Tree and Forestry Science and Biotechnology ©2010 Global Science Books

The Efficiency of Air-Drying Pared Corms of Banana Suckers in Reducing the Risk of Soil-Mediated Xanthomonas Wilt Infections in Ethiopia

Meki Shehabu[1] • Temesgen Addis[1] • Laban Frank Turyagyenda[2] • Tamiru Alemu[3] • Shiferaw Mekonen[1] • Guy Blomme[2*]

[1] Southern Agricultural Research Institute (SARI), Awassa Research Center, P.O. Box 06, Awassa, Ethiopia
[2] Bioversity International Uganda office. P.O.Box 24384, Kampala, Uganda
[3] Hawassa University, Awassa College of Agriculture, P.O. Box 05, Awassa, Ethiopia
Corresponding author: * G.BLOMME@CGIAR.ORG

ABSTRACT

Xanthomonas wilt caused by *Xanthomonas campestris* pv. *musacearum* is one of the most threatening constraints to banana and enset (*Ensete ventricosum*) production in Ethiopia. The disease was unknown outside of Ethiopia until it was reported in Uganda in 2001. Since then the disease has spread to many East and Central African countries. *Xanthomonas campestris* pv. *musacearum* can only enter a plant through mechanical wounds (e.g. inflicted by garden tools) or natural wounds (e.g. male flower scars). Corm paring is a good practice for the control of weevils and nematode pests in banana but when the practice is conducted and corms planted in Xanthomonas wilt infected fields, *Xcm* infection occurs. As a solution, curing of corms before planting has been recommended. It is however not known if the recommendation could be adopted in Ethiopia. The study was therefore initiated to evaluate the efficiency of air-drying pared corms of banana suckers in reducing the risk of soil-mediated Xanthomonas Wilt infections under conditions prevailing in Ethiopia. Four treatments, i.e., pared and immediately planted, non-pared and immediately planted, pared and air-dried for three days and non-pared and air-dried for three days were tested for 'Pisang Awak' and a 'Matooke' genotype in a pot experiment. A total of 30 plants were used for each of the treatments per genotype. The disease incidence was recorded during six months after planting. Samples from dead or wilted plants were collected and plated on a YPSA medium at 28°C to confirm whether the disease symptoms were due to *Xanthomonas campestris* pv. *musacearum.* Paring and air-drying of banana suckers before planting increased soil-mediated Xanthomonas wilt infections. To reduce soil-mediated Xanthomonas infections, suckers should be carefully uprooted to avoid wounding and the uprooted suckers should be planted immediately after uprooting.

Keywords: planting material, *Xcm* infection

INTRODUCTION

In Ethiopia, banana is the second major fruit crop after citrus (Gebre Mariam 1999). All banana cultivars are eaten as dessert. The main banana growing areas are located at Arba Minch, 1,200 meters above sea level (masl) in southern Ethiopia, and in south western Ethiopia along the Kaffa-Bench Maji axis (1,050 to 1,700 masl) (Addis *et al.* 2004). Throughout the main enset growing areas, and below 2,100 masl, a few banana mats can be found in most enset farms. However, banana production especially in areas with mixed banana-enset cropping systems is threatened by Xanthomonas wilt caused by *Xanthomonas campestris* pv. *musacearum* (*Xcm*).

The disease was first identified on enset in Ethiopia in 1960 (Yirgou and Bradbury 1968) and later reported on banana in the Keffa, Shoa, Sidamo, Harerge and Gamogofa regions of Ethiopia (Yirgou and Bradbury 1974). Currently, the disease is damaging the banana production in the southern region of Ethiopia, especially in Bench and Keffa zone, and Amaro district. The disease was unknown outside of Ethiopia until it was reported in Uganda in 2001. Since then the disease has spread to many East and Central African countries. It has been reported in Uganda (Tushemereirwe *et al*. 2003), Rwanda (Biruma *et al.* 2007), the Democratic Republic of Congo (Ndungo *et al*. 2006), Tanzania (Mgenzi *et al*. 2006) and Kenya (Aritua *et al*. 2008).

