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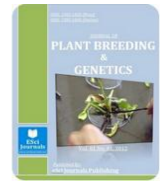

FARMERS AWARENESS AND PERCEPTIONS OF ALTERNARIA LEAF PETIOLE AND STEM BLIGHT AND THEIR PREFERRED SWEETPOTATO TRAITS IN UGANDA

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A B S T R A C T

A participatory rural appraisal was conducted in Kabale district in south-western Uganda and Luwero district in central Uganda to establish farmers' awareness and perceptions of Alternaria leaf petiole and stem blight (commonly referred to as Alternaria blight) and their varietal preferences. The study revealed that the two regions had similar production constraints but the degree of importance of the constraints varies between each region. Diseases, pests and drought are the most important production constraints in both regions. Among the diseases, Alternaria blight is the most important disease constraint in Kabale whereas sweetpotato virus disease is the most important in Luwero. Among the pests, caterpillars (*Acraea acerata)* are a bigger problem in Luwero than in Kabale, while vermin, especially mole rats (*Tachyoryctes splendens*), are a bigger problem in Kabale than in Luwero. Healthy planting material availability and distribution are important constraints. Among the most desired sweetpotato attributes in both districts are high yield, early maturity, high dry mass, and storability in the soil after maturity to enable sequential harvesting. Most of the farmers consider Alternaria blight to be a serious production constraint and estimate the yield loss in severely infected fields to be above 50%. However, Alternaria blight incidence has seasonal variations with higher incidences in the wet and very wet seasons in Kabale. On the other hand, Alternaria blight is most severe during the dry season in Luwero. Most of the farmers are not aware of any control measures for these diseases. However, some of them use rogueing as a control measure and others cultivate resistant genotypes like Rwabafuruki and Nyinakamanzi in Kabale, and Kakamega in Luwero. Since most of the existing genotypes are susceptible, breeding for Alternaria blight is a priority in both districts combined with an effective seed distribution system to increase utilization of the improved cultivars by the resource poor farmers.

Keywords: Sweetpotato, Alternaria blight, preferred attributes, production constraints, yield loss.

INTRODUCTION

Sweetpotato (*Ipomoea batatas* (L.) Lam.) is a major food security crop in Uganda (Low, 2000). It is a staple for both the urban and rural-resource poor communities with a per capita consumption of 82.5 kg yr^{-1} (FAOSTAT, 2010). The crop is mainly grown for its edible storage roots, but in isolated cases the leaves are eaten as vegetables (Bashaasha *et al*., 1995). Low productivity characterises sweetpotato production in the country and this has been attributed to several factors. These include susceptibility to diseases including sweetpotato virus disease (SPVD) and Alternaria leaf petiole and stem blight (commonly referred as Alternaria blight), use of marginal lands, low input use and use of low-yielding and narrowly adapted landraces (Bashaasha *et al*., 1995; Low, 2000). Some of these constraints can be overcome by the release of improved cultivars specifically bred to overcome those constraints. Between 1995 and 2011, the Uganda National Sweetpotato Program released a total of 20 cultivars (Mwanga *et al*., 2011). However, despite the abundance of new improved cultivars, the majority of the farmers still prefer their landraces which are lower yielding and more susceptible to diseases and pests (Abidin *et al*., 2002). Lack of an organised seed distribution system is one of the factors for low adoption

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of the new cultivar (Gibson *et al*., 2009). Another factor is the lack of farmer desired attributes. Cultivars NASPOT 2, NASPOT 5 and Sowola 6 from the National Sweetpotato Program were abandoned by farmers soon after their release because they lacked farmer preferred attributes (Abidin *et al*., 2002). The low adoption rate among the resource poor farmers is sometimes due to lack of exposure to acceptable new cultivars that can replace the landraces in use (Joshi and Witcombe, 1996; Derera *et al*., 2006).

Farmers have good knowledge of the traits they would like to have included in a new cultivar (Abidin *et al*., 2002; Were *et al*., 2012). Therefore a complementation between farmers' preferred traits and traits selected for by the breeder that the farmers may not understand due to the complexity thereof is the way forward. Farmer involvement has led to rapid selection and dissemination of new sweetpotato cultivars with desired traits in South Africa (Laurie and Magoro, 2008), in Kenya (Ndolo *et al*., 2001) and in some parts of Uganda (Gibson *et al*., 2008; Mwanga *et al*. 2011). In their selection criteria for sweetpotato, farmers take several factors into consideration which include the number and size of storage roots, the taste, skin and flesh colour, and culinary qualities (Abidin *et al*., 2002).

A farmer-oriented breeding process should start with a participatory rural appraisal (PRA) (Joshi and Witcombe, 1996). According to Chambers (1997), "PRA is a family of approaches and methods to enable local people to share, enhance, and analyse their knowledge of life and conditions, to plan and to act". It entails involving local people in the gathering of information so that the actual farmer conditions are understood and a dialogue between the scientists and farmers is established (Odendo *et al*., 2002). In Uganda, the National Sweetpotato Program initiated client-oriented breeding in 1995 with a survey of farmer needs (Bashaasha *et al*., 1995) which became the basis for the development of several improved cultivars (Mwanga *et al*., 2007). Similarly, in a bid to improve adoption, Gibson *et al*. (2008) worked with farmers and non-governmental organisations (NGOs) to develop new sweetpotato genotypes in Mpigi, Luwero and Kiboga districts. This effort yielded results with the release of NASPOT 11, the first cultivar bred from segregating populations by participatory plant breeding (PPB) in Uganda (Mwanga *et al*., 2011). During the early stages of evaluating this cultivar, Gibson *et al*. (2008) reported a decline in farmer enthusiasm among the participating farmers. To maintain farmers' enthusiasm, it is better to involve them in evaluating materials grown on the research station and only let them grow advanced materials in their fields (Ceccarelli *et al*., 2000). In this process, traits are identified that breeders had not considered important or were not previously aware of. With careful consideration of farmers' concerns and production conditions, genotypes selected using this procedure are likely to become widely adapted and more productive (Odendo *et al*., 2002).

