Varietal Response of Tomato to the Interaction of Salinity and *Meloidogyne incognita* Infection

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Abstract: Response of tomato (*Lycopersicon esculentum* cultivars to a range of conductivity levels was tested in the presence and absence of *Meloidogyne incognita*. The conductivity levels were produced by appropriate adjustment of a 1:1 solution of sodium chloride and calcium chloride. The growth of *M. incognita* resistant ('Beefmaster' and 'Atkinson') and susceptible ('Hunts 2580' and 'Ronita') tomato plants was inversely related to soil salinity between EC_e 0 and 5 mmhos/cm. Nematode inoculation of salt-stressed plants significantly reduced plant height, fresh and dry weight, number of flowers, and fruit weight in most cultivars. In Hunts 2580, flower number and fruit weight increased; apparently flower production shifted from determinate to indeterminate, with negative implications for mechanical harvesting. Nematode reproduction on susceptible varieties also decreased with increase in salinity. *Key words: Lycopersicon esculentum,* salt stress, root-knot. Journal of Nematology 14(1):57-62. 1982.

The physiology of salt tolerance of tomato and other crops has been extensively reviewed (1,2,3). Tomato is moderately tolerant to the presence of salt in the soil from late seedling stage to maturity (2), but growth and development are affected by ionic salts in the soil (3). Yield reductions of about 10% occur at EC_e^{25} (electrical conductivity of the saturation extract of the soil at 25 C) of 3.5 mmhos/cm, and about 30% at 5.0 mmhos/cm (1).

Soil salinity is a problem in irrigated agriculture of arid and semi-arid regions. Vast areas are worthless for crop production due to salt accumulation in the rhizosphere from poor water quality, inadequate water supply, and inadequate drainage. High evapotranspiration rates of plants in these regions may lower soil matric potential and increase salt concentrations around the

Accepted for publication 4 September 1980.

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roots. The result is fluctuating osmotic and ionic effects on organisms in or around the root zone.

Considerable progress has been achieved in breeding for nematode resistance, especially in tomatoes (4,12), and reported with detailed information on seed source (9). However, nematode resistance is only one of many factors to be considered in crop selection for specific conditions. The sum of these factors contributes to the adaptability of the plant to the prevailing soil and environmental conditions of the growing region.

The role of salinity in nematode-plant interactions has been partially studied on cotton (5), salt-tolerant tomatoes (7), and sweet orange (11). In each case, as salinity increased, nematode damage increased. The objectives of this study were to investigate the response for four tomato cultivars to variable levels of soil salinity, and to determine the effect of the interaction of *Meloidogyne incognita* (Kofoid and White, 1919), Chitwood, 1949, and variable levels of salts on the growth and performance of these cultivars.

MATERIALS AND METHODS

Cultivars were selected to provide a range of nematode response and salt tolerances, based on published reports of their characteristics. Tomato seeds of *M. incognita* resistant 'Beefmaster' (Burpee Seed Co.) and 'Atkinson' (Peto Seed Co.), tolerant 'Ronita' (Peto Seed Co.), and susceptible 'Hunts 2580' (Wesson Food Co.) were germinated and grown in vermiculite in the greenhouse at 20–27 C. After 35 days, the plants were individually transplanted into 550 g steam-sterilized blowsand (78% sand, 14% silt, 8% clay) in cups lined with plastic bags. Ten days after transplanting, the soil was adjusted to EC_e levels of 0, 1.5, 2.5, 3.5, or 5.0 mmhos/cm with a 1:1 sodium chloride (NaCl):calcium chloride ($CaCl_2$) solution (8). Three days later, 400 freshly-hatched second-stage *M. incognita* juveniles/plant were added to holes around the plant roots. From germination, the plants were fertilized weekly with Hoagland's solution and pest problems were managed as necessary.

Experiments were designed in a completely randomized 2 × 5 × 2 factorial, with two tomato cultivars, five salt levels, and presence or absence of *M. incognita*. Each treatment was replicated 12 times. The experiment was run with two cultivars at a time, Hunts and Beefmaster together, and Ronita and Atkinson. Sixty days after inoculation, the experiments were terminated and plant heights, fresh weights, and root gall indices were determined. Final nematode population densities were measured by soil and root extraction. Data were analyzed for differences in main effects (nematodes and salt levels) and interactions (relative response of one stress at different levels of the others).