Up to 90% yield loss due to Xanthomonas wilt has been reported in 'Pisang Awak' (*Musa* AABB group) plantations in Uganda (Karamura *et al.* 2006). The yield loss incurred on banana and enset in Ethiopia has not been well documented. However, once the disease appears in a plant; the whole plant is killed and some of the attached suckers can also develop the disease. Ethiopian farmers have abandoned their banana plantations/plots in areas with a high incidence of the disease and have resorted to growing other crops (Shimelash 2006).

When uprooting infected mats *Xcm* can survive in remaining infected live com pieces (Mwebaze *et al.* 2006; Tumushabe *et al.* 2006; Wolde-Michael *et al.* 2008). However *Xcm* has limited ability to survive saprophytically in soil and plant debris in the presence of other competing microoganisms (Mwebaze *et al.* 2006).

Xcm can only enter a plant through mechanical or natural wounds (*e.g.* male flower scars) (Tumushabe *et al*. 2006). According to Yirgou and Bradbury (1968) the disease is transmitted from an infected plant to a healthy plant through farm tools and insect vectors.

Corm paring is a good practice for the control of weevils and nematode pests in banana (Sarah *et al*. 1996; Gold *et al*. 1998) but when the practice is conducted and corms planted in Xanthomonas wilt infected fields, *Xcm* infection occurs (Mwangi *et al*. 2007). As a solution, curing of corms before planting has been recommended. It is however not known if the recommendation could be adopted in Ethiopia. The study was therefore initiated to evaluate the efficiency of air-drying pared corms of banana suckers in reducing the risk of soil-mediated Xanthomonas Wilt infections under conditions prevailing in Ethiopia.

Received: 4 February, 2009. Accepted: 5 April, 2010.

Short Communication

MATERIALS AND METHODS

Soil and plant recipient preparation

Top soil was collected from areas with no previous banana or enset cultivation and sterilized in an autoclave at 121°C for 15 min. Plastic buckets (22 cm in diameter and 22 cm height) were disinfested with a 2.5% sodium hypochlorite solution for 5 min. The buckets were subsequently rinsed with distilled water and air-dried before they were filled with the sterilized soil.

Collection and preparation of planting material

120 banana suckers from each of the two genotypes, 'Pisang Awak' (AABB genome group) and 'Matooke' (East African highland group; AAA-EA) were collected from farmers' fields in Yirgalem, Southern Ethiopia. No Xanthomonas wilt had been reported in this region. Uniform-sized banana suckers (with a 10 cm corm diameter) were carefully removed from the mother plants and kept in plastic woven bags. For each genotype 60 suckers were pared, while the other 60 suckers were non-pared. For each genotype, 30 pared and 30 non-pared suckers were immediately planted, while the remaining 30 pared and 30 non-pared suckers per genotype were air-dried during three days before planting.

Bacterial inoculation

Banana pseudostems infected with Xanthomonas wilt were collected from heavily diseased plots in Amaro district, Southern Ethiopia. The infected banana pseudostems were chopped into small pieces and these pieces were suspended in a bucket filed with 20 liters of sterilized water. The mixture was stirred intermittently for about one hour to allow the bacterial ooze to discharge into the water. The bacterial suspension was then separated from the chopped plant pieces and its concentration was adjusted using a spectrophotometer to 0.3 O.D at 460 nm, which is 10^7-10^8 cfu/ml. Finally, 500 ml of the bacterial suspension was gently poured on the soil around the pseudostem immediately after planting.

