

Full Length Research Paper

Distribution, incidence and farmers knowledge of banana *Xanthomonas* wilt in Burundi

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Banana *Xanthomonas* wilt (BXW) is a devastating bacterial disease caused by *Xanthomonas campestris* pv. *musacearum*. The disease was simultaneously reported in Cankuzo and Bubanza provinces, Burundi, in November 2010. However, the extent to which the disease has spread to other banana growing regions in the country is unknown. Therefore, to ascertain the distribution and incidence of the disease and farmers' knowledge on measures to control the disease, a survey was conducted in all 16 banana growing provinces of Burundi in August 2011. A total of 208 farms were sampled, selecting six farms per surveyed commune, three affected and three non-affected. The survey was conducted using a structured questionnaire. The disease was present in 10 out of 16 provinces constituting all agricultural lands in Burundi. The highest incidence was recorded in Ruyigi province (34%), where the Kayinja system is dominant and the lowest in Muyinga (3%), where the East African Highland bananas (EAHB) dominate. Awareness of BXW symptoms, modes of spread and control measures was generally low, ranging from 8 to 30% of households surveyed. The limited knowledge of the disease among farmers was thought to be largely responsible for driving the epidemic in Burundi.

Key words: Debudding, disease incidence, *Musa* species, *Xanthomonas campestris* pv. *Musacearum*.

INTRODUCTION

Banana (*Musa* species) is the first crop in Burundi in terms of production with 1,848,727 tonnes in 2011, followed by sweet potatoes and cassava (FAOSTAT, 2016). Plantains, which are also *Musa* spp., are not common in Burundi. Banana is used for beer, cooking the

and for dessert and therefore contributes significantly to food security and income. The crop protects land against soil erosion especially in Burundi, where the landscape is hilly with steep slopes (Rishirumuhirwa, 1997). However, banana production is threatened by wilt (BXW) caused

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by *Xanthomonas campestris* pv. *musacearum* (Xcm). BXW is one of the recent threats to banana production in East and Central Africa. The disease was first reported in Ethiopia on Ensete and banana (Yirgou and Bradbury, 1974; Smith et al., 2008). It was first reported in East and Central Africa in Uganda and the Democratic Republic of Congo (DR Congo) in 2001 and since then has continued to spread to most countries in the region (Tushemereirwe et al., 2003; Karamura et al., 2008). Other banana production constraints include soil fertility, poor management, inaccessibility to fertilizers, diseases and pests such as banana bunchy top disease, *Fusarium* wilt and Sigatoka (Tinzaara et al., 2007). BXW is a devastating disease with the potential to drastically reduce banana production and negatively impact farmers' livelihoods. At the vegetative stage, symptoms of BXW are mainly yellowing and wilting of leaves while flowering banana shows withering and rotting of male buds and premature ripening of the fruits (Tushemereirwe et al., 2003; Karamura et al., 2008; Ssekiwoko et al., 2010). The disease is spread by insects, birds, infected planting materials, cutting tools and animals which can browse on healthy banana after feeding on diseased mats (Biruma et al., 2008, Tinzaara et al., 2009). Recommended cultural control measures for the disease include destruction of affected plants, disinfection of farm tools, using clean planting material and early removal of male buds using a forked stick and keeping animals out of the fields (Tinzaara et al., 2016).

In Burundi, the disease was first confirmed in November 2010 in the provinces of Cankuzo and Bubanza which are bordering with Tanzania and Rwanda, respectively (Niko et al., 2011). In Cankuzo (East of Burundi), the disease was reported in Gisagara Commune, Gitanga colline, about 25 km from the Tanzania border whereas in Bubanza province (West of Burundi), the hotspot was observed in Musigati commune at Rushiha colline about 60 km from DR Congo border (Niko et al., 2001). A few months later, the disease spread rapidly to other provinces in the country and new pockets were identified in seven provinces. However, little is known on the actual disease distribution, incidence and farmer awareness on the disease in the country. This study, therefore, was aimed at determining BXW distribution, incidence and farmers' knowledge of disease symptoms, mechanisms of spread and control in Burundi.

