Arbuscular Mycorrhizal Fungi (AMF) in the rhizosphere of bananas systems and growth of tissue culture bananas

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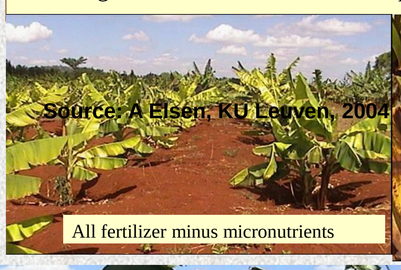
TSBF

Introduction

Bananas and plantain constitute a major staple food crop for millions of people in developing countries of the tropics. They are grown over approximately 10 million hectares, with an annual production of around 100 million metric tons. They are of major importance to food security as well as providing a valued source of income through local and international trade. They are the fourth most important global food crop. In Kenya (2003), 3355ha of land was under banana with estimate production of 38,040tons with market value of US $ 4,322,727. In Uganda, Burundi and Rwanda, per capita consumption has been estimated at over 200 kg per year, the highest in the world. Banana and plantain face major production constraints.



All fertilizer minus micronutrients

All fertilizer minus K

TC banana in a nutrient omission trial in Kenya manifesting nutrient deficiency in low fertility soils (TSBF Trial) and below a farm infested by *Fusarium* Wilt disease

All fertilizer minus P

All fertilizer

Fusarium wilt disease

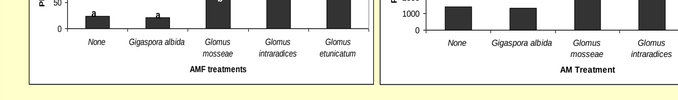
Interventions

- Tissue culture (TC) bananas are the most preferred planting material. They are disease free and homogenous and are produced in bulk
- There are challenges in survival and establishment of TC plants particularly in soil production constraints
- Use of rhizosphere organisms has great potential to alleviate or minimize these constraints.
- Banana is highly dependent on Mycorrhizae for its growth.
- The Arbuscular Mycorrhizal fungi (AMF), root endophyte can enhance survival and establishment of TC plants under the banana production constraints.

Photograph: Coyne, 2004

Tissue culture banana plantlet devoid of corm and few root systems. AMF increase the root surface area and explores fro nutrients beyond the nutrient depletion zone

Not all AMF species are effective on banana growth. A greenhouse trial by CIAT-TSBF clearly indicated the importance of the symbiosis on growth and nutrient uptake . AMF Inoculation trial with commercial exotic species showed three *Glomus* species to be colonize and enhance growth and nutrient concentration and *Gigaspora albida* to completely fail to colonize banana and no effect on growth. In the absence of AMF, growth and nutrient uptake of banana plantlets was poor even when nourished with Hewitt nutrient solution



Tissue culture banana plantlets nourished with Hewitt nutrient solution with and without AMF at 18 weeks after planting.

Effect of AMF inoculation with on shoot dry weight, leaf surface area and plant height at 18 weeks after plantings

AMF and nutrient uptake (CIAT-TSBF)

Greenhouse inoculation of TC banana with AMF enhanced nutrient concentration. This was evident with the three *Glomus* species and not *Gigaspora albida*

AMF and control of pests (Nematodes) and diseases

Annemie Elsen KU Leuven 2004

There is potential to utilize Indigenous AMF since they naturally associate with bananas and plantains. Below are some of the AMF species associated with Musa spp.

Scutellospora sp

Acaulospora sp.

Scutellospora sp

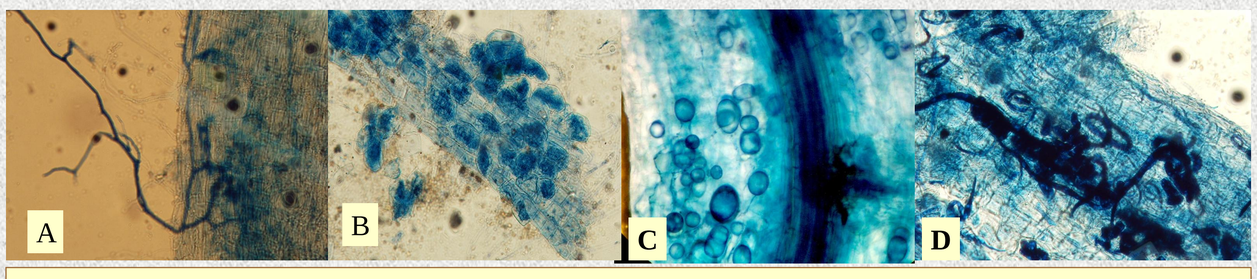
Glomus ap.

Five *Glomus* species

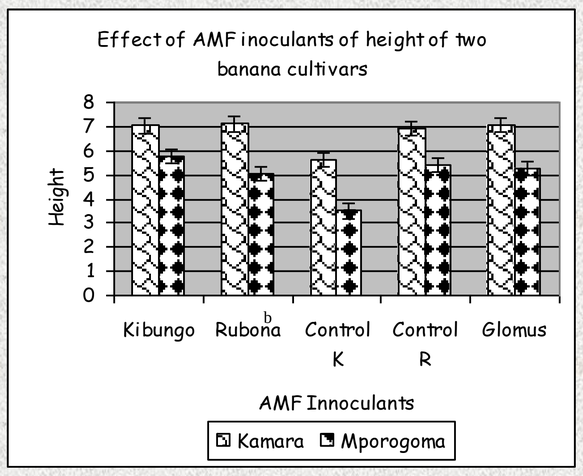
AMF species associated with banana cultivars on the table below

