CONTROL OF *Meloidogyne incognita* AND *Rotylenchulus reniformis* AND ITS EFFECT ON THE YIELD OF SWEET POTATO AND CASSAVA

Ruben M. Gapasin

Instructor, Department of Plant Protection, Visayas State College of Agriculture, Baybay, Leyte, Philippines.

Portion of MS thesis in Plant Pathology conducted by the author in UP at Los Baños.

ABSTRACT

Pre-plant treatment of different nematicides, in pot experiments, using the manufacturers' recommended rates had variable effects on the growth of sweet potato and cassava and on the population of *Meloidogyne incognita* **and** *Rotylenchulus reniformis* **4 months after application. Low gall and egg mass ratings were obtained in chemical-treated plants, except those treated with Hostathion 5G. In all cases, the application of Nemagon 75 E.C. and Temik 15G increased the root, tuber and top weights of sweet potato and cassava and gave from 65-85% reduction in nematode population compared to Furadan 5G and Bunema 40 E.C. which gave from 45-70% reduction. Hostathion 5G was the least effective among the chemicals tested. The application of chicken manure significantly increased roots, tubers and tops of sweet potato and cassava compared to those obtained with nematicides. However, there was no apparent correlation between growth response and per cent control.**

Ann. Trop. Res. 3:92-100.

KEY WORDS: Nematicides. Chicken manure. Sweet potato. Cassava. *Meloidogyne incognita. Rotylenchulus reniformis.* Yield. Gall and egg mass rating.

INTRODUCTION

The root-knot nematode, *Meloidogyne* spp., and the reniform nematode, *Rotylenchulus reniformis,* have been reported to damage sweet potato and cassava (Elliot, 1918; Poole and Schmidt, 1927; Krusberg and Nielsen, 1959; Nielsen and Sasser, 1959; Luc, 1968). Root-knot caused by *M. incognita* has been identified as a serious disease of cassava in the Gold Coast (Edwards, 1953, 1955). Gapasin and Valdez (1979) found that *M. incognita* could reduce tuber production by as much as 47.7% depending upon the nematode population, while *R. reniformis* could reduce tuber yield by 60.6%. However, limited studies have been conducted on the control of plant parasitic nematode on sweet potato and cassava (Nielsen and Sasser, 1959; Birchfield and Martin, 1968; Averre *et al.*, 1974). Brathwaite (1974) reported that D-D soil fumigant considerably reduced populations of plant parasitic nematodes in sweet potato fields and resulted in increased marketable yields by 56.2%.

Chemical control of nematode may not be practical for small growers because nematicides are expensive. Biological control, on the other hand, could provide a cheap alternative to chemical control. There are reports which show that root-knot nematode infection was greatly reduced by the addition of organic fertilizers into the soil (Linford *et al.*, 1938; Mankau and Minteer, 1962). Other organic fertilizers such as chicken manure, sawdust and rice straw compost have been found to control root-knot nematode (Singh *et al.* 1967; Bigcas and Davide, 1969). Davide and Quebral (1970) reported that relatively low population densities of plant parasitic nematodes in La Trinidad Valley and Atok, Benguet may be due to the application of chicken manure which harbor a number of nematode-trapping fungi.

This paper reports the effect of different nematicides and chicken manure in the control of *M. incognita,* and *R. reniformis* and the effect of treatments on the yield of sweet potato and cassava.

MATERIALS AND METHODS

Soil Infestation. — The soil in this experiment was first sterilized and then artificially infested by inoculating 10,000 eggs of *M. incognita* per 28 cm dia clay pots. Each pot was planted to susceptible tomato seedlings for population build-up. After 2 months, the tomato plants were cut leaving the root system in the soil. The infested soil was then mixed thoroughly and then returned to the pots. The same procedure was done to the soil artificially infested with *R. reniformis.* However, sweet potato was used as host for population build-up.