Experimental design and data collection

Four treatments, i.e., pared and immediately planted, non-pared and immediately planted, pared and air-dried for three days and non-pared and air-dried for three days were tested for each banana genotype. The treatments were arranged in a completely randomized design. A total of 30 plants were used for each of the treatments per genotype. Watering was done regularly depending on the weather condition with two liters of water per plant, while weeding was carried out when necessary. The disease incidence was recorded up to six months after planting. Samples from dead or wilted plants were collected and plated on YPSA medium at 28°C to confirm whether the disease symptoms were due to *Xcm*.

The percentage of disease incidence [(number of plants infected/total number of plants)*100)] was analyzed using SPSS 12.0 for Windows (SPSS 2003). Means were separated using Tukey's HSD test ($P<0.05$). The data was log transformed (log x+1) prior to analysis.

RESULTS AND DISCUSSION

As there was no significant difference between genotypes ($p=0.257$) we have presented the data for both genotypes combined (**Table 1**). The combination of paring and air drying of banana suckers before planting significantly increased Xanthomonas wilt soil-mediated infection (**Table 1**). The higher infection rate in pared compared to non-pared 'Pisang Awak' and 'Matooke' suckers is likely to be a result of the large wounds created on the corm during paring.

Although corm paring is desirable for the control of banana weevil and nematode pests (Sarah *et al*. 1996; Gold *et al*. 1998), the practice has been reported to predispose the plants to soil born *Xcm* infection (Mwangi *et al*. 2007). Our findings have also shown that the Xanthomonas wilt incidence was higher in the pared compared to the unpared corms suggesting that the wounds created pose a bigger risk for *Xcm* entry in case it is in the surrounding soil where the corms are planted. Previous research recommended that pared corms need to be cured for 3 days before planting to minimize this risk (Mwangi *et al* 2007). Our findings however show that curing/air drying for 3 days under Ethiopian conditions pose more risk of *Xcm* infection than previously anticipated. It is not understood why air-dried plants had a higher infection rate as it was expected that air drying would enhance wound healing. These findings suggest that corm paring be practiced in areas where the risk of *Xcm* infection from soil is low; otherwise corms should not be pared. In suspected cases of pest infestation, corm should be treated differently (e.g., boiling water treatment) or farmers should use tissue cultured disease and pest free materials. Our findings also show that for both genotypes and treatments a substantial number of plants did not get infected, suggesting that plants can escape soil borne Xanthomonas wilt infections even when the soil is heavily infected.

Table 1 Incidence of Xanthomonas wilt in banana plants arising from corms given different treatments prior to exposure to *Xcm*.

Treatment prior to exposure to *Xcm*	Infected plants (%)
Pared and air dried	43 b
Pared and planted immediately	10 a
Non pared and air dried	12 a
Non pared and planted immediately	13 a

Means followed by the same letter are not significantly different from each other; according to Tukey's HSD test ($P<0.05$)

CONCLUSIONS

To reduce a possible soil born Xanthomonas wilt infection, banana suckers should be carefully uprooted to avoid too many wounds. In addition, the uprooted suckers should be planted immediately after uprooting. However, in case the available planting material has weevil and/or nematode infections it is advisable to use tissue culture plantlets as planting material.

ACKNOWLEDGEMENTS

The authors would like to thank the Flemish Association for Development Cooperation and Technical Assistance (VVOB, Belgium) for its financial contribution to this study.

REFERENCES

Addis T, Handoro F, Blomme G (2004) Bacterial wilt (*Xanthomonas campestris* pv. *musacearum*) on enset and banana in Ethiopia. *InfoMusa* **13 (2)**, 44-45

Aritua V, Parkinson N, Thwaites R, Heeney JV, Jones DR, Tushemereirwe W, Crozier J, Reeder R, Stead DE, Smith JJ (2008) Characterization of the *Xanthomonas* sp. causing wilt of enset and banana and its proposed reclassification as a strain of *X. campestris. Plant Pathology* **57**, 170-177

