

# Hot Water and Chemical Dips for Nematode Control in Tubers of *Dioscorea Rotundata* Poir<sup>1, 2</sup>

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## ABSTRACT

Immersion of Guinea yam tubers (*Dioscorea rotundata* Poir) in hot water at 35°, 46°, 48°, 50°, 52°, and 54° C effectively controlled nematodes causing dry rot, regardless of the period of exposure. The tuber tissue was severely damaged by immersion in water at 65° C. Immersion in 300, 600, and 1200 p/m of Nemagon effectively controlled the nematodes present to a depth of 6 mm in the tuber tissue. Treatment with Dasanit and Nemafos at concentrations of 1250 p/m for 15 to 30 min, respectively, was also effective for nematode control in yams. The results were rather erratic at depths greater than 6 mm. Germination was not affected by hot water or chemical dips.

## INTRODUCTION

The local demand for the Guinea yam (*Dioscorea rotundata* Poir) is increasing in Puerto Rico, but production and quality of the crop is decreasing. This probably is due in part to a number of diseases caused by agents such as fungi, viruses, and nematodes. Among the latter, *Pratylenchus coffeae* (Zimmermann) Filip. Schuur-Stekh., damages the yam tuber (1,2,3), causing the condition known as dry rot which has been previously reported to be caused by *Scutellonema bradys* (Steiner & Lehew) Andrassy (11). This disease is expressed as a severe necrosis and cracking of the tuber cortex, which reduces quality and hence value for both local consumption and exportation.

The nematodes easily spread to clean soils through the indiscriminate use of infected tubers for propagation. They are now widely distributed among the commercial plantings in the Island as evidenced by a survey conducted in the areas of San Lorenzo, Las Piedras, Yabucoa, Corozal, Utuado, Isabela, and Aguada.

Guinea yam production in the Island could be increased by controlling the nematodes attacking the yam tubers. Among the different nematode

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control methods discussed in the literature, hot water baths (4,5,8) and chemical dips (4,9) of the tubers have been effectively employed for nematode control. Based on these reports, both methods were evaluated in the present report of several experiments for the control of the lesion nematode and others inside tubers.

### MATERIALS AND METHODS

Six laboratory experiments using hot water or chemical immersions were performed for the control of phytoparasitic nematodes attacking Guinea yam tuber. Cross sections of nematode-infected apical portions of the tuber, usually preferred for propagation in commercial plantings, were used. The sections were immersed in water at different temperatures in a constant temperature tank or in different concentrations of Nemagon<sup>4</sup> (DBCP), Dasanit (Fensulfothion), and Nemafos (Thionazin) for periods of 7, 15, 30, 45, or 60 min. Yam sections immersed in water at 25° C for 15, 30, and 60 min were used as controls. Four samples consisting of 15 g of tissue 3 mm thick (0 to 3, 3 to 6, 6 to 9, and 9 to 12 mm deep) were taken from each tuber section immersed in hot water or in the nematicide solution. The nematodes present were extracted using the Baermann funnel method (7). Population densities were recorded after 24 hr.

#### NEMATODE CONTROL BY HOT WATER DIPS

In the first test the tubers were immersed in hot water at 25° C (control), and at 35°, 50°, and 65° C for periods of 15, 30, and 60 min. In the second experiment the tubers were immersed in hot water at 25° C (control), and at 46°, 48°, 50°, 52°, and 54° C for the same exposure periods used in the first test. No germination tests were performed because the tubers were in their quiescent period. In a third test tubers were immersed in hot water at 46° C for 45 and 60 min, 48° C for 30 and 45 min, 50° C for 15 and 30 min, and 52° C for 7 and 15 min. After treatment, tubers were planted in steam sterilized soil. Plants were allowed to germinate and data on weight of tuber cortex, fresh weight of roots, and dry weight of stem were recorded at harvest 2 months later. Nematode population densities in 150 cm<sup>3</sup> of soil and in 3 g of chopped roots were determined. A complete randomized block design was used in all the tests and each treatment was replicated four times.

<sup>4</sup>Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of equipment or material by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment or materials not mentioned.

## NEMATODE CONTROL BY CHEMICAL DIPS

Solutions containing 300, 600, and 1,200 p/m of Nemagon were used to immerse tuber sections for 15, 30, and 60 min. Germination tests were not performed. In a second experiment solutions of 1,250 and 2,500 p/m of Dasanit were employed to treat tuber sections for 15 and 30 min. In a third test tuber sections were immersed in solutions of 625, 1,250, and 2,500 p/m of Dasanit, Nemagon, and Nemafofos for 30 and 60 min. The procedures used to submerge the tuber sections, to take samples, and to determine the nematode population density were similar to those used in the hot water tests. A complete randomized block design was used with four replicates per treatment.

