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Research article

INDIGENOUS KNOWLEDGE AND MANAGEMENT OF YAM (*DIOSCOREA CAYENENSIS – DIOSCOREA ROTUNDATA* COMPLEX) PESTS AND DISEASES IN NORTHERN BENIN

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ABSTRACT: Yam (*Dioscorea* spp.)production in Northern Benin is severely affected by pests and diseases resulting in poor yields and cultivars diversity loss in spite of the importanceof thiscommodity.In order to develop efficient integrated pestsand diseases management approaches, twenty seven (27) villages of the yam production zone of northern Benin were surveyed using participatory research appraisal to document farmers'indigenous knowledge, and traditional management practices of yam pests and diseases. Results indicated that farmers have good knowledge of the yam pests and diseases that were even reported as the third most important production constraints in the study area. Among the pests and diseases nematodes, termites, mealybugs and wilt diseases were the most signaled. Farmers surveyed have traditional methods for mealybugs but nothing for the other pests and diseases apart from the use of resistant/tolerant cultivars. An undetermined disease locally called Ban was reported as expanding at alarming rate throughout villages and yam fields seriously affecting the food quality of the tubers. Urgent intervention zones were identified with multivariate analysis and recommended to the national protection service. The sensitization of the yam producers of the necessity of treating both soil and tuber seeds before planting, the development and the use of pests and diseases tolerant cultivars were proposed as management strategies. Also, the extension of the study to other yam producing regions of the country for identifying more cultivars tolerant to pests and diseases was recommended.

Key words: Yam, Indigenous knowledge, Pest and diseases, Management, Northern Benin

INTRODUCTION

Guinea yams (*D. cayenensis – D. rotundata* species complex)constitute the predominant starchy staple in sub-Saharan Africa especially in the so-called West Africa yam belt where food security is becoming a critical issue (Fu et al., 2011; Demuyakor et al., 2013). West Africa is the world's most prominent region for the production of yams and produces alone more than 95% of the worldwide production (Demuyakor et al., 2013). The crop produces underground tubers that are good sources of carbohydrates, vitamins and minerals (Olajumoke et al., 2012). The tubers are eaten boiled, pounded, roasted or fried and could be also chipped, dried and produced into yam flour (Ayodeji et al., 2012; Oluwole et al., 2013). In Benin, fourth producing country behind Nigeria, Ivory Coast and Ghana, total annual yam production is 2,366,000 tonnes in average and yam consumption per capita per day is highest (418 kcal) than the other country (FAO, 2011). Different species are cultivated but *D. cayenensis – D. rotundata* complex is the most important and represents more than 95% of the total output (Loko et al., 2013). Despite the proved economic, nutritional, food security and cultural importance of the crop, very little attention has been given to its related pest and diseases, their impacts on the production and their control strategies (Asante et al., 2007, Korada et al., 2010, Dansi et al., 2013). Consequently and as reported by producers, pests and diseases in the fields and in the storage are still spreading, ware and dry tuber losses are high, many cultivars are being disappeared and a new phenomenon has even appeared and is widely and uncontrolledly spreading (Loko et al., 2013). To combat biotic factors in a crop production system, the development of an Integrated Pest and Diseases Management strategy is a necessity (Tanzubil and Yakubu, 1997; Pandey and Satpathy, 2009; Waterfield and Zilberman, 2012). For this, the documentation of farmers' knowledge and perceptions of yam pests and diseases and their traditional management is a prerequisite (Midega et al., 2012). In the traditional agriculture, farmers have a wealth of knowledge in tackling pest and diseases which are generally well adapted to their socioeconomic and environmental conditions (Mendesil et al., 2007; Azman and D'Silva, 2012; Chanu et al., 2010; Sesay et al., 2013).

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Moreover, to facilitate communication between farmers and researchers (or extension workers) local names of pests and diseases and details of the indigenous control methods must be also documented (Midega et al., 2012).
The objectives of this study were threefold:

- Assess the importance of pest and diseases within the overall farmers' perceived constraints of guinea yam production in northern Benin;
- Document farmers' knowledge of the nature, manifestation, impact and traditional management of yam pests and diseases in the study area;
- Identify within the study area and for the national plant protection system the urgent intervention zones and their associated key pest and diseases.

MATERIAL AND METHODS

Study area

The Republic of Benin is situated in West Africa and between the latitudes 6°10' N and 12°25' N and longitudes 0°45' E and 3°55' E (Akoègninou et al., 2006). It covers a total land area of 112,622 km2 with a population estimated at about 7 million (Adomou, 2005). The country is partitioned into 12 departments (Fig. 1) out of which four (Alibori, Atakora, Donga, Borgou) are located in the north (study area) and inhabited by 14 ethnic groups which are Ani, Bariba, Berba, Boko, Dendi, Ditamari, Gourmantché, Kotokoli, Lokpa, M'bermin, Natimba, Peulh and Wama (Adam and Boko, 1993).The north is situated in arid and semi-arid agro-ecological zones characterized by unpredictable and irregular rainfall oscillating between 800 and 950 mm/year with only one rainy season. Mean annual temperatures range from 26 to 28 °C and may exceptionally reach 35–40 °C in the far northern localities (Adomou, 2005; Akoègninou et al., 2006). The country has 2,807 plant species (Akooègninou et al., 2006). Vegetation types are woodland and savannah woodland (northeast), dry semi deciduous forest (south of northwest) and tree and shrub savannahs (far north).