RESULTS

Salt-stressed plants were reduced in height as salinity was increased in all varieties tested. Increased salt concentrations significantly (P = 0.05) decreased fresh weights of Hunts and Atkinson, but not Ronita or Beefmaster (Fig. 1). The addition of nematodes decreased fresh weights of Hunts, Atkinson, and Ronita, but not Beefmaster in non-salt-stressed plants. In the presence of nematodes, salt-stressed plants were significantly smaller than noninfected plants in all varieties but Beefmaster.

Number of flowers per plant varied among varieties. Flower number of Hunts and Atkinson was not affected at low salt levels (EC_e 1.5 mmhos/cm), but decreased as salinity increased. Presence of nematodes was also associated with an increase of flower number in Hunts at all salt levels, but with a decrease in flower number in Atkinson, Ronita, and Beefmaster (Fig. 2). In nematode infested plants, increase in salt concentration had no affect on number of flowers except in Hunts, where there was a striking reduction in flower number.

Fruit weight in Hunts was significantly decreased with increase in salinity (Fig. 3), and there were greater fruit weights in salt-stressed Hunts plants in the presence of nematodes. In Beefmaster the suppressive effect of nematode infection was reduced at increased salinity levels. In Ronita there was no affect of either salt or nematodes. Atkinson produced more fruit at the low to

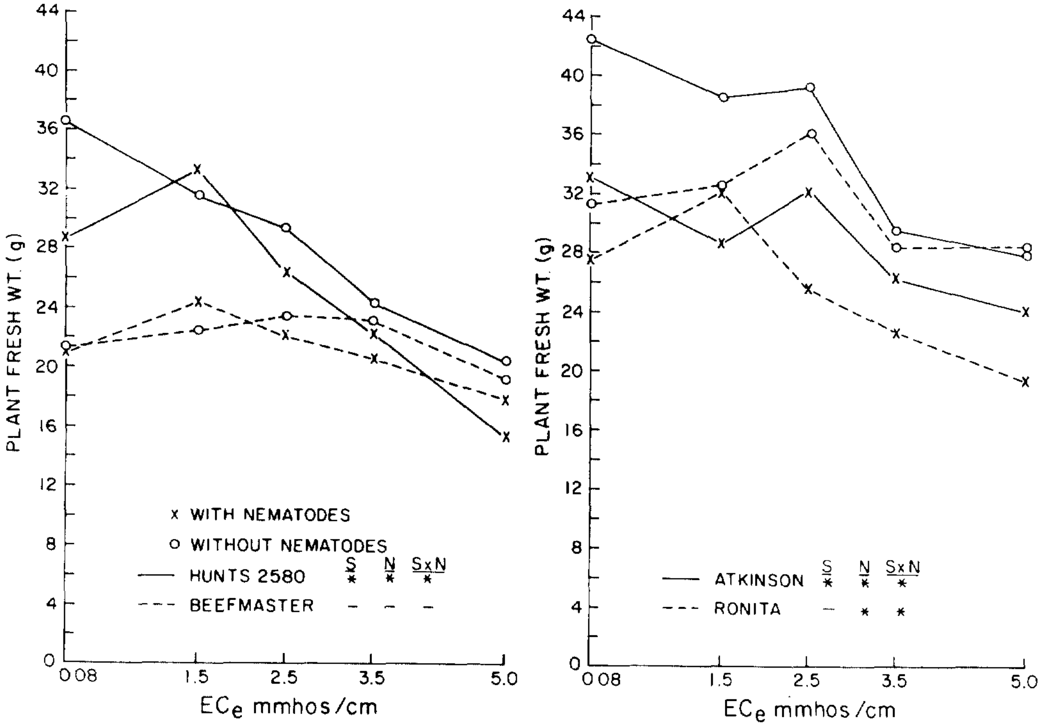

Fig. 1. Effect of salinity, *Meloidogyne incognita,* and their interaction, on fresh top weight of four tomato cultivars. S = salt; N = nematodes; S×N = salt-nematode interaction; * = significant differences ($P = 0.05$).

