YAM-BASED FARM PRACTICES AND NEMATODE PROBLEMS IN STORED YAMS (*DIOSCOREA* SPP.) IN GHANA

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ABSTRACT
A survey was made to provide fundamental information on yam-based farm practices, nematode problems and to establish farmers' perceptions of nematode diseases in stored yam tubers in Ghana. Most farmers intercropped yam with a mixture of three to five component crops and milking was practised to provide seed yams. Results showed that farmers could readily identify symptoms of nematode disease and estimated losses from dry rot disease to be about 21% in the forest zone and, 30% in the Guinea- Savannah zone. Even though farmers reported tuber galling in the forest transition, they estimated losses from root knot nematodes to be zero in the Guinea-Savannah. Most farmers had local names for nematode disease and this tends to suggest that farmers perceive nematode disease problem. They used cultural control methods such as selection of clean yam tubers, fallow and use of land not previously cropped to yam to reduce nematode disease spread. Scutellonema bradys was found to be associated with dry rot whilst Meloidogyne incognita was found to cause galling of yam tubers. Pratylenchus coffeae is known to be widespread in Ghana on Musa spp. but it was not encountered in our study. Different yam storage structures were used by farmers and tubers were apparently exposed to conditions that promoted damage by nematodes.

Keywords: *Scutellonema bradys, Meloidogyne incognita, yam, nematode disease, farm practices.*

INTRODUCTION
Ghana produces the second largest proportion of the world's yam (FAO, 2000). Yam cultivation and the yam industry are therefore of paramount importance in Ghana. Many farm families depend on the tubers for food, cash and other traditional uses. It is also an important non-traditional crop for export. However, yams are severely damaged by mainly field to store pests such as nematodes, reducing yield, food quality and market value. The nematode problem has been aggravated by intensive cultivation (African Farming and Processing, 1993), shortened fallow periods ranging between one and three years

(Plowright and Kwoseh, 1998; Kwoseh, 2000) and sub-optimal storage conditions. Generally, yam is grown as a base-crop with other arable crops such as maize, vegetables, melon and cassava which are alternative hosts of the pests. There is little or no information on nematode problems of stored yams in Ghana, therefore, the objectives of this paper are to provide information on farm practices, nematode diseases and pest status in stored yams, and establish yam farmers' perceptions of the diseases.

MATERIALS AND METHODS

An appraisal of nematode pests and diseases in stored yams and farm practices was made in parts of Ashanti, Brong Ahafo and Northern regions of Ghana. These regions visited are within the forest transition and the Guinea-Savannah agroecological zones where yams are very important. A total of 17 districts and 32 towns and villages within these districts were sampled during the appraisal (Table 1).

Towns and villages were selected along the main roads or turns from the roads. The selected sites, in most cases, were before and after towns within the district. People met within a town or village were asked whether they were yam farmers. Those that were yam farmers were interviewed. In most of the villages or towns they invited other yam farmers to come along to be interviewed. A prepared questionnaire was administered to these individuals or groups. During the survey, farmers provided information on the type of yam varieties they grow, yam-based cropping system, how they select planting material, how they stored their yams, how much yams they lost during the season with different problems and how they were controlled. In the forest transition zone 18 questionnaires were administered to 98 farmers, while 14 questionnaires were administered to 145 farmers in the Guinea-Savannah zone. Completed questionnaires were therefore 32 in total. Adequate care was taken to minimise domineering of opinion leaders in the large groups of farmers interviewed. A total of 243 farmers contributed. Based on the types of yam tuber diseases the farmers mentioned during the appraisal, they were asked to bring diseased tuber samples from their storage structure. The tubers that farmers described to be infected with the dry rot disease symptoms and with galled tubers were collected for nematode extraction using modified Baermann's tray and identification in the laboratory. The identification was done with the aid of the Commonwealth Institute of Helminthology (CIH) Description. The same yam samples were taken to CABI Bioscience, UK for confirmation. At least three yam tubers of each nematode disease type were collected and then labelled. This was done for each location visited. Frequencies and percentages were used to analyse the data. Bridge and Page (1980) and Bridge (1988) revealed that the extent of galling caused by *Meloidogyne* spp. and the amount of visible necrosis or burrowing caused by migratory endoparasites can be determined on a percentage basis.

RESULTS AND DISCUSSION

Nematodes constitute one of the major pests that cause problems of yams. They survive and multiply in the yam tissue especially in storage. The dry rot disease symptoms of the yam tubers identified were similar to those reported by West (1934), Goodey (1935) and Bridge (1972). Although most farmers had surplus yams, they remarked that losses from dry rot were great in some years. Farmers estimated losses from dry rot disease to be about 21 % in the forest transition zone and 30 % in the Guinea-Savannah whilst losses from root-knot nematode were estimated as 19 % in the forest transition and zero in the Guinea-Savannah (Table 2).