Site selection and survey

Twenty-seven (27) villages were randomly selected in the yam producing districts of the northern Benin for the survey (Figure 1). Data were collected during the first guinea yam harvest time (months of August -September 2012) in the various sites through the application of Participatory Research Appraisal tools and techniques following Poubom et al. (2005). In each village, interviews were conductedwith a group of 30 to 40 producers of both sexes and of different ages and with the help of a local translator (Kombo et al., 2012). Producers were identified and assembled with the help of the leaders of local farmers' associations and ofthe chiefs of the village involved in the study to facilitate the organisation of the meetings and the collection of data as described by Dansi et al.(2013). Prior to the meeting, farmers were requested in advance to bring samples of yam leaves and tubersthey considered infested or bearing a special disease. After detailed presentation of the research objectivesto the farmers and collection of the particulars of the area (agro-ecological zone, name of location, name of sub-location, name of village, ethnic group) the details on the village, farmers were asked to list (vernacular names) all their perceived constraints related to yam production in their area. The listed constraints were prioritized in groups by identifying and gradually eliminating the most severe constraint following Gbaguidi et al. (2013). In a first step of this procedure, producers were asked to identify, among the constraints they have listed, the most critical one and for which an urgent solution must be found. The constraint hence identified was ranked first and eliminated from the list. The same procedure was repeated until the last constraint was ranked and the results were immediately given to the producers for approval. After ward, producers were asked to list (vernacular name) and show (samples of infested yam leaves and tubers) the different types of yam pests and diseases they know about. Farmers' knowledge of the pests and diseases (type and nature of damage or symptoms, severity, traditional management or control measures, etc.) were documented following Jarvis and Campilan, (2006); Mulumba et al., (2012). Diseases were scientifically identified with the help of the plant protectionist (plant pathologist and nematologist) of the survey team. The identified diseases were prioritised using the procedure described by Obopile et al. (2008). Samples of the insects reported were collected and conserved in a flask containing 70% alcohol for the safeguarding and the identification of the species carried out at the Laboratory of Biotechnology, Genetic Resources and Animal and plant Breeding (BIORAVE) following Loko et al., (2013).

Data analysis

Data were analysed through descriptive statistics (frequencies, percentages, means, etc.) to generate summaries and tables at different (villages, individuals) levels using SAS software (SAS Institute 1996).The constraints were prioritized based on the average of the following three parameters:

- The total number of villages (TNV) in which the constraint is cited
- The number of villages in which the constraint was classified among the principal constraints (PCO) i.e. among the first five
- The number of villages where the constraint is the major one or ranked first (MAC).

Figure 1: Map of the northern Benin showing the geographical locations of the villages surveyed

For these three parameters, the higher the number is, the more important is the constraint.The importance of a constraint (IMC) was then determined by the formula IMC = (TNV + PCO + MAC)/3**.** The same approach was used to rank the different pest and diseases identified.

To examine the relationships between the 27 villages surveyed in terms of pest and diseases of significant impacts (farmers' perceptions), these last were considered as variables and scored 1 when important and 0 when not. With the binary matrix compiled, principal component analysis (PCA) was performed, with Minitab statistic program (Minitab version 14, Minitab Inc., State College, PA, USA). In addition, pairwise distances between villages were computed by the NTSYS-pc 2.2 software package(Rohlf 2000) using the simple matching coefficient of similarity and a dendrogram wascreated by Unweighted Pair-Group Method with Arithmetic Average (UPGMA) cluster analysis(Sneath and Sokal, 1973; Swofford and Olsen, 1990).

RESULTS

Importance of pest and diseases within yam production constraints in northern Benin

Seven constraints were identified throughout the different villages explored (Table 1). Their prioritization based on the three above-mentioned parameters ranks first climate change (mainly characterized by the delay, the early cut or the occasional excess of rain and the drought), followed by low soil poverty. Pest and diseases damages rank third. Other constraints included lack of performing cultivars, difficult post-harvest storage, lack of organized seed yam production system and organised markets (Table 1).

The importance of the pest and diseases as perceived by farmers varied across villages (Figure 2). Pest and diseases were reported as principal or major constraint in all the villages surveyed and ranked first in two villages (Sombouan and Sayakrou), second in eleven villages and within the first three constraints in 74.04% of the villages surveyed.

Table 1: Yam production constraints and their importance in northern Benin

Constraints	Number of villages			Mean	Rank
	TNV	PCO	MAC		
Climate change	25	25	14	21.33	1
Low soil fertility	27	27	7	20.33	2
Disease and pest attacks	27	27	2	18.67	3
Lack of performing yam cultivars	27	22	2	17	4
Difficult post-harvest storage	27	17	0	14.67	5
Lack of seed yam	27	15	0	14	6
Lack of organised markets	27	12	2	13.66	7

TNV: Total Number of Villages; *PCO*: Principal Constraint; *MAC*: Major Constraints

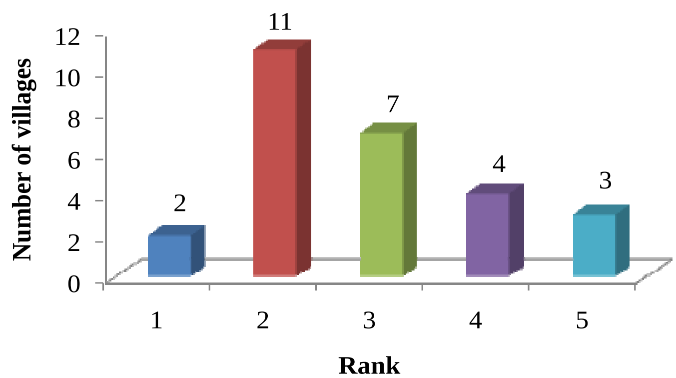

Figure 2: Importance of pests and diseases within the constraints listed by farmers