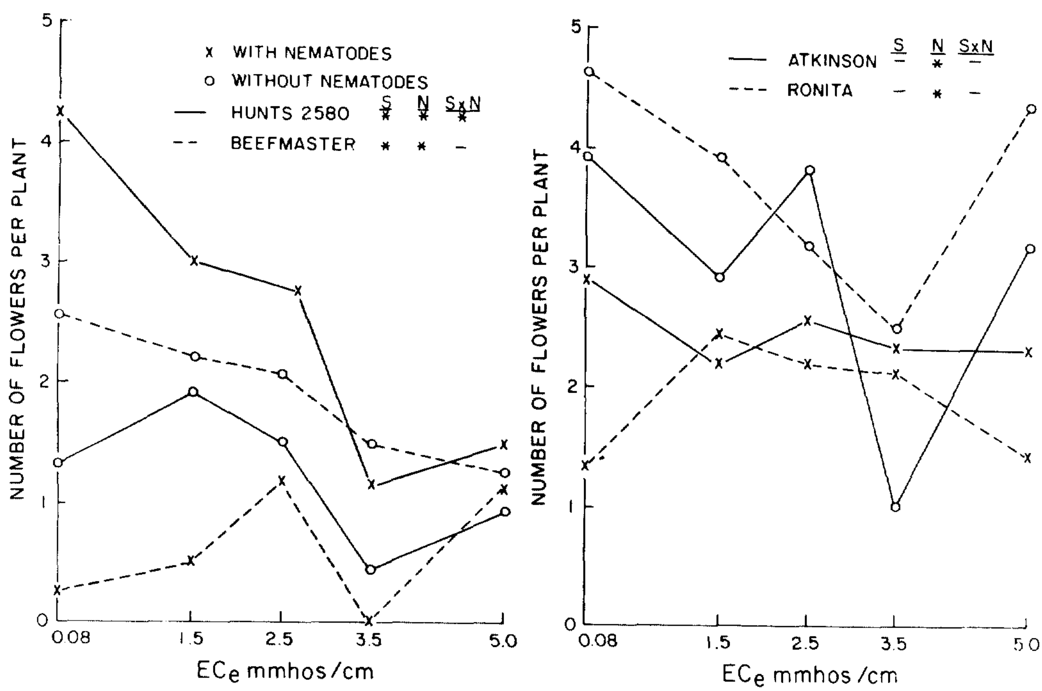

Fig. 2. Effect of salinity, *Meloidogyne incognita,* and their interaction, on numbers of flowers of four tomato cultivars. S = salt; N = nematodes; S×N = salt-nematode interaction; * = significant differences ($P = 0.05$).

