



# Virulence and Diversity of *Fusarium oxysporum* f.sp. *cubense* Infecting Bananas in Tharaka Nithi County, Kenya

**Malaka Musime**<sup>1\*</sup>, Mwongera Thuranira<sup>2</sup>, Maina Mwangi<sup>1</sup>, Nchore Shem<sup>1</sup>, Lubabali Hudson<sup>2</sup>, Gathambiri Charity<sup>2</sup>

<sup>1</sup>Kenyatta University, School of Agriculture and Enterprise Development, Kenya <sup>2</sup> Kenya Agricultural and Livestock Research Organization, Kenya



## Introduction

- Bananas (*Musa* spp.) of the family Musaceae originated from southern Asia (Blomme *et al.*, 2017).
- Banana is among the important cash crops that boost the economy and sustain people's lives and is 3<sup>rd</sup> largest starchy staple crop after cassava and sweat potato (Ferdowsi, 2010).
- Provides carbohydrates, starch, sugar, vitamins (A, B6, C, D and E).
- Ecological and cultural importance, e.g. Reduces rain and wind erosion, mulch, fodder, and used in various cultural rites.
- Kenya produces 1.4 million tons of bananas per year
- Main varieties grown in Kenya are dessert: Gros Michel (Kampala), Giant Cavendish, Apple, Grand Nain, FHIA (Wahome *et al.*, 2021).
- Pests and diseases cause about 90% losses.
- The crop is affected by several pests and diseases with the most lethal disease being Panama disease caused by *Fusarium oxysporum* f.sp. *cubense* which was first reported in Australia in 1876 (Jones 2018).
- This study was conducted in Tharaka Nithi County to isolate and determine the virulence of different *Fusarium oxysporum* f.sp. *cubense* isolates.

## Problem statement

- Production of bananas in Tharaka Nithi county in Kenya is constrained by deteriorated soil fertility, pests and diseases.
- Panama disease caused by *Fusarium oxysporum* f.sp. *cubense* which is more challenging to control.
- *Fusarium* wilt of banana incidence can reach >80% especially in areas where Gros Michel is dominant in Eastern and Central parts of Kenya (Njau *et al.*, 2010).
- They cause serious damage to banana impacting both the quantity and quality of marketable fruits.
- Most farmers in Tharaka Nithi county in Kenya lack knowledge on the spread and control of FOC and therefore play a key role in the spread of the disease via planting materials and farm implements.
- *Fusarium oxysporum* f.sp. *cubense* is invasive since it is distributed from one location to another. The disease can spread within plantations in runoff water, feet of animals in banana farms as well as shoes of banana workers in the farm.

### OBJECTIVE

- To assess the pathogenicity of 24 Foc isolated from 5 banana varieties; Gros Michel, Giant Cavendish, Apple banana, Grand Nain, and FHIA.

## Materials and methods



Plate. A: External symptoms on bananas infected with FOC

Plate. B: Internal symptoms on banana infected with FOC

Plate. C: Morphology of FOC spores

### Study area

Samples were collected from Tharaka Nithi County in Eastern Kenya. The laboratory experiments were done at the Kenya Agricultural and Livestock Research Organization-Horticulture Institute Mycology laboratory. The greenhouse experiments were done at the Kenya Agricultural and Livestock Research Organization - Coffee Research Institute. Tissue cultured bananas were obtained from The Coffee Research Institute tissue culture laboratory.

### Sample collection

The root samples were collected from the symptomatic banana plants. A total of 57 root samples were collected. A total of 24 Foc isolates were obtained using Potato Dextrose Agar.

### Conidia harvesting and adjustment

Conidia were harvested from 14 days old *Fusarium* cultures on PDA media and the spore density adjusted to 10<sup>-7</sup> cfu/mL using a hemocytometer. The pathogenicity test was carried out according to Dita & Martinez (2014). The pathogenicity test was done using the root dipping method.

Disease severity on external and internal plant symptoms was recorded every week for a period of 20 weeks following the disease scale as described by Dita & Martinez (2014). Data on plant root and shoot biomass was also recorded.