Farmers' knowledge of the nature, manifestation and impact of yam pests and diseases

A total of nine types of pests (Gomi, Kôba, Parakomongouba, Tinainnou, Torowounpougou) and diseases (Ban, Kpanro, Mouhounkra, Tassoudèrabou)were signalled by the farmers surveyed.Their various vernacular names recorded across ethnic groups are compiled in Table 2 and their scientific determination indicated,among pests, nematodes (Gômi), mealybugs and scale insects (*Torowounpougou*), termites (*Kôba*),tuber beetles(*Parakomongouba*) and leaf feeders (*Tinainnou*). Among thefour diseases cited, three were well known. These were wilt diseases (Tassoudèrabou), anthracnose (Mouhounkra) and shoe string virus disease (Kpanro). The nature of the disease locally called Ban (Table 2; Figure 2) is still undetermined. According to farmers and following our observations, Ban is characterized by the appearance in the whole tuber flesh of fine, hard, yellowish, elongated and finely hollowstructures, resembling to woodyfibres. It would be infectious as affected seedtubers, when planted, would produce only tubers affected by the same disease. All cultivars are vulnerableat various degrees but sweet cultivars like Kpouna (or Laboko), Koumagou and Yoossoussou are particularly sensitive. Ban particularly affects cooking quality as the boiled tubers or the pounded yam of the infected tubers becomes particularly difficult to chew.

Within the nematodes infestation farmers distinguished, described and differently named three categories of symptoms (Table 2) that corresponds to the damages of the three major yam nematodes species reported in Benin which are *Scutellonemabradys,Pratylenchus* spp.and *Meloidogyne* spp. (Baimey et al., 2006; Coyne et al., 2006).Farmers in all the village did not distinguish between mealybugs and scale insects, and so they have been treated as a single problem.Farmers reported that Tassoudèrabou is also observed on striga infested soils and is then called Sakara (which literally means striga in Bariba language) in some villages. Yam mosaic virus was reported in none of the villages surveyed although it has been observed in almost all of the fields visited.

Table 2: Local name, farmers' description and scientific identification of yam pests and diseases in Benin

Local names	Others names and corresponding ethnic groups	Farmer's description of damage	Scientific determination
Gômi (Bariba)	GômiSouanrou, GômiSôôga (Bariba)	**Form 1**: The tuber becomes dry, cracked and rotten.	Yam nematode (*Scutellonemabradys*)
	Gômiwonka, Gômboulélou, Gonyérou, Gombélénou (Bariba); Idjikomé (Ani); N'ku (Nago); Noukpélm (Yom); Kopowountowo (Lokpa)	**Form 2**: Rot of the tuber only at the level of the epidermis	Lesion nematodes (*Pratylenchus* spp.)
	Kouroussa, Kpanrorou, Koussakoussa, Tamgômèrou, Kpakourou (Bariba); Wonkpaaré (Wama); Noussaxa (Yom); Bipinssi (Ani)	**Form 3**: The tuber is covered with galls; Profuse growth of fine roots	Root-knot nematodes (*Meloidogyne* spp.)
Torowounpougou (Bariba)	Sounré (Bariba); Wompoukérébou (Natimba); Wonpoutouga (Wama); Nouflim,Noukpira(Yom); Kadégandékan (Nago); Moussoura (Lokpa); Goutchédé (Ani)	Damaged tubers are dehydrated, become more flexible and eventually dry.	Mealybugs *(Planococcuscitri)* Scale insects *(Aspidiellahartii)*
Kôba (Bariba)	Toubowoman (Natimba) ; Touméga (Wama), Odidi,Fouwoui (Nago) ; Djémnôr, Kootim (Yom) ; Fiwoun (Lokpa) ; Ounromain (Ani)	The infested tuber present only one or two holes at harvest while itsinternalflesh is already entirely consumed.	Termites *(Amitermes*spp.)
Parakomongouba (Bariba)	Totogourorou (Bariba)	Dig tunnels and causes tuber rot	Tuber beetles (*Heteroligusmeles*)
Tinainnou (Bariba)	Gochiwoungôléssoulé (Ani)	Defoliation of yam plant	Leaf feeders *(Criocerislivida)*
Tassoudèrabou (Bariba)	Tassouwôkoua,Tétannan, Sakara, Wouroudèlabou, Wondadabou, Sainkira (Bariba) ; Ewén'chun'gbon (Nago) ; Idjiwéréka (Ani) ; Tchaassika (Wama)	At the beginning of tuber development and in full rainy season yellowing and early wilting of the leaves are observed. Infested plants produce only small tubersand die. All cultivar is susceptible.	Wilt diseases
Mouhounkra(Wama)	Tchroo (Lokpa) ; Idjissitoné (Ani) ; Indéété (Nago)	Black spots on infected leaves; Yellowing and early wilting of the leaves which eventually fall off. Infested plants produce small tubers	Anthracnose
Ban (Bariba)	Soukia (Bariba) ; Wonkpari (Wama) ;Sêrxôm (Yom) ; Baanoum (Lokpa) ; N'déékpon (Nago)	Appearance in the whole tuber flesh of fine, hard, yellowish, elongated and finely hollow structures resembling to woody fibres.	Undetermined
Kpanro (Bariba)	Nouadjégn (Yom)	The leaves become long, tapered and wrinkled	Shoe string virus