In Nigeria, losses of 25 to 75 % due to *Scutellonema bradys* infection have been recorded within storage period of 16 weeks (Nwauzor, 1982). Storage losses of more than 80 % have also been reported in Nigeria (Hahn *et al.*, 1989). Root-knot nematode was generally con-

Table 1: Representative sites for the survey of yam nematodes in stored yam and yam-based farm practices in Ghana

Site	Agroecological Zone	Town/village	Lat.	Min	Long.	Min
1	Forest transition	Nokwareasa	7N	21.461N	1W	18.203W
2	Forest transition	Akyena Akura	7N	20.935N	1W	17.906W
3	Forest transition	Nokwareasa	7N	20.413N	1W	17.836W
4	Forest transition	Afrefreso	7N	41.157N	1W	2.577W
5	Forest transition	Old Komkrompe	7N	39.788N	0	59.757W
6	Forest transition	Old Komkrompe	7N	39.804N	0	58.888W
7	Forest transition	Fiapre	7N	21.367N	2W	20.984W
8	Forest transition	Fiapre	7N	21.310N	2W	21.035W
9	Forest transition	Odumase	7N	22.123N	2W	19.193W
10	Forest transition	Pramposo	7N	45.741N	1W	49.653W
11	Forest transition	Jema-Nkwanta	7N	53.060N	1W	46.666W
12	Forest transition	Tanfiano 1	7N	46.600N	1W	45.409W
13	Forest transition	Ekumasa-Domase	7N	32.626N	1W	44.175W
14	Forest transition	Atremso	7N	38.615N	2W	3.444W
15	Forest transition	Akrobi	7N	46.261N	2W	8.869W
16	Forest transition	Ayayo	7N	57.315N	2W	7.155W
17	Forest transition	Bomfo-Mamponteng	6N	47.709N	1W	35.185W
18	Forest transition	Gyamfionoo	6N	48.856N	1W	31.409W
19	Guinea-Savannah	Tunayili	9N	22.021N	0	58.598W
20	Guinea-Savannah	Kpachi	9N	25.694N	0	58.566W
21	Guinea-Savannah	Kanshiegu	9N	34.561N	0	49.963W
22	Guinea-Savannah	Pong-Tamale	9N	41.357N	0	49.766W
23	Guinea-Savannah	Yemo-Karaga Yerpala	9N	44.694N	0	28.299W
24	Guinea-Savannah	Shebo	9N	55.247N	0	22.637W
25	Guinea-Savannah	Gundowari	9N	29.108N	0	1.002W
26	Guinea-Savannah	Choo	9N	20.524N	0	0.371E
27	Guinea-Savannah	Gulnyasi	9N	2.035N	0	0.800W
28	Guinea-Savannah	Salaga-Nkwanta	8N	33.952N	0	29.739W
29	Guinea-Savannah	Kabache-Kasswurape	8N	41.645N	0	31.992W
30	Guinea-Savannah	Kasalgu	9N	24.400N	6W	54.811W
31	Guinea-Savannah	Kootutu No.2	8N	54.472N	1W	47.907W
32	Guinea-Savannah	Nabori	9N	9.135N	1W	51.182W

Table 2. Farmer's estimates of tuber dry rot disease caused by *S. bradys* and galling of tubers caused by root-knot nematode in two agroecological zones in Ghana

	Dry rot disease (*S. bradys*)				Root-knot tuber galling (*M. incognita*)			
	Yam tubers				Yam tubers			
Agroecological	Examined		No.	Mean	Examined		No.	Mean
Zone	Total	Infected	Range	(%)	Total	Infested	Range	(%)
Forest transition	1400.0	296.0	0.0-100.0	21.1	600.0	116.0	0.0-40.0	19.3
Guinea-Savannah	1300.0	392.0	2.0-100.0	30.2	1300.0	0.0	0.0-0.0	0.0

sidered by farmers to be unimportant since infected tubers rarely rot and galled tubers were only observed on the fourth consecutive crop. Farmers remarked that nematode-infected tubers have a sweet taste when cooked.

The prevalence of *S. bradys* in yam tubers was about 83 % of sites in the forest transition zone and 100 % in the Guinea-Savannah, whilst the occurrence of *Meloidogyne incognita* was about 72 % and 28.6 % in the respective zones (Table 3).

