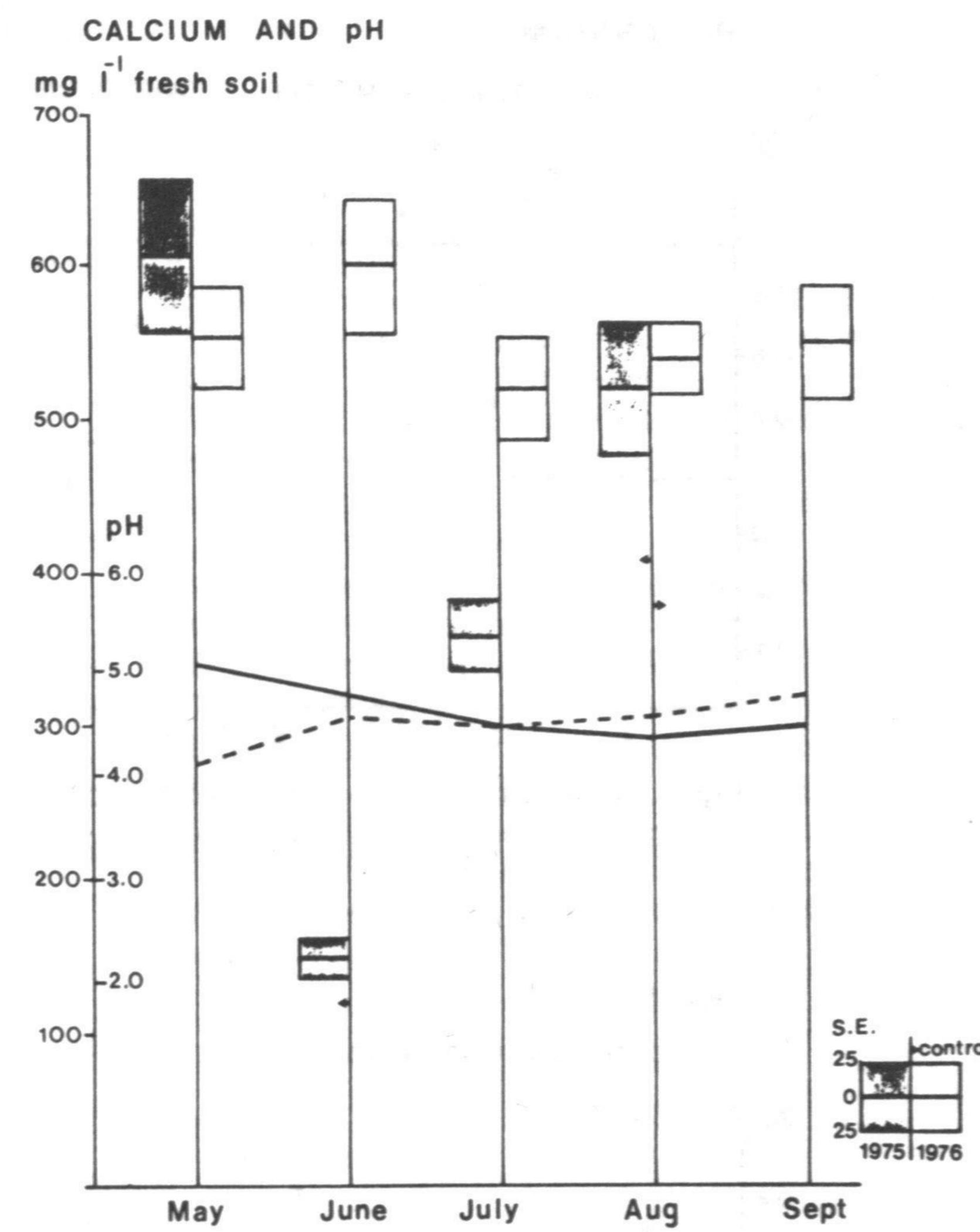


Fig. 6. The calcium contents and pH of the humus layer of the test sites during the years 1975 and 1976. The pH and calcium contents were highest in spring, which may be a consequence of the wintertime accumulation of fertilizers in the snow. The great difference between the July values is due to climatical factors.

(ROBIN and BAZILEVICHS 1967). The condition of nutrient status in plants is an indicator of the soil nutrient status. The natural mineral contents of herbs and grasses are higher than those of dwarf shrubs WILGOLASKI et al. 1975).

The results of this pilot study show that the overfertilization must have had an increasing effect on the nutrient status changes in the forest environment.

Potassium has been demonstrated to increase the plant tolerance against insects and pathogens and the tolerance of unfavourable conditions (TRESHOW 1970). Potassium and calcium have also been found to increase significantly the plant tolerance against air The main nutrients determining the an increase in the potassium and calcium sulphur in cells (KELLER and JÄGER 1980).