The present study was designed to obtain information from farmers to help understand their current farming conditions and problems. This information will help in supporting a sweetpotato breeding programme in Uganda for resistance to Alternaria blight. The PRA was carried out in January 2010 with the following objectives:

- identify farmers' preferred sweetpotato attributes,
- determine farmers' perceptions of sweetpotato production constraints,
- establish the sweetpotato production practices and the major genotypes grown in the study areas,
- assess farmers' awareness of Alternaria blight incidence and severity,
- assess farmers' practices in combating Alternaria blight,
- assess farmers' preferred sweetpotato genotypes; and
- establish the sweetpotato attributes that farmers consider as priorities for breeders to work on.

MATERIALS AND METHODS

Study area: The study was carried out in two districts: Kabale district (1°45' S; 29°18' E) located in South-western Uganda 400 km from Kampala; and Luwero district (0°50' N; 32°28' E) located in central Uganda 40 km from Kampala. Both districts are major sweetpotato producing areas. Kabale is a "hotspot" for Alternaria blight while Luwero is a "hotspot" for SPVD with medium Alternaria blight disease pressure (Osiru *et al*., 2007). In each district, one sub-county was selected; in each sub-county, two parishes were selected and in each parish two villages were selected. The areas selected for the study were those with the highest sweetpotato production. Selection of the sub-county was done in consultation with the district agricultural officers based on the sweetpotato production records. Selection of the parishes was done in consultation with the sub-county agricultural extension officers.

In Kabale, the study was carried out in Bubaare sub-county (1º15' S; 29º91' E), Bubaare and Nyamiyaga parishes. Bushura and Rwamutasya villages were selected from Bubaare parish, while Rwembugu and Hamurara were selected from Nyamiyaga parish. In Luwero district, Nakatonya and Sambwe parishes were selected in Nyimbwa sub-county (0º36' N; 32º48' E). In Nakatonya parish, Kikomeko and Mayirikiti villages were selected, while Kiyana village was selected in Sambwe parish.

Description of the study districts: Kabale district borders with Kisoro district in the west, Kanungu and Rukungiri districts in the north, Ntungamo district in the east, and the Republic of Rwanda in the south (Figure 1). Kabale district has a high population density of 317 people per km^2 in non-forested areas (Uganda Bureau of Statistics, 2002) and the residents are mainly from the Bakiga tribe and others are Banyarwanda and Bafumbira. It is characterised by small, highly fragmented landholdings and declining soil fertility and a high rate of male migration in search of employment (Low, 2000). The landscape in Kabale is very hilly, interlaced with narrow and broad valleys. Altitudes range from 1400 - 2500 m above sea level. Annual rainfall ranges from 1000 - 1500 mm and occurs in two seasons. The first season is from mid-February to May and is referred to as the short rains, while the second season is from September to December and is referred to as the long rains. The annual temperatures range between 11.6 and 24.1ºC, and the mean annual temperature is 18ºC.

Luwero district borders with Kiboga and Mubende districts in the west, Masindi and Nakasongola districts in the north, Kayunga and Mukono in the east, and Wakiso district in the south (Figure 1). The district has a population density of 90 persons per km^2 and the residents are of several ethnic backgrounds mainly the Baganda, who are the original inhabitants, Banyankole from western Uganda, Banyarwanda, Luo speakers and Nubians of Sudanese origin. Agriculture is the major economic activity employing over 85% of the workforce. Altitude ranges from 1050 - 1200 m above sea level. The climate can be described as modified equatorial climate with mean maximum diurnal temperature ranging between 18 and 35ºC while the corresponding mean minimum diurnal temperature ranges between 8 and 25ºC. Rainfall is well distributed throughout the year and much of the area receives 1000 - 1250 mm per annum with two peaks in March - June, and October - November (NEMA, 2004).

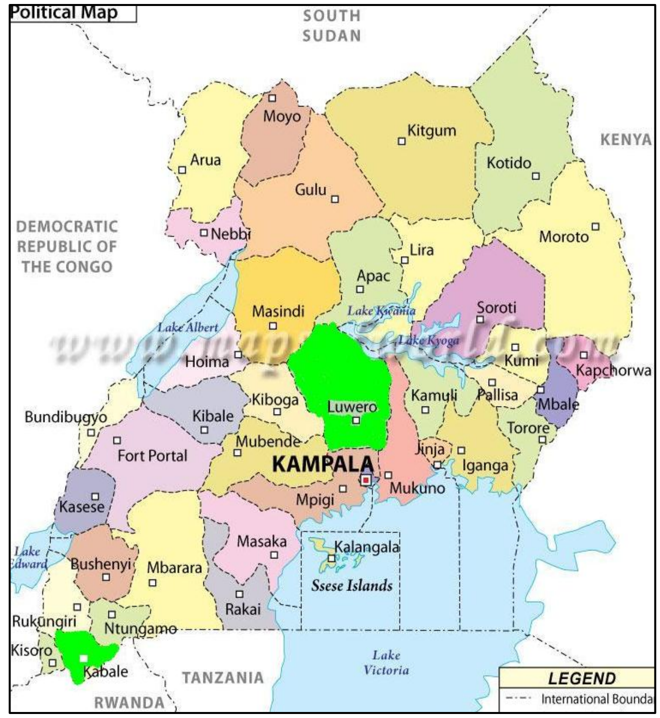

Figure 1. The two study districts in Uganda shaded green.

