Banishing banana wilt: Can it get any easier?

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Xanthomonas wilt disease is adversely affecting banana production in Eastern and Central Africa, where banana is a key food and cash crop. Learning with farmers and working with partners, Bioversity International is improving and scaling up a management practice to control the disease – the *Single Diseased Stem Removal*. It is low cost, easy to implement and effective; it involves cutting a diseased banana stem while leaving the banana mat intact. Using this practice increased the value of banana production by US$462/ha/annum per adopting farmer. Tens of thousands of farms can now provide for their food and livelihood security.

Banishing banana wilt: Can it get any easier?

Banana production in East and Central Africa has been under immense pressure from Xanthomonas wilt disease over the past 20 years, compromising the income and food security of over 70 million people. The disease is currently spreading westward towards the plantain belt, with the eastern part of the Democratic Republic of Congo being a large hotspot. Proactive measures are needed to prevent further spread. Learning with farmers, scientists improved the *Single Diseased Stem Removal* (SDSR), a low-cost, easy-to-implement and effective technique that involves cutting diseased banana stems while leaving the banana mat intact. This approach is currently being scaled out, giving hope to tens of thousands of farmers in East and Central Africa. Our analysis shows large economic benefits for farmers using SDSR, but adoption requires continued investments in communication campaigns and training that target women and use farmer-friendly tools and channels.

The challenge

Xanthomonas wilt (XW) disease, caused by a bacterium, *Xanthomonas campestris* pv. *Musacearum*, results in wilting (yellowing) of leaves, premature ripening and rotting of bunches, and the death of affected plants (Fig. 1). With no action, the yield from the affected plant will be zero, and entire banana fields can be wiped out in a matter of months. In addition to the loss of food and income, the disease potentially affects other important ecosystem services in the landscape, such as soil erosion control, nutrient recycling and biomass accumulation. Even though incidence levels lowered after farmers adopted practices to manage the disease, there were cases of resurgence since these practices were not always fully adopted or maintained. The disease is currently spreading westwards putting the plantain-producing zones of East, Central and West Africa at risk.

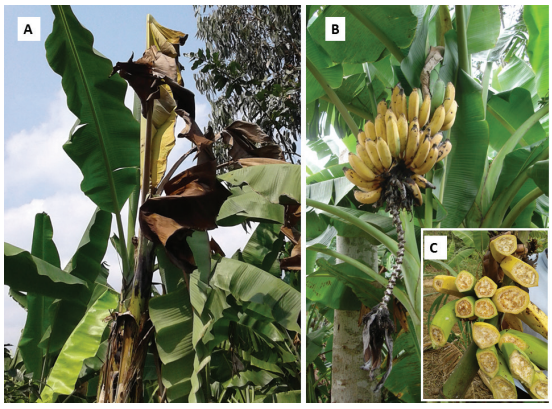

Figure 1. 1A) Banana plant showing leaf symptoms of Xanthomonas wilt; 1B) Banana plant with floral symptoms of Xanthomonas wilt (premature ripening of bunch, wilting of male bud bracts and rachis); 1C) Cross section of banana fingers showing brown discolouration. Credit: Bioversity International/ W. Ocimati

