Restricted Circulation

Legumes Pathology
Progress Report 2

INVESTIGATIONS ON THE POSSIBLE ROLE OF NEMATODESIN THE GROWTH VARIABILITY PROBLEM IÑ GROUNDNUT IN NIGER

(Report of research carried out during an assignment to ICRISAT Sahelian Center, Niger - 14 Aug to 30 Sep, 1988)

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1988

INTRODUCTION

Variability in crop growth is one of the very important constraints in production of groundnut and many other crops in the Sahel. In 1986 and 1987, surveys conducted by ICRISAT scientists indicated extensive occurrence of this problem in the farmers' fields especially in the sandy soils in Niger. Soil applications of high doses of pesticides (Dibromo chloro propane (DBCP), aldicarb and carbofuran) at the research farm of ICRISAT Sahelian Center were very effective in controlling the crop growth variability problem in groundnut and pearl millet - probably indicating that some biotic factors, that were controlled by these chemicals, might be involved in this problem. As these chemicals are effective nematicides, the present investigations were undertaken to study the spectrum of plant parasitic nematodes associated with these crops and to study effects of different pesticides on populations of plant parasitic nematodes.

Major objectives of this 45-day mission were:

- to survey the research farm of ICRISAT Sahelian Center for the presence of plant parasitic nematodes associated with groundnut;
- to study effects of application of different chemicals on densities of plant parasitic nematodes;
- to conduct a survey of groundnut producing regions in Niger for identification of plant parasitic nematodes associated with the crop.

The effects of application of different chemicals on nematode densities were studied in the following experiments being conducted by Dr. P. Subrahmanyam, Principal Groundnut Pathologist and Dr. B.J. Ndunguru, Principal Groundnut Agronomist:

- To determine the effects of different doses of carbofuran on crop growth variability and pod haulm yield of groundnut at Sadore.
- To investigate the effects of farm yard manure and carbofuran on crop growth variability and pod and haulm yields of groundnut at Sadore.
- To screen nematicides for control of crop growth variability in groundnut at Sadore.
- To test the performance of groundnut to phosphorus obtained from different sources, with or without carbofuran.
- To assess the growth and yield of groundnut with lime or

gypsum as source of calcium, with or without carbofuran.

- To assess the effect of phosphorus, and different micronutrients on the growth and yield of groundnut.

- Effect of carbofuran and DBCP on the plant growth and yield of bambara groundnut, cowpea, groundnut and pearl millet.

Materials and Methods

Survey of ICRISAT's research farm for plant parasitic nematodes: Soil and root samples were collected from different groundnut fields at the research farm of ICRISAT Sahelian Center, Sadore. Sampling was restricted only to the control plots in the fields that received different pesticide treatments. For every plot, 4 to 6 soil cores were collected up to 20-cm depth using a steel shovel and along with the soil samples, roots were also collected. Roots and pods were examined for any symptoms that were probably caused by the nematodes. Above ground symptoms were also recorded.

Extraction of nematodes from soil samples: Facilities available in the Department De Formation En Protection Des Vegetaux, Center AGRHYMET, Niamey, for processing the soil and root samples and other laboratory facilities for nematological investigations were utilized for this work. Thoroughly mixed 100 cm^3 soil sample was processed for each field using decanting and sieving technique. Approximately 750 mL to 1000 mL water was added to the soil sample in a plastic bowl and this slurry was stirred and passed through 725 µm-pore sieve (20 mesh) and 45 µm-pore sieve (325 mesh). Slurry passing through 45 µm-pore sieve was collected in a plastic container and was passed again through this sieve. Residue collected on the sieves (45 µm-pore sieve) was placed on a nematode filter supported on a steel guage immersed in water in a collecting tray and after 24 to 48 hours, water in the collecting tray was examined for the plant parasitic nematodes.

Roots about 5-g in weight were cut into lengths of 1-cm or less and nematodes were extracted by placing the root pieces on a nematode filter supported on a steel guage immersed in water. Incubation period was about 36 hours. Some samples were also processed in the mist chamber.

Estimation of nematode populations in different trials: Soil samples were collected up to 20-cm depth. Four to six soil cores were collected from each plot (3 to 6 rows of 4 m length). Around 1500 soil cores from more than 300 plots were collected for these investigations. For each plot 100 cm soil sample was processed.

Survey of groundnut producing regions of Niger: Survey trips to some of the groundnut growing regions of Niger were undertaken in August and September 1988 to get information on the fauna of plant parasitic nematodes associated with groundnut crop. The survey trip covered groundnut growing regions between Niamey and Maradi. Approximately 1000 km distance was covered during these trips and generally groundnut fields located adjacent to roads were surveyed. The distance between survey sites was variable. More sites were surveyed in Tara, Bengou (Gaya) and Maradi regions where groundnut was grown extensively (Fig 1). At each location, soil type, plant stand, cropping systems, and diseases were recorded. Soil and root samples were collected in polythene bags from different fields at each location and these samples were processed as detailed above.

RESULTS

Plant parasitic nematodes in groundnut fields at the research farm of ICRISAT: Plant parasitic nematodes belonging to nine genera were recorded. These nematodes are *Aphelenchoides* sp., *Ditylenchus* sp., *Helicotylenchus* sp. *Hoplolaimus pararobustus*, *Macroposthonia curvata*, *Siddiqia* sp., *Scutellonema clathricaudatum*, *Telotylenchus indicus*, and *Xiphinema attorodorum*. *Scutellonema clathricaudatum*, *X. attorodorum* and *T. indicus* were the most abundant nematodes.

Population of these three nematodes species were detected in root samples as well. The nematode population in roots collected from poor patches were in some cases three times more than that in roots collected from good patches. Cyst (*Heterodera* spp.) and root-knot nematodes (*Meloidogyne* spp.) were not encountered in the soil and root samples. Pods were generally free from lesions.