With the exception of some positive effects

POTASSIUM

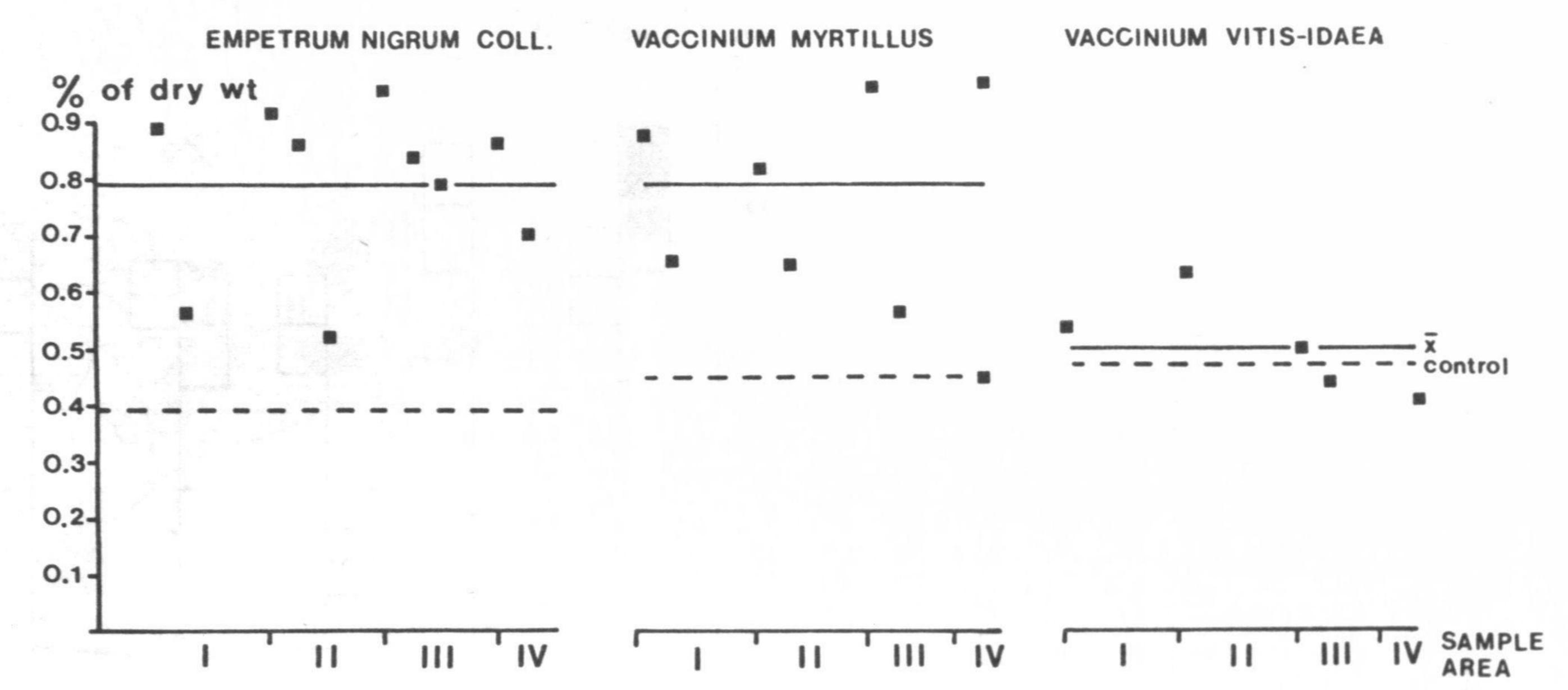


Fig. 7. The potassium contents of Vaccinium myrtillus and Empetrum nigrum coll. were exceptionally high, but that of Vaccinium vitis idaea was close to the control values.

MAGNESIUM

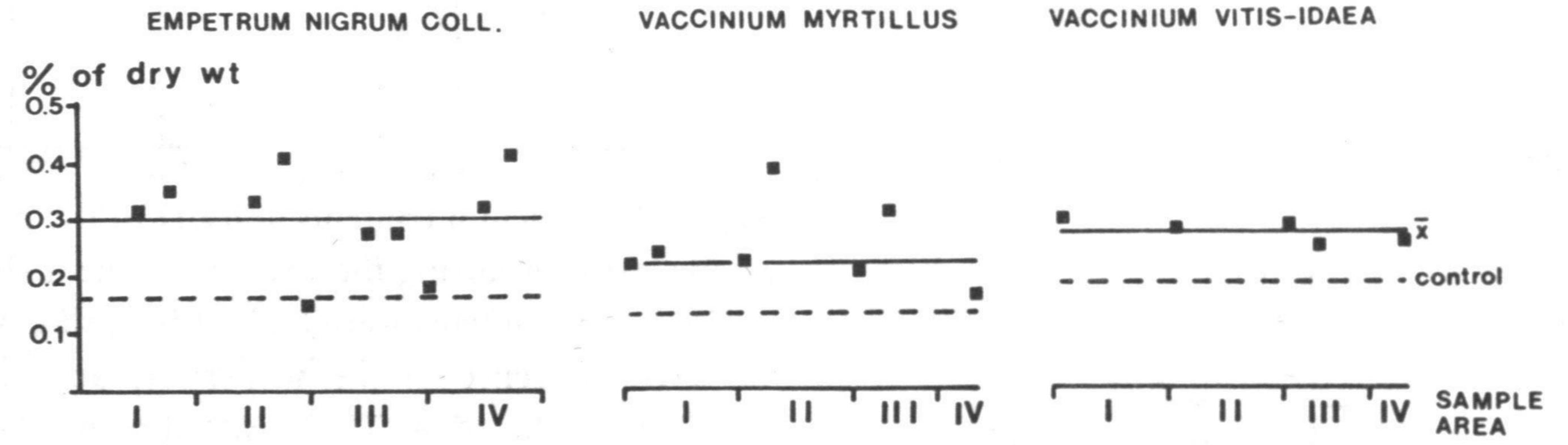


Fig. 8. The magnesium contents of dward shrub leaves were very close to the corresponding control values.

