NOTAS DE INVESTIGACIÓN - RESEARCH NOTES

EFFECT OF THE PREVIOUS CROP ON POPULATION DENSITIES OF *MELOIDOGYNE JAVANICA* AND YIELD OF CUCUMBER

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RESUMEN

Ornat, C., S. Verdejo-Lucas y F. J. Sorribas. 1997. Efecto del cultivo previo sobre la densidad de población de *Meloidogyne javanica* y la producción de pepino. Nematrópica 27:85-90.

El efecto del cultivo previo de tomate resistente o susceptible a *Meloidogyne* spp. sobre la producción de pepino Dasher II fue determinado en un invernadero comercial infestado por *Meloidogyne javanica.* Las densidades de población del nematodo cuando se plantó el pepino eran de 3 y 1 137 juveniles/250 cm^3 suelo en las parcelas plantadas previamente con tomate resistente y susceptible, respectivamente. La producción de pepino en las parcelas que habían sido cultivadas previamente con tomate resistente fue de 5.1 kg/m^2, mientras que en las parcelas donde se había cultivado tomate susceptible fue de 3.2 kg/m^2. El incremento de producción del 60% fue obtenido probablemente por las bajas densidades de población del nematodo que quedaron después del cultivo del tomate resistente.

Palabras claves: *Cucumis sativus*, gen de resistencia Mi, *Lycopersicon esculentum*, manejo, nematodo agallador, resistencia, rotación cultural, susceptibilidad, tomate.

Cucumber (*Cucumis sativus* L.), an important vegetable crop in Spain, is grown on some 6 700 ha, of which more than 50% are under protected cultivation. Total production exceeds 300 000 tons per year, a third of which is exported to foreign markets (Mapa, 1993). Cucumber is a major component of the multiple cropping systems common in plastic polytunnel greenhouses of coastal areas in northeast Spain (Sorribas and Verdejo-Lucas, 1994). In these coastal areas, two to three crops are grown on the same land in a growing season, leaving little time between crops. Cucumber is cultivated in summer, after a spring tomato (*Lycopersicon esculentum* Mill.) crop and before an autumn-winter lettuce (*Lactuca sativa* L.) crop. Cucumber is overlapped with tomato to save time and labor because the same canes are used for vertical support of both tomato and cucumber.

Cucumber is highly susceptible to *Meloidogyne* spp., and considerable plant damage and yield loss occur worldwide. For instance, root-knot nematodes are the most economically important cucumber disease in North Carolina (St. Amand and Wehner, 1991). Nematicides are often used in Louisiana to control the nematode on cucumber (Hanna *et al.*, 1994), but in Hungarian greenhouses, cucumbers are damaged considerably despite the use of nematicides (Budai, 1994). In Spain, cucumbers are frequently attacked by root-knot nematodes, especially *Meloidogyne incognita* Kofoid & White, *M. arenaria* (Neal) Chitwood, and *M. javanica* (Treub) Chitwood (Cenis, 1987; Esparrago and Navas, 1995; Frapolli-Daffari *et al.*, 1995; Millan de Aguirre, 1989; Rodríguez-Rodríguez *et al.*, 1983; Verdejo-Lucas *et al.*, 1994). Fumigant and non-fumigant nematicides increased yield of cucumber but did not control root-knot nematodes in greenhouses in the Canary Islands (Rodríguez-Rodríguez *et al.*, 1983, 1984).

Control of root-knot nematodes has been based on the use of chemicals; however, increasing environmental concerns and government regulation of agricultural chemicals have contributed to an increased emphasis on other nematode control measures. Crop rotation is an old and very important management practice used to minimize the impact of plant-parasitic nematodes in annual crops. Generally, the degree of control is based on the level of susceptibility and resistance of the crops involved and the cropping sequence (Trivedi and Barker, 1986). One of the most cost-effective nematode control measures is the use of resistant plant cultivars, but there is no commercial cucumber cultivar available with resistance to root-knot nematodes. The African horned cucumber (*Cucumis metuliferus* Naud) is resistant but not immune to *M. arenaria, M. javanica,* and *M. incognita* (Dalmasso *et al.*, 1981; Walters *et al.*, 1993; Wehner *et al.*, 1991). However, interspecific hybridization to transfer root-knot nematode resistance to the cultivated cucumber has not been achieved so far, possibly due to difficulties with cross incompatibilities (Deakin *et al.*, 1971; Fassuliotis, 1979). Cucumber and other cucurbit crops could be protected by including resistant crop cultivars in the rotational sequence to reduce population densities before planting the susceptible cucurbit crop. The objective of this study was to evaluate the effect of planting Mi-resistant tomato cultivars before cucumber to reduce root-knot nematode population densities and damage to cucumber.