MATERIALS AND METHODS

A survey was carried out in August 2011 covering all 16 provinces of Burundi. Two communes per province were surveyed, except in Makamba province where five out of six affected communes were surveyed. The number of communes per province in Burundi varies from 5 to 9 and the country has a total of 117 communes. Six farms per commune were selected randomly (three affected by BXW and three unaffected) from the 35 communes visited out of 117 countrywide.

Data from 208 farms were recorded using a structured

questionnaire. The questionnaire was designed to capture information on banana production constraints in general but with more emphasis on BXW. Farmer interviews were conducted and then observations made in banana fields to record data on banana plantation management, disease symptoms, and incidence of the main banana diseases and pests and the affected cultivars. Enumerators were selected based on the working experience on banana management and were trained to distinguish banana diseases, especially those that are present in Burundi. They further were further trained to use the questionnaire theoretically in a meeting as well as practically on farm level by simulating data collection from farmers.

The incidence of BXW, which consisted of percentage of diseased plants in a field, was calculated based on observation and counting of 30 plants selected using diagonal walks in the field. Geographical coordinates were also recorded using GPS unit to map the disease distribution. Data were subjected to descriptive statistics (means and percentages) and analyzed using SPSS 11.0, ArcGis 9.3 software.

RESULTS

The results of the farmer knowledge about cultural practices that contribute to BXW management are presented in the Figure 1. Banana plantations (57.2%) in Burundi are more than 20 years old while 59.6% are poorly managed. Forty-nine percent of the banana grown in Burundi is used for beer, 28.4% for cooking, 20.9% for dessert types and 0.7% for plantains. Banana plantations are mostly established in a mixed cultivars system in which farmers use at least two cultivars. The most common varieties observed include cooking banana Igisahira gisanzwe- AAA-EA, 19.4%), beer bananas Igitsiri (AAA-EA, 16.3%) and Kayinja (ABB, 13.6%), dessert banana Kamaramasenge (AAB) whereas hybrids FHIA (AAAA), which are currently the most widely promoted in the country, are not yet widespread (0.9%) on farm level.

BXW was observed in 10 (Bujumbura, Cibitoke, Bubanza, Makamba, Rutana, Ruyigi, Cankuzo, Karuzi, Muyinga and Ngozi) out of the 16 provinces surveyed (Figure 2). The province of Makamba (South) was the most affected with the disease found in five communes. Cibitoke, Cankuzo, Bubanza and Ruyigi provinces had each two affected communes while in Ngozi, Karuzi and Muyinga, the disease was observed at least in two sites (Figure 2). The incidence recorded varied in the different communes and is indicated in Table 1. The highest incidence was recorded in Ruyigi (34%) while the lowest was registered in Muyinga (3%). The incidence ranged from 17 to 25% in the most affected province (Makamba).

Farmers' awareness of symptoms, modes of spread and control measures of BXW was low (Figure 3). A small percentage of farmers ranging from 22.6 to 31.3% recognize BXW symptoms. Premature fruit ripening and wilting and yellowing of leaves were the most widely known symptoms, probably because they are visible by external observations. However, some farmers were still confusing BXW with *Fusarium* wilt due to the common