CALCIUM

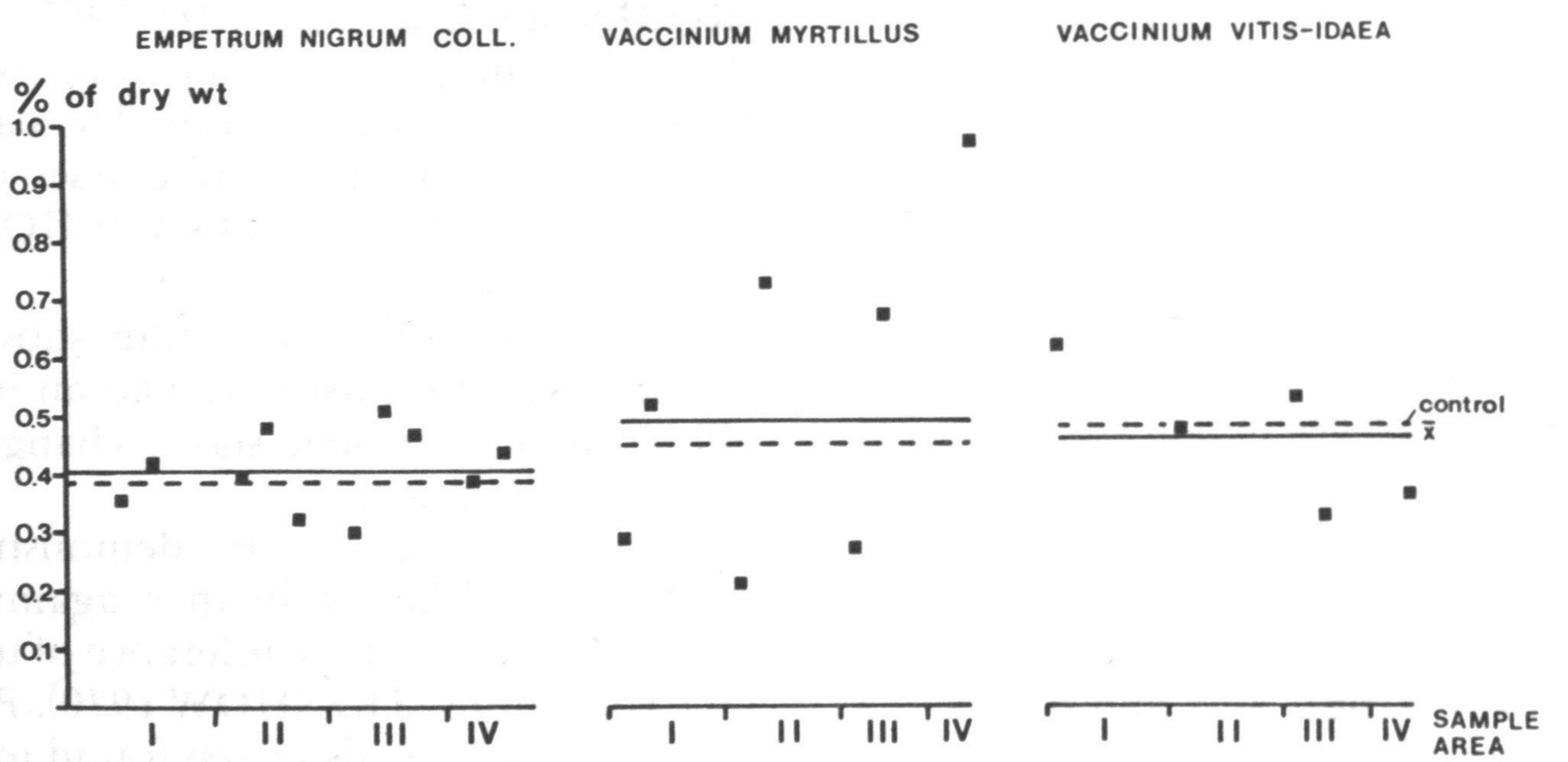


Fig. 9. The calcium contents of dwarf shrubs were close to the control values, except the great variation in Vaccinium myrtillus.

increasing tolerance, fertilization has been found to change the dominancy relationships of ground layer vegetation. An increasing nutrient status changes the competition

relationships between dwarfs and herbs and grasses. Dwarf shrubs have been found to decrease in this case, too (HUTTUNEN 1975).

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