Managing nematodes in sweet potatoes with resistance and nematicides

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Most of California's sweet potato production acreage is in the central San Joaquin Valley. The crop is grown primarily on sandy soils, in which root-knot nematodes (*Meloidogyne* spp.) are commonly distributed and where they are most likely to cause loss of yield.

Two strategies for root-knot pest management are currently employed to ensure a good yield. The first is preplant soil fumigation with materials containing 1,3-Dichloropropene (DD, Telone II). Fumigation, when applied by recommended procedures and conditions, generally provide excellent nematode control on these coarse-textured soils, and it is widely used over much of the sweet potato acreage. The second strategy, used almost entirely in conjunction with soil fumigation, is the use of cultivars resistant to root-knot nematode, a number of which are available to California growers. Some resistant sweet potatoes, such as 'Jewel' and 'Garnet', have been grown for many years while others, such as 'Eureka', have become available more recently (*California Agriculture*, January-February 1982). The breeding programs in North and South Carolina, Louisiana, and other states select for root-knot nematode resistance, and most new releases have moderate to high resistance to one or more species and races of *Meloidogyne*. However, sweet potatoes without resistance to root-knot, such as 'Jersey', are still widely grown.

From 1979 to 1982, we conducted field trials at Livingston, California, to compare alternative and additional nematicide treatments with standard fumigation treatments and to evaluate, under local conditions, the nematode resistance and commercial potential of improved clones and new cultivars received from breeding programs.

Stubby-root nematodes (*Paratrichodorus* and *Trichodorus* spp.), ectoparasitic nematodes that are also common in sandy soils, were monitored for effects on sweet potato root development, although they are not considered in the breeding programs.

Chemical evaluations

In 1979, several nematicide, nematicide/insecticide, and insecticide treatments were compared with 1,3-Dichloropropene-fumigation and non-treated checks on a site heavily infested with *Meloidogyne incognita*, and with low levels of wireworms (Elateridae), using the root-knot-susceptible cultivar 'Jersey' (table 1). Soil fumigation with DD gave significantly higher yield than the untreated check or the other treatments, including DD in combination with Dyfonate, Diazinon, or Lorsban.

Numbers of root-knot second-stage juveniles (J2) per 250 cubic centimeters of soil at harvest averaged 1,644 for the DD treatment, compared with 3,737 for the untreated check, indicating that a significant reduction in root-knot population had occurred following fumigation but that reproduction of the residual population on susceptible 'Jersey' resulted in population densities that would be damaging in the next season.

The nematicide/insecticides Dasinit (both disc- and Rototill-incorporated) and Temik improved yields when compared with the untreated check but were significantly inferior to soil fumigation.

Resistance

During three seasons in 1980 to 1982, we evaluated advanced clones and cultivars for yield on field sites infested with various levels of *Meloidogyne incognita* (high in 1980 and 1981; low in 1982). Replicated blocks were split into randomly assigned preplant fumigated (with DD or Telone II) and nonfumigated treatments, and the clones and cultivars were randomized across each block. Tables 2 and 3 summarize sweet potato yield and nematode population development in 1981 and 1982, respectively, which represent different climatic conditions and different nematode infection pressures.

In 1981 all tested clones and cultivars showed a dramatic increase in yield in response to preplant fumigation with Telone II (table 2). The significant yield increases were greatest in the No. 1 grade and less pronounced in the canner and jumbo grades. The response in yield varied from 41.7 to 72.3 percent for the different clones and cultivars, and indicates the variable sensitivity of the sweet potato cultivars to infection by root-knot nematode, the predominant nematode parasite in this case.

The final numbers of root-knot nematodes in the rhizosphere soil at harvest (table 2) and in the feeder roots (not shown) indicate that considerable infection and reproduction by this nematode occurred on all sweet potato clones and cultivars during the season, although, as found with yield, the amount of reproduction varied among sweet potato types. For example, reproduction on W-152 was much less than on 'Pope'.

