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Pathogenicity and Control of the Root-Knot Nematode *Meloidogyne incognita* on Sugarcane

O.A.Fademi and S.B.Agbana*
National Cereals Research Institute,
P.M.B. 8, Bida,
Nigeria.

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ABSTRACT

All the 13 sugarcane clones screened for resistance to Meloidogyne incognita were found to be susceptible to the pest. Infected roots had small discrete galls varying from few to many, depending on cane cultivar. In greenhouse experiments. increasing inoclum level of the nematode from 0 to 10, 000 increased tiller number and root galling with corresponding decrease in stalk diameter, shoot weight and brix content. Application of insecticides and herbicides resulted in reduction in nematode reproductive factor (RF=Pf/Pi) but not significantly.

INTRODUCTION

Commercial cultivation of sugarcane was started in Nigeria in the sixties. Generally, exotic sugarcane varieties are planted in the country.

Nematodes have been found to contribute to declining yields in many sugarcane plantations. Apt and Koike (1962), Rao and Swarup (1974) and Braithwaite (1980) reported significant yield losses following nematode invasion of sugarcane. Caveness (1967), Parson (1970), Fademi and Agbana (in press) have reported association of many nematode species with sugarcane in Nigeria. This paper reports on the reaction of some sugarcane clones to the root-Knot nematode, *Meloidogyne incognita,* its pathogenicity and control.

MATERIALS AND METHODS

Varietal screening : The effect of *M. incognita* on thirteen exotic and one local varieties sugarcane was studied in a greenhouse experiment. The sugarcane were planted in sandy loam soil in 10-litre sized plastic buckets and inoculated with 10,000 eggs of *M. incognita* obtained from galled roots of *Celosia argentea* (L.). Nematode eggs were extracted using chlorox (Hussey and Barker, 1973). Each sugarcane in randomised complete block design. After 10 months, data on stalk length, number of tillers and number of root galls were determined.

* Present address: Nigerian Sugar Company (NISUCO), Bacita, P.M.B. 65, Jebba, Nigeria.

Pathogenicity test : Sugarcane cultivar, Co 957, was grown from cuttings treated hot water (50° C for 2 h) to reduce infestation of viruses, fungi and stem borer. Single bud cuttings were taken from these stalks and sprouted in flat wooded trays (46 cm x 92 cm x 10 cm) filled with sterilized potting mix of soil, sand and weathered poultry manure (20:1:1). Two weeks after sprouting. uniform sized sugarcane cuttings were transplanted to 500 ml plastic cups filled with the potting medium and allowed to grow for 2 weeks. Twenty litre buckets were filled with potting medium and a depression created in the centre of each bucket to accommodate a 90 mm diameter (500 ml) plastic cup. Each bucket wes inoculated with the appropriate number of nematode inoclum. Transplants having uniform vigour were transferred to 20 litre buckets with as little disturbance as possible to the root system and surrounding soil. Incoulum levels used were 2000, 4000, 6000, 8000 and 10,000 eggs of *M. incognita.* Controls were inoculated with only the nematode supernatant (water only). All treatments were replicated four times. A recommended fertilizer mixture of N, P, and K (75-45-100 kg respectively per hectare) was used as single application one week after inoculation. The experiment was terminated after 10 months.

At termination of experiment, brix content of the canes were determined using hand refractometer after which plant tops were cut off at the ground level. Weights of stalks were taken. Each bucket was then inverted and taped gently to disengage root system from adhering soil. Roots were examined for galls. Severity of root galling were rated on a 0 to 10 scale where 0 represented roots free of galls and 10 represented severely galled root system (Barker, 1978).

Integrated control : Experiments were conducted at Bacita on Nigerian Sugar Company (NISUCO) plantation. The experimers were superimposed on on-going experiments one of which was evaluating insecticides for stem-borer control in sugarcane. The insecticide evaluation trial was sited on fied planted with Co 62175. The treatments comprised of Basdin 10G, Furadan 10G, Aldrex 40EC and control. Rates of application are as listed in the Table 3. Experimental design was randomized complete block with 4 replications. Soil sampling for nematode assays were made at planting (Pi), at mid-season (Pm) and at harvest (Pf). The relationship between populations of nematodes at plantain (Pi) and at harvest (Pf) were used to calculate nematode reproductive factor (Rf).

The herbicide evaluation trial was also planted with Co 62175. There were seven treatments comprising of various combinations and rates of Velpar, Diuron, Actril DS, 2,4-D and a control. The combinations and rates are as listed in the Table 4. Plot size, number of replicates and experimental design were similar to insecticide evaluation trial. Soil samplings were also taken at planting, mid-season and harvest, and data therefrom used in determining the Rf. In both cases (insecticide and herbicide of Baermann method as described by Whitehead and Hemming (1965).