The study was conducted in summer 1995 in an unheated plastic greenhouse of 2 600 m^2 located in Cabrera, Barcelona, Spain. This greenhouse was selected because vegetable crops grown in it had a history of root-knot nematode problems (Ornat and Verdejo-Lucas, 1994). Greenhouse soil was infested by *M. javanica,* identified according to its esterase phenotype (Davies and Beadle, 1995). Soil texture was a sandy loam (69% sand, 19% loam and 12% clay), with a pH of 7.1. The site was treated with methyl bromide on 11 February 1994 and with nonfumigant nematicides during the year. Crop sequence in 1994 was susceptible tomato-cucumber-lettuce.

Seedlings of the Mi-resistant tomato cv. Nikita and of the susceptible cv. Medea were transplanted when they had the third true leaf on 28 February 1995. Plant spacing within rows was 42 cm, and 1 m between rows (2.4 plants per m^2). Plants were vertically trained by tying the plants to canes. Nematode population densities (juveniles per 250 cm^3 soil) were 36 on Medea and 102 on Nikita on 28 February 1995, but changed to 132 following Medea and 7 following Nikita on 8 August 1995.

The experimental design was a randomized block design with two experimental units (plots) of 27 m^2 (6.8 × 4 m) per block and eight replications. Plots with either resistant or susceptible tomatoes had been marked in spring before planting tomatoes. Seedlings of cucumber cv. Dasher II were transplanted when they had the third true leaf on 18 July 1995, and cucumber plants were placed in between the old tomato plants in the same rows in which resistant and susceptible tomatoes were previously grown, but one out of every two rows was left free of plants. Plant spacing within rows was 42 cm and there was 1 or 2 m between alternate rows. The old tomato plants were cut 3 weeks later, and roots were left in the ground. Cucumber plants were vertically trained using the same canes that supported the tomato plants, and watered by drip irrigation. Soil samples consisting of five cores (2.5-cmdiam. × 30-cm-deep) were collected from each plot at planting and 14 weeks later to determine nematode densities. Soil cores were mixed thoroughly and a 500-cm^3 soil subsample was used for nematode extraction on Baermann trays. Nematodes migrating into the clean water were collected one week later, concentrated on a 25-mm sieve, and counted. Following sampling for final nematode densities, 10 cucumber root systems were removed from each plot and rated for galling on a scale of 0 to 10 where 0 = complete and healthy root system, no infestation, and 10 = plant and roots are dead (Zeck, 1971).

To determine cucumber yield, fruits produced by 10 plants from the 2 center rows of each plot were harvested as they reached marketable size. Cucumbers were harvested 3 times per week between 28 August and 23 October 1995. Fruits were counted, weighed, and yield was expressed as kilogram per m^2. The greenhouse was managed by a commercial grower, therefore the resulting information represented grower conditions. Data were subjected to analysis of variance, and means separated by Tukey's Test ($P \leq 0.05$).

Total yield and the number of fruit per plant of cucumber planted after the Mi-resistant tomato cv. Nikita were higher ($P \leq 0.05$) than after the nematode susceptible tomato cv. Medea (Table 1). The average fruit weight did not differ between treatments. Significant differences in yield between treatments were observed in the 3rd and following weeks of harvest (Fig. 1). Cucumber plants stopped producing marketable fruit 6 weeks after the initial harvest in plots following susceptible tomato, while cucumbers remained productive for 3 additional weeks in plots following resistant tomato (Fig. 1).

Final population density of *M. javanica* on cucumber was 3.4 times higher following the susceptible than the resistant tomato cultivar, but the Pf/Pi relationship decreased in plots that had the susceptible tomato, and increased in plots preceded by the resistant tomato (Table 1). Cucumbers grown after the resistant tomato showed lower ($P \leq 0.05$) root galling than those cropped after the susceptible tomato (Table 1). The senescence of cucumber plants was quicker when preceded by susceptible rather than resistant tomato; 20% of the cucumbers were fully senescent at the last harvest in plots following susceptible tomato (data not shown). Population densities before planting cucumber after the susceptible tomato were high enough to explain the poor performance of

Table 1. Effect of the previous tomato cultivar on cucumber yield, fruit number, and weight, and on initial density (Pi), final density (Pf), and root gall index of *Meloidogyne javanica* on cucumber.

