

Field resistance to nonfumigant nematicides in *Xiphinema index* and *Meloidogyne incognita*

Tom T. YAMASHITA and David R. VIGLIERCHIO

Division of Nematology, University of California, Davis, Ca 95616, USA.

SUMMARY

Populations of *Xiphinema index* and *Meloidogyne incognita* were sampled from three vineyard plots. Two had been treated with either carbofuran or phenamiphos. The third was an untreated control. In the fourth year all three plots were treated with carbofuran. Assessments in the first year of treatment indicated that carbofuran applications had reduced the *X. index* population to one half of the control levels. In the fourth year, however, the *X. index* population levels from the carbofuran and phenamiphos-treated vines were significantly higher than numbers taken from the control plot. Nematode numbers from the carbofuran-treated vines were more than three times the levels from the control plot. *In vitro* bioassays indicated that nematodes

Populations were assessed for the presence of resistance using an *in vitro* bioassay as outlined in a previous study (Yamashita & Viglierchio 1987).

56; Tab. 1). Because samples were not taken in 1983, it is difficult to estimate the populations that followed since 1982. However, in 1984, the population was

Table 2

In vitro bioassays with carbofuran, oxamyl and phenamiphos : percent activity of three field populations of *Xiphinema index*

Field populations	Carbofuran Treatment			
	Control	0.02 mM	0.20 mM	0.60 mM
Wild	92 ABC	95 AB	79 E	41 F
Carbofuran	85 CDE	88 BCD	83 DE	85 CDE
Phenamiphos	95 AB	96 A	98 A	87 CD
	Oxamyl Treatment			
	Control	0.06 mM	0.30 mM	0.60 mM
Wild	92 ab	89 ab	67 ef	63 f
Carbofuran	85 bc	88 ab	78 cd	71 de
Phenamiphos	95 a	92 ab	78 cd	44 g
	Phenamiphos Treatment			
	Control	0.032 mM	0.096 mM	0.160 mM
Wild	92 αβ	69 γ	35 ε	2 η
Carbofuran	85 β	89 αβ	56 δ	14 ζ
Phenamiphos	95 α	87 β	10 ζ	1 η

Numbers represent the means of ten replications. Nematodes were exposed to each of the three nematicides for 24 hours and then evaluated for active *vs* inactive using a touch-response method. Means not followed by a common letter are significantly different at an α level of 5 % or less.

IN VITRO TESTS FOR RESISTANCE

Xiphinema index

Nematodes from both carbofuran and phenamiphos-treated plots demonstrated greater tolerance to carbofuran (Tab. 2). The response to oxamyl, however, was not as well defined. Nematodes from the carbofuran plot exhibited higher tolerance to 0.30 mM and 0.60 mM oxamyl. Those from the phenamiphos-treated vines displayed an ability to better withstand 0.30 mM but not 0.60 mM oxamyl. This lack of distinct differences in tolerance levels to oxamyl was also observed in an earlier study with *X. index* (Yamashita & Viglierchio, 1987a). Nematodes from the carbofuran plot demonstrated

Meloidogyne incognita

Nematodes from the carbofuran plot demonstrated a higher tolerance to all three nematicides (Tab. 3). This was best expressed at the highest concentrations. In previous *in vitro* studies with *M. incognita* populations that had been stressed with carbofuran also showed a similar pattern of increased tolerance to the three nematicides (Yamashita & Viglierchio, 1986c).

Table 3

In vitro bioassays with carbofuran, oxamyl and phenamiphos : percent survival of two field populations of *Meloidogyne incognita*

Field populations	Carbofuran Treatment			
	Control	0.20 mM	0.40 mM	0.60 mM
Wild	100 A	97 A	75 B	22 C
Carbofuran	100 A	100 A	99 A	72 B
	Oxamyl Treatment			
	Control	0.04 mM	0.20 mM	0.40 mM
Wild	100 a	90 b	62 c	5 f
Carbofuran	100 a	98 ab	53 d	32 e
	Phenamiphos Treatment			
	Control	0.08 mM	0.20 mM	0.40 mM
Wild	100 α	85 βγ	63 δ	23 ε
Carbofuran	100 α	100 α	90 β	79 γ

Numbers represent the means of ten replications. Nematodes were exposed to each of the three nematicides for 24 hours and then evaluated for active *vs* inactive using a touch-response method. Means not followed by a common letter are significantly different at an α level of 5 % or less.

Discussion

Development of nonfumigant nematicide (NFN) resistance under field situations would seem unlikely

more, relationships between previous applications, microbial enrichment and rapid degradation of carbofuran have been observed (Felsot, Maddox & Bruce, 1981; Gorder, Dahm & Tollefson, 1982).

However, under field situations, populations of *Pratylenchus scribneri* demonstrated increased tolerance to nematicidal levels of carbofuran (Smolik, 1978). The corn fields, on which these tests were conducted, had been treated for five consecutive years with carbofuran. Applications of phenamiphos or oxamyl over a three-year period were reported to have had little effect on

found to be most sensitive to phenamiphos. During initial greenhouse studies, a series of tests were designed from which the factor of microbial degradation could possibly be detected (Yamashita, Viglierchio & Schmitt, 1986). When nematodes were inoculated onto test plants, nematode-free leachings from respective stock culture pots were added. When the population levels were evaluated following nematicide treatments, some interesting results were observed. The effects of enhanced population reductions or enhanced protection from nematicidal doses varied with the specific nema-

assessments for resistance are based upon population levels alone, this latter condition could be easily misinterpreted as "no resistance". Nematodes also demonstrate subtle as well as distinct host preferences. When cultured on one particular host (host no. 1), for example, the wild-type strain will reach significantly higher populations levels than the resistant strain. In some cases a fourteen-fold difference has been observed. Here, the resistant strain can demonstrate higher tolerance to a nematicidal application and still appear to be lower in numbers than the wild strain. When the two different populations are cultured on another host (host no. 2), however, the resistant and wild strains may both attain equal but low population levels. A farm advisor sampling for nematodes, then, would not find ample cause for nematicide investments. By the time host no. 1 is replanted, the resistant strain may have reverted back to the wild-type. Previous tests with stressed, unstressed

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