RESULTS AND DISCUSSION

Varietal screening : All the 13 sugarcane cultivars were susvceptinle to *M. incognita* (Table 1). Galls were mostly small and disjointed. The degree of susceptibility (indicated by root galling) varied. Seven cultivars exhibited slight susceptibility, four were moderately susceptible while three, namely Co 285, Co 957 and B 63340 were susceptible. Plants infected with *M. incognita* were generally taller than unaffected plants. Tiller numbers in infected plants were similar to, of mostly greater than those from nematode-free plants. Cane width for each cultivate was higher when plants were nematode-free compared to the canes infected with *M. incognita.*

Pathogenicity : Slight decreases in fresh shoot weight were recorded as inoculum level increased form 2000 to 10,000 eggs of per plant. These weights were not significant at 5% level (Table 2). Tiller number increased with increasing inoculum level although differences, as for shoot weight, were not significant (P=0.05). Stalks in nematode infected buckets were thinner than those in nematode-free buckets, decreasing with increasing nematode number. Differences in stalk width was also not significant. showed that brix decreased with increase in nematode number. Significant differences was obtained in root galling only. Galling indices indices increased significantly with increasing inoculum level. Correlation between inoculum level and other parameters were negative for shoot weight, brix content and stalk width (Table 3) and positive for tiller number and galling index.

Control : There was no significant difference in plant height between treatments in the insecticide evaluation evaluation trial. Rf value was the highest in the control (Table 4). Among the insecticides, Rf was the least at 30 kg/ha of Basudin 10G followed by Furadan at 20kg/ha. Aldrex 40 EC effected greater nematode population suppression than the two lower rates of Basudin and Furandan. In the herbicide evaluation trial, plant height was also not significantly differences. Rf was greatest in treatment 2 i.e. Velpar+ Actril DS at 0.5+ 1.5 litres respectively). All other teratments had lower Rf than the control (Table 5). The lowest was in treatment 6 (Diuron +Actril DS at 4.0 + 1.5 litres respectively).

Although cases of varietal resistance to *M. incognita* by sugarcane has been reported elsewhere (Moura *et al.*1983); this investigation revealed that all sugarcane cultivars examined were susceptible to root-knot nematode, infected plants were taller. Apt and Koike (1962) reported similar stimulation of growth of sugarcane seedlings at low levels of infection by Tfrichodors christei. Salawu *et. al.* (1986) obtained similar results with the varieties he examined. Reduction in weight of top growth of inoculated sugarcanes was not significant as compared to the non-inoculated canes. The results indicated that levels of inoculum used in this experiment were below the economic threshold levle of *M. incognita* on sugarcane at which significant reduction in shoot weight, tiller number and stalk length would occur. The results nevertheless confirm the compatibility between sugarcane and *M. incognita.*

Table 1. Reaction of thirteen sugarcane varieties to the root-knot nematode, *Meloidogyne incognita*.

Cane variety	Status	Stalk length (cm)	Tiller number	Galling index	Resistant rating
Co 285	Infected	304.8*	5	5	S
	Uninfected	267.6	2	0	-
Co 301	Infected	248.9	3	3	MS
	Uninfected	248.3	3	0	-
Co 404	Infected	254.0	3	2	SS
	Uninfected	218.4	2	0	-
Co 421	Infected	304.8*	2	2	SS
	Uninfected	246.3	3	0	-
Co 740	Infected	228.6	5	2	SS
	Uninfected	203.2	4	0	-
Co 957	Infected	244.7	3	5	S
	Uninfected	252.5	4	0	-
Cok 30	Infected	299.7	3	3	MS
	Uninfected	292.1	2	0	-
B 4362	Infected	292.1	3	3	MS
	Uninfected	274.3	2	0	-
B 59162	Infected	304.8	3	2	SS
	Uninfected	254.0	4	2	-
B 63340	Infected	297.2	4	6	S
	Uninfected	266.7	3	0	-
F 141	Infected	271.8	4	3	SS
	Uninfected	254.0	4	0	-
Mex 25/29	Infected	304.8*	2	2	SS
	Uninfected	276.9	3	0	-
LS 21	Infected	304.8*	2	2	SS
	Uninfected	287.0	2	0	-

Galling index: 1-10 after Hussey and Barker, 1973.

Resistance rating based on the galling index:

R= Resistant; SS=Slightly susceptible;

MS= Moderately susceptible; S= Susceptible.

Up till now, cane growers are generally hard to convince about the economic importance of nematodes on sugarcane because stalk length and cane weight in infected plants and nematode-free plants are rarely different. In some cases, slight increases are recorded in infected plants over the uninfected ones. In this study, brix content of sugarcane was found to be adversely affected by *M. incognita*. It indicates the need for nematode control in sugarcane.

Table 2. Effects of inoculum levels of *Meloidogyne incognita* on a susceptible sugarcane clone, Co 957.

