Tolerance increase of tomato to root-knot nematodes in plants receiving nitrate nutrition compared to ammonium

Plant nutrition can affect nematode development indirectly by improving growth. The effect of various ratios of NH_4^+/NO_3^- in the nutrient solution on parasitism by the root-knot nematode

Meloidogyne javanica

was studied in a greenhouse in Israel. Tomato plants were grown in a hydroponic system with sand, either in plastic 0,75 L pots or in 50 L containers, fertigated with Hoagland solution in which the nitrogen was introduced as one of the three ratios of NH_4^+/NO_3^- : 100/0, 50/50 or 0/100. Seedlings were inoculated with

M. javanica

14 days after transplant and one and two months after inoculation plant samples were taken for assessment of plant biomass, leaf and root content of N, P and K and the nematode infection degree.

In the 0,75 L pots the total biomass (root+shoot) two months after inoculation was lower in the plants given 100% NH_4^+ . Inoculated plants were smaller compared to nematode-free plants, and the difference in plant weight was 20% larger in the ammonium (100/0)-fertilised plants compared to the nitrate (0/100)-fertilised plants. Although the population in number of nematodes/mm root was initially lower for the 100% NH_4^+ -fertilised plants, there was no difference between the treatments after two months.

In the 50 L containers inoculated with

M. javanica

, NH_4^+ - treated plants were less developed with more – nematode related - necrotic

symptoms compared to NO_3^-- treated plants. Infected root systems were poorly developed and discoloured, especially those of NH_4^+ - treated plants. Fresh weight biomass was severely affected by nematodes in the first month, with the most decrease in weight due to nematode inoculation in the NH_4^+ - treated plants (Figure 1). After two months this effect of N-source on the relative decrease in biomass between healthy and nematode infested plants was no longer apparent, but the absolute weight was higher for plants fertigated with 50-100% NO_3^-in the nutrient solution compared to 100% NH_4^+ -fed plants.

During the second month conspicuous differences in N, P and K content were seen between nematode-free and inoculated plants, particularly marked in the nitrate treatment: nematode-free plants had higher concentration of these elements in the top of the plants, inoculated plants showed higher concentrations in the roots. Tissue parasitized by root-knot nematodes may function as a metabolic sink, and this may explain accumulation of potassium within the galls induced by nematodes, since potassium accompanies carbohydrate anions from shoots to roots.

The results indicate that there is no difference in plant resistance to nematode attack between NH_4^+ and NO_3^- N-nutrient forms. However, a remarkable increase in tolerance to root-knot nematode damage in plants receiving nitrate nutrition was evident. This can be explained by the interrelationship between N-source in the nutrition and carbohydrate metabolism: Carbohydrates are required to prevent toxic accumulation in the roots of free ammonium for plants fed with NH_4^+ and this mechanism can only function satisfactorily when carbohydrate supply is adequate:

metabolic energy that would otherwise be used for protein or cell wall synthesis is utilized in an unproductive manner when the only supply of N is NH_4^+.This can explain why plants fertilised with NO_3^- could develop better, despite nematode infection.