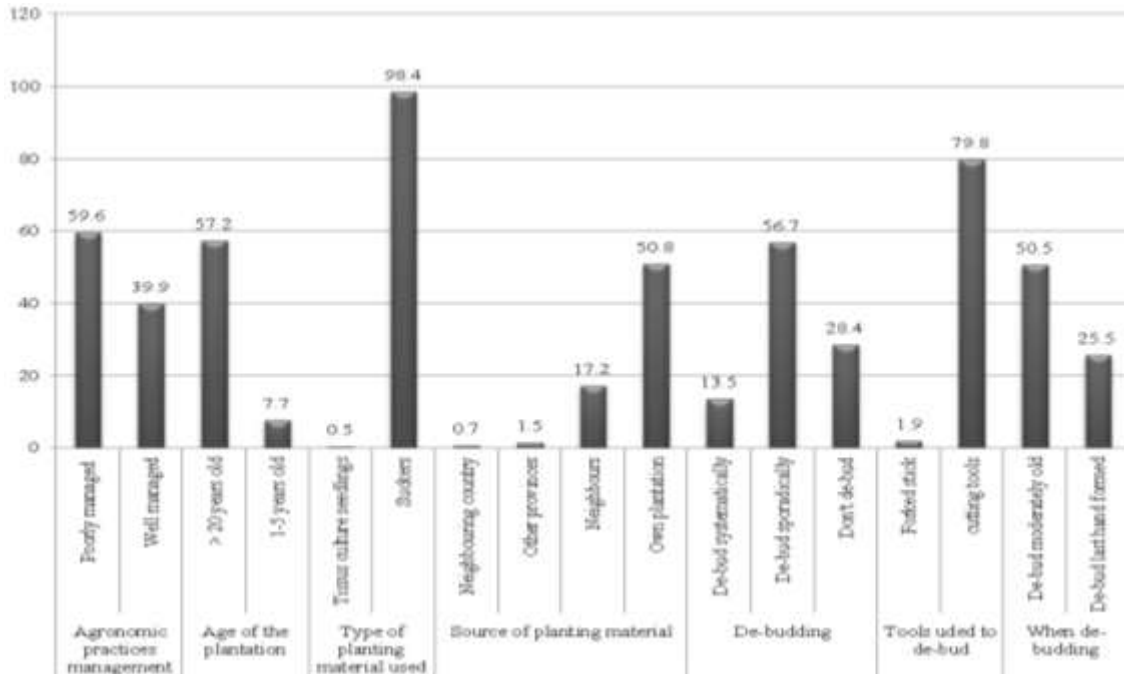


Figure 1. Cultural practices that contribute to BXW management.

yellowing and wilting of leaves. Very few of the interviewed farmers (1.9 to 26.4%) had knowledge of the mechanisms of BXW spread. Moreover, the percentage of the interviewed farmers who were aware of and implementing disease control was extremely low (ranging from 1.9 to 14.9% of farmers interviewed). Those who were aware reported that their main sources of information on BXW were radio/TV (22.6%), friends/neighbours (14%), extension (12.8%), research (2.3%), schools/churches (0.8%) and NGOs (0.4%). However, certain control practices were less known to farmers (or farmers did not have sufficient information on the practices). For instance most of farmers were not aware of the removal of male bud when the last hand has formed.

Most farmers (98.4%) also used suckers from their own field or neighbours to establish new plantations. The use of tissue culture and macropropagated materials is not yet widespread (Figure 1). Some households exchange suckers of improved varieties between provinces (1.5%) and even from neighbouring countries (0.7%). This was particularly true for the provinces of Muyinga and Ngozi. Farmers are also unaware of agronomic practices that contribute to disease control.

DISCUSSION

BXW has spread rapidly within the Burundi since its outbreak reported in two provinces in November 2010. This study showed that 10 out of the 16 provinces were

already affected in less than a year with an incidence ranging from 3 and 34%. The low incidence in the Mabanda and Bubanza commune reflects the recent infection of these areas. Disease transmission was suspected to be driven by insects in Kayinja-based banana systems although tool-infection was locally important in several sites. Kayinja, also known as Pisang Awak, is preferred by farmers for its different uses but it is considered as one of the susceptible cultivars to BXW (Biruma et al., 2007). The only affected field found in Ngozi belongs to a farmer who owns another infected banana plantation in Karuzi. It is believed that the farmer involuntarily contaminated his plantation in Ngozi with non-disinfected tools after his passage in Karuzi. Additionally, some farmers admittedly reported that they were not aware about tools disinfection when they cut down a diseased banana, contributing involuntarily to the spread of the disease. The rapid spread of BXW is also influenced by farmers' limited knowledge and use of management measures such as timely removal of male buds and decontaminating tools. De-budding and decontamination of farm tools are known to be effective means of eliminating existing sources of inoculum and reducing opportunities of further spread of Xanthomonas wilt by insect vectors (Eden-Green, 2004; Tinzaara et al., 2006; Nakakawa et al., 2016). Considering that BXW can spread up to a radius of 75 km per year (Kwach et al., 2013), the lack of awareness and small size of a province in Burundi (from 830.60 to 2465.64 km²), one can understand why the disease moved rapidly from the two affected provinces to the closest provinces.