Plant growth was very variable in these fields. In every field there were areas where plant growth was very good and in other portions, plant growth was poor and stunted. Leaves were chlorotic and smaller in size. There were large patches in different fields where plant growth was very poor and occasionally some healthy plants could be seen in the poor patches. The sick plants closed their leaves during hot sunny days. Root systems of the poorly growing plants were sparsely developed. In many plants root tips were swollen. Roots were stubby and had many small bunches of lateral roots.

Effect of application of different chemicals on densities of plant parasitic nematodes:

- Effect of 3, 6, 9, 12 and 15 kg a.i. ha^{-1} of carbofuran 5 G: Populations of *S. clathricaudatum*, *T. indicus* and *X. attorodorum* were significantly less ($P = 0.01$) in carbofuran treated plots. Nematode populations (mainly *S. clathricaudatum*) in roots were very high in the control plots where as soil treatment with carbofuran at the time of planting protected the roots from nematode invasion and thus low nematode number could be extracted from the treated plots (Fig. 2). Carbofuran doses higher than 3 kg ai ha^{-1} reduced

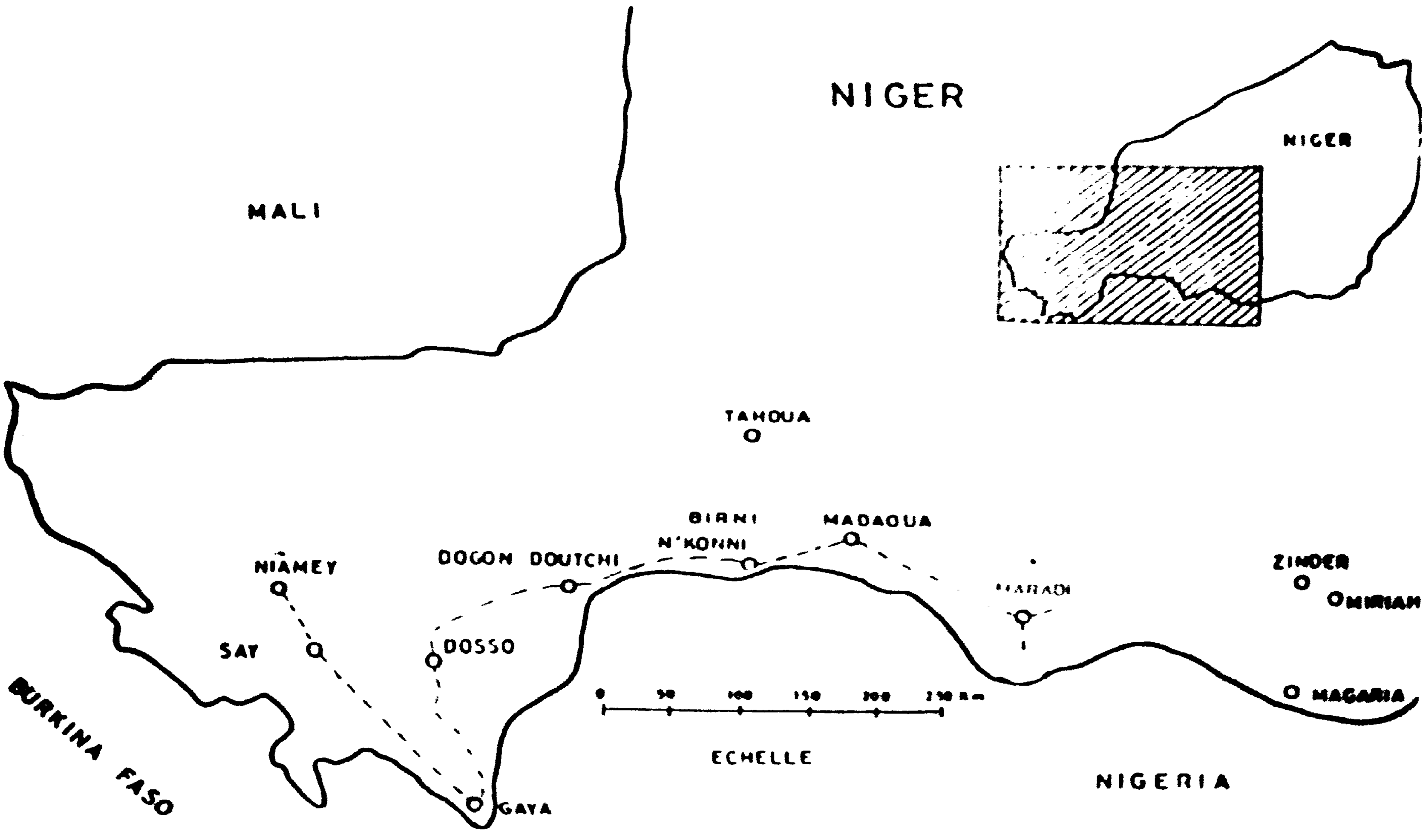


Fig 1. Survey of nematode diseases of groundnut in Niger-route followed (August-September, 1988)