Application of Nematicides and Chicken Manuare. — The nematicides used in this experiment were the following: Temik 15G (15% 2-methyl-2-(methylthio) propionaldehyde 0 -(methylcarbamoyl) oxime); Furadan 5G (5% 2, 3 -dihydro —2, 2- dimethyl -7 -benzofuranyl methyl-carbamate); Hostathion 5G (5% 1 -Phenyl -3 -(0, 0 -diethyl -thionophosphoryl) -1, 2, 4 triazole); Nemagon 75 E.C. (75% 1, 2 dibromo 3- chloropropane); and Bunema 40 E.C. (40% potassium N-hydroxy-methyl-N methyldithiocarbamate). The first three nematicides were applied as granules and the last two as emulsifiable concentrates. All the namaticides were used at the manufacturer's recommended rate of 15 kg a.i./ha, 2 kg a.i./ha, 10 kg a.i./ha, 8 gal/ha and 2.4 gal/ha for Temik 15G, Furadan 5G, Hostathion 5G, Nemagon 75 E.C. and Bunema 40 E.C., respectively. The chemicals were incorporated with previously heat-sterilized soil in the pots, followed by water seal and then covered with plastic sheet to minimize rapid loss. The chicken manure was applied at the rate of 10 t/ha and mixed with the soil in the pots. After 10 days, cassava and sweet potato cuttings were planted in the treated soil. The treatments were replicated 3 times using completely randomized design.

Evaluation of the Effects of Treatments. — The effects of the different nematicides and chicken manure were assessed 4 months after planting. The degree of galling, caused by *M. incognita,* per plant was rated using the galling index, based on percentage of galled portions of the root system: 1 = no galls (0%); 2 = trace (1-25%); 3 = slight (26-50%); 4 = moderate (51-75%); 5 = severe (76-100%). The egg mass index, determined by counting the egg masses present in each root system, was based on the following: 0 = 0; 1 = 2; 2 = 3-10; 3 = 11-30; 4 = 31-100; and 5 = more than 100. The final nematode population was assessed by getting 300 cc soil from each pot after the soil has been thoroughly mixed and was processed for nematodes in the nematology laboratory using the sieving Baermann funnel combination. Populations of *R. reniformis* in feeding position on the roots were counted by getting one g root samples from each plant and stained with acid fuchsin lactophenol. The fresh weight of roots, tubers and tops were recorded and statistically analyzed. Per cent control was based on the nematode population density in the soil as compared with counts from the untreated control.

RESULTS AND DISCUSSION

Effects of Different Chemicals and Chicken Manure on Meloidogyne incognita and Rotylenchulus reniformis.

The mean gall index and egg mass index ratings in sweet potato and cassava clearly indicate that the different nematicides had considerably reduced the root-knot nematode infection compared to the control (Tables 1 and 2). Lowest gall and egg mass indices were obtained from Nemagon 75 E.C.-treated plants followed by Temik 15G, Furadan 5G and Bunema 40 E.C. Hostathion 5G was the least effective among the chemicals tested. This finding confirms the report of Davide and Zorilla (1980) on the effect of four nematicides on *M. incognita.* Temik 10G-treated plants had the lowest gall index (1.6); Vydate 10G- and Mocap 10G-treated plants had trace to slight galling index, while Furadan-treated plants had slight galling.

Based on nematode recovery from the treated soil grown to sweet potato, the percentage control was

Table 1. Effects of different treatments on potted soil infested with *Meloidogyne incognita* and grown to sweet potato.

Treatment	Galling index	Egg-mass index	Fresh weight (g)[1] Roots	Tubers	Tops	No. of nematodes recovered[2]	% control
Untreated	2.6	4.6	10.6	46.6	34.3	2066.3	—
Nemagon 75 EC	1.3	1.3	12.3(13.8)	80.0(41.7)	56.0(38.7)	398.0	80.7
Temik 15G	2.0	1.6	11.3(6.2)	75.3(38.1)	35.6(3.6)	537.0	74.0
Furadan 5G	2.3	2.6	11.0(3.6)	64.6(27.9)	34.6(0.9)	665.3	67.8
Bunema 40 EC	2.3	2.6	11.0(3.6)	52.6(11.8)	37.6(8.8)	762.0	63.1
Hostathion 5G	2.6	4.0	10.3	52.3(10.9)	37.3(8.0)	939.3	54.5
Chicken manure	2.3	2.6	11.6(8.6)	74.6(35.5)	44.3(22.6)	818.3	60.4

[1] Numbers in parenthesis denote percent increase over the untreated control.
[2] Based on 300 cc soil per pot.

Table 2. Effects of different treatments on potted soil infested with *Meloidogyne incognita* and grown to cassava.

