Farmers' knowledge and perceptions of insect pests of yam (*Dioscorea* spp.) and their indigenous control practices in northern Ghana

S. K. ASANTE, G. W. K. MENSAH & E. WAHAGA
(S. K. A. & E. W. : CSIR-Savanna Agricultural Research Institute, P. O. Box 52, Tamale, Ghana; G. W. K. M.: University of Development Studies, P. O. Box 1350, Tamale, Ghana)

ABSTRACT

Farmers' knowledge and perceptions of insect pests of yam were studied between July 2000 and October 2001 in the Northern Region of Ghana using structured interview (questionnaire) and diagnostic surveys. A survey of 130 farmers randomly selected from 10 yam-growing districts of the Northern Region showed a wide range of ages (20-86 years, average 50.3 years). Over 80 per cent of the farmers were above 40 years of age with an average of 25.6 years of farming experience. Land holdings for these farmers were small, averaging 2.8 acres (range 0.5-12 acres). Most farmers were illiterate, because 88 per cent had not received formal education. Farmers identified yam pests as one of the major production constraints. Pests mentioned by farmers as causing the most serious damage in the field and storage, and confirmed by diagnostic surveys, included scale insect, *Aspidiella hartii* Ckll; termite, *Amitermes guineensis* Sands; tuber beetle, *Heteroligus meles* Billb; mealybug, *Planococcus* spp.; leaf beetle, *Crioceris livida* Dalm; and millipede, *Habrodesmus* sp. Despite the high level of pest awareness, most farmers (97%) did not practice any type of pest control because they lacked appropriate control methods. Only 3 per cent of them reported that they had used traditional methods of control such as wood ash, cow dung and aqueous extract of dawadawa, *Parkia biglobosa* (Jacq) Benth, pod or fruit. It is important to improve farmers' pest management abilities by providing them with field diagnostic tools and educational materials through farmer field school. This will help them to acquire basic knowledge of pest identification and key concepts of pest control to enable them to become independent decision-makers.

RÉSUMÉ

ASANTE, S. K., MENSAH, G. W. K. & WAHAGA, E.: *La connaissance et les perspicacités d'agriculteurs d'insectes ravageurs d'igname* (Dioscorea *spp*.) *et leurs pratiques de contrôle indigènes dans le nord du Ghana.* Des études étaient entreprises entre le Juillet 2000 et l'Octobre 2001 sur la connaissance et les perspicacités d'agriculteurs d'insectes ravageurs d'igname dans la région du nord du Ghana adoptant les interrogations structurées (le questionnaire) et les enquêtes diagnostiques. Une enquête de 130 agriculteurs choisis au hasard de dix districts producteurs d'igname de la région du nord révélait de grande envergure des âges (20-86 ans, moyen 50.3 ans). Plus de 80% d'agriculteurs avaient de plus de 40 ans d'âge ayant une moyenne de 25.6 ans d'expérience agricole. Les possessions de terrain pour ces agriculteurs sont petites, atteignant la moyenne de 2.8 acres (variation 0.5 - 12 acres). La plupart d'agriculteurs sont analphabètes, comme 88% n'ont pas suivi de cours formels. Les agriculteurs identifiaient les ravageurs d'igname comme l'un de contraintes principales de production. Les ravageurs mentionnés par les agriculteurs comme causant les dégâts les plus sérieux aux cultures aux champs et en stockage et confirmé par l'enquête diagnostique comprennent: le coccidé, *Aspidiella hartii* Ckll; le termite, *Amitermes guineensis* Sands; le coléoptère, *Heteroligus meles* Billb; l'aleurode, *Planococcus* spp.; le coléoptère de feuilles, *Crioceris livida* Dalm; et le mille-pattes, *Habrodesmus* sp. Malgré la prise de conscience élevée de ravageurs, la majorité d'agriculteur (97%) ne pratiquent pas aucun type de maîtrise de ravageur parce qu'ils manquent les méthodes de maîtrise appropriées. Seulement 3% d'entre eux signalaient l'application de méthodes traditionnelles de maîtrise telles que la cendre de bois, le fumier de vache, et l'extrait aqueux de la cosse, ou du fruit de dawadawa *Parkia biglobosa* (Jacq) Benth. Il est important d'améliorer la capacité de l'agriculteur de lutter contre les ravageurs par la fourniture des outils de diagnostic sur le terrain, et les matériels de vulgarisation à travers