Cover Photo: Luc Denissen

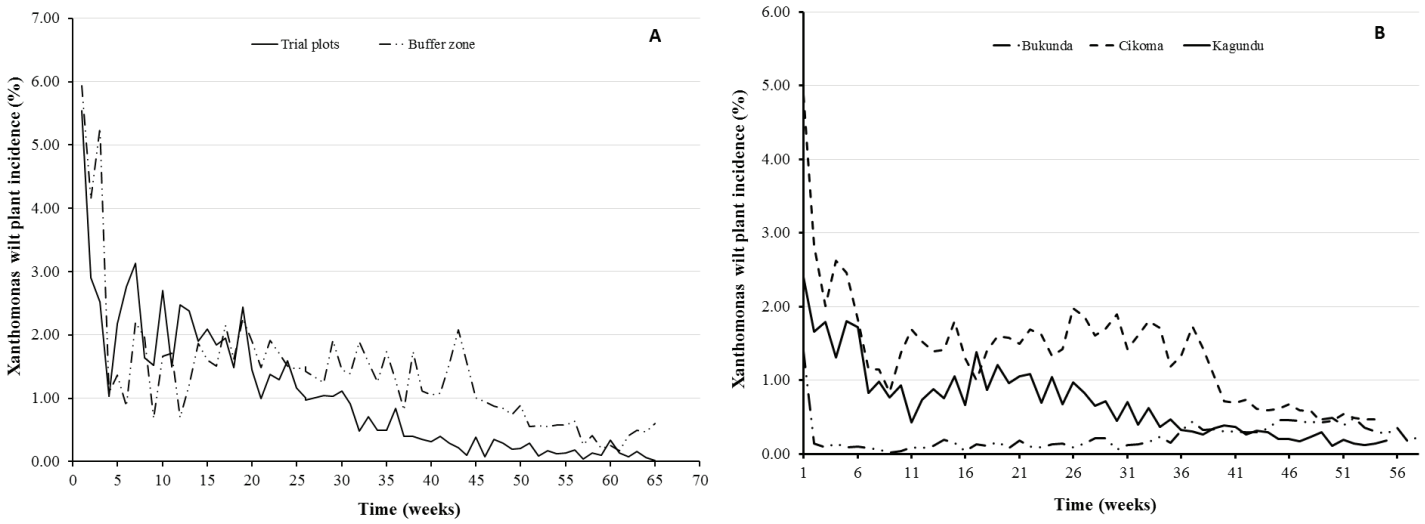

Figure 2. Changes in Xanthomonas wilt plant incidence over time following application of SDSR in: a) controlled experiments on farmers' fields at the Katana and surrounding 200m wide buffer zone; b) across farms in three villages. The initial Xanthomonas wilt incidences were 80%, 45.5%, 32.6% and 1.4% for Katana, Cikoma, Kagundu and Bukunda, respectively. Studies were conducted in South Kivu, eastern DR Congo. Source: Blomme et al. (2017).

Our solution

To control the disease in affected areas, Bioversity International is scaling up the Single Diseased Stem Removal (SDSR) technique, working with local, national and international partners. Co-developed by farmers and scientists, SDSR is an alternative to the complete uprooting of diseased mats (CUDM). While effective in controlling the disease, adoption rates of CUDM have been poor because it is labour-intensive and results in the loss of an entire mat or harvest. In contrast, SDSR is a low-cost and easy-to-apply solution; it involves cutting a diseased banana stem at soil level, destroying its apical meristem to prevent resprouting but leaving the banana mat intact. SDSR is based on the fact that XW bacteria spread within a mat is partially systemic, i.e. they do not spread to all plants that are physically attached to an infected plant in a mat. This technology, applied in conjunction with early male bud removal and sterilization of farm tools, reduces the incidence of disease from as high as 80% to below 2% within 3–4 months (Fig. 2). The farmers continue to harvest bunches from their farms as the mats recover to full production. It has also alleviated farmers' concerns for seed in areas such as eastern Democratic Republic of Congo (DR Congo) that have little to no access to clean planting materials. With correct SDSR application, the banana plantation completely recovers within 10 months.

An important part of the solution is to strengthen early warning, surveillance and disease prevention that can limit further spread of XW to disease-free areas in Central, West and Southern Africa. In support of this, we have undertaken a study to understand the key variables for XW spread at landscape level, and to map hotspots and vulnerable landscapes.