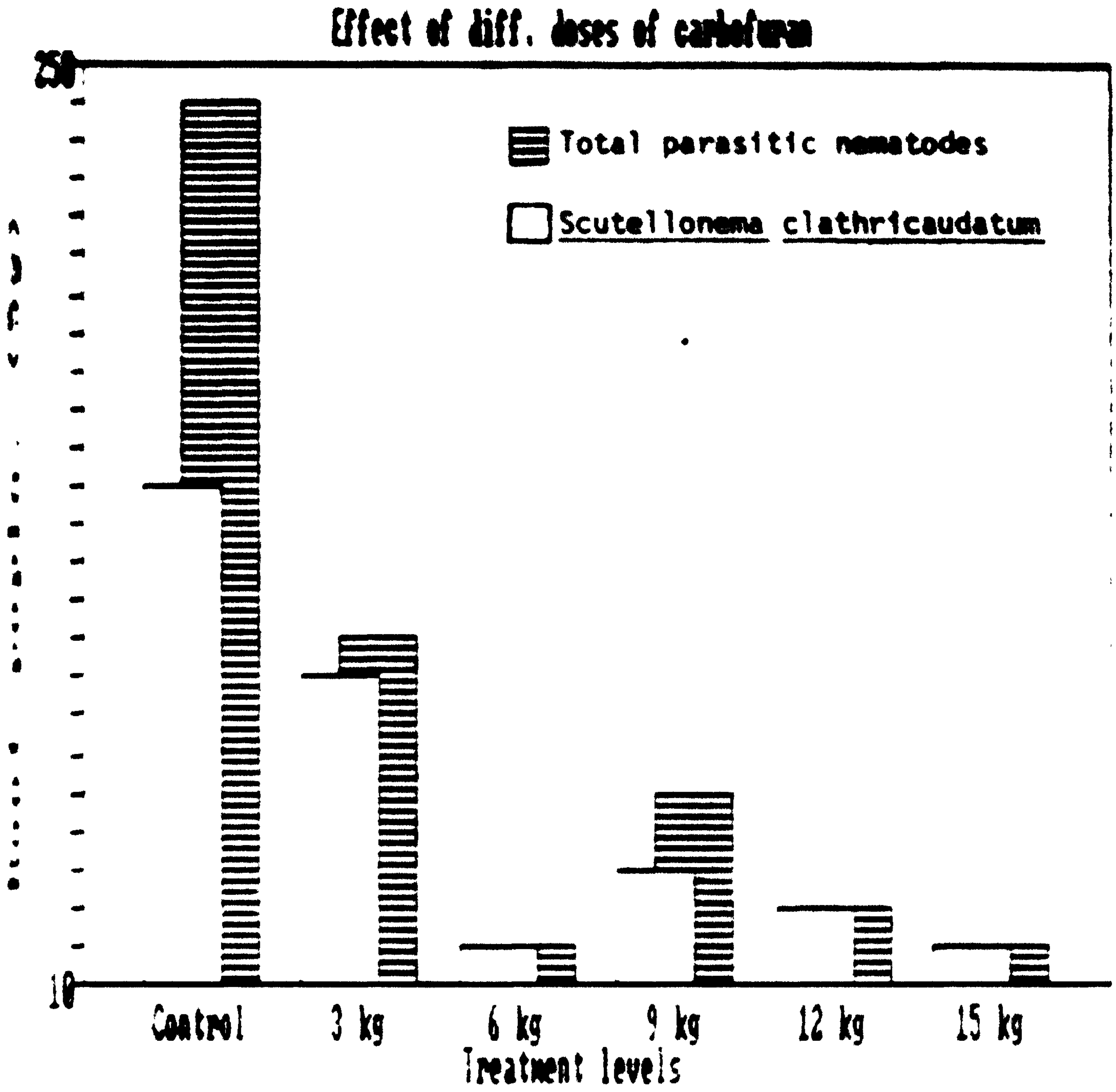


Fig 2 Effect of different doses of carbofuran 5 G on populations of plant parasitic nematodes.

the nematode populations drastically (P = 0.01). (Table 1).

Effect of carbofuran and farm yard manure : Carbofuran 5 G (@ 10 kg ai ha^{-1}) significantly reduced the nematode populations under rainfed as well as irrigated conditions (Table 2, Fig. 3). There was no difference in nematode densities in farm yard manure treated plots and in the control plots. No interactive effects of combined application of carbofuran and FYM on the nematode populations were evident, however, slightly higher nematode number was recorded in roots collected from carbofuran and FYM treated plots than the carbofuran-alone treated plots. Carbofuran was apparently more effective in the irrigated fields than in the unirrigated fields.

Table 1. Population densities of *Scutellonema clathricaudatum*, *Telotylenchus indicus*, *Xiphinema attorodorum* and total plant parasitic nematodes in carbofuran treated and control plots.

Nematode	Carbofuran 5 G doses (a.i kg ha^{-1})					
	0	3	6	9	12	15
S. clathricaudatum	137.5	70.0	45.0	40.0	27.5	27.5
					SE ±	17.86
T. indicus	102.5	35.0	25.0	22.5	15.0	10.0
					SE ±	8.68
X. attorodorum	35.0	17.5	0.0	0.0	2.5	0.0
					SE ±	8.53
Total parasitic nematodes	292.5	145.0	70.0	70.0	57.5	45.0
					SE ±	23.21

Table 2. Population densities of *Scutellonema clathricaudatum*, *Tylenchorhynchus indicus*, and *Xiphinema attorodorum* in carbofuran 5 G (10 kg ai ha^{-1}) and farm yard manure (10 t ha^{-1}) treated fields under rainfed and irrigated conditions.