TABLE 1.—Mean nematode population density in 15 g of Guinea yam tuber (*Dioscorea rotundata* Poir) tissue at different depth of tuber after being immersed in hot water at four temperatures for different periods of time

Temperature	Exposure time	Nematode population at different depths (mm)		
		0 to 3	3 to 6	6 to 9
°C	Min			
25°	15	44,545 b <sup>1</sup>	28,188 b	2,214 a
	30	1,085 a	1,076 a	185 a
	60	1,166 a	1,031 a	545 a
35°	15	923 a	1,733 a	364 a
	30	3,645 a	3,888 a	2,043 a
	60	2,948 a	1,746 a	113 a
50°	15	212 a	32 a	45 a
	30	293 a	288 a	36 a
	60	140 a	68 a	0 a
65°	15	0 a	0 a	0 a
	30	0 a	0 a	0 a
	60	0 a	0 a	0 a

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

## RESULTS

## NEMATODE CONTROL BY HOT WATER DIPS

Effective nematode control was obtained immersing Guinea yam tuber sections in hot water at 35°, 50°, and 65° C for 15, 30, or 60 min (table 1). The best control of nematodes in the outer layer was obtained at temperatures of 50° or 65° C; but the tuber tissue was destroyed at the higher temperature. The results were erratic beyond a 6 mm depth of tuber tissue. No nematodes were recovered at any depth at 65° C (table 1).

All the treatments effectively controlled nematodes when compared with the control at any exposure time used (table 2) in the second test.

In the third test greatest dry stem weight was obtained when yam tubers were immersed in water at 52° C for 7 min (table 3). The fresh weight of roots and the weight of the cortex increased 90 and 81% respectively, over the control. Nematodes were not recovered from the soil around the treated tubers.

TABLE 2.—*Mean nematode population density in 15 g of Guinea yam (Dioscorea rotundata Poir) tuber tissue after being immersed in hot water at six temperatures for different periods of time*

Temperature	Exposure time	Nematode population (15 g of tuber tissue)
°C	Min	
25°	15	828 b <sup>1</sup>
	30	840 b
	60	865 b
46°	15	150 a
	30	15 a
	60	0 a
48°	15	12 a
	30	12 a
	60	0 a
50°	15	18 a
	30	18 a
	60	9 a
52°	15	3 a
	30	0 a
	60	0 a
54°	15	17 a
	30	12 a
	60	0 a

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

#### NEMATODE CONTROL BY CHEMICAL DIPS

Nematode populations in the controls (tubers immersed in water for 30 or 60 min) were higher than those recovered from the tubers treated with Nemagon at concentrations of 300, 600, or 1,200 p/m. These concentrations effectively controlled the nematodes inside the tuber tissue. However, nematode kill in tissue deeper than 6 mm was rather erratic. The best results were obtained with concentrations of Nemagon at 600 p/m at depths of 3 mm compared with the controls. Good control was attained when tubers were immersed in Nemagon solution at 300 or 1,200 p/m (table 4).

Table 5 lists the mean fresh weight of the cortex and roots and the dry weight of stems of yam plants grown from tubers treated with different concentrations of Dasanit for different exposure periods. None of the rates gave significant growth differences over the control. However, there was a tendency toward higher stem dry weight with concentrations of 1,250 p/m for 15 min. Concentrations of 2,500 p/m curtailed plant growth.

Table 6 shows the dry weight of stems and fresh weight of roots of yam plants from tubers treated with Dasanit, Nemagon, and Nemafox at different exposure times. There were no significant differences among treatments in stem dry weights or root fresh weights.

TABLE 3.—*Mean weight of tuber cortex, fresh roots and dry stem of plants of Guinea yam (Dioscorea rotundata Poir) grown from tuber sections treated with hot water at different temperatures for different periods of time*

Temperature	Exposure time	Average weights		
		Fresh cortex	Fresh roots	Dry stem
°C	Min		g	
25°	30	1.38 ab <sup>1</sup>	10.44 ab	5.88 a
46°	45	.31 b	3.40 b	1.68 a
	60	1.90 ab	12.79 ab	4.58 a
48°	30	.97 ab	6.57 ab	3.38 a
	45	.60 b	8.97 ab	3.94 a
50°	15	1.50 ab	9.53 ab	3.67 a
	30	1.23 ab	4.10 b	1.09 a
52°	7	2.51 a	19.94 a	12.60 b
	15	1.94 ab	12.98 ab	5.36 a

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

## DISCUSSION

Results obtained from the first two experiments using hot water dips at 35°, 50°, and 65° C, and 46°, 40°, 50°, 52°, and 54° C for the control of phytoparasitic nematodes inside the yam tuber compare with those obtained by Ayala and Acosta (4). They reported good nematode control using water at 45° C for 15 to 60 min. Bruhn and Wolfgang (5) found that dipping the seed in water at 45° C for 30 min also was effective.

Results from the first test were rather erratic when compared to those from the second experiment. That may have been due to the fact that the tuber sections used in the first trial were heavily infected and extremely damaged, with thick corky tissue which probably inhibited penetration of heat to deeper levels.