The effects of the pests and diseases on yam foliage and tubers as perceived by the farmers are diverse. Termites were said to damage tubers by eating the flesh and adversely affect germination. It has been signalled in all the villages apart from Perporiakou and Dikokore and reported as principal (high impact; 20 to 60% of the tubers damaged) and first constraint in 25 and 3 villages respectively. Like with the termites, scale insects and mealybugs impacts were also high (20 to 40% of the seed tuber stocks) in the great majority (90.90%) of the villages (Table 3). Scale insects and mealybugs were said to affect germination of seeds which sometimes remain in the ground without rotting. Affected tubers are dry and light and are of bad taste for consumption. All the different types of nematodes were reported in the 27 villages surveyed and farmers emphasised that they prevent seeds from germinating, reduce the amount that can be consumed and cause a bad taste and adversely affect the market value of the crop. Nematodes were principal constraint (30 to 80 % of the field were infested) in all the villages and ranked first in 5 villages out of the 27 considered (Table 3). Anthracnose was reported in only 12 villages although it was found in all the yam field visited in the study area. In many villages anthracnose is unknown of the farmers as disease. It has a significant impact of 20 to 60% yield loss (farmers' perception) in all but one of the village in which it has been emphasized (Table 3). Popular cultivars that are particularly susceptible according to farmers include Kpouna, Morokorou, orougninsingué, Ayimon, Tankpando, Koussadi and Douroukonou.Like anthracnose, Ban (undetermined) and Tassoudèrabou (wilt diseases) seems also dangerous for guinea yam production in the study area. With Tassouderabou, infected plants either produce small tubers or no tubers at all. According to the producers, Ban is seriously expanding in the villages surveyed with a degree of infestation ranging from 20 to 50% of the cultivated fields. Viruses were not well known from the farmers as disease on yam. The unique form reported in five villages is the Shoestring virus is only besides important that Bouka (a village of the Northwest) where a farmer lost 1.5 ha of yam due to this virus disease. Tuber beetles and Leaf feeders are not important. The classification of the pests and diseases following the procedure described above ranks first Nematodes followed by Termites, Mealybugs and scale insects, Wilt diseases, Anthracnose and Ban (Table 3).

Table 3: Distribution, farmers' perceived importance and ranking of pests and diseases in the study area.

Pest or diseases	Distribution(TNV)	Importance of damage			Mean	Rank
		Low	High /PCO	High/FC		
Nematodes	27	0	27	5	19.67	1
Termites	25	0	25	3	17.67	2
Mealybugs	22	0	22	7	17	3
Wilt diseases	18	0	18	8	14.67	4
Anthracnose	12	1	11	0	7.66	5
Bandisease	10	2	8	1	5.67	6
Shoe string virus	5	4	1	0	2	7
Tuber beetles	4	4	0	0	1.33	8
Leaf feeders	2	2	0	0	0.66	9

TNV: Total Number of Villages; *PCO*: Principal Constraint; *FC*: First Constraint

Traditional management of yam pests and diseases and urgent intervention zones

In all the villages surveyed, farmers reported that they have no control methods for the pests and diseases identified apart from mealybugs. To traditionally combat mealybugs three methods were used.Infested tubers are immediately isolated at harvest to avoid contamination or are watered every morning until the day of planting or sprinkled with the ashes of the rootsof *Nauclealatifolia*. Farmers indicated that susceptibility to disease or pest varied among cultivars.Throughout the study area, farmers reported the existence of twenty (20)nematodes resistant or tolerant cultivars which are Alagbara, Bâkourakabodi, Dori, Ibérégnainsé, Kemiolokogoun,Kokoro agbalè, Kourikouri, Kpégoré, Kprakpra, Kourou,Obinhi, Olouba,Otoukpannan, Sabisagui, Singor, Souwoukou, Tabané, Tabouinrou, and Wofougou. Similarly two cultivars resistant to termites (*Soussouka* and *Komopéina*) and one tolerant to anthracnose (*Kpakara)* were reported. No cultivarsresistant towilt and *Ban*diseases were listed. The dendrogram constructed using the UPGMA method to examine the relationships between surveyed villages in terms of pests and diseases classified villages into 11 types that were further clustered, at 65% of similarity, into three groups namely G1, G2 and G3 (Figure 3). G1 clusters together all the villages (16 in total) located in Bariba cultural area and the villages Banon and Okoutaossé (Figure 1). G2 comprisedsix villages in which a great number of village (4) were of Donga department and 2 (Tchakalakou andToukountouna) were of Atakora zone; G3 associated the remaining two villages (Perporiakou and Dikokore) of Atakora zone and one (Nagayilé) of Donga zone (Figure 3). In the plan defined by the first two axis (explaining 84.4% of the total variability), of the principal component analysis (PCA) performed to visualize the projection of the villages in a two-dimensional plan, G1, G2 and G3also appeared well demarcated (Figure 4).

Apart from Nematodes represented everywhere, G1 is characterized by wilt diseases, termites and mealybugs, G2 by termites and ban diseases and G3 by anthracnose. In the villages of G1 urgent intervention by the plant protection service and by the NGOs should focus on wilt diseases, termites and mealybugs in addition to nematodes while in G2 focus will be on termites and ban after nematodes.