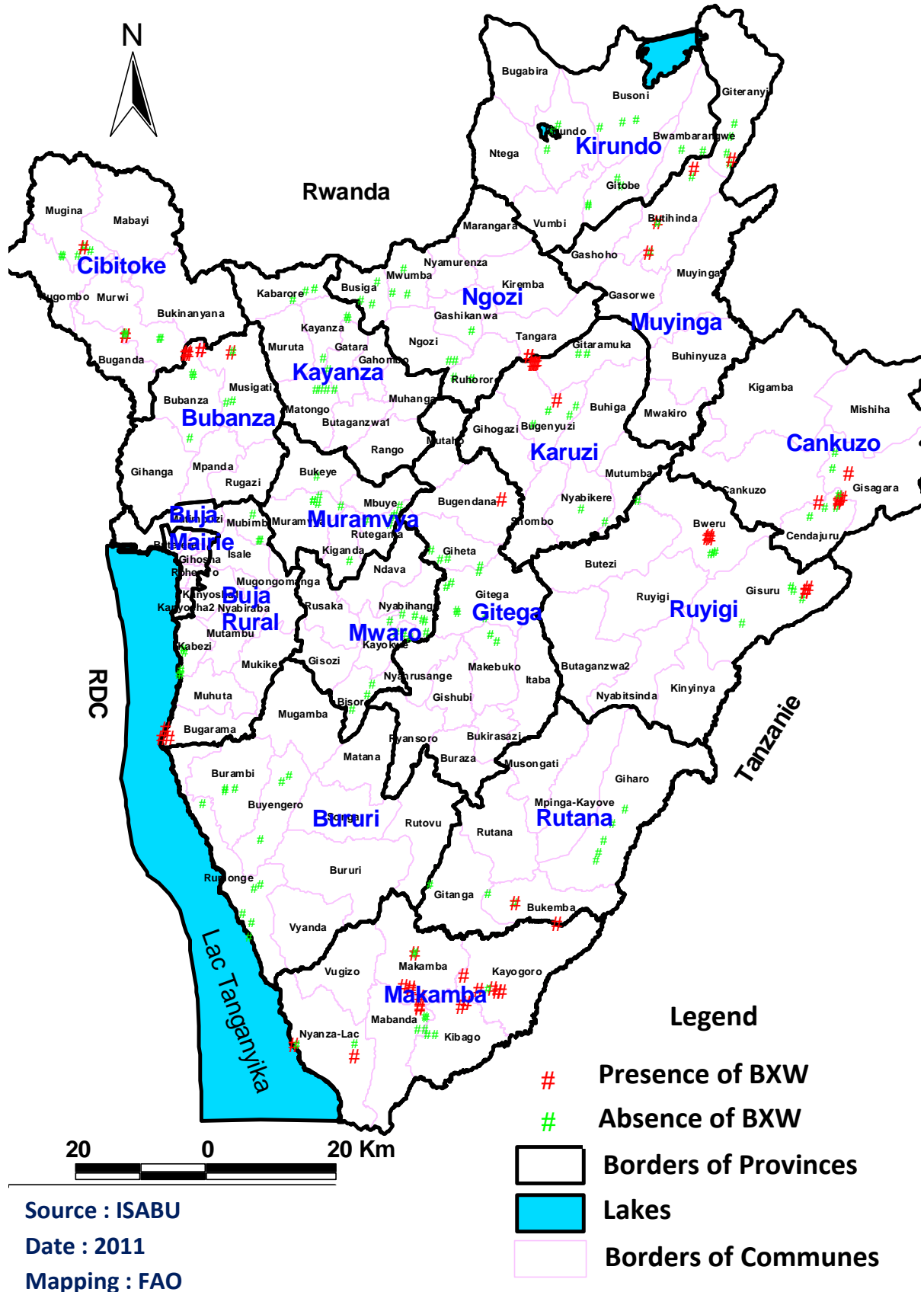


Figure 2. Distribution map of BXW in Burundi, August 2011 (ISABU, 2011).