Treatment	Galling index	Egg-mass index	Fresh weight (g)[1] Roots	Tubers	Tops	No. of nematodes recovered[2]	% control
Untreated	4.3	4.6	14.0	28.6a	20.6a	1449.0	—
Nemagon 75 EC	2.0	1.0	9.6	40.0(28.5)ac	21.0(1.9)a	438.0	69.77
Temik 15G	2.0	1.3	15.0(6.7)	39.3(27.2)ac	22.3(7.6)a	461.0	68.18
Furadan 5G	2.0	2.0	14.3(2.1)	35.6(19.7)a	25.0(17.6)a	523.3	63.88
Bunema 40 EC	3.0	2.3	15.3(8.5)	34.6(17.3)a	19.6a	538.3	62.85
Hostathion 5G	3.6	4.3	13.0	25.3ab	21.0(1.9)a	897.3	38.07
Chicken manure	2.6	2.6	13.0	69.6(58.9)d	32.3(36.2)b	677.6	53.23

[1] Numbers in parenthesis denote percent increase; mean followed by the same letter is not significantlv different using DMRT.
[2] Based on 300 cc soil per pot.

higher in the chemical treatments, except, Hostathion 5G with 54% as compared with Nemagon 75 E.C. which gave the highest with 80.7%, followed by Temik 15G with 74.0%; Furadan 5G with 67.8% and Bunema 40 E.C. with 63.1%. The effectiveness of the different chemicals on the root-knot nematode population grown to cassava showed the same trend. Percentage control was highest in Nemagon 75 E.C., followed by Temik 15G, Furadan 5G and Bunema 40 E.C. Hostathion gave the lowest percentage control of 38.1%.

The effect of the different treatments on the population of *R. reniformis* is shown in Table 3. Based on nematode counts recovered in the soil, per cent control was highest with the application of

Temik 15G followed by Nemagon 75 E.C. with 85.6% and 77.7%, respectively. The percentage control with the application of chicken manure was 61.4% which was higher than Bunema 40 E.C., Furadan 5G and Hostathion 5G with 43.4%, 54.4% and 8.6%, respectively.

The effectiveness of the different nematicides in this study has been confirmed by several investigators (Gilpatrick *et al.* 1956; DiSanzo, 1969). The effectiveness of Nemagon 75 E.C. could be attributed to its low volatility, hence, it diffuses slowly in the soil (Ichikawa *et al.* 1955). Also, Nemagon 75 E.C. diffuses slowly in light soil than in heavy soil (Allen and Raski, 1950). According to DiSanzo (1973), the mode of action of Furadan 3G is more on the modification of the physiology of the host plant making it more unsuitable for nematode infection, thus, the reduction of the nematode population in the soil in Furadan-treated plants may be due to starvation and subtoxicity of the chemical.

No studies have been made on the performance of Bunema 40 E.C. In this experiment, however, good to fair control was obtained based on the reduction of nematode population which ranged from 40-60%. Hostathion 5G seemed ineffective in controlling nematode population. Youngson and Goring (1962) found the same results with Hostathion applied on sandy soil. This was due to the high porosity of sandy soil so that diffusion of the vaporized molecules was much too rapid to effect any influence on the nematode. The sandy medium may have degraded the chemical and it was removed from the scene of action (Goring, 1957). The soil type used in this experiment was sandy loam and the results corroborate those of Youngson and Goring (1962).

Table 3. Effects of different treatments on potted soil infested with *Rotylenchulus reniformis* and grown to sweet potato.

Treatment	Fresh weight (g)[1]			No. of Nematodes recovered[2]		% Control
	Roots	Tubers	Tops	Soil	Roots	
Untreated	12.0a	58.6a	39.6	3037.3	404.0	—
Temik 15G	13.0(7.7)a	90.3(35.1)b	43.0(7.9)	529.6	239.6	85.6
Nemagon 75 EC	18.6(35.5)b	87.6(33.1)b	43.3(8.5)	678.6	229.6	77.7
Bunema 40 EC	14.3(16.1)b	69.6(15.8)a	41.6(4.8)	1719.3	299.3	43.4
Furadan 5G	13.0(7.7)a	68.3(14.2)a	40.3(1.7)	1384.6	349.0	54.4
Hostathion 5G	11.3a	58.0a	32.0	2776.6	383.6	8.6
Chicken manure	24.6(51.2)c	101.6(42.3)b	55.6(28.8)	1172.6	265.0	61.4

[1] Numbers in parenthesis denote percent increase; mean followed by the same letter is not significantly different using DMRT.

[2] Based on 300 cc soil and 1 g roots per plant.

The use of chicken manure, which was regarded as a method of biological control, also reduced galling and egg mass production of the root-knot nematode on both crops. Low gall and egg mass ratings were obtained compared to the control and Hostathion 5G. Chicken manure also gave from 53.3%-61.4% control of the root-knot and reniform nematodes 4 months after inoculation. The relatively low population of these nematodes may be due to the presence of nematode-trapping fungi harboring in the manure (Davide and Quebral, 1970). Also, the decomposition of chicken manure may have changed the ionic composition of the soil contributing to reduced population (Linford *et al.*, 1938).