Field	Treatments	*S. clathricaudatum*	*T. indicus*	*X. attorodorum*	Total parasitic population
Irrigated	Control	30.0	115.0	15.0	160
	Carbofuran	10.0	25.0	2.5	38
	FYM	32.5	82.5	20.0	135
	Carbofuran + FYM	10.0	12.5	2.5	25
	SE ±	6.1	15.1	6.9	22.4
Rainfed	Control	52.5	52.5	25.0	130.0
	Carbofuran	25.0	15.5	17.5	57.5
	FYM	50.0	27.5	15.0	92.5
	Carbofuran + FYM	12.5	20.0	7.5	40.0
	SE ±	6.7	7.1	5.3	9.43

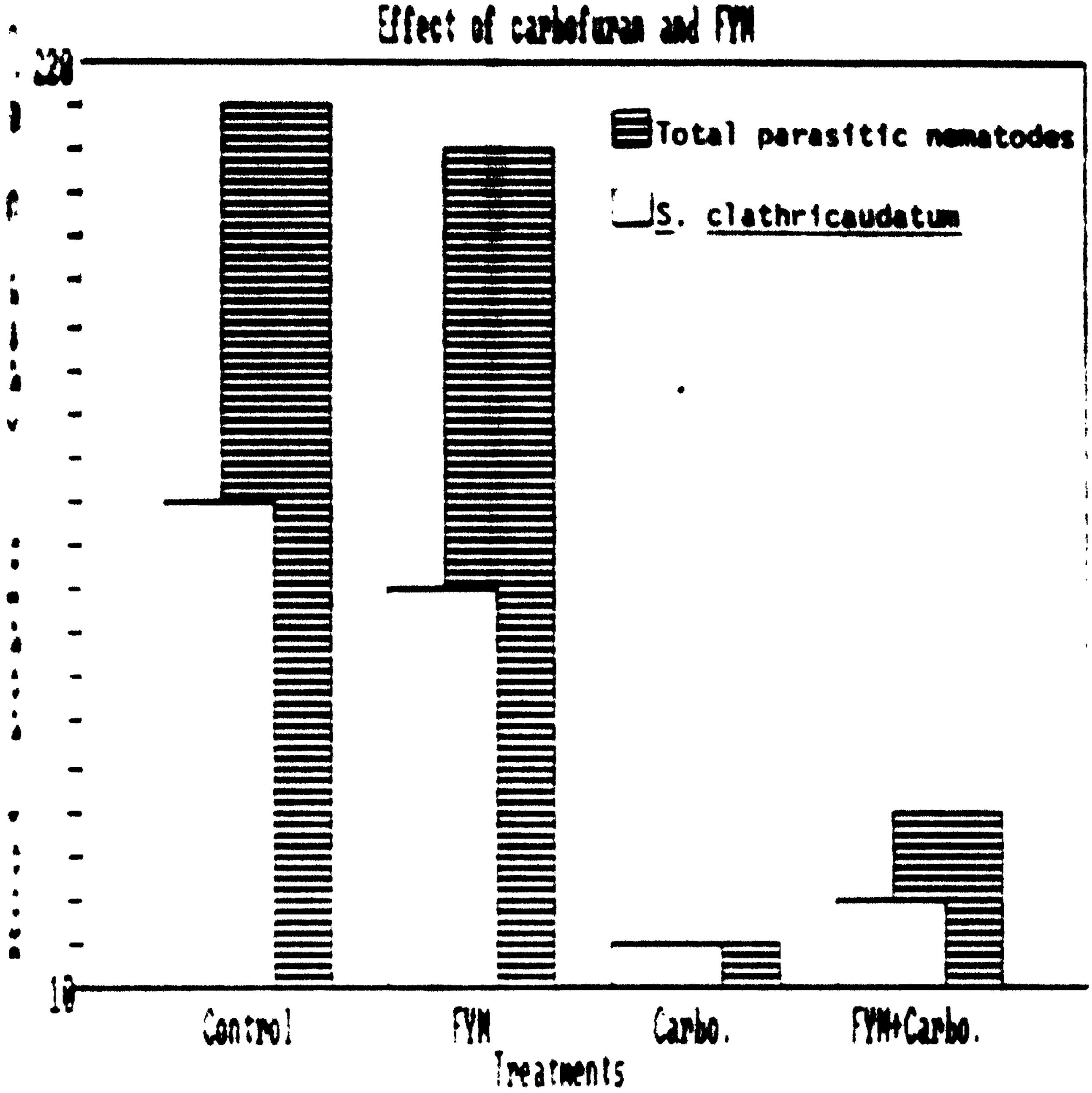


Fig 3 Effects of carbofuran 5 G and Farm yard manure on populations of plant parasitic nematodes.

__Effect of different nematicides__: Nematodes populations in DBCP treated irrigated plots were below detectable levels. DBCP (20 L ha^{-1}) and isazofos 5G (6 kg a.i ha^{-1}) treated plots had significantly (P = 0.05) less population of S. __clathricaudatum__, T. __indicus__, and X. __attorodorum__. Aldicarb (10 G (4 kg a.i ha^{-1}) and carbofuran 5 G (6 kg a.i ha^{-1}) appeared to be less effective under irrigated conditions in reducing the nematode populations in soil in this trial. However, nematode populations in roots indicated that plants in the control plots had higher population levels than the plants in plots treated with aldicarb, carbofuran, isazofos and DBCP (Fig. 4).

__Effect of different levels of calcium, phosphorus and carbofuran__: Populations of plant parasitic nematodes in plots treated with different levels and sources of calcium [gypsum (20 and 40 kg ha^{-1} ca) and lime (20 and 40 kg ha^{-1} ca)] and phosphorus [rock phosphate, super phosphate and acidulated rock phosphate at 20 and 40 kg ha^{-1} P2O5) were not different from those recorded in the control plots. The nematode populations were low (P = 0.01) only in those plots that received application of carbofuran at the time of planting (Fig. 5 and 6; Table 3).

__Plant parasitic nematode populations in different crops__: Populations of S. __clathricaudatum__, T. __indicus__, X. __attorodorum__, __H. pararobustus__, and __Siddiqia__ sp. were found in the soil samples collected from the rhizosphere of pearl millet (__Pennisetum glaucum__ (L.) R. Br.) bambara groundnut (__Vigna subterranea__ (L.) Verdc) and cowpea (__Vigna unguiculata__ (L.) Walp). __Scutellonema clathricaudatum__ was the most predominant nematode in soil and root samples of these crops. Densities of this nematode as well as other plant parasitic nematodes were very low in soil and root samples collected from DBCP and carbofuran treated plots (Fig. 7).