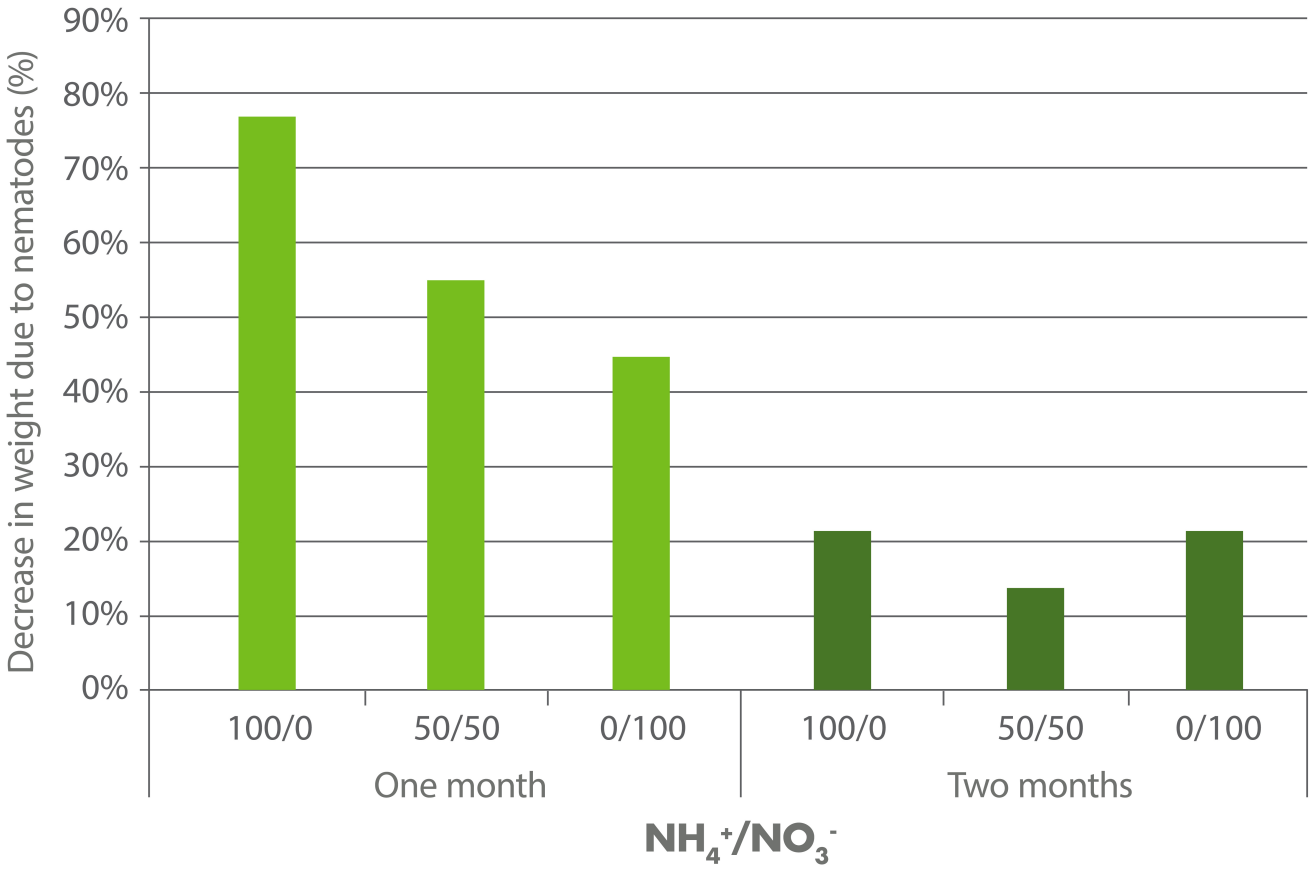

Figure 1. Relative* decrease in plant weight between

M. javanica

-infected and non-infected tomato plants, receiving ammonium and nitrate fertilisation in different ratios, one and two months after inoculation (50-liter containers, sand culture). * Based on shoot+root fresh weight: (weight non-infected – weight infected) / weight non-infected.

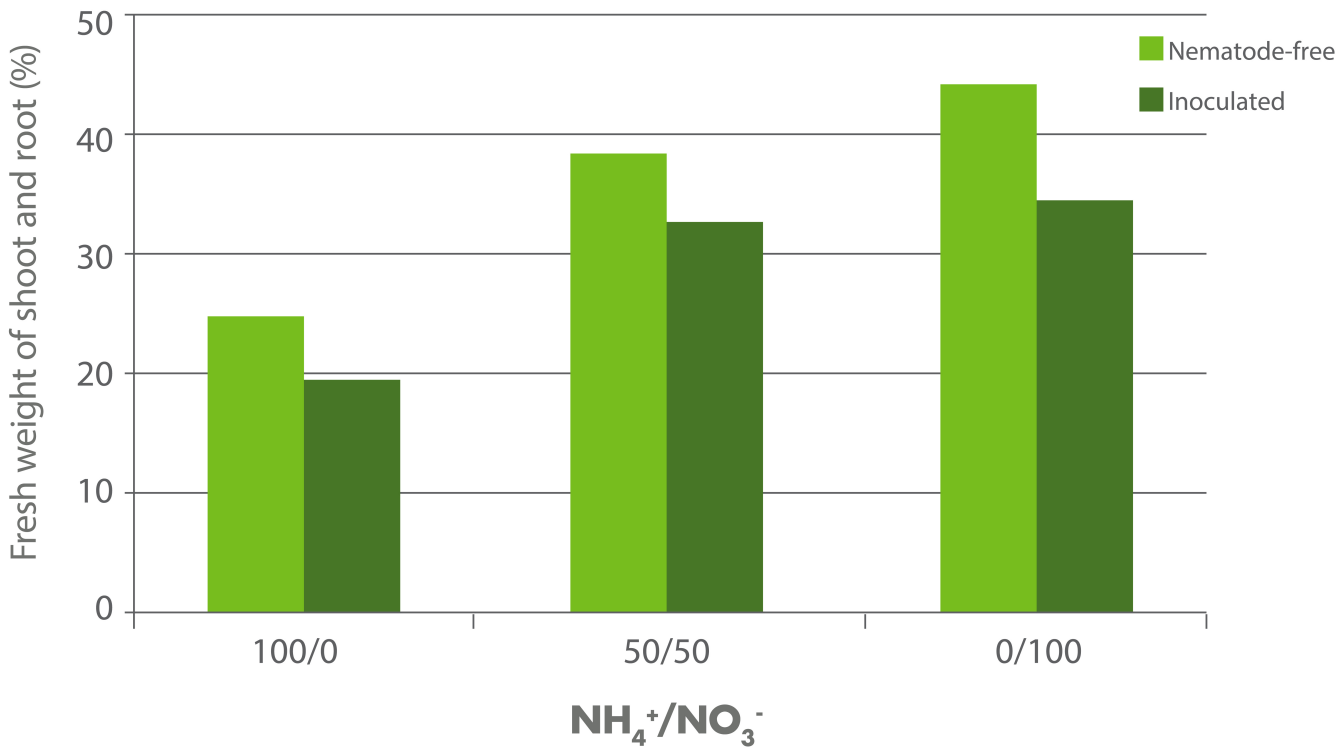

Figure 2. Plant fresh weight (shoot+root) of *M. javanica* infected and non-infected tomato plants measured two month after nematode inoculation. Plants were grown in 50 L containers receiving ammonium and nitrate fertilisation in different ratios.