The study was conducted in January 2010. In order to obtain qualitative and quantitative data; both an individual household questionnaire and focus group discussion (FGD) (semi-structured questionnaires) were used. Fifteen farm households were selected from each village. One FGD was conducted in each of the study parishes, thus a total of four FGD. Each focus group consisted of 15-20 people who included experienced sweetpotato farmers, opinion leaders/elders, local council or village leaders, a youth representative and a trader.

Prior to the study, the principal researcher together with a socio-economist carried out a reconnaissance study of the two districts to establish a rapport with the district agricultural officers (DAO) and the sub-county agricultural extension officers. During the visits, the production records were reviewed with the assistance of the DAO and a decision made on which sub-counties to conduct the study in. Each sub-county agricultural extension officer assisted in selecting the parishes and villages. A questionnaire was developed, pre-tested in Mukono and corrections made before the study was carried out.

Household (individual) interviews: The individual interviews (Figure 2) were carried out by the principal investigator and the socio-economist using a questionnaire to obtain the following information: the farmers' bio-data (background information e.g. sex, age, marital status, size of the family); size of the farm, crops grown; area under sweetpotato; why the farmer grows sweetpotato; yields per hectare; genotypes grown; seed supply system; attributes of sweetpotato genotypes and pairwise ranking of these attributes; criteria for selecting or rejecting genotypes; sweetpotato production constraints and pairwise ranking of these constraints; Alternaria blight awareness; incidence and severity; varietal susceptibility; seasonal variation; yield loss; Alternaria blight control measures; and market values for the different genotypes. The farmers compared the prevalence of the constraints over different seasons and years. Throughout an interview, open-ended questions were used so as to capture as much information as possible. A compass direction was randomly taken by the team and along that direction the fourth homestead, for example, would be randomly selected. For the owner of the homestead to be interviewed, he/she had to be a regular sweetpotato grower and have a field grown to sweetpotato during the season of the study. Sixty farmers were interviewed in each district providing a total of 120 farmers for the whole survey.

Figure 2. Individual household interviews in Bubaare sub-county, Kabale district (2010).

Focus group discussions: The discussion (Figure 3) was assisted by a facilitator who was proficient in both the local language and English. A checklist of discussion topics/questions was developed and used to guide the discussion. Open-ended questions were asked to generate discussion and the facilitator made sure every person present contributed towards the discussion topic. The information obtained in these focus group discussions included: sweetpotato production constraints (biotic and abiotic and their causes), genotypes grown and preferred sweetpotato attributes. All these were ranked using the pairwise ranking method (Narayanasamy, 2009) (Figure 4) so that the factor with the highest number of points is ranked as number one. Particular attention was given to Alternaria blight and the participants drew a seasonal calendar and indicated which time of the year the disease was more likely to occur.

Figure 3. Focus group discussions at Nyamiyaga parish, Bubaare sub-county, Kabale district (2010).

Since one of the objectives of the PRA was to identify breeding priorities, the participants were asked what attributes they desired in new sweetpotato cultivars.

Secondary data: Details of the geographical location of each sub-county was obtained from the sub-county records including the neighbouring sub-counties, demographic information, major crops grown and sweetpotato production trends over the last five years. Meteorological information was also collected from each sub-county.

Data analysis: Data from the survey were analysed using the Statistical Package for Social Scientists Version 15.0 for Windows (SPSS, Inc. 2008). Cross tabulation was used in the analysis and the percentage respondents calculated.

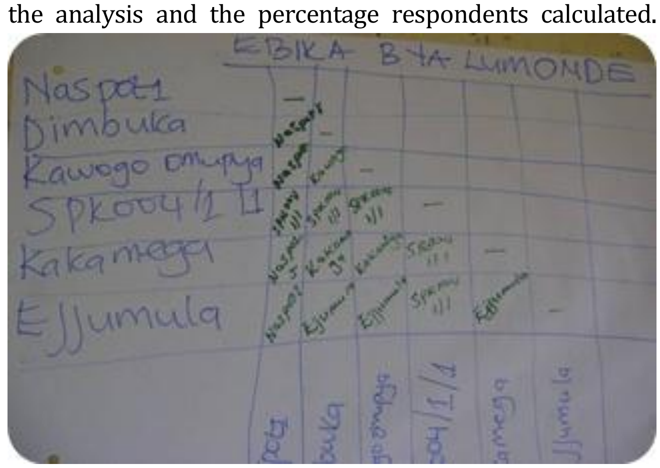

Figure 4. Pairwise ranking for sweetpotato genotypes at Nakatonya, Luwero district (2010).

RESULTS

Gender and ages of interviewed farmers: Most of the respondents in both districts were females (72.5%). The ages of the respondents varied greatly with the youngest being 19 and the oldest 81 years old. The farmers in Kabale have been growing sweetpotato for periods ranging from 2 to 65 years while those from Luwero for 3 to 7 years.