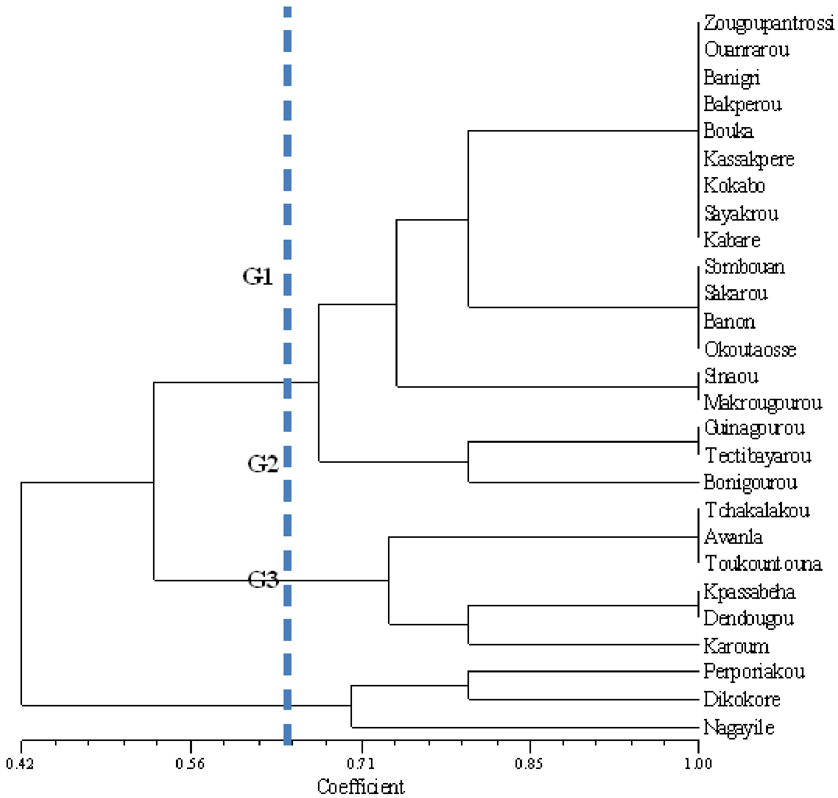

Figure 3: UPGMA dendrogram showing the grouping of the villages with regard to the important pests and diseases listed

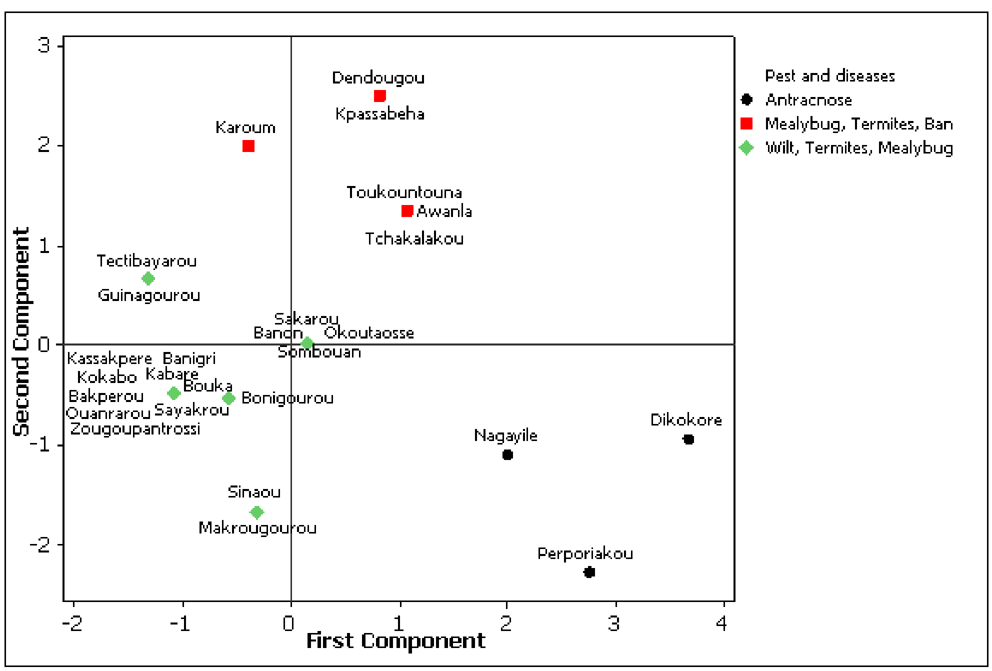

Figure 4: Organization of the villages surveyed in urgent intervention groups for the national plant protection service.