Effects of Different Chemicals and Chicken Manure on Yield of Sweet Potato and Cassava.

Increase in the weight of roots, tubers and tops of sweet potato and cassava was evident in the different nematicide treatments and in chicken manure. In sweet potato, Nemagon 75 E.C. gave the highest yield increase in tuber weight with 41.7% followed by Temik 15G and Furadan 5G with 38.1% and 27.9%, respectively (Table 1). Compared with the nematicide treatments, chicken manure gave 35.5% yield increase which was better than the treatments with Furadan 5G, Bunema 40 E.C. and Hostathion 5G. Nevertheless, statistical analysis showed no significant differences in the increase among root, tuber and top weights.

The fresh weight of roots, tubers and tops of cassava grown in potted soil infested with *M. incognita* increased with the application of different nematicides and chicken manure (Table 2). Among the chemicals tested, Nemagon 75 E.C. gave the highest yield increase in tuber weight with 28.5% followed by Temik 15G with 27.2%. Furadan 5G and Bunema 40 E.C. with 19.7% and 17.3%, respectively. Hostathion 5G did not increase tuber weight of cassava. Compared with nematicide treatments, chicken manure increased tuber weight by 58.9% which was twice that of Nemagon 75 E.C., the best among the nematicides tested. Statistical analysis showed that increases in tuber weights in the various treatments were significantly different from each other (P = 0.01). The application of Nemagon 75 E.C. and Temik 15G were statistically significant over Hostathion 5G. However, no significant differences occurred among Furadan 5G, Bunema 40 E.C. and the control. The increase in tuber weight by adding chicken manure was significantly different compared with the nematicide treatments and the untreated control.

The effect of the different nematicides on the weight of roots, tubers and tops of sweet potato infested with *R. reniformis* is shown in Table 3. among the nematicides, Temik 15G and Nemagon 75 E.C. gave increased tuber weight of 35.1% and 33.1% respectively. The application of chicken manure gave the highest tuber weight increases of 42.3%. Statistical analysis showed that tuber weight increases from the different treatments were significant (P = 0.05). Temik 15G, Nemagon 75 E.C. and chicken manure were different over the untreated control or with Bunema 40 E.C., Furadan 5G and Hostathion 5G.

Increase in the roots, tubers and tops of sweet potato and cassava by the application of chemicals and chicken manure was evident in this experiment. Similar findings have been reported by Nielsen and Sasser (1959) on the effect of D-D and EDB (W-85) on the root-knot nematode. The nematicides effectively killed the larvae and increased the yield and quality of sweet potato. Likewise, fumigation studies in Louisiana effectively controlled the reniform nematode affecting sweet potato (Birchfield and Martin, 1968).

The weight of roots, tubers and tops of sweet potato and cassava applied with chicken manure increased significantly compared to those obtained when applied with nematicides. However, the percentage reduction in the nematode population was only 55-65% or about 20-30% less effective than Nemagon 75 E.C. It appears that the increased root, tuber and top weights were due to the fertility provided by the chicken manure rather than on nematode control. Watson (1944) reported similar results where mulches of decaying organic matter improved the growth of the plant and in some cases actually reduced the damage caused by nematodes. Likewise, Smith and Batista (1942) pointed to an improved fertility condition which permitted good growth of plants brought about by some metabolic by-products in the decomposition of organic matter. It was also possible that the changes in the physical and chemical condition of the soil may have altered the host-nematode relationships thereby resulting in the host being more resistant to the development of the nematode within its roots (van der Laan, 1956).

Although the role of chicken manure in nematode control was not demonstrated effectively in this experiment because sterilized soil was used, it nevertheless showed potential in increasing yields. However, under field conditions where the growth of nematophagous fungi would be enhanced by the application of chicken manure its usefulness would be better appreciated.

LITERATURE CITED

ALLEN, M.W. and RASKI, D.J. 1950. The effect of soil types on the dispersion of soil fumigants. *Phytopathology* 40: 1043-1053.

AVERRE, C.W., NIELSEN, L.W. and BARKER, K.R. 1974. Organic pesticides for controlling *Meloidogyne incognita* on *Ipomoea batatas*. (Abstr.). Phytopathology 64: 767.

BIGCAS, F.S. and DAVIDE, R.G. 1969. Biological control of root-knot nematodes. *Agric. at Los Baños* 9: 15.