Previous tomato cultivar	Total yield (kg/m^2)[x]	No. fruits/ plant[x]	Average fruit weight (g)[x]	Juveniles/250 cm soil[y] Pi	Pf	Root gall index[x,z]
Nikita (resistant)	5.1 ± 0.5	12 ± 2	274 ± 6	3 ± 9	248 ± 190	2.3 ± 1.2
Medea (susceptible)	3.2 ± 0.4*	7 ± 1*	268 ± 13	1,137 ± 900	846 ± 430	7.9 ± 1.4*

[x]Data are mean values ± standard deviations of 10 plants from 8 replications.
[y]Data are mean values ± standard deviations from 8 replications.
[z]Based on scale from 0 (none) to 10 (severe).
*Indicates differences between means in column according to Tukey's test ($P \leq 0.05$).

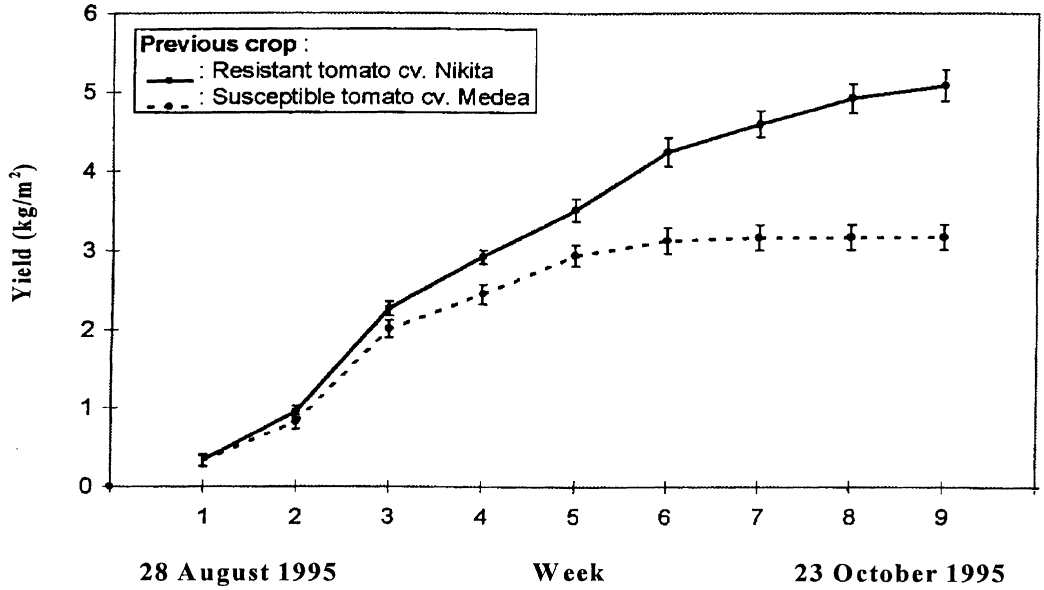

Fig. 1. Accumulated yield over a 9-week harvesting period of cucumber cv. Dasher II planted after a root-knot nematode-resistant (solid line) or a susceptible (broken line) tomato cultivar in a plastic polytunnel greenhouse infested by *Meloidogyne javanica*. Values are means ± standard deviations of three harvests per week for 9 weeks from eight replications.

cucumber in these plots. The damage to cucumber plants probably accounted for Pf < Pi following the susceptible tomato, since population densities will decline rapidly once plants are severely damaged (Barker and Olthof, 1976).

Since root-knot nematode damage is more frequent and severe in greenhouses than in open-air cultivated fields in northeast Spain, greenhouse crops must be protected from nematode damage (Ornat and Verdejo-Lucas, 1994; Sorribas and Verdejo-Lucas, 1994). Double cropping cucumber with nematode-resistant cultivars has been shown to be a feasible alternative to chemical control for improving cucumber yield in root-knot nematode-infested soil (Hanna *et al.*, 1993, 1994). The results of this study suggest that this approach can also be effective in plastic polytunnel greenhouses infested with *Meloidogyne* spp. The use of a resistant tomato cultivar as the preceding crop in the same season reduced damage caused by root-knot nematodes to cucumber and improved plant performance. This result was likely due to the lower population densities following the resistant tomato. Tomato cultivars carrying the *M. incognita* resistance gene are resistant but not immune to other *Meloidogyne* spp. and permit reduced nematode reproduction (Table 1) (Roberts and Thomason, 1986). Therefore, the use of nematicides in combination with resistant cultivars may be needed in some double or triple cropping systems to reduce population densities below an economic damage threshold.

In summary, this study indicated the importance of introducing a genetically resistant crop into the crop rotation sequence in order to reduce population densities of nematodes and their effect on plant performance of a subsequent susceptible crop. Additional research is needed to optimize cultural methods of control for crop performance in root-knot nematode infested soil in multiple cropping systems.

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