Ghana Jnl agric. Sci. **40**, 185-192

Original scientific paper. Received 01 Feb 2005; revised 13 Nov 2006.

l'école d'agriculteur sur le terrain. Ceci peut les aider à acquérir la connaissance de base d'identification de ravageur, les notions fondamentales de la lutte contre les ravageurs, pour leur permettre de devenir des décideurs originaux.

Introduction

Yam, which belongs to the family Dioscoreacea, is probably one of the oldest groups among the angiosperms (Orkwor, 1998). It is believed to have originated in the tropical areas of three separate continents: Africa, *Dioscorea rotundata* Poir, *D. cayenensis* Lam., *D. dumetorum* (Kunth) Pax; South East Asia, *D. alata* L., *D. esculenta* (Lour.) Burkill; and South America, *D. trifida* (L.) (Ayensu & Coursey, 1972; Coursey, 1976). In Ghana, most cultivated yam are cultivars of *D. rotundata* (white yam) and *D. alata* (water yam). Although yam is cultivated all over the country, larger proportion (> 60%) is produced in Northern and Brong Ahafo regions (Nyanteng, 1978). Other areas where yams are produced in Ghana include Eastern, Ashanti, Volta, and Upper West regions (Fig. 1). From these areas, yam is transported all over the country (Nyanteng, 1978).

In Ghana, yam is processed into various types of food such as fufu; boiled, roasted or grilled yam; mashed yam; and chips. Compared to other food crops such as cassava and plantain, yam tubers have better storability. Hence, farmers and retailers store them either in the ground or on racks in farm stores and are gradually released onto the market, particularly during the lean season (i.e., between March and June). Yam, therefore, contributes to food security in Ghana, in addition to generating income for farmers from local trade and revenue from export. However, its production is confronted

Fig. 1. Map of Ghana showing districts in the Northern Region that were surveyed.

with many constraints including pests and diseases. Yam is attacked and damaged by field and storage pests wherever it is grown in Ghana and elsewhere, resulting in yield and storage losses (Taylor, 1964; PANS, 1978; Akinlosotu, 1985; Emehute *et al*., 1998).

Although yam plays an important role in meeting the food needs of the rapidly increasing human population in Ghana and ensuring food security in general, very little attention has been given to its pest problems and their control interventions. Hence, farmers continue to lose substantial part of their produce or revenue through the activities of these biotic agents (Taylor, 1964; Wood *et al*., 1980; Akinlosotu, 1985). However, considering recent interest in producing exportable yams, food security and in enchancing income generation of resource-poor farmers, including women (poverty alleviation) in Ghana, it is imperative to develop appropriate technologies to manage these pests. A necessary prerequisite to achieving these aims is to obtain precise information on the incidence, distribution, abundance, and pest status of the different species of pests associated with yam at different locations (ecological zones).

Understanding the farmers' awareness of crop pests and traditional pest control will facilitate the introduction of appropriate control strategies (Matteson, Attieri & Gagne, 1984; Atteh, 1984; Thurston,1992; Chitere & Omolo, 1993). Indigenous pest control practices need to be documented, tested, adapted, and promoted to farmers with other integrated pest management (IPM) measures, because the efficiency of small-scale farmers probably improves through gradual modifications of their agronomic practices rather than through radical changes to the *status quo*. Moreover, local names for pests and diseases, and details on indigenous pest control methods need to be compiled so that researchers and extension workers can communicate with farmers.