Size of the land and crops grown: From the structured survey, the average size of farmland in the two districts was 1.1 ha with farmers in Luwero district owning an average of 1.2 ha while those in Kabale had an average of 0.9 ha. Of this farmland, the average area under crops was 0.9 and 0.7 ha in Luwero and Kabale, respectively. Farms in Luwero district had a larger area under sweetpotato production per season of 0.3 ha as compared to 0.2 ha in Kabale. Luwero district had higher average sweetpotato yields (6.9 t ha^{-1}) than Kabale (4.6 t ha^{-1}). Farmers in both districts grew a large number of crops and most of them were grown as intercrops. Other than sweetpotato, the most common crops in Kabale were dry bean (*Phaseolus vulgaris* L.) (96.7%), Irish potato (*Solanum tuberosum* L.) (78.3%) and sorghum (*Sorghum bicolor* L.) (65.0%), whereas in Luwero they were maize (*Zea mays* L.) (93.3%), cassava (*Manihot esculenta* Crantz) (91.7%) and dry bean (75.0%). Cassava and groundnut (*Arachis hypogea* L.) were grown only in Luwero district whereas wheat (*Triticum aestivum* L.) was grown only in Kabale (Figure 5).

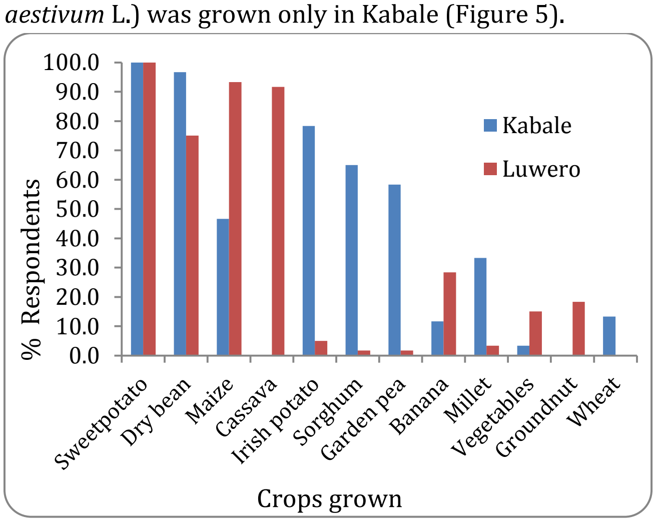

Figure 5. Major crops grown in Kabale and Luwero districts of Uganda (2010).

Source of planting materials: The principal source of sweetpotato planting materials (vines) in both districts was the farmers' own fields (Figure 6). Most farmers (97.5%) retained some vines from the previous season in the field as a source of planting material for the new season. Some farmers (65.8%) sourced their vines from other farmers. In Kabale, all vines were shared free of charge whereas in Luwero, the vines were occasionally sold. The other common sources of vines were research stations, especially in Luwero, and the National Agricultural Advisory Services (NAADS) in Kabale.

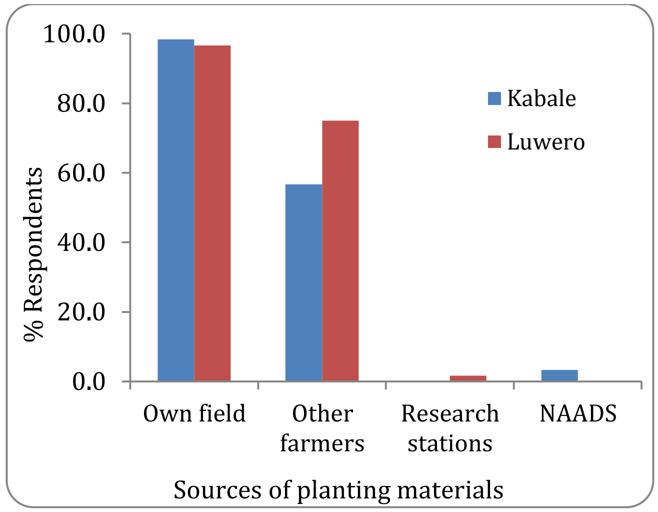

Figure 6. Sources of sweet potato vines in Kabale and Luwero districts of Uganda (2010).

The majority of farmers (61.7%) in both districts had problems with planting materials. The problems included lack of access to good (healthy) vines and scarcity thereof, especially after a long dry spell. Infestation by caterpillars of vines was a problem in Luwero district (14.9%), usually after a long dry spell.

Sweetpotato cropping method: The majority of farmers in both districts (76.0%) planted sweetpotato in pure stands. In Kabale, some farmers intercropped, mainly with dry bean and garden pea (*Pisum sativum* L.) whereas in Luwero some farmers intercropped with dry bean, cassava or maize (Table 1). In Kabale, the farmers intercropped because of shortage of land whereas in Luwero for food security reasons.

Table 1. Crops commonly intercropped with sweetpotato in Kabale and Luwero districts of Uganda (2010).

Intercrop	% Kabale	% Luwero
Maize	0.0	16.7
Dry bean	61.5	16.7
Cassava	0.0	66.6
Garden pea	38.5	0.0

The majority of the farmers (83.0%) planted several sweetpotato genotypes in a single plot or garden. In

Kabale, all the farmers planted mixed genotypes, whereas in Luwero only 16.7% planted a single genotype per field and these were mainly for the production of vines and roots for the market. All the farmers in Luwero planted sweetpotato on individual mounds whereas most of the farmers in Kabale (95.0%) planted on long, narrow ridges across the hill slope. In Kabale, some farmers planted sweetpotato in the wetlands during the dry season to provide planting materials for planting on the hillsides in the forthcoming rainy season.