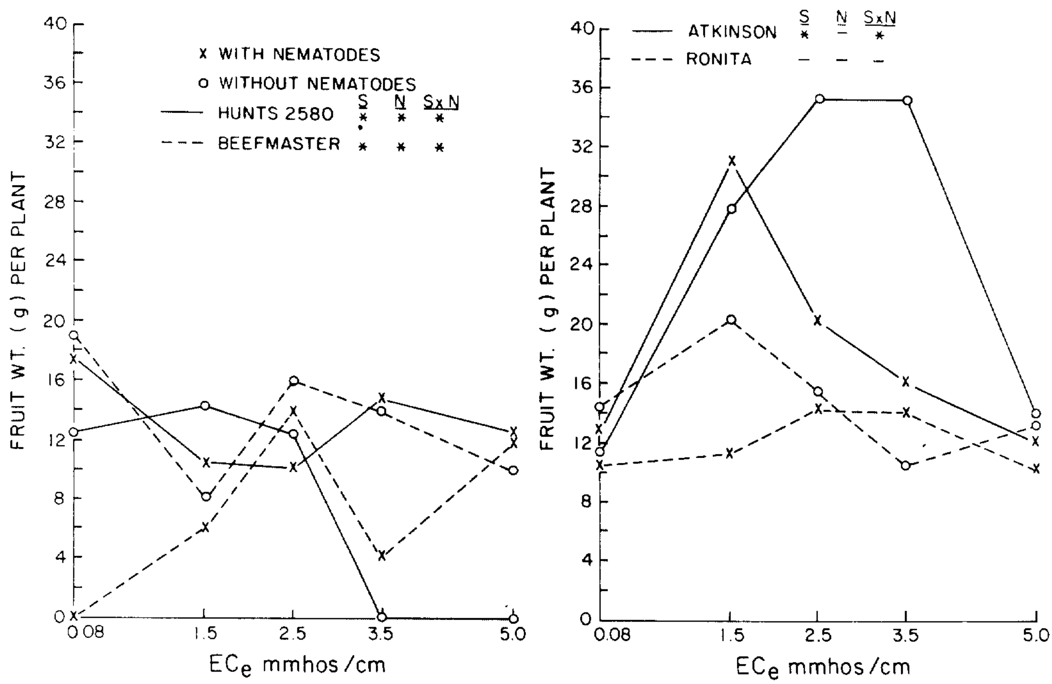

Fig. 3. Effect of salinity, *Meloidogyne incognita*, and their interaction, on fruit weight of four tomato cultivars. S = salt; N = nematodes; S×N = salt-nematode interaction; * = significant differences (P = 0.05).

intermediate salinity levels; however, the suppressive effect of nematode infection was seen at intermediate salt concentrations.

Root weights of all varieties but Ronita were significantly reduced by increased salt concentration, while root weights of Hunts and Beefmaster were significantly increased by the galling associated with nematode infection. Root weight of Ronita was increased by the nematode galling in the absence of salts, but decreased by nematodes at higher salt concentrations. Final population densities per root system were greatest in Hunts (26×10^4), compared to 11×10^4, 9.6×10^4, and 3.5×10^3 juveniles for Beefmaster, Ronita, and Atkinson respectively, in non-salt-stressed plants (Fig. 4). Final nematode densities decreased in all varieties, except Atkinson, with increase in salt concentration until a basal level was reached at about EC_e 3.5 mmhos/cm. Final nematode densities were at a low level in Atkinson at all salt concentrations (Fig. 5).

DISCUSSION

At higher salinity levels, plants were stunted with succulent dark green leaves, resulting in the reduction of fresh and dry weights of the shoot. Nematode damage was generally more evident at higher salinity levels where conditions were unfavorable for plant growth, as reported elsewhere (5,7,11). However, such conditions were also unfavorable for the nematode, resulting in lower final population densities. The responses were not uniform in all varieties tested.

Hunts was unique among varieties in producing more flowers in the presence of nematodes at all salt concentrations than in the absence. A possible explanation is that infection of Hunts by *M. incognita* induced the expanded inflorescences to become indeterminate. Similar effects have been reported for *Trichodorus christiei* on Rutgers tomato (6). The increased number of flowers resulted in greater fruit weight for Hunts. However, Hunts is a cultivar selected for mechanical harvesting where determinate flowering, uniform fruit production, and ripening are important. The increased

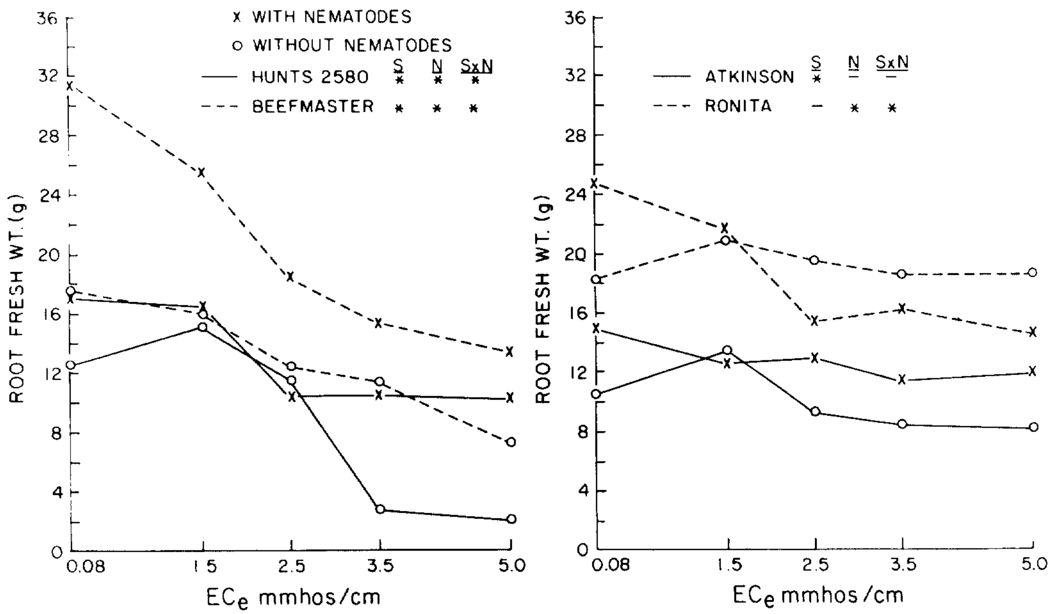

Fig. 4. Effect of salinity, *Meloidogyne incognita,* and their interaction, on fresh root weight of four tomato cultivars. S = salt; N = nematode; S×N = salt-nematode interaction; * = significant differences ($P = 0.05$).