BIRCHFIELD, W. and MARTIN, W.J. 1968. Evaluation of nematocides for controlling reniform nematodes on sweet potatoes. *Plant Dis. Reptr.* 52: 127-131.

BRATHWAITE, C.W.D. 1974. Effect of D-D soil fumigant on nematode population and sweet potato yields in Trinidad. *Plant Dis. Reptr.* 58: 1048-1051.

DAVIDE, R.G. and COMEDIS, A. 1972. Chemical control of nematodes on cabbage in Atok, Benguet. *Phil. Agric.* 55: 282-288.

DAVIDE, R.G. and QUEBRAL, F.C. 1970. A survey of plant parasitic nematodes associated with vegetable crops in Benguet. *Agric. at Los Baños* 9: 12-14.

DAVIDE, R.G. and ZORILLA, R.A. 1980. Effect of four nematicides on nematode control and yield of cabbage. *Phil. Phytopath.* 16: 53-58.

DISANZO, C.P. 1969. Some observations on the effect of carbofuran on three plant parasitic nematodes. *J. Nematology* 1: 285.

DISANZO, C.P. 1973. Nematode response to carbofuran. *J. Nematology* 5: 22-27.

EDWARDS, E.E. 1953. The root eelworm on weeds and cultivation plants in the Gold Coast. *J. Helminth.* 27: 181-184.

EDWARDS, E.E. 1955. Further observations on the occurrence of nematodes of the genus *Meloidogyne* in the Gold Coast. *J. Helminth.* 29: 153-170.

ELLIOT, J.A. 1918. Nematode injury to sweet potato. *Phytopathology* 8: 169.

GAPASIN, R.M. and VALDEZ, R.B. 1979. Pathogenicity of *Meloidogyne* spp. and *Rotylenchulus reniformis* on sweet potato. *Ann. Trop. Res.* 1: 20-25.

GILPATRICK, J.D., ICHIKAWA, T., TURNER, M. and McBETH, C.W. 1956. The Effect of placement depth on the activity of nemagon. *Phytopathology* 46: 529-531.

GORING, C.A.I. 1957. Factors influencing diffusion and nematode control by soil fumigants. Agr. Res. Lab. Western Div. The Dow Chem. Co. Seal Beach Calif. *ACD Information Bull.* No. 110: 1-58.

ICHIKAWA, S.T., GILPATRICK, J.D. and McBETH, C.W. 1955. Soil diffusion pattern of 1, 2-dibromo 3 -chloropropane. *Phytopathology* 45: 576-578.

KRUSBERG, L.R. and NIELSEN, L.W. 1958. Pathogenesis of root-knot nematode to Porto Rico variety of sweet potato. *Phytopathology* 48: 30-39.

LAAN, VAN DER, P.A. 1956. The influence of organic manuring on the development of the potato root eelworm, *Heterodera rostochiensis*. *Nematologica* 1: 112-125.

LINFORD, M.B., YAP, F. and OLIVEIRA, M. 1938. Reduction of soil population of the root-knot nematode during decomposition of organic matter. *Soil Sci.* 45: 127-141.

LUC, M. 1968. Nematological problems in the former French African Tropical Territories and Madagascar. In: G.C. Smart and V.G. Perry (Ed.) *Tropical Nematology*, Univ. of Fla. Press. Gainsville p. 93-112.

MANKAU, R. and MINTEER, R.J. 1962. Reduction of soil population of the citrus nematode by the addition of organic materials. *Plant Dis. Reptr.* 46:375-378.

NIELSEN, L.W. and SASSER, J.N. 1959. Control of root-knot nematode affecting Porto Rico sweet potato. *Phytopathology* 49: 135-140.

POOLE, R.F. and SCHMIDT, R. 1927. The nematode disease of sweet potatoes. *Phytopathology* 17: 549-554.

SINGH, R.S.,SINGH, B. and BENIVAL, P.S. 1967. Observations on the effect of sawdust on incidence of root-knot and on yield of okra and tomatoes in nematode infested soil. *Plant Dis. Reptr.* 51: 861-863.

SMITH, F.B. and BATISTA, J.W. 1942. The nematode problems from the soil microbiological standpoint. *Proc. Soil Sci. Fla.* 4-13: 144-147.

WATSON, J.R. 1944. Mulches to control root-knot. *Proc. Fla. Acad. Sci.* 7: 151-153.

YOUNGSON, C.R. and GORING, C.A.I. 1962. Diffusion and nematode control by 1-2 - dibromoethane, 1,3 - dichloropropane and 1,2 - dibromo - 3-chloropropane in soil. *Soil Sci.* 93: 306-316.