Sweetpotato genotypes grown: In Kabale, 95.0% of the farmers grew only landraces while the rest grew both improved cultivars and landraces. In Luwero, 8.3% of the farmers grew improved cultivars only and 91.7% grew both improved cultivars and landraces. The farmers who planted only the improved cultivars were those involved in commercial vine production and some also produced orange fleshed sweetpotato (OFSP). The most highly ranked attributes by farmers were high yield, early maturity and sweetness of the roots (Tables 2 and 3). The most commonly grown genotypes in Kabale were all landraces whereas in Luwero they were all improved cultivars.

Table 2. Most commonly grown sweetpotato genotypes in Kabale district of Uganda and their attributes (2010).

Genotype	Desirable attributes (ranked)			
	1	2	3	4
Nyinakamanzi	High yield	Early maturity	Good ground cover	Sweetness
Mukazi	High yield	Sweetness	Early maturity	High dry mass
Rwabafuruki	Early maturity	Sweetness	High yield	High dry mass
Mukono	High yield	Early maturity	Sweetness	Good ground cover
Kanyasi	Sweetness	High dry mass	High yield	Ground storability
Kidodo	High yield	Early maturity	Sweetness	Large roots

Table 3. Most commonly grown sweetpotato genotypes in Luwero district of Uganda and their attributes (2010).

Genotype	Desirable attributes (ranked)			
	1	2	3	4
NASPOT 1	High yield	Early maturity	Sweetness	High dry mass
Kakamega	High yield	Early maturity	Sweetness	Resistance to SPVD
Ejumula	Early Maturity	High yield	Sweetness	Vitamin A
NASPOT 10 O	Early maturity	High yield	Large roots	Sweetness
New Kawogo	High dry mass	High yield	Early maturity	Sweetness
NASPOT 9 O	Early maturity	High yield	Sweetness	High dry mass

Farmers' preferred genotype attributes: The farmers listed several desired sweetpotato attributes. The most important attributes ranked by the farmers in Luwero were high yield (96.7%) followed by early maturity (68.3%), sweetness/taste (46.7%) and drought tolerance (25.0%) (Table 4). Ranking of attributes in Kabale was in the following order: sweetness/taste (95.0%); high yield (91.7%); early maturity (80.0%); and high dry mass (25.0%). Sweetness/taste of the sweetpotato root was ranked first in Kabale and third in Luwero and was one of the reasons that the farmers mentioned for not adopting recently introduced high yielding, disease resistant cultivars. Early maturity is ranked third in Kabale but second in Luwero. The genotypes grown varied greatly in the time required to reach harvest maturity. Some matured within three months and others within six months. Another related attribute that was only important in Luwero district (11.7%) was the ability to yield well in all types of soils especially infertile soils. Disease resistance was ranked the fourth most desired attribute in Luwero and sixth in Kabale. The major diseases were the SPVD and the Alternaria blight. Resistance to sweetpotato weevil was only important in Luwero (25%) where it was ranked sixth. Good groundcover was reported as a desired attribute by 6.7% of the farmers in Kabale and 3.3% of the farmers in Luwero. The farmers in Kabale wanted genotypes that covered the soil surface fast so that the speed of water runoff was reduced (because of the hilly nature of their terrain) and the requirement for weeding was less. According to the farmers in Luwero, such genotypes that cover the ground rapidly protect the roots from weevil damage and rotting during the dry season. This attribute goes hand in hand with good seed production which was ranked eighth (15.0%) in Kabale with a nil response for this attribute in Luwero. There was no commercial vine production in Kabale and the farmers preferred genotypes that produce enough vines and are tolerant to dry conditions to provide planting materials at the beginning of the planting season. Orange flesh and red skin of the sweetpotato roots were lowly ranked in both districts. The reason the farmers gave for the low ranking of the OFSP was the unpleasant flavour and low dry mass. Of the farmers interviewed, only those who produced for the market were concerned about the skin colour where red was preferred.

Table 4. Percentage respondents and ranking of farmers' preferred sweetpotato attributes in Kabale and Luwero districts of Uganda (2010).

Attribute	Kabale		Luwero	
	% Respondents	Rank	% Respondents	Rank
Sweetness	95.0	1	46.7	3
High yielding	91.7	2	96.7	1
Early maturity	80.0	3	68.3	2
High dry mass	25.0	4	18.3	10
Large roots	21.7	5	20.0	9
Disease resistance	20.0	6	46.7	4
Tolerance to drought	13.3	7	25.0	7
Good seed production	15.0	8	-	-
Soft roots (low dry mass)	8.3	10	-	-
Good in-field root storability	6.7	11	38.3	5
Good ground cover	6.7	12	3.3	14
Orange fleshed (Vitamin A)	3.3	13	5.0	13
Resistance to caterpillars	1.7	14	5.0	12
Resistance to weevils	0.0	-	25.0	6
Yields well in all soils	0.0		11.7	11
Red skin	0.0	-	3.3	15

Farmers perceptions of sweetpotato production constraints: The most important constraint identified by most farmers in Luwero district was the caterpillars of sweetpotato butterfly (Acraea spp.), and in Kabale it was Alternaria blight (Table 5). Some of the most popular genotypes (Mukazi in Kabale and NASPOT 1 in Luwero) turned out to be the most susceptible to Alternaria blight and caterpillars. Caterpillars usually become a serious problem during the dry season. The SPVD was a more important constraint in Luwero (ranked second) than in Kabale (ranked eighth). Drought was ranked as the fourth most serious constraint in Luwero, but was ranked eleventh in Kabale. Low soil fertility, theft, stray animals and low yielding genotypes were the other serious constraints in Kabale. Vermin and weevils were important production constraints in the two districts. Vermin were considered a bigger problem in Kabale while weevils were a bigger problem in the Luwero. Weevil damage was considered to be highly linked to drought. Low yielding genotypes was a more important production constraint in Kabale (40.0%), where mostly unimproved genotypes are planted. This problem may be further compounded by the low soil fertility levels in the area. Scarcity of vines was reported in both districts but was considered a more serious problem in Luwero (28.3%) than in Kabale (15.0%). In addition, shortage of land and labour were important constraints in Kabale expressed by 23.3 and 31.7% of the respondents, respectively. The labour problem was exacerbated by the women having the sole responsibility for food production while the men are involved in cash crop production or marketing.

