QUANTITATIVE ANALYSIS OF GROWTH, MINERAL COMPOSITION AND ION BALANCE OF THE POTATO CULTIVAR IRENE INFESTED WITH GLOBODERA PALLIDA (STONE)

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The susceptible, late potato cultivar 'Irene' was grown in pots at a range of population densities of Globodera pallida pathotype Pa 3 in a growth room: growth and yield were not reduced by initial nematode numbers fewer than 35 eggs/g soil, whereas in glasshouse and field experiments growth and yield were decreased when more than 2 eggs/g soil were present. Growth retardation in the growth room was associated with reduced water consumption/g haulm/day and increased dry matter content of the haulms. These phenomena suggest that in the growth room only Seinhorst’s ‘second mechanism of growth reduction’ was effective and that his ‘first mechanism of growth reduction’ (the main cause for yield losses in the field) was not operating.

The concentrations of K+, NO3- and PO43- in the haulms decreased with 185 and 975 eggs/g soil. Ca2+ concentration increased with 35, 185 and 975 eggs/g soil, leading to an increased Ca/K ratio with 185 and 975 eggs/g soil, which was in accordance with the reduction of water consumption/g haulm/day, observed with the same nematode numbers. Cl- concentration was not affected by nematode attack, whereas Na+ increased with 975 eggs/g soil. The (C-A), i.e. organic anion, concentrations of plants grown with nematode densities of 185 and 975 eggs/g soil also increased by comparison with that of plants with fewer nematodes.

Mechanical damage to root tips by the nematodes probably interfered with ion uptake and ion excretion, thus modifying the mineral composition of the potato haulms and causing the phenomena associated with Seinhorst’s ‘second mechanism of growth reduction’.

Keywords: shoot/root ratio, Ca/K ratio, growth reduction, potato cyst nematode, nematode damage.

Trudgill et al. (1975a) summarized research on mineral content of potato plants attacked by nematodes and the often contradictory conclusions. Some researchers found no effect on the transport of minerals to the top of the plants, whereas others reported a decrease in mineral transport, in particular of K, P, Ca and Mg. Trudgill et al. (1975a, b, c), Trudgill (1980), Trudgill & Cotes (1983), Evans et al. (1977) and Evans (1982a, b) conclude from experiments that attack by potato cyst nematodes (Globodera rostochiensis and G. pallida) on potato plants decreased N, P and K content and increased Ca content of potato haulms (on a dry weight basis).

However, the results of the different investigations are not comparable because the nematode numbers involved were expressed in different ways: in soil at planting but in general terms (small, intermediate, large - each consisting of a wide range of nematode densities), in soil from the fallow paths.
between plots some five months after planting (introducing uncertainty because of irregular distribution of the nematodes in the field and an unknown decrease of population density between planting and sampling) and as juveniles per g root eight weeks after planting (the relation of which to numbers in the soil at planting is unknown, but is not linear (Rao & Peachey, 1965). Moreover, at large nematode densities, numbers decrease with increase in root age.

A further difficulty is that sampling for analysis was done only once or twice during the growing period. Mineral concentration in haulms changes considerably during growth (Hawkins, 1946), especially when minerals like NO₃⁻ and K⁺ are translocated because of tuber formation, and it is by no means certain that the rate of change is the same at different nematode densities. Differences in mineral concentration on a single date may, therefore, be the result of a direct effect of nematode attack or a difference in rate of growth and development of plants at different nematode population densities. Seinhorst (1979) demonstrated that the latter was the case for shoot/root weight ratios of oats attacked by *Heterodera avenae*. These ratios increased with age of plants and were larger for plants without nematodes than for those of the same age with nematodes. However, the shoot/root ratio proved to be the same for plants of the same weight, irrespective of nematode numbers.

Seinhorst (1981) proposed that growth and yield of plants attacked by tylenchid nematodes is affected by two growth reducing mechanisms operating at different levels of nematode numbers: if the effect of the ‘first mechanism’ becomes noticeable at nematode density *T* (tolerance limit) then that of the ‘second mechanism’ can be observed at densities > 16*T*. The first mechanism may reduce growth up to 90% and since hardly any mechanical damage is found, it is attributed to a hypothetical metabolic agent. The second mechanism is always accompanied by a decrease in water consumption/g haulm/day and an increase in dry matter content of the plant.

To measure the effects of nematode attack on concentrations of minerals in potato plants and to investigate whether they are related to one or both of Seinhorst’s mechanisms of growth reduction, potato plants, growing at a range of accurately known nematode densities, defined as pre-plant populations, were analysed at two week intervals for 13 weeks. At the same time, plant weight, water consumption/g plant and dry matter content were determined.

**MATERIALS AND METHODS**

The ‘soil’ used in this experiment was a mixture of 60% silversand, 30% ground earthenware and 10% clay powder to which 1 g of NPK fertilizer (12-10-18) and 100 ml of Steiner’s nutrient solution (Steiner, 1968) were added per kg soil. Two litre pots as described by Seinhorst (1966) were filled with 2 kg of the mixture gently compressed to the same volume in each pot. Water con-