The study, therefore, aimed to (i) collect, identify and characterize arthropods and other pests associated with yams in different ecological (yam-growing) zones in northern Ghana, and to (ii) interview farmers to collect information on their knowledge and perceptions of yam insect pest constraints and their indigenous control methods.

Materials and methods

The study was in the Northern Region of Ghana, within latitude 8^0-10^0 40' N and longitude 0 30' E, 3' W. The annual rainfall of the area ranges between 1069 and 1253 mm. The survey covered 10 yam-growing districts: Tolon-Kumbungu, West Gonja, Bole, East Gonja, Nanumba, Savelugu-Nanton, Yendi, Gushegu-Karaga, Zabzugu-Tatali, and Saboba-Chereponi (Fig. 1). The districts were surveyed between July 2000 and October 2001 when yams were growing in the field. A fully structured questionnaire was used to interview selected farmers from the 10 districts. Between 10 and 20 farmers were selected in each district through the assistance of agricultural extension agents (AEAs) and interviewed individually. The questions centred on personal history, history of cultivation, planting materials, problems of pests and diseases and their control interventions. A total of 130 farmers were interviewed. Thereafter, a diagnostic survey was used in their farms to record the incidence of disease and damage caused by field pests by randomly selecting 30 plants (mounds) from each farmer's field for thorough inspection.

Because yam farmers in the Northern Region store yam in barns (constructed using local materials) in their farms after harvest, a second diagnostic survey focused on storage pests between December 2000 and March 2001. Yam barns of some farmers in the West Gonja, Zabzugu-Tatali, and Saboba-Chereponi districts were inspected to record pests attacking the yams in storage. One hundred yam tubers were selected at random from each barn for thorough examination. In addition, field damage by yam tuber beetle and millipede was assessed from the selected tubers. Specimens of termite and tuber beetle found attacking yams were sent to the International Institute of Tropical Agriculture

(IITA), Biological Control Centre for Africa, Cotonou, Republic of Benin, for identification.

Results and discussion

Socio-cultural background of farmers

The results of the survey showed a wide range of ages (20-80 years, mean 50.3 years) among farmers growing yam with an average of 25.6 years (range 2-70 years) of farming experience. Eighty-three per cent of the respondents were above the age of 40. Therefore, to increase and sustain yam production in northern Ghana, the youth must be encouraged and motivated to go into yam farming. Ninety-five per cent of the respondents were males married with number of wives ranging between 1 and 7, and family size between 2 and 17. Large family sizes were found to be beneficial to them because they contribute to their labour force in farming activities. The survey indicated that farmers obtain 25 per cent of labour from family, 65.6 per cent from seasonal or hired labour, and 4.7 per cent from friends.

Diverse ethnic groups (Dagomba, Gonja, Basare, Safaliba, Dagati, Mo, Bono, Kokomba, Chokosi) were represented in yam cultivation in Northern Region of Ghana. However, some of these ethnic groups were found to be settler farmers. The illiteracy level amongst the farmers was high because 88.1 per cent of the respondents were illiterate, 6.8 per cent had received elementary education whilst 5.1 per cent had secondary education. Therefore, the literate youth, particularly those who have had training in agriculture, should be encouraged and motivated to go into farming. Because they would be able to interact effectively with the researchers and extension agents, and easily adopt newly generated and proven technologies. Also, literate farmers would be interested, willing and able to access credit to expand their farms. For instance, Goodell (1984) stated that a major bottleneck in international pest management research and extension in the Third World was translating IPM messages into a language that can be understood and applied by farmers.