Table 3. Population densities of __Scutellonema clathricaudatum__, __Telotylenchus indicus__ and __Xiphinema attorodorum__ in carbofuran treated and control plots (Calcium trial).

Nematode	Control	Treated	SE
S. __clathricaudatum__	51.7	15.4	5.77
T. __indicus__	27.1	7.9	4.28
X. __attorodorum__	40.0	17.5	4.91
Total parasitic nematodes	118.8	40.8	10.36

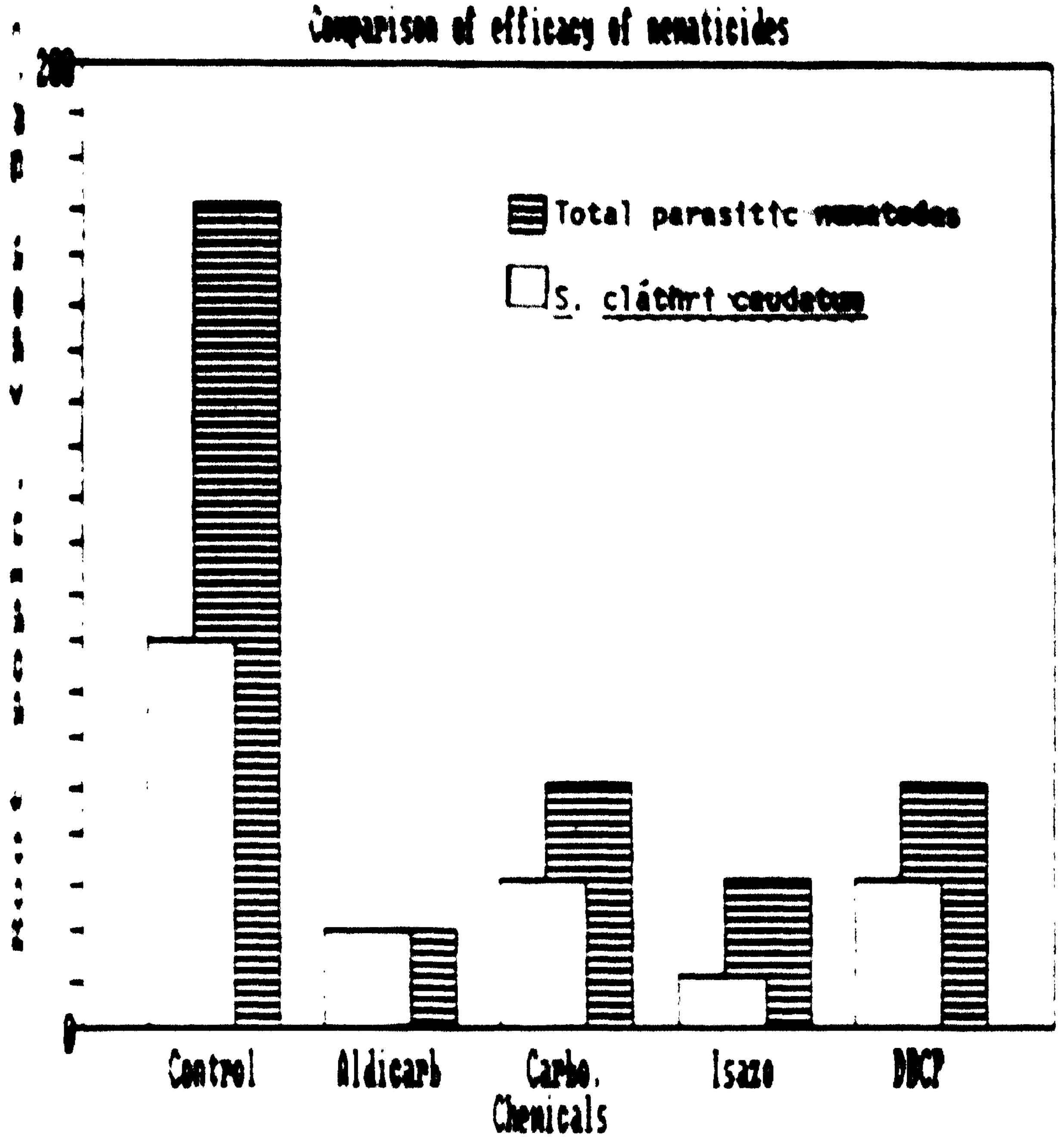


Fig 4 Effects of different nematicides on populations of plant parasitic nematodes.