DISCUSSION

The results obtained clearly showed that pests and diseases are important constraints to yam production in northern Benin. The constraints listed and ranked by Benin farmers werealmost the same reported in Burkina Faso (Somé et al., 1995), in Ghana (Asante et al., 2007), Nigeria (Ayanwuyi et al., 2011) and Togo (Dansi et al., 2013) with also pests and diseases occupying important positions.Apart from wilt diseases, the major yam pests and diseases reported by farmers have also been described as major problems in Ghana (Braimah et al., 2007) and Ivory Coast (Soro et al., 2010). Wilt diseases signaled by farmers are well known in yam as caused by soil borne fungi such as *Fusariumoxysporum* and *sclerotiumrolfsii* (Nwankiti and Arene, 1978;Amusa, 2003) and described as important disease that may cause premature death of 45–70% of the yam plants in the fields (Amusa, 2003). On this basis, the importance given to wilt diseases by the yam producers (entire field infested, phenomenon expending) in the northern Benin may be justified and call for urgent action such as sensitization of the farmers on the necessity of threating seed tubers with fungicide before planting. Like in Nigeria (Adegbitè et al., 2006), Ivory Coast (Ettien et al., 2013) and Togo (Dansi et al., 2013), nematodes were also considered in all the villagesasa very important problem to be solved. Interestingly and without scientific knowledge, farmers recognize three types of damage on yam tuber that they consider as belonging to the same "disease" locally called Gomi. It is scientifically known that tuber dry rot disease with external cracks, knobbly tubers with profuse growth of fine roots and tuber rot only at the level of the epidermis are caused by *Scutellonemabradys*, the root knot nematode *Meloidogyne spp* and *Pratylenchus* spp. respectively (Amusa et al., 2003; Mudiope et al., 2007; Olabiyi and Ogunbowale, 2010).Therefore, farmer's descriptions of nematodes damageswere consistent with scientific knowledge. Farmer also reported that among the different types of nematode attacks, tuber dry rot with external cracks (caused by the nematode *Scutellonemabradys*) were more frequent. This is concordant with the results of several studies according to which *Scutellonemabradys*is, within the nematode species, more abundant in Benin than the others (Baimey et al., 2006; Baimey et al., 2009; Coyne et al., 2012). Altogether and as reported by Osei et al. (2004) in Ghana, the study revealed that Benin yam farmers have a very good knowledge of nematodes diseases. Considering the importance of the nematodes diseases, management strategies should be developed and vulgarized. This can be achieved by one or more of the following measures: (1) controlling nematodes in field soil by cultural or chemical means (2) use of clean planting material or treatment (with nematicide) of tuber seed material prior to planting and (3) use of resistant cultivars. Farmer listed somenematode tolerant or resistant cultivars but these have yet to be confirmed.Following Amusa et al. (2003), Mercer and Perales (2010) and Frison et al. (2011), genetic control through use of tolerant or resistant cultivars will be the most practical,economic, least expensive, eco-friendly and healthy way of minimizing effects of biotic constraints such as nematodes.

Although farmers' knowledge in describing effects of mealybugs and scale insects on yam tubers was good, they were unfortunately not able to differentiate mealybugs from scale insects and even ignore the existence of these two types of insects. This could be explained by the fact that these two insects have a similar appearance and damage (Hollingsworth, 2005). In many villages, anthracnose and yam mosaic virus disease, contrary to the shoe string virus disease, were not locally recognized while they are present in all the fields surveyed and their damage wereeven important. The fact that virus diseases have a range of symptoms that can vary considerably from one leaf to another may explain the misdiagnosis by farmers and indicated the limits of their knowledge (Amusa et al., 2003; Kamanula et al., 2010). In Benin tuber beetles are well known and still seen by the farmers as minor pests although they can have serious impact on yam production ranging from 23 to 60% yield losses (Tobih et al., 2007).

Despite their level of knowledge of the yam pests and diseases, farmersinterviewed do not used pesticides, the most conventional way of controlling insect pests and diseases in yam according to Korada et al., (2010). The control of mealybugs was done through use of the ash of *Nauclealatifolia* roots. There were some studies on this well-known African medicinal plant that highlighted its antibacterial and antifungal activity (Anowi et al., 2012; Fadipe et al., 2013) but not on its insect repellent and insecticide capacity. Experiments should be conducted to assess the effects of the extract of *N. latifolia* on storage insect pests that damage yam particularly mealybugs and scale insects following Sharma and Sawant (2012). TheBenin national plant protection serviceshould appropriatethe results of this study, develop for the farmers appropriate treatment solution (including nematicide, insecticide and fungicide) forseed tubers and soil cleaning and initiate some publicawareness actionaccording to the defined intervention zones. Research institutions and particularly plant pathologists should focus on the nature and the control methods of Ban disease which is at an alarming rateexpanding throughout the yam production zones. The study should be extended to yam production zones of southern and central Benin with the aim of identifying, in participatory way, the cultivars that eventually have resistance to pests and diseases for exploitation in yam breeding programmes.

CONCLUSION

This study provided some basic information on farmers' perceptions, knowledge and management of pests and diseases that were found to be among the most important yam production constraints in northern Benin. The results obtained will help in developing sustainable pestsand diseasescontrol measures. Nematodes, wilt diseases, Ban (undetermined), termites and mealybugs were considered the most important pests and diseases in the study zone. To sustainably control pests and diseases for better yam production in Benin, it will be important to improve farmers' pestsand diseases management abilities by providing them with field diagnostic tools and educational materials through farmer field schools. This study has also revealed the existence of some yam cultivarsresistant to nematodes. Therefore a participatory evaluation of the existing cultivarsmay help identifying more cultivars resistant to pest and diseases that can be exploited in breeding programs or directly through cultivar exchanges.

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REFERENCES

Adomou AC. (2005). Vegetation patterns and environmental gradients in Benin: Implications for biogeography and conservation, Ph.D. Thesis, Wageningen University, The Netherlands

Akoégninou A, van der Burg WJ, van der MaesenLJG (eds) (2006) Flore analytique de Bénin. Backhuys Publishers, Leiden, 1034 p.

Amusa NA, Adegbite AA, Muhammed S, Baiyewu RA. (2003). Yam diseases and its management in Nigeria. African Journal of Biotechnology 2(12): 497-502.

Anowi CF, Cardinal NC, Onyegbule AF, Anowi LN. (2012). Antimicrobial Properties of the Ethylacetate Extract of the Leaves of Nauclealatifolia. Research Journal of Pharmacy and Technology, 5(5): 645-651.

AsanteSK, Mensah GWK, Wahaga E. (2007). Farmers' knowledge and perceptions of insect pests of yam (Dioscorea spp.) and their indigenous control practices in northern Ghana.Ghana Jnl agric. Sci. 40: 185-192.