History of cultivation

The area planted to yam per individual farmer ranged from 0.5 to 12 acres, but most (63%) had between 2 and 4 acres of yam farm. This agrees with Steiner (1982) who reported that most farmers in sub-Saharan Africa (80-90% in West Africa) have smallholdings of less than 2 ha where their main objective is subsistence from sheer necessity. Also, 87.9 per cent of the farmers were found to obtain their planting materials from their own farm, 10.6 per cent from the market, and 1.5 per cent from friends. The consequence is that planting material is often of low quality, being infected with fungal or bacterial diseases, viruses or nematodes or both (Nutsugah *et al*., 1998). However, they did not know whether the source of seed yam could influence the incidence of pest and disease in their yam fields. It was also observed that farming activities in yam cultivation (land preparation, mounding and planting) normally begin in October (i.e., toward the end of the rainy season) and end in May of the following year. Because the rainy season in Northern Ghana is between May and October and yam needs about 5 months of rainfall for optimum yield, farmers in the Region time their planting to coincide with this period. Over 94 per cent of the farmers practised cultural methods such as mulching, staking and weeding, and thought such practices influenced the incidence of pests and diseases, particularly millipede and tuber beetle infestation.

Production constraints

Farmers showed a deep understanding of the crop ecosystem and the constraints that limit production. Production constraints were many and included declining soil fertility, lack of credit facilities, lack of transportation to market centres, inaccesible roads to areas of production, high crop perishability due to lack of storage facilities, high cost of labour, unpredictable weather, high cost of planting materials, and pests and diseases (Tetteh & Saakwa, 1991). In all the surveyed areas, over 90 per cent of the farmers reported that they had pest problems (Table 1). Insects were

TABLE 1

Pests Mentioned by Farmers as Damaging Their Yam in the Field and Storage in Northern Region of Ghana in a Survey Between July 2000 and October 2001

Pest	*% of farmers reporting*	*Where is it a problem?*	*Nature of damage*	*Rank*[1]	*Available control method*
Scale insect	93.7	Field and storage	Suck sap from tuber	1	Dawadawa, ash, cowdung*
Termite	87.0	Field and storage	Tunneling and nesting in tuber	2	Nil
Tuber beetle	93.8	Field	Create large holes on tuber	3	Nil
Millipede	82.8	Field	Create small holes on tuber	4	Nil
Mealybug	57.4	Field and storage	Suck sap from tuber	5	Dawadawa, ash, cowdung*
Leaf beetle	100	Field	Eat tender leaves and tips of vines	6	Nil**
Cricket	10.9	Field	Eat tuber/seed and cut vines	7	Nil

* 3% of farmers use wood ash, cowdung and aqueous extract of dawadawa pod to control scale insect and mealybug on seed yam before planting.

** Some farmers said that they pray for rain to fall and wash down leaf beetle when they observe high infestation on their fields.

[1]Rank: 1 = the most damaging pest; and 7 = the least damaging, according to farmers.

recognized as the most important constraint. Some pests mentioned as infesting or damaging yam, in the field and in storage, included tuber beetle, leaf beetle, millipede, mealybug, scale insect, termite, and cricket. They ranked scale insect, termite and tuber beetle as the three most important yam pests. They thought that damage caused by the scale insect and termite adversely affect sprouting, whilst tuber beetle damage also affect the market value of yam. Except for crickets, all the pests mentioned were identified as the potential field and storage pests by the diagnostic surveys (Tables 2 and 3).

Yam tuber beetle damage appeared to be the major constraints to yam production at some locations in East Gonja, Saboba Chereponi, Bole, and Savlugu-Nanton districts (Fig.1); particularly amongst those who cultivate yam along big rivers such as Daka, Oti, Black and White Volta. The tuber beetle and termite were identified as *Heteroligus meles* (Billberg) (Coleoptera: Scarabaeidae, Dynastinae) and *Armitermes guineensis* (Sands) (Isoptera: Termitidae), respectively. However, Taylor (1964) reported that four species of yam beetles (i.e. *H. meles, H. appius Klug*, *Prionorcytes rufopiceus* Arrow, and *P. canaliculus* Arrow) are known to attack yams in tropical Africa and are particularly significant in West Africa. Scale insect and mealybug infestations of stored yam were widespread (Table 4). Eighty-six per cent of the farmers could identify and name some important yam pests in various languages. Moreover, some farmers were able to determine the stage of the crop at which some