yields would not be realized at a single harvest in the field, underscoring the danger of general extrapolation from greenhouse results. In Beefmaster, the presence of salts and nematodes resulted in abortion of most of the flowers and reduced tomato production.

Salts may function as stimulant or depressant factors to various physiological functions of the plant, especially when combined with other stressful agents, such as nematodes. At lower concentrations, they may stimulate vegetative growth. In general, plant growth and yield was reduced

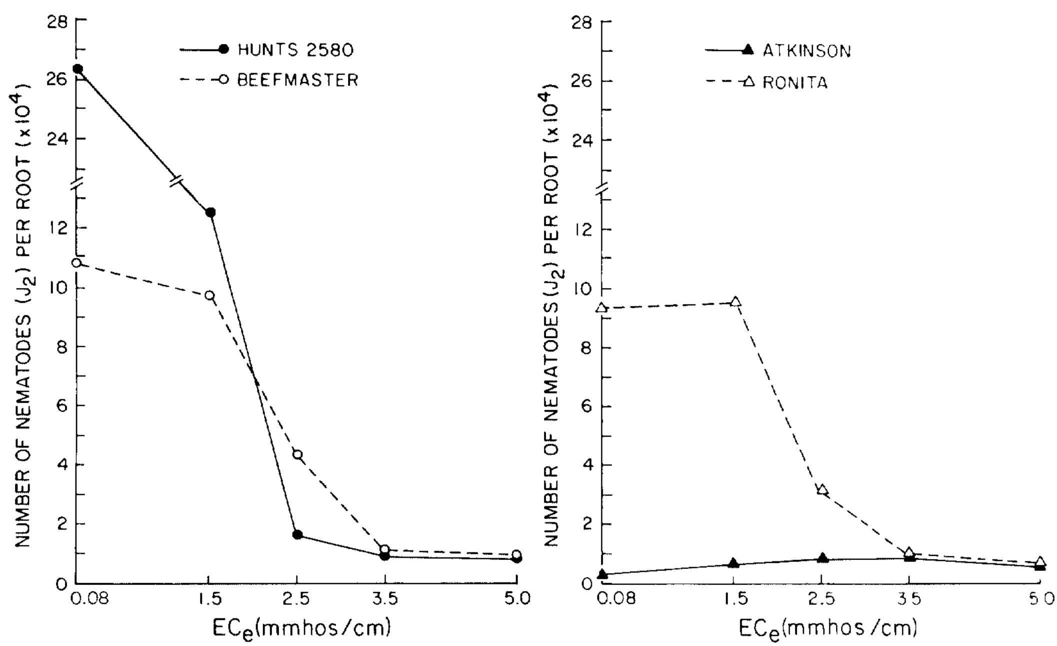

Fig. 5. Effect of salinity on numbers of *Meloidogyne incognita* recovered per root of four tomato cultivars. S = salt; N = nematode; S×N = salt-nematode interaction; * = significant differences ($P = 0.05$).

very little in the absence of nematodes and at salt concentrations at or below EC_e 2.5. However, where nematodes affected vegetative plant growth, reductions were seen at lower salt concentrations.

The root-knot nematode (*M. incognita*) reproduced on all four cultivars, although only marginally on Atkinson, regardless of the presence or absence of salts. The cultivars ranked according to their suitability as hosts were Hunts, which supported the highest nematode reproduction, Beefmaster, Ronita, and finally Atkinson, on which the nematode increase was low. Interestingly, over a period of several years during which these and related experiments were conducted, the population of *M. incognita* cultured in our greenhouse improved in its ability to develop and reproduce on Beefmaster. During early experiments, Beefmaster showed considerable resistance to the population, as reported elsewhere (10). After several generations of reculturing from Beefmaster roots, a population was selected which increased on the Beefmaster cultivar. There was no selection for virulence to Atkinson.

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