Ayanwuyi E, Akinboye AO, Oyetoro JO. (2011). Yam Production in Orire Local Government Area of Oyo State, Nigeria: Farmer’s Perceived Constraints. World J Young Researchers, 1(2): 16-19.

AyodejiSP, Olabanji OM, Adeyeri MK. (2012). Design of a Process Plant for the Production of Poundo Yam. International Journal of Engineering (IJE), 6 (1): 10-24.

Azman A, D’Silva JL. (2012). Comparative Study on Sustainable Agriculture Knowledge among Malaysian Contract Farmers. American Journal of Applied Sciences 9 (5): 673-677.

Baimey H, Coyne D, Labuschagne N. (2006). Effect of fertiliser application on yam nematode (*Scutellonemabradys*) multiplication and consequent damage to yam (*Dioscorea* spp.) under field and storage conditions in Benin. International Journal of Pest Management, 52(1): 63-70

Baimey H, Coyne D, Labuschagne N. (2009). Pathogenicity of Scutellonemabradys populations from different geographical areas in Benin on yam (*Dioscorea* spp.) Crop Protection, 28 (9): 715-721.

Braimah H, AnchirinahVM, Adu-Mensah J. (2007). Yam pests in the Ashanti and BrongAhafo regions of Ghana: A study of farmers’ indigenous technical knowledge and control practices. Ghana Jnl agric. Sci. 40: 33-42.

ChanuLB, Chhetry GKN, Sharma GD. (2010). Sustainable Indigenous Practices for the Management of Pest and Diseases of Upland Rice in Manipur, North East India. Assam University Journal of Science &Technology : Biological and Environmental Sciences, 5 (1): 58-62.

Coyne D, Tchabi A, Baimey H, Labuschagnec N, Rotifa I. (2006). Distribution and prevalence of nematodes (*Scutellonemabradys* and *Meloidogyne* spp.) on marketed yam (*Dioscorea* spp.) in West Africa. Field Crops Research, 96(1): 142–150.

Coyne D, Williamson V, Tchabi A, Baimey H, Rotifa I. (2012). Comparison of pathogenicity of geographically separate populations of Scutellonemabradys on yam (*Dioscorea* spp.) in West Africa. Nematropic, 42 (2): 181-190.

Dansi A, Dantsey-Barry H, Agré AP, Dossou-Aminon I, Assogba P, Loko YL, N'KpenuEK, Kombaté K, Dansi M, Vodouhè R. (2013a). Production constraints and farmers’ cultivar preference criteria of cultivated yams (*Dioscorea cayenensis* - *D. rotundata* complex) in Togo. International Journal of Applied Biology and Pharmaceutical Technology, 4 (2): 191-199.

Demuyakor B, Dukrog TM, Chikpah SK. (2013). Yam Germplasm in Ghana – A Survey on Varietal Identification and Characterisation of *Dioscorea Rotundata – Alata* in Northern Region of Ghana.International Journal of Agronomy and Plant Production. 4 (4): 719-726.

EttienJBD, Sorho F, Brahima K. (2013). Screening of new yam clones (D. alata and D. rotundata) in nematode prone ecology of guinea savanna zone in West Africa. Journal of Applied Biosciences, 61: 4540 – 4550.

Fadipe LA, Haruna K, Mohammed I, Ibikunle1 GF. (2013). Phytochemical and in-vitro antibacterial evaluation of the extracts, portions and sub-portions of the ripe and unripe fruits of Nauclealatifolia. Journal of Medicinal Plants Research, 7(11): 629-636.

FAO. (2011). FAOSTAT Database.Food and Agriculture Organization, Roma, Italy.Avaible online at URL: www.fao.org

FrisonEA, Cherfas J, Hodgkin T. (2011). Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. Sustainability 3(1): 238-253.

Fu YRH, Kikuno H, Maruyama M. (2011). Research on yam production, marketing and consumption of Nupe farmers of Niger State, central Nigeria.African J. Agricul. Res., 6(23): 5301-5313.

Gbaguidi AA, Dansi A, Loko LY, Dansi M., Sanni A. (2013). Diversity and agronomic performances of the cowpea (*Vignaunguiculata*Walp.) landraces in Southern Benin.International Research Journal of Agricultural Science and Soil Science, 3(4): 121-133.

Hollingsworth RG. (2005). Limonene, a Citrus Extract, for Control of Mealybugs and Scale Insects. Journal of Economic Entomology 98(3): 772-779.

Jarvis DI, Campilan DM. (2006). Crop genetic diversity to reduce pests and diseases on-farm: participatory diagnosis guidelines. Version1. Bioversity Technical Bulletin No. 12. Bioversity International, Rome.

Kamanula J, SileshiGW, Belmain SR, Sola P, Mvumi BM, NyirendaGKC, NyirendaSP, Stevenson PC. (2010). Farmers' insect pest management practices and pesticidal plant use in the protection of stored maize and beans in Southern Africa. International Journal of Pest Management 57(1): 41-49.

Kombo GR, Dansi A, Loko LY, Orkwor GC, Vodouhè R, Assogba P, Magema JM. (2012). Diversity of cassava (*Manihot esculenta* Crantz) cultivars and its management in the department of Bouenza in the Republic of Congo. Genetic Resources and Crop Evolution. 59 (8): 1789-1803.

Korada RR, Naskar SK, Edison S. (2010). Insect pests and their management in yam production and storage: a world review. International Journal of Pest Management 56 (4): 337-349.