From the survey results, *S. bradys* and *M. incognita* are widespread and cause damage to stored yams. At all sites, dry rot symptoms in yam tubers were associated with *S. bradys*, and galling was associated with *M. incognita* (Table 3). A general survey of plant parasitic nematodes of yams in mid-Western Nigeria showed that *S. bradys* and *Meloidogyne* spp. were economically important nematodes of yam tubers (Adesiyan *et al.*, 1990; Jatala and Bridge, 1990; Emehute *et al.*, 1998). Goodey (1935), Bridge (1972), Adesiyan and Odihirin (1977) also observed that *S. bradys* was associated with dry rot of yam tubers. Even though *Pratylenchus coffeae* is known to be widespread in Ghana on *Musa* spp. it was not encountered in our study and it is not likely to become a serious pest of yams in Ghana.

The closely related species of *S. bradys*; *S. cavenessi* and *S. clathricaudatum* were not found infecting stored yam tubers in this study proba-

Table 3: Prevalence of dry rot and root-knot nematodes in two agroecological zones in Ghana

Agroecological Zone	*Total sites Examined	S. bradys No. sites	%	*M. incognita* No. site	%	P. coffeae No. site	%
Forest transition	18.0	15.0	83.3	13.0	72.2	0.0	0.0
Guinea-Savannah	14.0	14.0	100.0	4.0	28.6	0.0	0.0

**32 sites were visited*

bly because yams are not favourable hosts for them. It could also be due to the uncertainty of their pathogenicity. Bridge (1972) found *S. clathricaudatum* endoparasitic in yam roots and not in tubers.

In most years, farmers grew 10 to 15 different yam varieties mostly of *D. rotundata*, but also *D. alata*, *D. cayenensis*, *D. dumetorum* and *D. bulbifera*. All were thought by farmers to be susceptible to dry rot, but some *D. rotundata* varieties, for example, "Lili" and species such as *D. alata* were said to store better. Traditional yam varieties were often described to be free of dry rot.

During the survey, different crop components were planted by the farmers and there were various yam/crop mixtures. Farmers grew these crop mixtures because they mature early, for food security and for income before yam is harvested. Coursey and Booth (1977) reported that yams are intercropped to minimise risk associated with diseases, price variability of produce and to ensure availability of food during the year. It was observed that the crop mixtures in yam fields in the forest transition zone were slightly different from those in the Guinea-Savannah zone. The dominant component crops were cassava, chilli/maize for the forest transition and millet, cassava, maize/sorghum for the Guinea-Savannah. The other component crops included melon, tomato, okra, pigeon pea and sorghum. This cropping system is similar to the practice in Nigeria. According to Orkwor and Asadu (1998), in the humid forest zone of Nigeria, yam-based crop mixtures included maize, vegetables, oil seed (e.g. egusi), cocoyam, beans and cassava while in the Guinea-Savannah zone, the crops included sorghum and millet. Unfortunately, most of the crop mixtures in the yam cropping systems have been reported by Bridge (1973,1978) and Adesiyan (1976) as hosts of *S. bradys* and *Meloidogyne* species. The high infestation of yam tubers by the nematodes may be due to build up of nematodes in the soil and presence of the component crops, which serve as alternative host crops, therefore increasing disease incidence. There was no data on the effects of the nematodes under sole crop yam however, if infected planting materials are used nematode disease is likely to be observed.

From the survey results, most farmers planted yams on land never previously cropped because they remarked that the crop requires very fertile soil. However, due to pressure on land some of the farmers planted on farmlands which had been under fallow for about three to four years. The farmers knew that continuous cropping on the same piece of land resulted in pests and disease problems reducing yield, food quality and market value. This is in line with the reports by Gowen (1992) and African Farming and Food Processing (1993) regarding problems associated with intensive cultivation. It was observed that most farmers avoided planting yam consecutively on the same piece of land to avoid disease problems.

Generally, double harvesting or milking, the most important traditional system for producing seed yams, was practised by all farm families in both agroecological zones. It was observed that milking was done mainly from July to August and it was limited to early maturing yam varieties of *D. rotundata*, such as "Puna" and "Labarko". The milked tubers were either consumed or sold for income. Farmers remarked that seed yams also had dry rot symptoms at harvest and in storage. The farmers also reported that infected seed yams when planted yields diseased tubers at harvest. Bridge (1982) and Degras (1993) noted that the double harvesting technique of producing planting material is prone to dry rot infection.

Out of 243 farmers questioned, only one farmer practised the yam minisett technique (Otoo *et al.*, 1987). This agrees with Bakang (1998) but contrary to the observation by Ezeh (1991) that the technique is viable and widespread in West

Table 4: Storage structures for yam tubers in two agroecological zones in Ghana

	Agroecological zone*			
	Forest transition		Guinea-Savannah	
Storage structure/type	No. farmers	%	No. farmers	%
Field store[a]	44.0	44.9	118.0	81.4
Yam barn	29.0	29.6	9.0	6.2
Building	25.0	25.5	9.0	6.2
Buried in soil	0.0	0.0	9.0	6.2

**A total of 98 farmers (Forest transition) and 145 farmers (Guinea-Savannah)*
[a] The yam tubers are heaped under a tree and then covered with dry yam vines, straw mat and stakes.