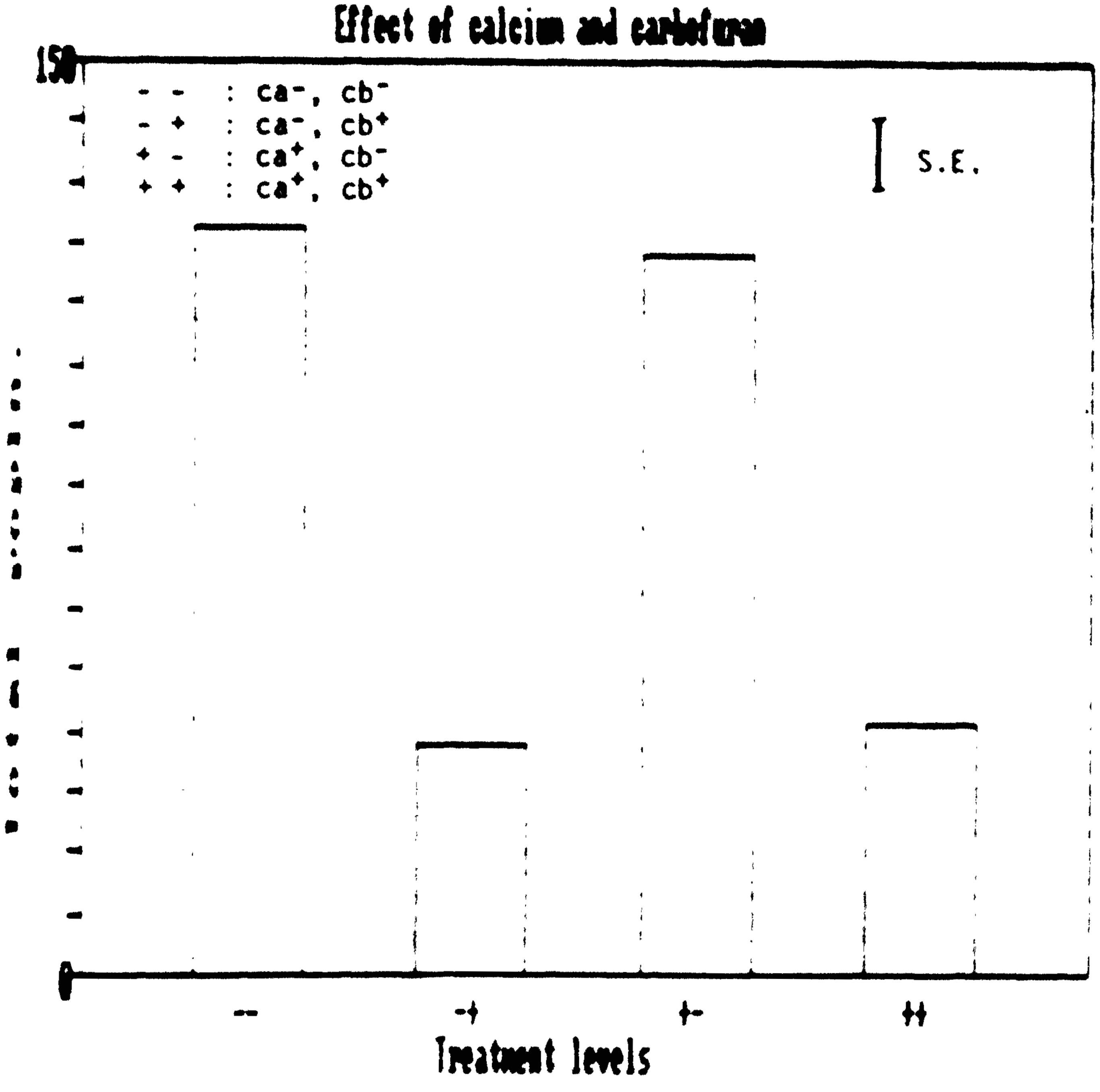


Fig 5 : Effect of calcium (gypsum and lime) (ca) and carbofuran 5 G (cb) on population of plant parasitic nematodes.