TABLE 2

Incidence and Abundance of Field Insect Pests of Yam in Northern Region of Ghana During the 2000 and 2001 Cropping Seasons

District/Zone	*Yam leaf beetle*		*Yam tuber beetle*		*Millipede*		*Termite % of stands infested*	*Mealybug score (0-9)*[3]
	Larvae/Stand[1]	*Score*[2] *(1-5)*	*Adult/ mound*	*Holes/ tuber*	*Adult/ mound*	*Holes/ tuber*		
Nyankpala	3.4 (0-25)	2.3	0	0	1.8	1.4	0	0
Wantungu	3.7 (0-24)	2.4	0	0	1.4	0.9	0	0
Tolon	3.5 (0-22)	2.3	0	0	1.1	2.5	0	0
Kumbungu	6.3 (0-49)	2.5	0.2	0.4	2.0	2.1	0	0
Saboba	0.6 (0-12)	2.0	0.3	0.4	0.3	0.1	3	2.5
Chereponi	3.0 (0-19)	2.2	0.1	0.1	0.5	0.1	0	1.2
Zabzugu	0.5 (0-6)	2.0	0	0	0.3	0.3	15	0.7
Bole	0.8 (0-16)	2.1	0	1.3	0.2	0.2	6	1.0
Nanumba	0.6 (0-25)	2.4	0	0	0	0	0	0
East Gonja	1.2 (0-25)	2.0	2.0	4.5	0	0	0	0

[1] Ranges are in parenthesis

[2] Yam leaf beetle damage (to canopy) score: 1 = no damage, 2 = < 10% damage, 3 = > 10% < 25% damage, 4 = > 25% < 50% damage.

[3] Mealybug score (per tuber): 0 = no mealybug, 1 = 1-4 insects, 3 = 5-20 insects, 5 = 21-100 insects, 7 = 101-500 insects, and 9 = > 500 insects.

TABLE 3

Percentage of Yam Tubers Infested by Insect Pests, Millipede and Vertebrate in the Field and Storage in Northern Region of Ghana During the 2000 and 2001 Cropping Seasons

District	*Village/ Town*	*Yam tuber beetle*[1]	*Millipede*[1]	*Termite*	*Mealybug*	*Scale insect*	*Vertebrate*[2]
West Gonja	Delado	28	44	33	48	27	3
	Kayereso	86	56	26	6	93	0
	Ekumdi I	62	49	4	4	83	0
	Ekumdi II	91	29	17	62	54	0
	Ekumdi III	92	46	9	18	41	0
	Kalande	4	71	20	17	40	0
Zabzugu-Tatali	Kukpalgu I	2	46	21	8	44	2
	Kukpalgu II	0	51	29	25	96	10
	Kukpalgu III	1	69	23	31	2	3
	Nakpali	0	42	33	10	24	1
Saboba-Chereponi	Sambuli I	38	18	10	32	17	7
	Sambuli II	19	57	5	37	32	2
	Sambuli III	47	39	8	18	56	0
	Sambuli IV	62	39	14	64	4	4
	Sambuli V	37	35	25	27	81	7
	Nakpando	15	35	0	1	20	3

[1] Means percentage of tubers with at least one tuber beetle or millipede damage hole

[2] Rats and bush fowl

TABLE 4

Severity of Infestation by Field and Storage Pests of Yam in Northern Region of Ghana During the 2000 and 2001 Cropping Seasons