The effect of fumigation on the nematode population was revealed by numbers of 9 and 172 root-knot nematodes (J2) per 250 cubic centimeters of soil in fumigated and nonfumigated plots, respectively, assessed following fumigation but before planting, a trend that was still detectable at harvest time (table 2). The poor yield and large increases in root-knot nematode numbers that occurred on these nonfumigated sweet potatoes, all of which have moderate to high root-knot resistance, probably reflect the above-normal temperatures in 1981, when soil temperatures above 30°C occurred at times. High temperatures are known to reduce the effectiveness of resistance to root-knot in sweet potato.

By contrast, in 1982, at a site with preplant, post-fumigation root-knot nematode J2 levels of 0 and 6 per 250 cubic centimeters of soil in fumigated and nonfumigated plots, respectively, infection and reproduction were minimal on 'Jewel' and even less on other sweet potatoes (table 3). The very high temperatures of 1981 were not recorded in 1982, and resistance remained effective. However, significant responses of increased yield following fumigation were recorded for most cultivars. In this test, stubby-root nematodes may have affected yield in nonfumigated plots. The host preference of stubby-root nematodes for 'Eureka', as shown by significantly higher final population levels on this cultivar (also found in 1981, see table 2), may be responsible for the relatively poor yield of 'Eureka' in 1982 (table 3) when root-knot infection was low.

TABLE 1. Comparisons of 'Jersey' sweet potato yields following different nematicide and insecticide treatments, Livingston, California, 1979

Treatment	Rate a.i./acre	Yield (T/ha)* U.S. No. 1	Canners	Total marketable (U.S. No. 1 + canners)
DD (broadcast)	21 gal	6.4 a‡	3.0 b	9.4 a
DD† + Dyfonate	4 lb	4.5 b	3.6 a	8.1 b
DD† + Diazinon	4 lb	5.1 b	2.3 bc	7.4 b
Dasinit (disced)	7 lb	4.1 bc	2.1 bc	6.2 c
DD† + Lorsban (rototilled)	2 lb	3.3 bcd	2.6 bc	5.9 c
DD† + Lorsban (disced)	2 lb	2.3 cd	3.5 a	5.8 c
Temik (sidedressed)	3 lb	4.0 bc	1.6 c	5.6 c
Dasinit (rototilled)	7 lb	3.7 bcd	1.9 bc	5.6 c
Untreated control	—	1.8 d	1.7 c	3.5 c

* T/ha (metric tons per hectare) × 0.3983 = tons per acre.
† In combined treatments, DD applied at 21 gallons per acre.
‡ Within a column, values followed by same letter are not significantly different (P=0.05).

TABLE 2. Comparisons of sweet potato yields and final nematode population densities at Livingston, California, 1981

Entry	Nematicide treatment	Yield (T/ha) U.S. No. 1	Canner	Jumbo	Culls	Total yield†	Response to fumigation for total yield‡	Densities/250 cubic cm soil: *Meloidogyne incognita* 2nd-stage juveniles	*Paratrichodorus minor*
Pope	+	13.5 a§	5.8 abc	2.0 ab	0.3 a	21.6 a	—	523 b	18 bc
	−	7.5 bc	5.0 bc	0.0 b	0.1 a	12.6 bc	41.7	3,426 a	12 bc
Jewel	+	14.1 a	6.0 abc	3.4 a	0.1 a	23.6 a	—	1,102 b	3 c
	−	4.6 cd	5.5 abc	0.0 b	0.1 a	10.2 c	56.8	2,011 ab	2 c
Garnet	+	9.7 ab	7.4 ab	3.2 a	0.2 a	20.5 a	—	598 b	18 bc
	−	2.7 d	4.2 cd	0.0 b	0.4 a	7.3 c	64.4	3,968 a	27 b
NC-719	+	11.5 ab	7.7 a	0.0 b	0.0 a	19.2 a	—	319 b	14 bc
	−	1.5 d	5.2 abc	0.1 b	0.0 a	6.8 c	64.6	630 b	11 bc
Eureka	+	11.7 ab	4.1 cd	1.6 ab	0.4 a	17.8 ab	—	949 b	62 a
	−	3.8 cd	2.3 d	0.0 b	0.1 a	6.2 c	65.2	3,452 a	16 bc
W-152	+	10.1	8.6	2.6	0.7	22.0	—	149	11
	−	1.2	4.9	0.0	0.0	6.1	72.3	911	3

* +, 12.5 gal/acre Telone II broadcast; −, no treatment.
† U.S. No.1's + Canners + Jumbos + Culls.
‡ Response for total yield calculated as (Treated − Nontreated/Treated) × 100.
§ Within a column, values followed by same letter are not significantly different (P=0.05). W-152, with two replicates, was not included in statistical analyses.