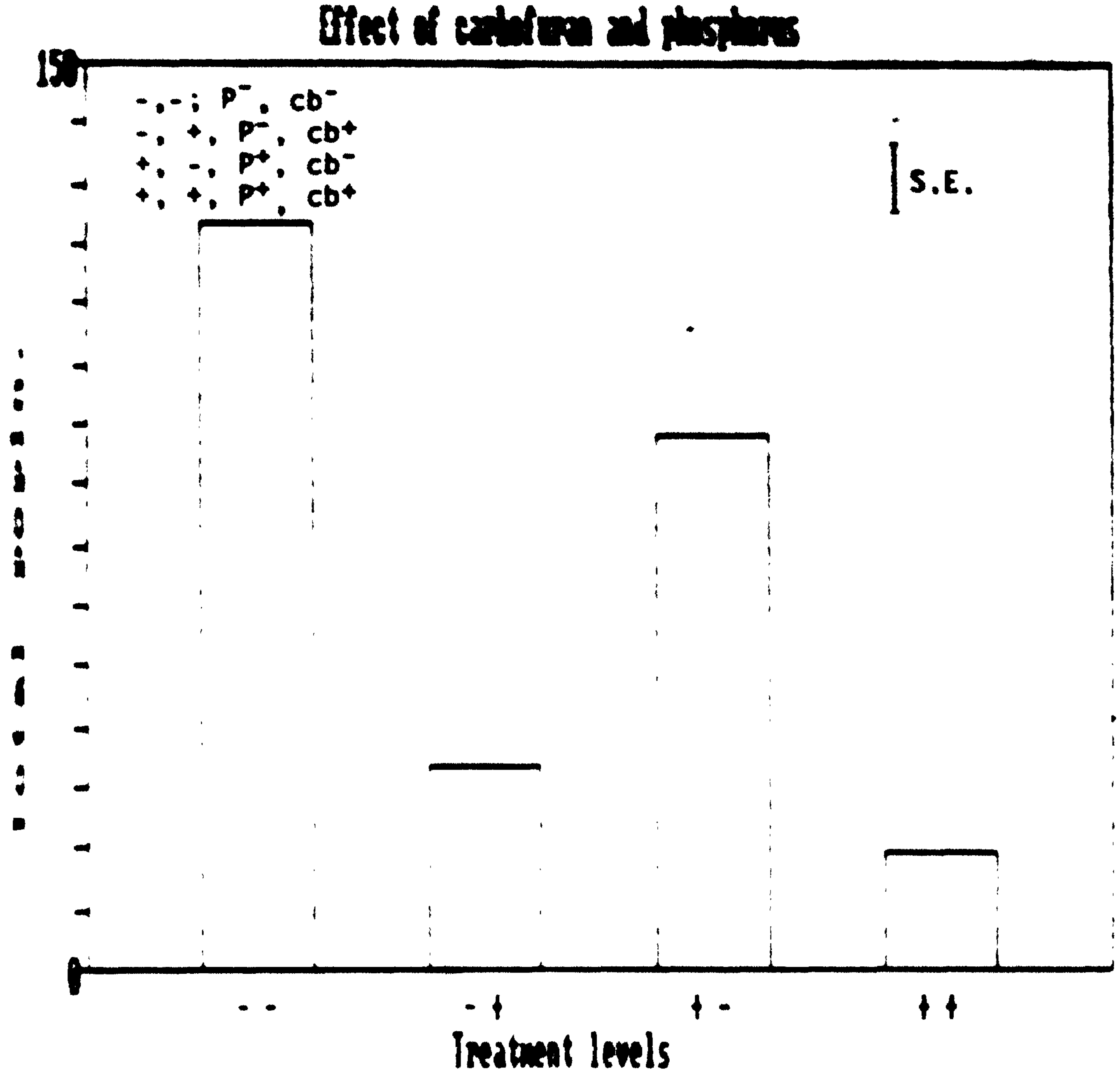
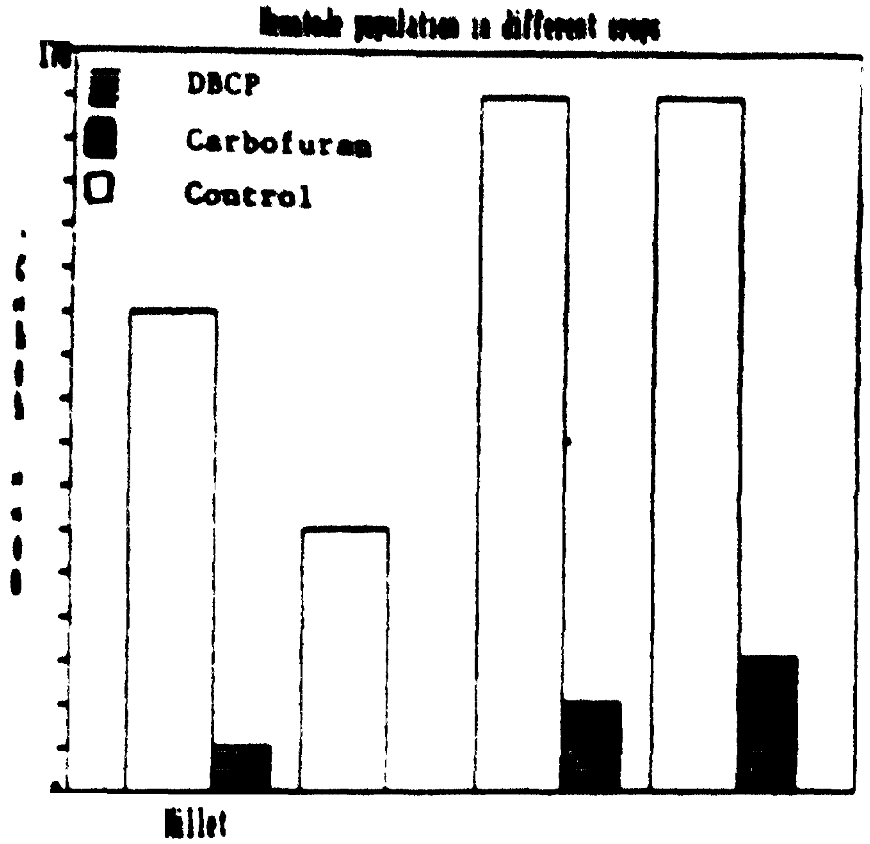


Fig 6 Effect of phosphorus (P) and carbofuran 5 G(b) on populations of plant parasitic nematodes.



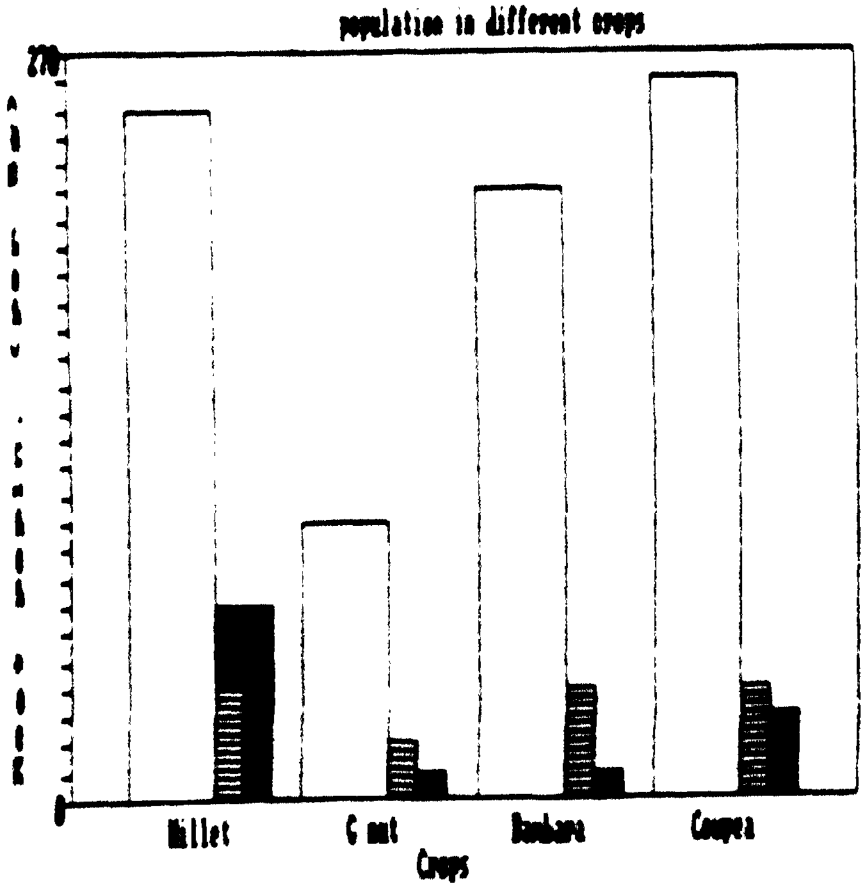


Fig 7 : Nematode populations in pesticide treated, and control plots of millet, groundnut, bambara groundnut and cowpea.