District	*Village/Town*	*Tuber beetle*[1] *Mean no. of holes per tuber*	*Millipede Mean no. of holes per tuber*	*Termite damage symptom (+, ++, +++)*	*Mealybug Mean score*[2] *(0-9)*	*Scale insect Mean score*[2] *(0-9)*
West Gonja	Delado	3.3 (1-13)	2.6	+	1.9	1.9
	Kayereso	10.2 (1-28)	1.4	++	1.0	3.5
	Ekumdi I	9.1 (1-32)	3.3	+	1.5	3.4
	Ekumdi II	13.2 (1-35)	3.0	++	2.1	2.3
	Ekumdi III	11.1 (1-28)	3.3	+	1.7	4.9
	Kalande	1.3 (1-2)	5.7	++	2.2	1.2
Zabzugu-Tatali	Kukpalgu I	3.0 (2-4)	3.1	+	1.3	3.5
	Kukpalgu II	0	3.3	+	1.9	6.8
	Kukpalgu III	3.0 (1-3)	6.3	++	2.5	3.0
	Nakpali	0	3.5	++	2.5	2.8
Saboba-Chereponi	Sambuli I	2.1 (1-6)	1.4	+	1.8	2.9
	Sambuli II	2.6 (1-8)	4.2	+	1.6	3.2
	Sambuli III	3.9 (1-18)	3.9	+	1.8	3.9
	Sambuli IV	3.2 (1-16)	2.9	+	2.3	4.0
	Sambuli V	3.4 (1-9)	3.0	+	1.4	5.0
	Nakpando	2.9 (1-5)	4.2	+	3.0	3.4

[1] Ranges are in parenthesis

[2] means 0 = no mealybug/scale insect, 1 = 1-4 insects, 3 = 5-20 insects, 5 = 21-100 insects, 7 = 101-500 insects, and 9 = > 500 insects.

Termite damage to yam tuber: + = slight damage, ++ = moderate damage, +++ = severe damage.

pests attack the yam. The above information is useful because it would facilitate the interaction between scientists, extension agents, and farmers.

Over 40 per cent of the respondents did not know about mealybug infestation and damage. Also, nematode and fungal attack (on foliage) were prevalent in moist areas (i.e. areas which become flooded during heavy rainfall) as well as viral diseases, but farmers did not mention any of them as a constraint. It has been reported that generally farmers have good knowledge about objects in nature they can easily observe, such as plants and large insects including locusts and grasshoppers (Van Huis & Meerman, 1997). Less conspicuous insects such as stem borer larvae and sorghum midge, and natural enemies as well as plant diseases caused by bacteria and viruses may escape their attention (Harris, 1961; Van Huis, Nauta & Vulto 1982; Bentley,1992; Nutsugah *et al*., 1998).

Pest control practices

Most (97%) farmers do not attempt to control the pests because they lack appropriate control methods. Although they perceive these pests as enemies causing damage to their crops, they do not have any solution to them. Few farmers (3%) reported using traditional methods of control such as the use of wood ash, aqueous extract of dawadawa, *Parkia biglobosa* (Jacq) Benth., pod or fruit and cowdung to control some pests, particularly scale insect and mealybug. For yam leaf beetle, some farmers believed that rain could control them because it washed them away.

Therefore, they pray for rain to fall whenever they detect high infestation on their fields. All the respondents (farmers) were willing and ready to use any available and proven control strategy because yam is one of their major cash crops. Therefore, it is important to improve farmers' pest management abilities by providing them with field diagnostic tools and educational materials through farmer field school. This will help them to acquire basic knowledge of pest identification, key concepts of pest control to enable them to become independent decision-makers.

Acknowledgement

The authors are thankful to Mr Issah Ramat, CSIR-Savanna Agricultural Research Institute, and all Ministry of Agriculture (MoFA) Extension Agents in the Northern Region who helped in data collection. They are also grateful to Dr G. Georgen and H. E. Davis (IITA) for identifying the yam tuber beetle and termite. Financial support provided by the Root and Tuber Improvement Programme (RTIP) is gratefully acknowledged.

REFERENCES

Akinlosotu,T. A. (1985) Studies of the yam shoot beetles, *Crioceris livida* (Dalm). (Coleoptera: Crioceridae). *Niger. agric. J.* **2**, 190-196.

Atteh, O. D. (1984) Nigerian farmers' perceptions of pests and pesticides. *Insect Sci. Applic*. **5**, 213-220.

Ayensu, E. S. & **Coursey, D. G.** (1972) Guinea yams: The botany, ethnobotany, use and possible future of yams in West Africa. *Econ. Bot*. **26**, 301-318.

