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Fusarium wilt race 1 on the Silk 'Sotoumon' banana variety in Benin: distribution, impact on small farmers and agroecological management approaches

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- The Sotoumon variety, sweet banana, also called ("Figue pomme" in French) is a small banana with sweet flesh that is both sweet and tangy.
- The yellow skin of this short banana splits when ripe.



Sotoumon plants



Sotoumon bunch





□ The Sotoumon is rich in minerals and trace elements: potassium, iron, copper, and is a good source of group B vitamins.

□ Its flesh and skin provide various antioxidant phenolic compounds: flavonoids and carotenoids, as well as an interesting quantity of fibers.

□ This variety of bananas is highly appreciated by people in the country and is produced by all banana farmers.



□ It is sold and often very expensive during the stock-out period in many local markets.



- Despite its economic importance, Sotoumon is heavily attacked by race 1 *Fusarium*, affecting therefore its productivity.
- □ The destruction of infested banana plants is a huge loss for banana farmers, especially since it is a variety in high demand by consumers.
- The economic impact of the damage of this disease on banana variety is enormous, but no study has been carried out on its distribution in the major production areas.





Infested Sotoumon banana plants





As management strategies for this disease, the use of host plant varietal resistance, agricultural practices and soil amendments could be investigated.

□Soil amendments that improve host plant resistance to *Foc* have been widely demonstrated (Thangavelu & Mustaffa, 2012; Ghag et al. 2015;).

□ Compost based on weeds is an agroecological alternative for managing soil fertility and also crop pests (weeds, bacteria, pathogenic fungi and insects, etc.) due to their allelopathic effects (Wato, 2020; Nawaz et al., 2020; Kumar et al., 2021).









Allelopathy

ANGERS - FRANCE



Objectives

To understand the distribution and damage of *Fusarium* oxysporum f. sp. cubense race 1 and their impact on the income of small farmers to develop organic fertilization methods and to increase the tolerance of varieties to this disease





First step of the study: survey

□ This study was carried out in the Department of Atlantique, which is one of the largest area in term of banana production.

It is located in the south of the Republic of BeninLocalities of Allada, Toffo and Tori-Bossito

- The criteria of selection were the relative importance of Sotoumon banana production, ethnic diversity
- 03 villages per locality
- 30 farmers per village





□ To collect data from the banana farmers on:

- Sotoumon banana plant damaged by *Fusarium* wilt in each farmer's banana plantation
- The number of plants damaged and the symptoms
- Isolation of *Fusarium* from Sotoumon plants at the lab
- The agricultural practices
- The causes of the disease dispersion
- The current solutions against the disease
- The yields and the income in the case of the damage and not.





Second step of the study: experiment in the greenhouse

- Effet of different doses of Chromolena-based compost on the tolerance of Sotoumon plants to *Fusarium*:
- The soil was sterilized
- 2 doses (20% and 40%) of Chromolena-based compost
- Manures
- Sotoumon plants were produced by the macropropagation technique (PIF)
- 3 treatments with 60 Sotoumon plants
- Total of 180 plants for the experiment
- Inoculation of *Fusarium* to the 180 plants
- Measures of symptoms
- PCR to determine the evolution of *Fusarium* in the plants



Statistical analyses

- Descriptive statistics were used to describe the farmer's responses
- □ The *Fusarium* wilt distribution
- □ Prevalence incidence by village.
- To describe the yields and incomes per uninfected or infected plant
- □ The loss of yield and income per plant in case of *Fusarium* wilt attack.
- □ The evolution of *Fusarium* across the different doses of Chromolena-based compost and also the manures
- □ Software R version 4.2





Fusarium wilt frequency distribution according to the villages surveyed

 All the fields (100%) containing the Sotoumon banana plants visited in the villages of Gankpétin, Hounkpa and Tori-Zèbè were infected with *Fusarium wilt*.

Frequency of Sotoumon banana plantations infected by Fusarium wilt







Incidence of Fusarium wilt on the Sotoumon banana

- The incidence of *Fusarium wilt* was highest in the village of Tori-Zèbè (50.83%) and lowest in the village of Akpè.
- All the observed infested plants showed yellowing and wilting of the leaves, generally evolving from the oldest leaves to the youngest.