Korada RR, Naskara SK, Edison S. (2010). Insect pests and their management in yam production and storage: a world review. International Journal of Pest Management, 56(4): 337–349.

Loko YL, Dansi A, Linsoussi C, Tamo M, Vodouhè R, Akoegninou A, Sanni A. (2013). Current status and spatial analysis of Guinea yam (Dioscorea cayenensis Lam. -D. rotundata Poir. complex) diversity in Benin.Genetic Resources and Crop Evolution. (*in press*).

Mendesil E, Abdeta C, Tesfaye A, Shumeta Z, Jifar H. (2007). Farmers' perceptions and management practices of insect pests on stored sorghum in southwestern Ethiopia. Crop Protection 26: 1817–1825.

Mercer KL, Perales HR. (2010). Evolutionary response of landraces to climate change in centers of crop diversity.Evolutionary Applications. 3 (5-6): 480-493.

Midega CAO, Nyang'au IM, Pittchar J, Birkett MA, Pickett JA, Borges M, Khan ZR. (2012). Farmers' perceptions of cotton pests and their management in western Kenya. Crop Protection 42: 193-201.

Mudiope J, Speijer PR, Coyne D, Maslen RN, Adipala E. (2007). Nematode distribution and damage to yam in central and Eastern Uganda.AfricanCrop Science Journal 15 (2): 93-99.

Mulumba, JW, Nankya R, Adokorach J, Kiwuka C, Faddac C, De Santis P, Jarvis DI. (2012). A risk-minimizing argument for traditional crop varietal diversity use to reduce pest and disease damage in agricultural ecosystems of Uganda. Agric. Ecosyst. Environ., 157: 70–86.

Nwankiti AO, Arene OB. (1978). Diseases of Yam in Nigeria.Tropical Pest Management 24 (4): 486-494.

Obopile M, Munthali DC, Matilo B. (2008). Farmers' knowledge, perceptions and management of vegetable pests and diseases in Botswana. Crop Protection 27: 1220-1224.

Olabiyi TI, Ogunbowale BB. (2010). Pathogenicity Study of Meloidogyne incognita and Scutellonemabradys on White Yam Cultivars in Nigeria. World Journal of Fungal and Plant Biology 1 (1): 12-14.

OlajumokeOL, Agiang MA, Mbeh E. (2012). Proximate and anti-nutrient composition of white Guinea yam (*Dioscorea rotundata*) diets consumed in Ibarapa, South West region of Nigeria. J. Nat. Prod. Plant Resour., 2 (2): 256-260.

Oluwole OB, Awonorin SO, Henshaw F, ElemoGN, Ebuehi OAT. (2013). Assessment of Microbial Changes and Nutritional Qualities of Extruded White Yam (*Dioscorea rotundata*) and Bambara Groundnut (*Vigna subterranean*) Blends. Food and Nutrition Sciences, 4: 100-107.

Osei K, AwuahRT, Tabil MA, AsanteJS. (2004). Prevalence and farmers' perceptions of parasitic nematodes in yam rhizosphere soils from some yam producing areas of Ghana. Agricultural and Food Science Journal of Ghana, 3: 217-226.

PandeyKK, Satpathy S. (2009). Development of integrated pest management in chilli against major diseases and insect pests. Indian Journal of Plant Protection, 37 (1/2): 104-110.

PoubomCFN, Awah ET, Tchuanyo M, Tengoua F. (2005). Farmers' perceptions of cassava pests and indigenous control methodsin Cameroon. International Journal of Pest Management 51(2): 157–164.

RohlfFJ. 2000. NTSYS-pc Version 2.2: Numerical Taxonomy and Multivariate Analysis System. New York, NY, USA: Exeter Software.

Sesay L, Norman PE, Massaquoi A, Kobba F, Allieu AP, Gboku ML, FombaSN. (2013). Assessment of farmers' indigenous knowledge and selection criteria of yam in Sierra Leone. Sky Journal of Agricultural Research, 2(1): 1-6.

Sharma PP and Sawant RJ. (2012). Indigenous traditional practices for eco-friendly management of insect/pest in Maharashtra, India. Recent Research in Science and Technology, 4(10): 21-24.

SneathPHA, Sokal RO (1973) Numerical taxonomy. San Francisco, Freeman

Some S, Kam O, Ouedraogo O. (1995). Contraintes liées à la production de l'igname au Burkina Faso. Cahiers Agric. 4: 163-169.

Soro S, Diallo AH, Doumbia M, Dao D, Tano Y.(2010). Inventaire des insectes de l'igname (*Dioscorea* spp): cas de Bouaké et Toumodi (Côte d'Ivoire). Journal of Animal & Plant Sciences, 6 (3): 715- 723.

Swofford DL, Olsen GJ (1990) Phylogeny reconstruction. In: HillisDM, Moritz C (eds) Molecular systematic. Sinauer Associates, Sunderland, Mass

Tanzubil, PB, Yakubu, EA. (1997). Insect pests of millet in northern Ghana. 1. Farmers' perceptions and damage potential. International Journal of Pest Management 43 (2): 133–136.

Tobih FO, Emosairue SO, Okonmah LU. (2007). Studies on the occurrence and damage by yam tuber beetles (Heteroligus spp) in Aniocha and Oshimili areas of Delta state. Nigeria Journal Central Eur. Agric 8: 129-134.

Waterfield G, Zilberman D. (2012). Pest Management in Food Systems: An Economic Perspective. Annual Review of Environment and Resources, 37: 223-245.