Survey of some groundnut producing regions in Niger: Plant parasitic nematodes belonging to more than 10 genera were recorded in the soil samples collected from 20 different locations. Scutellonema spp. (S. clathricaudatum and Scutellonema sp.), Telotylenchus indicus, Xiphinema spp. (X. attorodorum, and X. italiae) were more frequently encountered than other species. Xiphinema italiae was encountered in soil samples collected from Farmers' fields in Maradi and Mahamanedi. Aphelenchoides spp. were observed in samples collected from Bengou, Tara and Maradi. Trichodorus sp. in soil samples from Kabra, Pratylenchus spp. in soil samples from Yarriddi and Maradi, and Histotylenchus sp. in soil samples from Mahamanedi were recorded. Crop growth variability problem was severe at some locations (Table 4). Groundnut rosette disease was very severe in many areas particularly in locations at Maradi. Pearl millet and cowpea were the most common companion crops of groundnut at all these locations. S. clathricaudatum, Xiphinema spp. and Siddiqia sp. were recorded from root samples.

Table 4 : Plant parasitic nematodes associated with groundnut crop in Niger.

Sl. No.	Location	A	Nematode species 1	2	3	4	5	6	7	8	9	10
1.	Bengou	1	-	30	-	-	-	20	-	30	-	-
2.	Bengou	2	-	20	-	-	-	-	40	20	-	10
3.	Bengou*	2	20	50	-	20	-	-	20	40	-	30
4.	Bengou*	2	-	20	-	-	-	-	50	30	-	20
5.	Tara		-	-	30	-	-	30	250	20	-	20
6.	Tara		20	30	-	-	-	30	40	30	-	20
7.	Tara		10	60	-	-	-	-	90	-	-	10
8.	Tara*		10	50	-	-	-	-	30	20	-	20
9.	Tara		-	20	-	-	-	-	50	30	-	30
10.	Kabra	3	20	-	10	-	-	20	50	30	20	20
11.	Boureiri	3	20	-	20	10	-	80	60	10	-	30
12.	Milo	4	-	-	10	10	-	60	80	-	-	20
13.	Yarriddi	4	-	-	20	10	20	-	80	20	-	30
14.	Mahamanedi	3	-	50	-	10	-	20	40	30	-	30
15.	Maradi	4	10	-	10	-	-	40	30	10	-	20
16.	Maradi	4	20	-	10	20	-	-	40	20	-	10
17.	Maradi	2	-	30	-	-	-	-	20	10	-	-
18.	Maradi*	2	-	60	-	20	-	20	30	-	-	40
19.	Maradi*	2	-	-	-	10	10	-	-	20	-	-
20.	Kowakore	5	-	-	10	-	-	20	70	-	-	30

Nematode species :

1 = *Ditylenchus* sp., 2 = *Helicotylenchus* sp.,
3 = *Hoplolaimus* sp., 4 = *Macroposthonia curvata*,
5 = *Pratylenchus* sp., 6 = *Siddiqia* sp.,
7 = *Scutellonema clathricaudatum* 8 = *Telotylenchus indicus*
9 = *Trichodorus* sp., 10 = *Xiphinema attorodorum*, and *X. italiae*

* Institute national de recherches agronomique du Niger (INRAN)/ICRISAT research farm.

A Above ground symptoms (1 to 5 scale): 1=Uniform growth; 5=Severe variability in crop growth

DISCUSSION

Plant parasitic nematode species belonging to more than 10 genera were recorded associated with the groundnut crops in some of the major groundnut growing regions of Niger. Some of these nematodes (Scutellonema spp., Xiphinema spp., Siddiqia spp. and Macroposthonia sp.) are very important pathogens of field crops and are capable of causing severe damage to annual crops. Surveys indicated that species of Scutellonema, Xiphinema and Telotylenchus are widely distributed in different groundnut growing regions where variability in crop growth appear to be a serious constraint. I had an opportunity to meet with groundnut scientists from West African region during the Groundnut Regional Workshop at Niamey. It seems that crop growth variability problem is wide spread in other countries such as Burkina Faso, Mali, Cameroun etc.

Some of the root systems observed in farmers' fields and at the research farm of ICRISAT at Sadore indicate that nematodes might be involved in the growth variability problem in groundnut. Poor, stubby and bunchy roots with their swollen ends might be produced due to their parasitism by nematodes. In sandy and nutritionally poor soil such as present in the groundnut growing regions of Niger, even low number of parasitic nematode population might cause considerable harm to the roots and can affect uptake of nutrients and absorption of water. Use of high doses of pesticides reduced the nematode populations and increased the plant growth and yield. As these chemicals are broad spectrum pesticides and are known to have growth stimulatory effects, it seems highly desirable to prove the pathogenecity of the associated nematode species to confirm the involvement of nematodes in the variability problem. Pre-plant nematode densities are very important descriptors of the damage caused by nematodes and data on nematode densities at the time of planting would be helpful in relating the intensity of symptoms (growth variability) with nematode densities present at Sadore. It might be possible to control these nematode populations by some non-chemical methods. For instance, I would expect the nematode species to be in anhydrobiotic condition during the hot summer months in absence of the host, and rains might be activating these nematodes and susceptible crops that are planted after the first rain would be attacked by these nematodes. Activating these nematodes by irrigation during May and June and ploughing the soil to expose the active nematodes to high summer temperature might result in better crop growth and yield by reducing the nematode populations and damage being caused by the nematodes.