Farmer awareness of Alternaria blight of sweetpotato: Most of the farmers in both districts were aware of Alternaria blight. Only 1.7% of the farmers in Kabale and 13.8% of the farmers in Luwero did not know the disease. Of those who knew the disease, 94.8 and 89.5% considered it a major production constraint in Kabale and Luwero districts, respectively.

The most common local names for the disease in Kabale were “Okubabuka” (88.3%) and “Kusirira” (6.7%). Literal translation of these two names is “getting burnt”. In Luwero district, some of the farmers (21.7%) called it “Alternaria”, and these were the farmers who had interacted with NARO, NAADS and The Regional Network for Improvement of Potato and Sweetpotato in Eastern and Central Africa (PRAPACE); 13.3% called it "Okubabuka" and 1.7% called it "Kusirira" and the rest (58.3%) did not know the local name.

Table 5. Percentage respondents and ranking of sweetpotato production constraints in Kabale and Luwero districts of Uganda (2010).

Constraint	Kabale		Luwero	
	%Respondents	Rank	%Respondents	Rank
Alternaria blight	76.7	1	11.7	10
Vermin	60.0	2	13.3	6
Soil infertility	45.0	3	6.7	11
Theft	41.7	4	1.7	12
Caterpillars	38.3	5	76.7	1
Shortage of labour	31.7	6	11.7	9
Low yielding genotypes	40.0	7	1.7	13
Sweetpotato virus disease	28.3	8	61.7	2
Stray animals	25.0	9	1.7	14
Lack of planting materials	15.0	10	28.3	5
Shortage of land	23.3	10	11.7	8
Drought	15.0	11	61.7	3
Lack of market	6.7	12	11.7	7
Weevils	6.7	13	58.3	4
Rotting of roots	5.0	14	6.7	10
Delayed/late maturity	5.0	14	0.0	-
Poor quality roots	1.7	16	0.0	-
Price fluctuation	1.7	17	0.0	-
Fibrous roots	1.7	17	0.0	-

In Kabale, 44.1% of the farmers reported the disease to be more severe during the wet season and 37.3% during the dry season (Table 6). According to some farmers (16.9%), the disease becomes severe only when the rainfall is above average while others (1.7%) reported no seasonal variations in disease severity. However, in Luwero district 98.2% of the farmers reported the disease to be more severe during the dry season and only 1.8% in the wet season.

Table 6. Farmers' perceptions of the season in which Alternaria blight caused the most severe damage in Kabale and Luwero districts of Uganda (2010).

Season	Overall (%)	Kabale (%)	Luwero(%)
Dry season	66.9	37.3	98.2
Wet	23.5	44.1	1.8
Very wet season	8.7	16.9	0.0
All seasons	0.9	1.7	0.0

According to the farmers, disease symptoms become severe during the first two (35.1% of the respondents) to three (35.1%) months after planting (Table 7). In Luwero, 42.3 and 34.6% of the respondents reported the disease to become severe during the second and third month after planting, respectively. In Kabale, the disease becomes severe from the second month (28.8%), third month (35.6%) through to the fourth month (30.5%). Some farmers in Luwero reported higher incidences of the disease in older fields especially those used for sequential harvesting.

Information on control and management Alternaria of blight: The sources of information about the control measures for the Luwero farmers were mainly NARO and PRAPACE. Only a few farmers (22%) made an effort to control Alternaria blight mainly by rogueing infected plants, spraying with fungicides, use of healthy planting materials and use of resistant genotypes. The control measures employed included rogueing infected plants, spraying with fungicides, use of healthy planting materials and use of resistant genotypes. Some farmers did not rogue when infection was wide spread. Rather than pulling an infected plant out of the ground, they left it so as to at least obtain some small harvest. Most farmers (73.0%) were aware of the differences in resistance between genotypes to Alternaria blight. The resistant genotypes identified in Kabale are Rwabafuruki (14.1%), Nyinakamanzi (10.6%), and Kanyansi (10.6%); and in Luwero are Kakamega (27.1%), New Kawogo (16.5%) and Ejumula (12.9%).

Table 7. Farmers' record of the time in months after planting when Alternaria blight symptoms become severe in the two districts of Uganda (2010).

Time after planting	Overall (%)	Kabale (%)	Luwero(%)
1 month	1.8	0.0	3.8
2 months	35.1	28.8	42.3
3 months	35.1	35.6	34.6
4 months	19.8	30.5	7.7
5 months	2.7	3.4	2.0
7 months	5.4	1.7	9.6

Farmers' classification of sweetpotato genotypes according to the level of resistance to Alternaria blight in Kabale and Luwero districts: The farmers classified their most commonly grown sweetpotato genotypes according to the level of resistance to Alternaria blight. In Kabale (Table 8), Rwabafuruki was ranked by 18.2% of the farmers as a resistant genotype, 10.1% ranked it as a moderately resistant genotype and 3.5% as a susceptible genotype. Kanyasi was classified by most farmers (16.8%) as a moderately resistant genotype followed by Kidodo. Most farmers (23.0%) classified Mukazi as a susceptible genotype.