TABLE 3. Comparisons of sweet potato yields and final nematode population densities at Livingston, California, in the San Joaquin Valley, 1982 (Trial III)

Entry	Nematicide treatment	Yield (T/ha) U.S. No. 1	Canner	Jumbo	Culls	Total yield†	Response to fumigation for total yield‡	Densities/250 cubic cm soil: *Meloidogyne incognita* 2nd-stage juveniles	*Paratrichodorus minor*
Garnet	+	13.2 cde§	7.4 de	3.7 a	3.9 ab	28.2 bcd	—	0 a	20 c
	−	10.6 de	5.1 e	2.2 abcd	3.9 ab	21.8 de	22.7	0 a	55 bc
Jewel	+	26.7 a	11.3 bc	3.1 ab	2.1 bc	43.2 a	—	27 a	17 c
	−	20.5 ab	9.3 cd	1.4 bcd	1.9 bc	33.1 bc	23.4	49 a	33 c
Pope	+	18.1 bc	9.9 cd	2.7 abc	3.2 abc	33.9 b	—	0 a	19 c
	−	11.3 de	9.5 cd	0.7 cd	2.5 abc	24.0 cde	29.2	1 a	45 bc
W-152	+	26.6 a	15.7 a	1.4 bcd	1.3 c	45.0 a	—	0 a	18 c
	−	14.8 bcd	13.7 ab	0.3 d	1.1 c	29.9 bcd	33.6	1 a	24 c
Eureka	+	11.6 cde	9.1 cd	0.2 d	4.4 a	25.3 bcde	—	1 a	173 a
	−	6.9 e	6.5 de	0.0 d	2.8 abc	16.2 e	36.0	1 a	103 b

* +, 19 gal/acre DD broadcast; −, no treatment
† U.S. No. 1's + Canners + Jumbos + Culls.
‡ Response for total yield calculated as (Treated - Nontreated/Treated) × 100.
§ Within a column, values followed by same letter are not significantly different (P=0.05).

Discussion

Yield summaries of copper-skinned sweet potatoes over three years of testing showed that 'Jewel' yielded consistently more than both 'Pope' and 'Eureka'. 'Pope' has been reported to yield as well as and better than 'Jewel' in other states. It can be advantageous to grow 'Eureka' in fields with soil rot (pox) because of its good resistance to this pathogen. Red-skinned 'Garnet' yielded well overall, but red-skinned W-152 produced greater yields than 'Garnet', particularly on fumigated soil. W-152 may have commercial potential for California conditions. Oklamex and LS-19 (tested in 1980) and NC-719 were not retested after one year because of poor yield or quality characteristics or both.

Damage in appearance (cracking) of storage roots, a common symptom in root-knot-susceptible cultivars, was not found on any of the resistant sweet potatoes that we tested, even in 1981. This is an obvious benefit of the nematode resistance character. However, the sensitivity to root-knot infection, shown by poor yield of all these resistant sweet potatoes on nonfumigated soil, especially in a warmer than average season, emphasizes the benefits and importance of preplant fumigation for nematode management. Resistance alone should not be relied upon for protection against root-knot, but should be used in conjunction with fumigation to limit a resurgence of damaging populations.

The nonfumigant nematicides tested in 1979 were not as effective as soil fumigation with 1,3-Dichloropropene for controlling root-knot nematode, and therefore do not appear to be suitable alternatives under these conditions. New clones and releases will continue to be evaluated under California conditions as they are developed.

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