Table 1. Incidence of BXW in different communes in Burundi, August 2011.

Province	Commune	Incidence (%)
Bubanza	Musigati	27
	Bubanza	3
Bujumbura	Bugarama	10
Cankuzo	Gisagara	14
	Cendajuru	13
Cibitoke	Murwi	14
	Mugina	6
Karuzi	Gitaramuka	14
Ngozi	Tangara	9
Rutana	Bukemba	21
Makamba	Nyanza-lac	25
	Makamba	22
	Kayogoro	19
	Kibago	18
	Mabanda	17
Muyinga	Giteranyi	10
	Butihinda	3
Ruyigi	Bweru	34
	Gisuru	33

The entry of the disease in Burundi is still a puzzle, though disease is suspected to have come on infected planting material or contaminated tools. The provinces of Makamba and Ruyigi which border the Kigoma region of Tanzania were the most affected. The Tanzania border region was reported to be affected by BXW in 2010 (Mgenzi et al., 2010) although there is a quite distance in between occupied by forests. However, it is likely that farmers on either side of the border exchange planting materials and trans-boundary workers can spread the disease using their working tools. The disease probably came to those provinces from Tanzania through either planting material or tools. In Makamba, Bujumbura and Rutana provinces, the most dominant symptoms are the shrivelling of inflorescences and premature ripening of banana fruits. This indicates that the disease was transmitted by insects as Kayinja, dominant in these provinces, is more susceptible to insect-mediated infections (Mbaka et al., 2009; Tinzaara et al., 2006).

Farmers' knowledge of the disease symptoms, spread mechanisms and control options is very critical in the management of the disease (Nkuba et al., 2015; Tinzaara et al., 2016). Farmer awareness of the disease was generally low in all provinces of Burundi. Additionally, farmers' management practices are not conducive to

eradication of the disease once a field is infected as they prefer to abandon infected fields. This constitutes a major threat to farmers who are implementing control measures as abandoned banana fields act as a permanent source of the inoculum. This suggests the need for mobilization and sensitization at community level. The approach of engaging the community to own the problem contributed to the success in BXW management in Uganda (Kubiriba et al., 2012; Tinzaara et al. 2013; Ochola et al., 2015). This would include engaging locals in the bid for zero tolerance of Xanthomonas wilt by eliminating any sources of inoculum through effective implementation of control measures backed-up by community by-laws that most efficiently brings to book errant farmers who hesitate to manage the disease. The farmers need to understand that the disease is extremely devastating but can be controlled. This encourages farmers to aggressively fight the disease.

Conclusion

The rapid spread of BXW and its high incidence in affected fields in Burundi poses a serious threat to food security and incomes of rural communities in banana