Bentley, J. W. (1992) The epistemology of plant protection: Honduras campesinos knowledge of pests and natural enemies. In *Proceedings of a Seminar on Crop Protection for Resource-poor Farmer* (CTA/NRI) (ed. R. W. Gibson and A. Sweetmore), pp. 107 - 118.

Chitere, P. O. & **Omolo, B. A.** (1993) Farmers' indigenous knowledge of crop pests and their damage in Western Kenya. *Int. J. Pest Mgmt* **39**, 126-132.

Coursey, D. G. (1976) The origin and demonstration of yams in Africa. In *Origins* of *African plants domestification* (ed. J. R. Harlan, J. M. J. de Wet and A. B. L. Stemler), pp. 383-403. Mouton, The Hague.

Emehute, J. K. U., Ikotun, T., Nwauzor, E. C. & **Nwokocha, H. N.** (1998) Crop protection. In *Food yams: Advances in research* (ed. G. C. Orkwor, R. Asiedu and I. J. Ekanayake), pp. 143-186. IITA and NRCRI, Nigeria.

Goodell, G. (1984) Challenges to international pest management research and extension in the Third World: Do we really want IPM to work? *Bull. ent. Soc. Am.* **30**,18-26.

Harris, K. M. (1961) The sorghum midge, *Contarinia sorghicola* (Coq.), in Nigeria. *Samaru Res. Bull. No.* 7. (Zaria, Northern Nigeria: Regional Research Station).

Matteson, P. C., Attieri, M. A. & **Gagne, W. C.** (1984) Modification of small farmer practices for better pest management. *Ann. Rev. Ent.* **29**, 383-402.

Nutsugah, S. K., Tsigbe, F. K., Peters, J. & **Osei, C**. (1998) Yam diseases in northern Ghana. In *Proceedings of the 7th Triennial Symposium of ISTRC-AB* (ed. M. O. Akoroda and J. M. Ngeve), pp. 534-540.

Nyanteng, V. K. (1978) *Yam production and marketing in Ghana* (M Sc Thesis). University of Ghana, Legon, Ghana. 159 pp.

Orkwor, G. C. (1998) The importance of yams. In *Food yams: Advances in research* (ed. G. C. Orkwor, R. Asiedu and I. J. Ekanayake), pp. 1-12. IITA and NRCRI, Nigeria.

PANS (1978) Pest control in tropical root crops. Pest Articles and News Summaries: *PANS Manual No. 4.* Centre for Overseas Pest Research. Hobbs Printers, London. 234 pp.

Steiner, K. G. (1982) *Intercropping in tropical smallholder agriculture with special reference to West Africa*. Eschbom: GTZ. 303 pp.

Taylor, T. A. (1964) Studies on the Nigerian yam beetles: II. Bionomics and control. *J. W. Afr. Sci. Ass.* **9**(1), 13-31.

Tetteh, J. P. & Saakwa, C. (1991) Prospects and constraints to yam production in Ghana. In *Proceedings of 9th Symposium of ISTRC* (ed. K. Ofori and K. Hahn), pp. 235-238.

Thurston, H. D. (1992) *Sustainable practices for plant disease management in traditional farming systems*. Westview Press, Boulder, San Francisco, Oxford. 279 pp.

Van Huis, A. & Meerman, F. (1997) Can we make IPM work for resource-poor farmers in sub-Saharan Africa? *Int. J. Pest Mgmt* **43** (4), 313-320.

Van Huis, A., Nauta, R. S. & Vulto, M. E. (1982) Traditional pest management in maize in Nicaragua: A survey. *Med. Landbouw. Wage* **82-86**. 43 pp.

Wood, T. G., Smith, R. W., Johnson, R. A. & Komolafe, P. O. (1980) Termite damage and crop loss studies in Nigeria. Pre-harvest losses to yams due to termite and other oil pests. *Trop. Pest Mgmt* **26** (4), 355-370.