Nemagon solutions effectively controlled nematodes in yam tubers. These results confirm those of Ayala and Acosta (4) who controlled nematodes in yam tubers by dipping the seed piece in 625 p/m of Nemagon for 60 min. The nematode kill in that test was also erratic, which may have been caused by the method used and the thick corky tissue covering the damaged tubers. This corky tissue probably reduced the penetration of heat and chemicals, thus allowing the survival of nematodes present in tissue deeper than 6 mm in the tuber tissue.

TABLE 4.—Mean nematode population density in 15 g of Guinea yam tuber (*Dioscorea rotundata* Poir) tissue at different depths of tuber after being immersed in Nemagon (DBCP) solutions for three periods of time

Nemagon	Exposure time	Nematode population at different depths (mm)		
		0 to 3	3 to 6	6 to 9
<i>P/m</i>	<i>Min</i>			
0	15	44,545 b <sup>1</sup>	2,888 b	2,214 ab
	30	1,085 a	1,076 a	185 a
	60	1,166 a	1,031 a	545 a
300	15	1,256 a	1,620a	1,327 ab
	30	2,331 a	1,809 a	1,697 ab
	60	688 a	1,486 a	826 ab
600	15	180a	571 a	288 a
	30	529 a	517 a	738 ab
	60	81 a	405 a	328 a
1200	15	6,114 a	6,665 a	33,099 b
	30	184 a	40 a	40 a
	60	517 a	540 a	103 a

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

TABLE 5.—Mean fresh weights of the tuber cortex and plant roots and the dry weights of the stem of plants of Guinea yam (*Dioscorea rotundata*) from tuber sections treated with Dasanit for different periods of time

Dasanit	Exposure time	Average weights		
		Fresh cortex	Fresh roots	Dry stem
<i>P/m</i>	<i>Min</i>		<i>g</i>	
0	30	1.38 a <sup>1</sup>	10.44 ab	5.88 ab
1250	15	1.43 a	19.48 b	8.56 b
2500	15	.99 a	3.39 a	1.04 a
1250	30	1.60 a	10.31 ab	6.00 ab
2500	30	.85 a	3.46 a	3.04 ab

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

TABLE 6.—Mean weights of dry stem and fresh roots of plants of Guinea yam (*Dioscorea rotundata*) grown from tuber sections treated with different nematicides for different periods of time

Nematicide	Exposure time	Average weight	
		Dry stem	Fresh roots
<i>P/m</i>	<i>Min</i>		<i>g</i>
0	60	13.53 a <sup>1</sup>	44.08 ab
Dasanit			
625	30	13.55 a	48.25 ab
	60	8.50 a	8.88 b
1250	30	17.74 a	31.45 ab
	60	14.81 a	22.50 ab
2500	30	20.15 a	36.83 ab
	60	16.60 a	42.98 ab
Nemagon			
625	30	15.00 a	44.60 ab
	60	9.60 a	13.80 ab
1250	30	13.58 a	34.25 ab
	60	12.50 a	23.65 ab
2500	30	15.10 a	39.75 ab
	60	14.05 a	29.38 ab
Nemafos			
625	30	12.35 a	31.75 ab
	60	6.73 a	29.63 ab
1250	30	12.28 a	49.38 a
	60	11.09 a	28.58 ab
2500	30	14.10 a	33.65 ab
	60	8.40 a	24.65 ab

<sup>1</sup> Means in the same column followed by the same letter are not significantly different at the .05 level by Duncan's New Multiple Range test.

Other chemical treatments, such as 1,250 p/m of Dasanit for 15 min and 1,250 p/m of Nemafos for 30 min, were also effective for the control of nematodes in the yam tuber tissue.

The results obtained with different nematicides indicate that immersion in 1,250 p/m for 15 to 30 min is enough to control nematodes inside the tuber tissue without affecting germination.

#### CONCLUSIONS

Based on the results obtained in these tests, it is concluded that the propagating material of the Guinea yam cultivar should be treated either with hot water or chemical dips before planting. The use of extremely damaged tubers should be avoided because the treatment would not be effective due mainly to the protective barrier provided by corky tissue. Hot water at 46° to 52° C should be preferred for the treatment of yam

tubers for 15 to 30 min to control the nematodes inside yam tissue without affecting germination.

### RESUMEN

Inmersiones de tubérculos de ñame de Guinea, *Dioscorea rotundata* Poir, en agua caliente a 35, 46, 48, 50, 52 y 54° C. por siete hasta 60 minutos resultaron eficaces para el control de los nematodos fitoparasíticos del tejido. El agua a 65° C. fue detrimental al tejido. Los nematodos presentes en los tubérculos de ñame se controlaron hasta una profundidad de 6 mm., al sumergir la semilla (pedazos del tubérculo) en soluciones de 300, 600 y 1200 p.p.m. de Nemagon. Inmersiones en soluciones conteniendo 1,250 p.p.m. de Dasanit y Nemafos por 15 a 30 min. y 30 min., respectivamente también los controlaron eficazmente. Los resultados fueron erráticos a profundidades mayores de 6 mm. La germinación de los tubérculos no fue afectada por las inmersiones en agua caliente o en soluciones nematicidas.

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