Inoculum level	Shoot weight (kg)	Stalk width (cm)	Tiller number	Brix content (%)	Galling index
0	2.2	5.2	2.8	17.0a	0.0e
2,000	2.1	5.1	2.5	17.3a	1.8cd
4,000	2.1	5.1	2.5	16.0b	2.3c
6,000	2.0	5.0	2.5	16.7a	2.5c
8,000	2.1	4.7	3.0	15.9b	3.8b
10,000	2.0	4.8	3.0	14.9c	4.8a
	NS	NS	NS		

Means are averages of four replications; and those with the same letter within a column are not different at 5% level according to Duncan's Multiple Range Test.

NS= Not significant

Table 3. Correlation coefficients between *Meloidogyne incognita* inoculum level and growth parameters of infected sugarcane.

	IL	SW	SD	TN	BC	GI
IL	-					
SW	-0.746*					
SD	-0.939*	0.577				
TN	0.598**	-0.012	-0.727*			
BC	-0.849*	0.422	0.754*	-0.675**		
GI	0.976*	-0.671**	-0.921*	0.511	-0.842*	

*P = 0.05, **P = 0.01

IL= inoculum level; SW= shoot weight; SD= satik diameter

TN= tiller number; BC= brix content, GI =galling index.

Table 4. Effects of some insecticides used for stem borer control on plant parasitic nematodes in a sugarcane field.

Treatment	Rate (Per ha)	Population of nematodes			Plant height (cm)
		Pi	Pf	Rf	
Basudin 10G	20 kg	152.3	344.7	2.3	230.2
Basudin 10G	30 kg	248.5	344.3	1.4	232.4
Furadan 10G	10 kg	209.8	420.3	2.0	237.9
Furadan10G	20 kg	235.5	323.0	1.4	232.5
Aldrex 40EC	5.0L	222.0	358.0	1.6	247.0
Control	nill	154.8	413.8	2.7	229.5
		NS	NS	NS	

PI= Population at planting; Pf= population at final sampling;

Rf (reproductive factor)=Pf/Pi.

Table 5. Influence of some herbicides on plant parasitic nematoeds in a sugarcane field planted with cultivar Co 957.

Treatment	Rate/ha	Nematode population			Plant height (cm)
		Pi	Pf	Rf	
Velpar+ Diuron	0.5kg+ 2.0kg	129.5	196.3	2.3	245.7
Velpar+ Actril DS	0.5kg+ 1.5L	120.3	355.5	3.0	232.3
Velpar+ 2,4-d(72%)	1.3L	299.5	433.5	1.5	248.8
Diumon+ Actril DS	2.0kg+ 1.5L	419.0	537.5	1.3	231.3
Diuron+ 2,4-D(72%)	3.0L	181.0	378.3	2.1	235.1
Diuron+ Actril DS	4.0kg+ 1.5L	370.5	411.5	1.1	249.3
Diuron	4.0kg	266.0	560.3	2.1	241.8
Control	HW*	144.5	417.3	2.9	226.8

*HW= Hand weeding;

Pi= Nemtode population at planting;

Pf= Nemtode population at harvesting;

Rf= Nematode reproductive factor (Pf/Pi).

Reproductive factor (Rf), the totality of envifonmental effects on the rate of inerease of the population (r), current size of the population (N) and time interval (t) is the most relevant factor for assessing impact of the environment and, of agro-inputs on a nematode community (Norton, 1978). The Rf values were generally lower in plots which received insecticides compared to the control implying that these chemicals had a supressive impact on "r" in cane soil during the experiment. In a similar manner, some herbicides suppressed Rf, although differences between treatments and the control were small. The results corroborate the results reported by Witkowski (1979), Saly (1980), Kraus and Sikora (1982) and Spaull and Newton (1982).

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APPENDIX

Chemical names of the herbicides and insecticides used:–

Velpar (hexazinone):

3-Cyclo-hexyl-6-dimethylamino-1-methyl-1,3,5,-triazine-2,4 (1H,3H)-dione.

Diuron:

3-(3, 4-dichlorophenyl)-1,1- dimethylurea.

2,4-D:

2,4= dichlorophenoxy acetic acid.

Actril DS= (bromoxynil + dichorprop+ ioxynil+ MCPA):

bromoxynil: 3,5-dibromo-4-hydroxybenzonitrile

dichorprop: (R) -2-(2,4-dichlorophenoxy) propionic acid

ioxynil: 4-hydroxy-3,5- iodobenzonitrile

MCPA: (4-chloro-2-methylphenoxy) acetic acid

Basudin (Diazinon):

0,0-diethyl-0-2-isopropyl-6-methylpyrimidin-4-y1- phosphorothioate.

Furadan (Carbofuran):

2,3-dihydro-2,2- dimethylbenzofuran-7-y1-methylcarbamate.

Aldrex 40EC (Aldrin):

1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4=5,8-
dimethanonaphthalene.