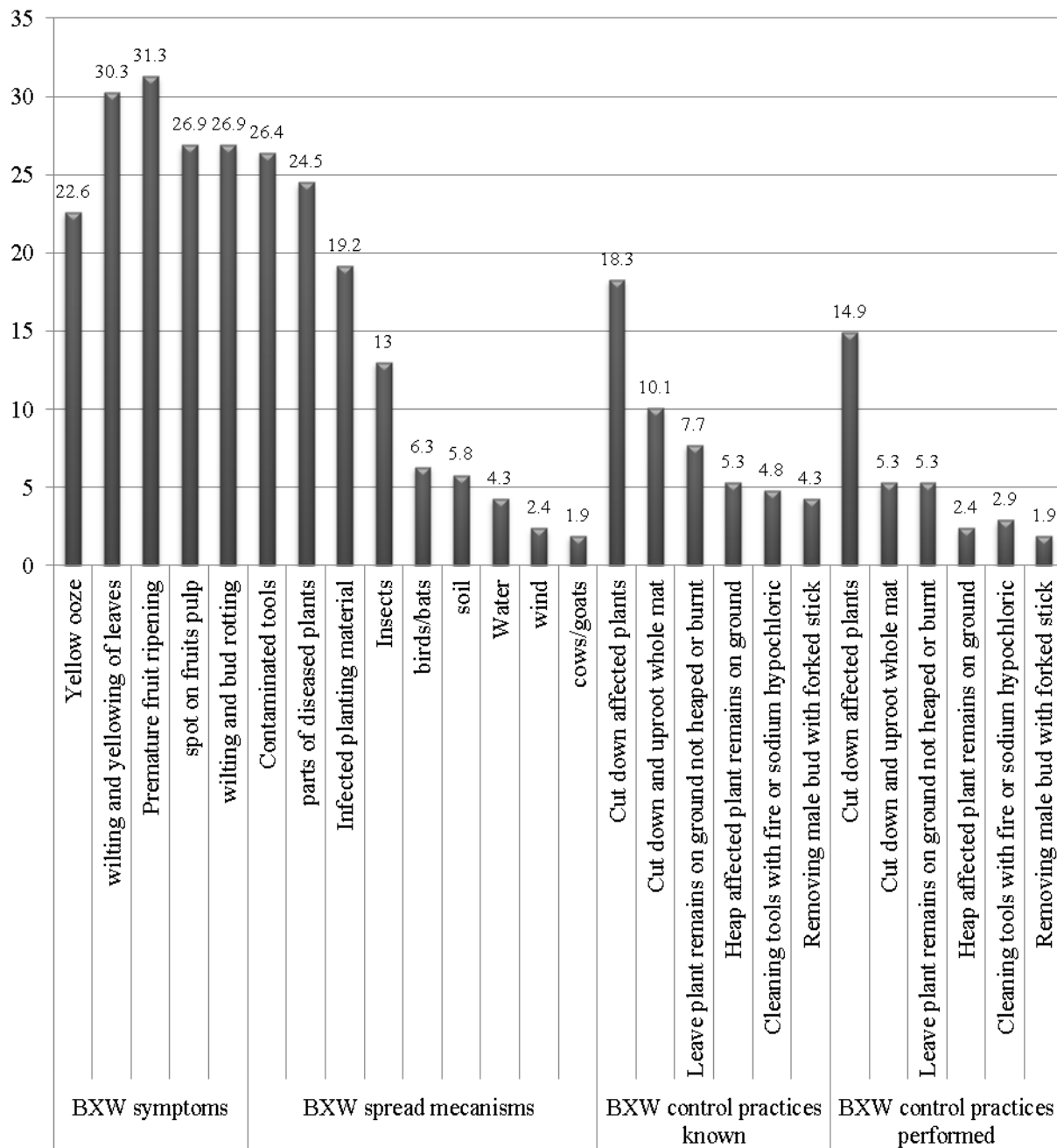


Figure 3. Farmers' knowledge on BXW symptoms, spread mechanisms and controls measures.

based cropping systems. The limited knowledge of the disease by the farmers and other stakeholders in the country makes it difficult to control. Farmers have limited awareness about the control measures, in particular when to remove the male bud. In the infected areas, farmers who are following control measures such as removing the male buds and disinfecting tools are harvesting bananas. BXW is also spreading by contaminated tools, with workers involuntarily transmitting the disease because they are not aware of tools

disinfection. Poor management of banana plantations in Burundi makes control measures very difficult when bananas are infected. To remove mats constituting of up to ten plants makes control labour intensive and farmers are discouraged when they have to uproot poorly managed plantations which are no longer profitable. Farmers' knowledge is particularly low on control measures and the proportion of farmers using control practices is also low. There is therefore a need of improving awareness of farmers on banana cultural

practices and how to make banana a profitable crop while controlling BXW and other diseases and pests.

Conflict of interests

The authors have not declared any conflict of interests.

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