Africa. Planting materials were either inherited, farmer's own, obtained from friends or bought from the market or fellow farmers. This finding agrees with a report by Bridge (1987) that farmers normally produce their own seed materials, and occasionally obtained some from neighbours or suppliers. Farmers could readily identify yam tubers with dry rot symptoms and these tubers were rejected at planting.

It was observed that most of the farmers used cultural control methods such as selection, fallow and the use of land never previously planted to yam to reduce disease spread. However, the yams were infected with dry rot probably because the yam tuber is the main source of inoculum as reported by Bridge (1972). Also, low populations of the nematodes do not produce external symptoms of damage (Bridge, 1973) and it is difficult to suspect infestaton in such cases.

None of the farmers used chemical control of any form against nematodes. In all the agroecological zones, farmers mentioned the shortage and high cost of planting materials.

When yam tubers are harvested they are stored for different periods before they are sold or consumed. The shelf-life of yam tubers varies according to species and genotype. Ware yam tubers are usually stored for longer periods than seed yams because they provide food throughout the year. Four storage structures for yam tubers, namely yam barns, field stores, bedrooms (building) and burying tubers in the ground (pit) were identified during the survey (Table.4). The yam barns and the field stores were the most common storage structures found. A total of about 45 % and 81 % of farmers used field stores as storage structures in the forest transition zone and Guinea-Savannah whilst, about 30 % and 6 % used yam barns in the respective zones (Table 4).

Yam barns were made of branches of raffia palm as walls and roofed with grass or aluminium roofing sheets and yam tubers were stored on raised platforms in the barn. For the field storage, the yam tubers were heaped under a tree and then covered with dry yam vines, straw mat and stakes. The yam barn and the field stores according to farmers, provided good shading and ventilation for good yam storage. Farmers remarked that the pit storage method is being discouraged because of high losses from insect pests and rodents.

The high incidence of nematode disease and yam tuber loss caused by nematodes incurred in storage probably because the storage structures created favourable environmental conditions such as optimum temperatures for the high reproduction of *S. bradys* resulting in rapid deterioration.

CONCLUSIONS

S. bradys and *Meloidogyne* spp. were prevalent in the forest transition and Guinea-Savannah zones of Ghana and were economically important on yam tubers. However, farmers in the Guinea-Savannah estimated losses from root-knot nematode to be zero, mainly because infected tubers rarely rot and knotted tubers were observed on the fourth consecutive crop. Farmers, therefore, knew that continuous cropping of yam on the same piece of land resulted in nematode problems. The symptoms of nematode injury were clearly identified by farmers. Nematode diseases were well known to farmers and they displayed this through various attempts to control the problems. The indigenous knowledge of nematode disease is also shown by the local names given to the disease symptoms. All this tends to suggest that farmers perceive the nematode disease problem and would, therefore, readily adopt a resistant variety, if such is identified or developed. Farmers grow a large number of yam varieties for different reasons, so any new yam variety has to be acceptable to the farmers and fit the reasons why they are grown.

At all sites, dry rot disease symptoms were associated with *S. bradys*. Dry rot was never associated with *P. coffeae* although known to be widespread in Ghana on *Musa*. *M. incognita* was found to cause galling on yam tubers.

Although farmers tried to control nematodes, the yam tubers were still infected with dry rot disease. The yam tuber is the main source of inoculum, consequently, seed and ware yams are infected reducing yield and quality. Yam nematodes are difficult to control and their elimination by chemicals is not feasible therefore, ways must be found to promote sustainable yam production and maximise yield while at the same time keeping ecological disturbances at a minimum before a nematode resistant variety is developed. The use of hot water treatment of seed yams and yam setts, and exploitation of natural enemies could be alternative nematode management options.

Also, farmers intercropped yam with a mixture of crops for a good purpose, unfortunately most of intercrops are hosts to the nematode pests.

Yam planting materials were either inherited, farmers' own or bought. Farmers remarked on the shortage and high cost of planting materials. In a situation such as this, farmers are forced to use diseased yam tubers for planting consequently, nematode disease continues to spread. The yam minisett technique, although a solution to the shortage and high cost of planting materials, was only practised by one farmer out of all interviewed. There is, therefore, the need to identify the causes of low adoption of the minisett technique, and find ways of promoting it.

It was observed that the yam storage structures used by the farmers were not good enough so the tubers were exposed to conditions that apparently exacerbated their spoilage by nematodes and other pests. It will be appreciated if modified structures could be developed for farmers to reduce tuber loss.

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