Village	Plant number	Damaged plant number	Incidence (%)	
Tori-Zèbè	120	61	50.83	
Hounkpa	261	115	44.06	
Gankpétin	448	175	39.06	
Agbo Tagon	648	250	38.58	
Attogon	89	24	26.97	
Agbanou	188	44	23.4	
Akpè	1992	385	19.33	





Effect of agricultural practices and intensity of tree shade on the infestation rate of Sotoumon bananas

- □ The agricultural practices did not have a significant effect on the infestation rate
- \Box Except only the crop associations which negatively influenced the rate of infestation of the plants (p value = 0.0255).

Environmental factors	Estimate	Std. Error	t.value	Pr (> t)
and agricultural				
practices				
(Intercept)	-1.1403	0.2492	-4.576	< 0.0001
Plantation	0.0080	0.0137	0.585	0.5599
Use of chemical	0.1307	0.4992	0.262	0.7940
fertilizers				
Use of organic pesticides	1.2745	0.6834	1.865	0.0655
Use of chemical pesticides	-1.0721	0.6354	-1.687	0.0950
Crop association	-0.3462	0.2962	-1.169	0.0255
Under trees	-0.1030	0.4036	-0.255	0.7991
Shade	-0.4407	1.2451	-0.354	0.7242





□ Sotoumon banana yield per plant and loss in the case of plant attack by Fusarium wilt

- The yield estimated by the farmers varied from 5 to 20 kg in the absence of *Fusarium* infestation with an average of 10.81 kg.
- In case of infestation, this yield decreased varying from 0 to 12 kg with an average of 2.12 kg and a loss of an average of 8.69 kg.

Variable	Mean ± SE	CV (%)	Min	Medium	Max
Yield of uninfected plants (kg)	10.81 ± 0.31	31.90	5	10	20
Yield of infected plants (kg)	2.12 ± 0.27	139.26	0	0	12
Loss of brut yield (kg)	8.69 ± 0.27	34.42	0	8.50	20





Sotoumon banana income and loss in the case of plant infestation by *Fusarium wilt*

- The income per Sotoumon banana plant at each harvest estimated by the farmers varied from 550 to 4000 FCFA in the absence of *Fusarium wilt* infestation with an average of 1610 FCFA.
- In case of infestation, this yield decreased and varied from 0 to 1000 FCFA with an average of about 185 FCFA and an average loss of about 1420 FCFA.

Variable	Mean ± SE	CV (%)	Min	Median	Max
Income in absence of fusariose (FCFA)	1606.3 ± 59.4	40.48	550	1500	4000
Income in case of fusariose (FCFA)	186.3 ± 26.8	157.84	0	0	1000
Loss of income in case of fusariose (FCFA)	1420.0 ± 53.3	41.15	550	1250	3500





Causes of banana plant infestation by *Fusarium wilt*

- Among the 16 causes identified, the use of infected suckers and the use of infected soil were those most mentioned by farmers with respective relative frequencies of 60% and 44.17%.
- The other causes according to some farmers were:
- drought (10%),
- poor soil (9.17%),
- dispersion of *Fusarium* by the wind (8.33%),
- transport of seedlings (5.83%),
- the use of other releases (5.83%),
- poor weed management (4.17%),
- dispersion of *Fusarium* after flooding (3.33%),
- high plant age (2.50%),
- spiritual (2.50%),
- insects (2.50%),
- leaf destruction by sheep (1.67%)
- and the heat of dead leaves (0.83%).



Second step: Data collection is still underway.

- The first observations showed that the Sotoumon plants that grow on chromolena-based composts have few *Fusarium wilt* disease symptoms.
- □ We will confirm these results by PCR analyses





Discussion

- This development of Sotoumon plants showed that composts have improved the soil physico-chemical and biological properties (Bubici et al. 2019).
- □ This organic fertilizer enriched the soil with organic matter and nitrogen, particularly in forms assimilated by plants (Dias et al., 2010).





Discussion

- □ These results proved that a good quality compost based on different plant species can be used successfully in the biological control of diseases.
- □ Several biological mechanisms are based on the hypotheses of allelopathy and the development of antagonist fungal communities which would reduce the populations of *Fusarium*.









Thanks for your attention

