It is also crucial to understand the economic benefits of SDSR application. In Uganda, we conducted a XW management

Figure 3. Interaction between extension agents and farmers during SDSR scaling in eastern DR Congo (A) and a high-level policy engagement meeting on SDSR use in XW control in Burundi (B). Credit: Bioversity International/B. Van Schagen

cost-benefit analysis involving a broad range of stakeholders, such as national and local governments, research institutions, development organizations, and agricultural extensionists. The study shows the impact of adopting a full SDSR package on the livelihoods of small-scale farmers.

Results

To scale up SDSR in the hotspots and endemic zones of East and Central Africa, we have established and strengthened partnerships with field-based governmental and non-governmental agencies, with whom we are now testing innovative extension approaches. In Eastern DR Congo, teams of public extension workers are applying SDSR side-by-side with farmers. This not only guarantees results but also offers farmers opportunities to learn by doing, ask questions, and see for themselves the benefits of applying SDSR on their own farms (Fig. 3A). Burundi takes a different approach, reaching 14,000 households through cascade training by way of decentralized capacity building of extension service providers, and distribution of simple factsheets to households as aide-mémoires. High-level policy engagement is taking place in Burundi and Rwanda to institutionalize SDSR as the front-line defense against XW (Fig. 3B). In Rwanda, four SDSR demonstration sites have been established in collaboration with the Rwanda Agriculture Board to showcase to decision-makers over the course of 2019.

An adoption analysis based on a household survey conducted in 2018 in Uganda revealed that while 91% of the farmers applied some management practices, only 30% used the full SDSR package, which is crucial for the successful control of the disease.

Our findings show that SDSR adoption has a positive and significant impact on banana farmers' productivity and sales. Maximum benefits accrue when farmers use the full SDSR package, and this is more likely to happen when women receive training, since they are more engaged in the day-to-day management of banana plantations.

As a first step to contain the disease, we created a map that highlights hotspots and disease fronts (eastern DR Congo) and vulnerable landscapes with low (e.g. north-western Tanzania) or no XW (northern Mozambique) (Fig. 4, Ocimati et al. 2019). Incidence of XW was mainly correlated to rainfall and to the levels of investment in disease and crop management. Given the complexity of XW spread and management, and using this map as a basis, we recommend proactive measures such as quarantines and dissemination of information on XW diagnosis and epidemiology to support surveillance and timely control. This should primarily target the disease-free but vulnerable banana growing landscapes in Africa.

Potential for impact

Cost-benefit on a farm: Our cost-benefit analysis concluded that adoption of the full SDSR package is not only cost effective, but also generates considerable financial benefit for the farmer, by significantly reducing XW incidence and increasing the value of banana production by US$462/ha/annum per adopting farmer, and banana income by more than $222/ha/annum per adopting farmer.

SDSR scaling: SDSR is appealing for subsistence-oriented banana production systems in the region. We aim to reach 200,000 households by 2020 across East and Central Africa. A key challenge is how to reach hundreds of thousands of affected farmers, particularly in remote locations of eastern DR Congo. 20,000 households in Burundi and Eastern DR Congo have already recovered banana production using SDSR, and another 37,000 will be applying it in Burundi, DR Congo and Uganda by the end of 2019. Burundi has expressed willingness to deepen engagement with research and development partners for validating SDSR for use at national level (RTNB, 2019). In Rwanda, SDSR trials are expected to