Table 8. Farmers' perceptions of the level of resistance of the sweetpotato genotypes to Alternaria blight in Kabale district .

Genotype	Percentage cases		
	Resistant	Moderate resistant	Susceptible
Rwabafuruki	18.2	10.1	3.5
Nyinakamanzi	14.6	9.2	8.1
Mukazi	14.6	11.8	23.0
Kidodo	12.6	13.5	6.9
Kanyansi	10.9	16.8	12.6
Mukono	7.3	7.6	17.2
Other varieties	21.8	31.0	28.7

In Luwero district (Table 9), Ejumula was classified as a resistant genotype by the highest number of farmers (11.6%), NASPOT 10 O was classified as a moderately resistant genotype by the highest number of farmers (15.2%) and NASPOT 1 classified as a susceptible genotype by most of farmers (73%).

Table 9. Farmers' perceptions of the level of resistance of the sweetpotato genotypes to Alternaria blight in Luwero district.

Genotype	Percentage cases		
	Resistant	Moderate resistant	Susceptible
NASPOT 1	2.7	15.2	73.2
Kakamega	6.3	3.0	0.0
Ejumula	11.6	9.1	7.1
NASPOT 10 O	8.1	15.2	0.0
New Kawogo	7.5	12.1	3.6
NASPOT 9 O	4.1	6.1	0.0
Other varieties	59.7	39.3	16.1

Farmers' estimation of yield loss per hectare in a field severely infected by Alternaria blight: The farmers estimated the yield loss attributed to Alternaria blight in susceptible genotypes (Figure 7). The greater percentage of farmers in both districts indicated a 50.0% yield loss. However, others indicated higher yield losses especially when the environmental factors favour disease spread. For example in Luwero, according to 10.8% of the farmers, the yield loss can be as high as 80.0%. A small percentage, 4.1% in Kabale and 3.8% in Luwero, indicated that in some cases the yield loss can be 100%.

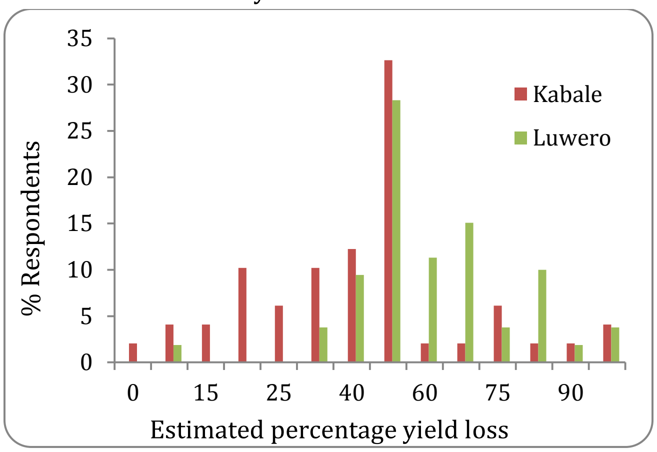

Figure 7. Farmers' estimates of total sweetpotato yield loss due to Alternaria blight in Uganda (2010).

The farmers in the two districts estimated the percentage yield loss for each of the commonly grown sweetpotato genotypes (Table 10). In Kabale district, Mukazi had highest estimated yield loss of 46.7% while in Luwero NASPOT 1 had the highest estimated yield loss of 57.9%.

Table 10. Farmers' perceptions of the percentage yield loss per sweetpotato genotype due to Alternaria blight in Kabale and Luwero districts.

	Genotype	Estimated % yield loss (Ha^{-1})
Kabale	Rwabafuruki	36.8
	Nyinakamanzi	41.0
	Mukazi	46.7
	Kidodo	33.2
	Kanyansi	38.7
	Mukono	37.6
Luwero	NASPOT 1	57.9
	Kakamega	50.0
	Ejumula	42.0
	NASPOT 10 O	10.0
	New Kawogo	50.7

DISCUSSION

The PRA highlighted the farmers' production problems, their desired sweetpotato attributes and their knowledge about Alternaria blight. The study identified the actual production constraints, desired genotype attributes and the extent to which the farmers regard Alternaria blight as a serious production constraint. All these aspects will be important in designing future sweetpotato breeding programs.

Crop management and genotype mixes: The study revealed that a large number of crops are grown alongside sweetpotato and in some cases as intercrops. Kabale farmers intercrop legumes with sweetpotato unlike in Luwero where the majority of the farmers intercrop with cassava. This indicates a lack of good extension advice in Luwero district, since both cassava and sweetpotato are root crops and will compete for the same nutrients and root space, and therefore neither crop will yield to its full potential. Farmers who do not intercrop, plant several sweetpotato genotypes on the same piece of land either as mixed genotypes or each genotype planted separately in a small portion of the land. The major reason cited for this practice is a lack of enough planting materials for one genotype to cover the available land especially after the dry season. In some cases the farmers plant several genotypes as a security measure in case one of the genotypes fails. Some farmers exploit the different maturation periods of the genotypes to meet their harvest requirements. Since some genotypes mature very early and others late, the farmers are able to sequentially harvest a crop over an extended period of time. This has been previously reported by Bashaasha *et al.* (1995). Low (2000) while working in Kabale reported that some farmers harvest roots from their land for a period of 3 months after planting up to 10 months after planting by planting genotypes with different maturation dates.