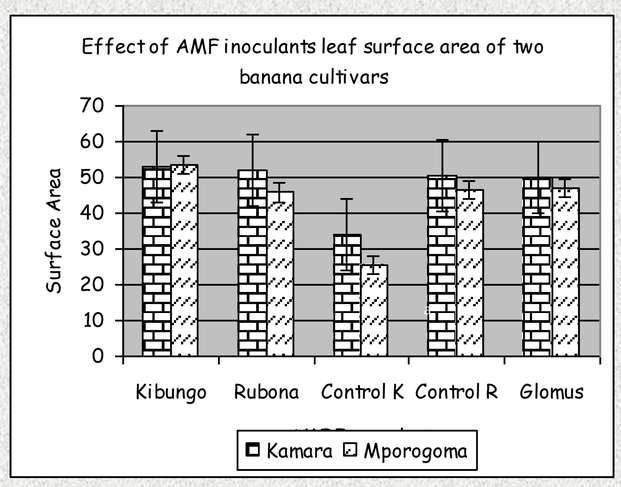
Banana cultivars	No. of bananas sampled	Mean spore abundance	Most abundant AMF species	No. of AMF species
Cavendish	84	5.167±0.93	*A. scrobiculata*	16
Chinese	2	0	0	0
Grand naine	4	3±1.915	*A .scrobicuata*	2
Valery	94	6.904±2.08	*A .scrobiculata*	17
Williams	14	9.29±4.57	*Glomus* straw	11
Gros mitchel	85	6.941±2.732	*Glomus* rusty (m)	15
Lactan	3	1.667±1.667	*A. scrobiculata*	2
Sweet banana	2	20.50±17.50	*Acaulospora* fulv	5
Gichagara	1	0	0	0
Githumo	14	2.143±1.06	*Glomus* ivory	6
Kibutu	3	1.33±1.33	*A .scrobiculata*	4
Kiganda	2	6.5±1.5	*Acaulospora* hyalin	
Mugithi	0	0	0	0
Muraru	36	0.472±0.216	*A. scrobiculata*	5
Muhato	0	0	0	0
Nyauve	0	0	0	0
Nyoro	0	0	0	0
Uganda red	2	0.50±0.5	*Acaulospora* fulv	1

AMF naturally associate with bananas and plantains. AMF Colonization (A) Entry point (B) Arbuscules (C.) Vesicles (D) Nematode infestation

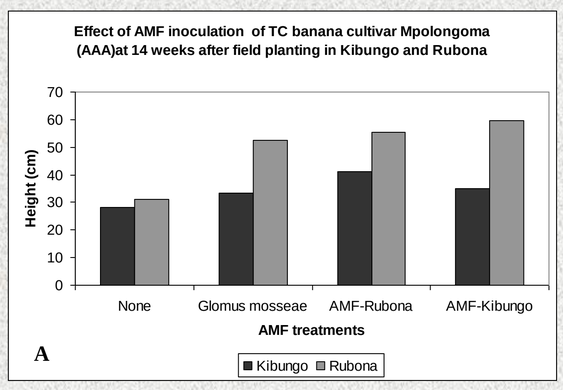


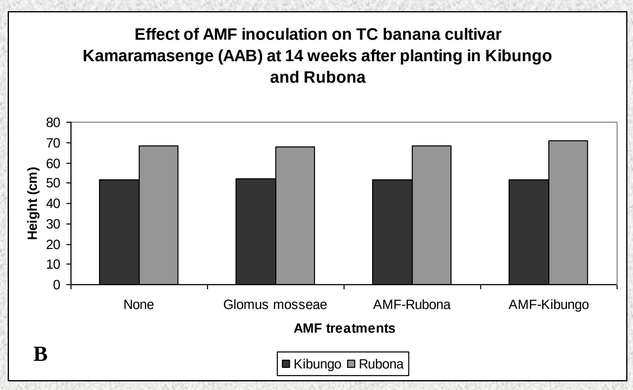
Although commercial inoculum is available, there are challenges on the effectiveness of the exotic AMF species in new environmental conditions. Mixed AMF inoculum was prepared from Indigenous AMF species isolated from banana plantations in two banana growing regions, Kibungo and Rubona, in Rwanda. Two banana cultivars (AAA -Mporogoma (and AAB-Kamaramasenge (Kamara)) were evaluated for AMF dependence in soils from the two regions in Rwanda (Kibungo and Rubona). Two mixed inoculants, AMF Kibungo and AMF Rubona were derived from the two region Kibungo and Rubona respectively and single species inoculum was derived from Rwanda and prepared in KU Louvain Belgium. All the three AMF inoculants enhanced growth with the mixed inoculants performing better than the single species inoculum.





The banana plantlets were transferred to natural field conditions at 12 weeks after potting to the two sites (Kibungo and Rubona) and evaluated for growth (See Figures below). Mporogoma (AAA) was more responsive to inoculation than Kamaramasenge (AAB) (Fig A & B). Soils from Reubona were more receptive to inoculation than Kibungo (Fig A).





Banana plants inoculated with Indigenous AMF in Rubona at four months after field establishment

Conclusion

Bananas naturally associate with AMF and cultivars show preference for specific AMF species. There is clear evidence of dependence with growth and nutrient uptake entirely regulated by AMF under greenhouse conditions. Tissue culture bananas failed to take nutrients even when supplied with nutrients. There was significant evidence of preference with one species, Gigaspora albida completely failing to colonize banana. Banana respond to both commercial and Indigenous AMF inoculants though highly dependent on soil conditions.

Since indigenous AMF species were effective, there is need to screen AMF species for their functions (Nutrient uptake and control of pests and diseases) and also establish practices that would manipulate conditions that promote or enhance these beneficial organisms.

Organizations: The authors acknowledge Rockefeller Foundation