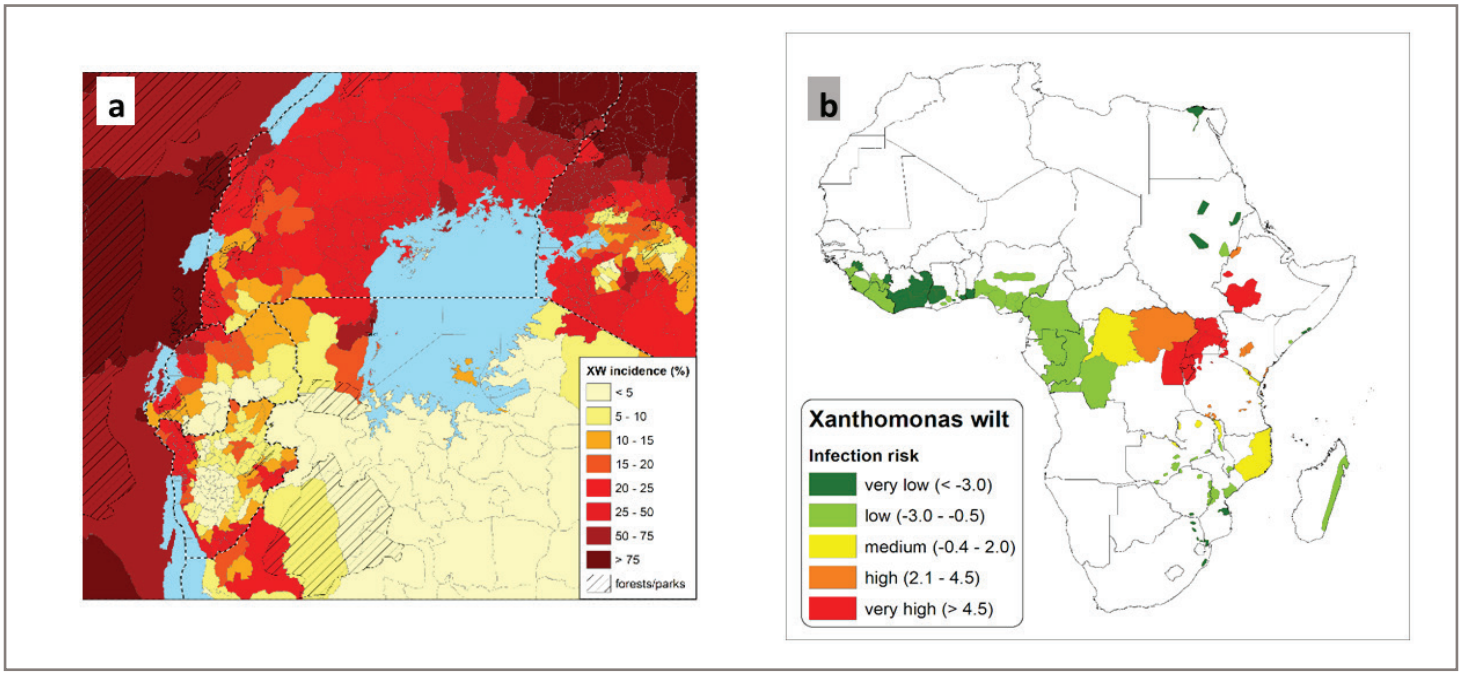

Figure 4. Aggregated (by administrative boundaries) XW incidence in the Africa Great Lakes Region (a) and infection risk of Xanthomonas wilt in tropical Africa (b). Large lakes are shaded blue while black dashed lines are areas unsuitable for banana production (e.g. > 2500 m), forests and or national parks. Source: Ocimati et al 2019.

encourage the use of SDSR, which is currently not practiced due to a perceived policy preference for complete mat uprooting.

Containing XW to East and Central Africa region: The eradication of XW has proved to be elusive due to its fast rate of spread, the complexity of its spread mechanisms, a long incubation and latency period, and a high cost of control. The losses attributed to the disease through harvest failure and management costs are enormous. Losses incurred by regulatory and supporting ecosystem services have not been accurately evaluated to date. Proactively engaging farmers and extension agents in vulnerable disease-free landscapes through preventive measures, and providing training on disease symptoms and epidemiology, is thus the more strategic way forward than a purely reaction- or mitigation-based approach. Such measures will prevent disease from being introduced in the first place, and, in case of entry, result in timely control measures to reduce and minimize losses.

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Photo: Banana plant affected by Xanthomonas wilt in Uganda. Credit: Bioversity International/N.Capozio

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