Access to disease free planting materials is also a problem in the area surveyed. There is no organised system of distribution of planting materials to the farmers. The major sources of planting materials are farmers replanting vines from their previous crop and others obtaining vines from neighbours. Vines from the neighbours are normally provided free of charge thus there is no incentive for commercial seed production (Gibson *et al.*, 2009). This informal distribution system lacks any proper seed quality control mechanisms and is a major avenue for the spread of pests and diseases since no thorough inspection is done. However, according to Chiona (2009), the informal farmer to farmer seed supply system may be advantageous in that farmers are able to select genotypes with the desired attributes for their particular locality.

Preferred attributes: While high yield is the most important attribute to farmers in Luwero; taste (sweetness) is the most important in Kabale. This is indicative of the divergence in preferred traits and necessitates localised selection of genotypes. Before adoption, farmers evaluate a number of important traits often accepting genotypes of lower yield but with higher quality. Therefore, high yield is not always the most important determinant of the adoption of new cultivars. Some of the other quality attributes that farmers desire are high dry mass, and certain flesh and skin colours. This was also previously reported by Low (2000). The majority of the farmers prefer white-fleshed genotypes with high dry mass but for the traders, red skin colour is also important. That farmers normally reject OFSP because of their unpleasant flavour and low dry mass underlines the need to educate them about the health benefits of OFSP in terms of vitamin A. For the market oriented farmers and traders, genotypes with red skin are easier to market than the other colours. However, farmers who don't produce for the market require a sweetpotato genotype with their preferred attributes such as high yield, taste and high dry mass while skin colour is not considered very important.

Production constraints: The two districts have almost similar production constraints. However, the perceived seriousness of the constraints differs considerably. Constraints considered to be very important in Kabale are not necessarily important in Luwero. In Kabale, Alternaria blight and vermin, especially mole rats, are the most important constraints whereas in Luwero caterpillars, weevils, SPVD, and drought are important. These differences in constraints can be influenced by the prevailing weather conditions at the two locations whereby the colder and moister conditions in Kabale do not favour caterpillars but favour the development of Alternaria blight. Consideration of the different constraints and attributes for the two regions calls for different breeding strategies. If this is not done, then breeding cultivars with multiple complementary traits that can be released in both locations could be the answer (Mwanga *et al*., 2007). Most farmers in both districts consider Alternaria blight a constraint to sweetpotato production but it is a more serious production constraint in Kabale. In Kabale the disease is most severe during the wet season, while in Luwero it is most severe during the dry season. This is an indication that the *Alternaria* pathogens do not only cause severe damage under high levels of moisture as earlier reported by Osiru *et al*. (2007), but also under dry conditions. It may be true that infection takes place during the wet season but due to the crop vigour at that time the disease is suppressed and the severe symptoms are more prominent during the dry season and when the crop is older (Ojiambo *et al*., 1999). The majority of the farmers in both locations reckon that the disease causes about 50% yield loss. A large number of farmers in Luwero district (73%) classified NASPOT 1 as a very susceptible genotype to Alternaria blight with an estimated yield loss of up to 57.9%. Similarly, Osiru *et al*. (2007) reported yield losses of 27.3 to 54.3% among susceptible cultivars. Susceptibility of NASPOT 1 to Alternaria blight was also reported by Mwanga *et al*. (2003). Yield loss estimates close to what was obtained through field trials indicates that the farmers have a very good understanding of their genotypes in terms of resistance to diseases and should be involved in evaluation of advanced breeding materials. There are several options in controlling the disease but given that sweetpotato is a low value crop and mainly grown by resource poor farmers who use marginal lands, the best control measure is use of host plant resistance (Hakiza *et al*., 2000). Thus breeding efforts should be geared towards the development of new Alternaria blight resistant genotypes.

Drought remains a major challenge in Uganda where sweetpotato is grown during dry seasons (Bashaasha *et al*., 1995). During prolonged dry spells most of the farmers who cannot afford supplemental irrigation lose most of the vines (Bashaasha *et al*., 1995; Yanggen and Nagujja, 2006). Therefore, if a formal seed system is to be established, there is a need to invest in irrigation equipment so that vines can be produced during the dry months under irrigation and supplied to farmers at the beginning of the rainy season. Farmers with access to wetlands produce vines during the dry season (Bashaasha *et al*., 1995; Gibson *et al*., 2009) but some of these wetlands dry out during prolonged dry spells.

The overall sweetpotato yields are higher in Luwero than in Kabale. This situation may be attributed to highly degraded soils in Kabale due to overuse of the soil for crop production and subsequent loss of fertility, lack of manure to replenish nutrients, soil erosion especially on steep slopes (Bashaasha *et al*., 1995; Low, 2000), and use of landraces with lower yield potential.

CONCLUSION

The study identified what the farmers considered to be their major production constraints, as well as the farmers' preferred sweetpotato attributes and their perceptions on Alternaria blight. Sweetpotato farmers in the different regions of Uganda face the same production constraints and have the same preferred attributes but the degree of importance of the constraints and ranking of the preferred attributes differ. Some farmers were able to classify the sweetpotato genotypes into resistant, moderately resistant and susceptible categories. However, we cannot rely on farmer classification thus the need to evaluate all genotypes whose resistance levels are not yet known. Presence of resistant genotypes is an indication that sources of resistance to the disease are available within the germplasm and therefore it is possible to breed for resistance to the disease. These findings will be important in designing future breeding programs as farmers' production constraints and preferred attributes have been identified. However, careful parental and progeny genotype selection and involvement of farmers at an appropriate stage of selection is essential to ensure that the traits identified as important by the farmers will be incorporated into the new genotypes. In turn, this will lead to an increase in the adoption rate of the new genotypes since they will meet the requirements of the farmers.

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