Biruma M, Pillay M, Tripathi L, Blomme G, Abele S, Mwangi M, Bandyopadhyay R, Muchunguzi P, Kassim S, Nyine M, Turyagyenda FL, Eden-Green S (2007) Banana *Xanthomonas* wilt: a review of the disease, management strategies and future research directions. *African Journal of Biotechnology* **6**, 953-962

Gebre Mariam S (1999) Banana production and utilization in Ethiopia. Research Report No. 35. Ethiopian Agricultural Research Organization, Ethiopia, 48 pp

Gold CS, Night G, Abera A, Speijer PR (1998) Hot-water treatment for control of banana weevil, *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) in Uganda. *African Entomology* **6**, 215-221

Karamura E, Kayobyo G, Blomme G, Benin S, Eden-Green SJ, Markham R (2006) Impacts of BXW epidemic on the livelihoods of rural communities in Uganda. In: *Proceedings of the 4th International Bacterial Wilt Symposium*, 17-20 July 2006, Central Science Laboratory, York, UK, 57 pp

Manners JG (1993) *Principles of Plant Pathology* (2nd Edn), Cambridge University Press, 343 pp

Mgenzi SRB, Eden-Green SJ, Peacock JJ (2006) Overview of banana Xanthomonas wilt in Tanzania. In: *The 4th International Bacterial Wilt Symposium. Programme and Abstracts Book*, 17-20 July 2006, Central Science Laboratory, York, UK, p 107

Mwebaze JM, Tushme G, Tushemereirwe W, Kubiriba J (2006) The survival

of *Xanthomonas campestris pv musacearum* in soil and plant debris. *African Crop Science Journal* **14 (2)**, 121-127

Mwangi M, Bandyopadhyay R, Ragama P, Tushemereirwe WK (2007) Assessment of banana planting practices and cultivar tolerance in relation to management of soilborne *Xanthomonas campestris* pv. *musacearum. Crop Protection* **26**, 1203-1208

Ndungo V, Eden-Green S, Blomme G, Crozier J, Smith JJ (2006) Presence of banana Xanthomonas wilt (*Xanthomonas campestris* pv. *musacearum*) in the Democratic Republic of Congo (DRC). *Plant Pathology* **55 (2)**, 294-294

Sarah LJ, Pinochet J, Stanton J (1996) The burrowing nematodes of bananas, *Radopholus similis*, Cobbe 1913. *Musa Pest Fact Sheet No 1*, INIBAP, 2 pp

Shimelash D (2006) Importance of spread of bacterial wilt of banana by insect vectors in southwest Ethiopia. Msc thesis, Awassa Agricultural Collage, Hawassa University. 2006, 73 pp

SPSS 12.0 (2003) SPSS 12.0 for windows. Release 12.0.0 (4 Sep 2003). ©SPSS Inc., 1989-2003

Tumushabe A, Ssekiwoko F, Tushemereirwe WK (2006) Potential of infected banana parts to transmit *Xanthomonas campestris* pv *musacearum. African Crop Science Journal* **14 (2)**, 137-142

Tushemereirwe W, Kangire A, Smith JJ, Ssekiwoko F, Nakyanzi M, Kataama D, Musiitwa C, Karyaija R (2003) An outbreak of bacterial wilt on banana in Uganda. *InfoMusa* **12 (2)**, 6-8

Welde-Michael G, Bobosha K, Addis T, Blomme G, Mekonnen S, Mengesha T (2008) Mechanical transmission and survival of bacterial wilt on enset. *African Crop Science Journal* **16 (1)**, 97-102

Yirgou D, Bradbury JF (1968) Bacterial wilt of enset (*Ensete ventricosum*) incited by *Xanthomonas* species. *Phytopathology* **58**, 111-112

Yirgou D, Bradbury JF (1974) A note on wilt of banana caused by the enset wilt organism *Xanthomonas campestris* pv. *musacearum*. *East African Agricultural and Forestry Journal* **40 (1)**, 111-114