Effects of Nabam Solutions on Emergence of Larvae from Cysts of Heterodera schachtii in Aqueous Solutions and in Soil

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In areas infested with the sugar-beet nematode, economic production of sugar beets is made possible through discriminant use of rotation systems. Production of sugar beets is limited to once in three to six years, depending on the severity of infestation and local conditions that determine the persistency of this nematode pest.

Methods that will accelerate hatching of larvae from soil-borne cysts in the absence of host plants may enable shortening of rotations or increase the efficiency of control by rotations.

In previously reported tests, Steele (2)[2] found that solutions containing 1,000 parts per million of disodium ethylene bis dithiocarbamate (nabam) increased hatching of *Heterodera schachtii* Schmidt larvae as compared with tap water controls but only 60% as much as sugar beet root diffusate. Addition of 1,197 ppm of manganese sulphate or 1,316 ppm of zinc sulphate reduced the action to about the same as tap water. Nabam at concentrations of 2,000 ppm inhibited hatching of sugar-beet nematode larvae.

Nabam has recently been marketed as a wettable powder (Dithane A-40)[3]. A test was undertaken to compare the effects of this material and liquid nabam. In addition, attempts were made to determine whether hatching is permanently inhibited by concentrations of nabam exceeding 2,000 ppm and whether stimulatory effects of 1,000 ppm nabam would be retained after removal of the treatment solution.

Materials and Methods

In the first of two tests, seven treatments were checked for their effects on emergence of larvae from cysts of *Heterodera schachtii*. Four replications, each consisting of 40 cysts, were treated for 7 weeks with either tap water, beet root diffusate, 1,000 or 4,000 ppm nabam (Dithane D-14, a liquid formulation), or 1,000 ppm nabam (Dithane A-40). Equal numbers of cysts

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[2] Numbers in parentheses refer to literature cited.

[3] Dithane A-40 (93% nabam) and Dithane D-14 (22% nabam) were supplied by Rohm and Haas Company. Use of trade names and company names is for identification only and does not imply indorsement by the Department of Agriculture over similar ones not mentioned.

were treated for one week with either 1,000 or 4,000 ppm nabam after which the cysts were transferred to tap water where they remained an additional 6 weeks. Collection of diffusate and conduct of the test were essentially the same as described by Golden (1). Counts of larvae emerged from cysts are listed in Table 1.

A second test consisted of drenching various treatment solutions on soil contained in cylindrical paper cartons of 2 quart capacity. Each carton measured 3.5 by 13.5 inches. Before application of the treatments, three tea bags, each containing 50 cysts, were placed in each of 36 cartons 1, 6, or 12 inches below the soil surface.

Treatments consisted of tap water, beet root diffusate, 1,000 or 2,000 ppm nabam, 1,000 ppm nabam plus 658 ppm zinc sulphate, or 2,000 ppm nabam plus 1,316 ppm zinc sulphate. The treated cartons were kept in a utility room. The temperature of the treated soil remained at about 65° F. Ten days after treatment the cartons were removed to the laboratory, where the cysts were recovered and placed in Syracuse watch glasses containing about 15 ml of beet diffusate. The cysts were treated with diffusate for three weeks to induce hatching and emergence of the remaining larvae from the cysts. Counts of the remaining larvae are listed in Table 2. Data of both tests were analysed for statistical significance by the "analysis of variance" method.

Results and Discussion

Treatment of sugar beet nematode cysts with 4,000 ppm of nabam inhibited emergence of larvae (Table 1, treatment 1). However, considerable numbers of larvae emerged from cysts in tap water after they were removed from the 4,000 ppm solution

Table 1.—Numbers of larvae emerging from cysts of *Heterodera schachtii* in 7 weeks with treatments as detailed in text.

Treatment			Replications 1	2	3	4	Total	Average	Hatch of 1st week[c]
1	Nabam	4,000	6	12	1	17	36	9.0	25.0
2	Tap water	......	433	1,320	654	552	2,959	739.8	60.3
3	Nabam[a]	1,000	2,384	1,364	1,398	2,431	7,577	1,894.3	78.3
4	Nabam[a]	4,000	2,232	1,438	2,784	2,676	9,130	2,282.5	.2
5	Nabam[b]	1,000	3,541	3,676	4,639	3,604	15,460	3,865.0	46.6
6	Nabam	1,000	4,790	4,661	4,380	5,258	19,089	4,772.3	27.7
7	Beet diff.	......	6,952	6,997	7,201	8,857	30,007	7,501.8	34.0
	Significance							**	
	LSD .05							793.1	

[a] Cysts of treatments 3 and 4 were treated one week with the indicated solutions followed by treatment with tap water for 6 weeks.

[b] Treatment 5 was with Dithane A-40. All other nabam treatments were Dithane D-14.

[c] Expressed as a percent of the total number of larvae emerged from cysts in 7-week period.

(Table 1, treatment 4), indicating that nabam or a breakdown product of nabam is probably responsible for the inhibiting effect. Dithane A-40 (Table 1, treatment 5) gave greater hatches during the first week than did Dithane D-14 (Table 1, treatment 6).

Table 2.—Emergence of larvae remaining in cysts of *Heterodera schachtii* after recovery from 2 weeks in soil treated with nabam and beet diffusate. Average number of larvae per cyst from 6 replications.

Depth of cysts (inches)	Tap water	Nabam 1,000 ppm	Nabam 2,000 ppm	Nabam 1,000 ppm + 658 ppm Zn SO_4	Nabam 2,000 ppm + 1,316 ppm Zn SO_4	Beet diffusate
1	326.3	311.1	322.0	299.6	319.0	126.4
6	313.2	316.3	298.4	346.9	313.4	83.7
12	319.5	344.7	339.8	347.6	341.8	309.4
Total	959.0	972.1	960.2	994.1	974.2	519.5
Average	319.7	324.0	320.1	331.4	324.7	173.2
Least significant mean difference (.05)						72.6

Results of the second test (Table 2) indicate that soil drenches of beet diffusate stimulated emergence of larvae from cysts. The effects of all nabam treatments to the soil were similar to the effects of tap water drenches. Absorption of nabam by soil or decomposition in soil may be contributing factors.

Literature Cited

(1) GOLDEN, A. M. 1958. Influence of leaf diffusate of sugar beet on emergence of larvae from cysts of the sugar-beet nematode (*Heterodera schachtii*). U. S. Dept. of Agr. Plant Dis. Reptr. 42: 188-193.

(2) STEELE, A. E. 1961. The effect of nabam solutions on the emergence of larvae from cysts of *Heterodera schachtii* Schmidt. J. Am. Soc. Sugar Beet Technol. 11 (6): 528-532.