## Results and Discussion

Table 1: Effect on Plant biomass

Fusarium Isolate	Root biomass	Shoot biomass
CONTROL	31.73 a	99.08 a
AP005	30.55 a	96.53 a
AP001	29.43 ab	95.83 a
AP008	28.30 abc	70.55 b
AP003	28.30 abc	69.98 b
UK001	27.70 abcd	68.40 bc
FH001	25.80 abcde	68.20 bc
CV002	25.76 abcde	68.05 bc
GN001	25.67 abcde	66.10 bcde
AP004	25.58 abcde	67.83 bc
CV006	25.43 abcde	66.55 bcd
AP012	20.78 bcdef	65.88 bcde
KL001	20.75 bcdef	65.70 bcde
AP010	20.20 bcdef	62.40 bcdef
AP011	20.05 bcdef	60.55 bcdef
AP002	19.75 bcdef	60.48 bcdef
CV004	19.20 bcdef	57.45 bcdef
CV001	18.80 cdef	56.58 bcdef
AP006	17.45 cdef	54.38 cdef
EM001	17.13 def	52.90 defg
AP007	16.45 ef	52.65 defg
KL004	15.48 ef	51.60 efg
KL002	14.60 ef	50.14 fg
CV005	14.58 ef	40.17 gh
AP009	12.73 f	35.38 hi
LSD (P=0.05)	8.97	13.37
CV%	47.47%	37.88

Table 2: Effect on external symptoms

Isolate	External symptoms				
	84 DAYS	98 days	112 days	126 days	140 days
AP009	2.25 a	2.50 a	2.75 a	3.00 a	4.25 a
CV005	2.25 a	2.50 a	2.50 a	2.75 a	4.00 ab
KL002	2.25 a	2.50 a	2.50 a	2.75 a	4.00 ab
KL004	2.00 a	2.25 a	2.50 a	2.75 a	3.5 abc
AP007	2.00 a	2.25 a	2.25 a	2.50 a	3.5 abc
EM001	2.00 a	2.25 a	2.25 a	2.50 a	3.00 abc
AP006	2.00 a	2.25 a	2.25 a	2.50 a	3.00 abc
CV001	2.00 a	2.25 a	2.25 a	2.50 a	3.00 abc
CV004	2.00 a	2.25 a	2.25 a	2.50 a	2.75 abc
AP002	2.00 a	2.00a	2.25 a	2.25 a	2.75 abc
AP011	2.00 a	2.00a	2.25 a	2.25 a	2.5 bcd
AP010	2.00 a	2.00a	2.00a	2.25 a	2.5 bcd
KL001	2.00 a	2.00a	2.00a	2.25 a	2.25 cd
AP012	2.00 a	2.00a	2.00a	2.25 a	2.25 cd
CV006	2.00 a	2.00a	2.00a	2.25 a	2.25 cd
AP004	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
GN001	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
CV002	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
AP001	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
UK001	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
AP003	2.00 a	2.00a	2.00a	2.00ab	2.00 cd
AP008	1.75 a	2.00a	2.00a	2.00ab	2.00 cd
FH001	1.75 a	2.00a	2.00a	2.00ab	2.00 cd
AP005	1.75 a	2.00a	2.00a	2.00ab	2.00 cd
CONTROL	1.00 b	1.00 b	1.00 b	1.00 c	1.00 d
LSD (P=0.05)	0.34	0.43	0.48	0.63	0.95
CV%	12.16	14.75	16.16	20.03	26.5



Acknowledgements: KALRO HRI NRF  
Banana project, KALRO CRI and KU



### Conclusion

- ❖ External Panama disease symptoms start appearing after two months of pathogen inoculation in a healthy plant (Pegg et al., 2019).
- ❖ Isolates AP009, CV005, KL002, KL004, AP007, EM001, AP006, CV001, CV004, AP002, AP011, AP010, KL001and AP012 were more virulent compared to the other isolates. Agrees with Alghuthaymi et al. (2020).
- ❖ Virulence did not depend on the variety isolate was recovered from.
- ❖ Panama disease significantly reduced plant biomass (Segura-M. et al., 2021)
- ❖ All the Foc isolates were pathogenic to the cv. Gros Michel (Kampala)
- ❖ Foc is clearly a major challenge to banana farmers in Tharaka Nithi county attacking at least five different cultivars preferred by farmers.

### References

1. Alghuthaymi, M., Alshehri, W. A., Al-Maary, K. S., Bahkali, N. A., AlKahtani, M. D., Alarfaj, A. A., ... & Ameen, F. (2020). Mycotoxigenicity of *Fusarium* isolated from banana fruits: Combining phytopathological assays with toxin concentrations. *Journal of King Saud University-Science*, 32(2), 1482-1485.
2. Blomme, G., Dita, M., Jacobsen, K. S., Pérez Vicente, L., Molina, A., Ocimati, W., ... & Prior, P. (2017). Bacterial diseases of bananas and onset: current state of knowledge and integrated approaches toward sustainable management. *Frontiers in plant science*, 8, 1290.
3. Dita, M.A. & Martinez E. (2014). Technical Manual Prevention and diagnostic of Fusarium Wilt (Panama disease) of banana caused by *Fusarium oxysporum* f. sp. *cubense* Tropical Race 4 (TR4. FAO, 74.
4. Ferdowsi, M. A. (2010). UNCTAD-United Nations Conference On Trade And Development. In *A Concise Encyclopedia of the United Nations* (pp. 698-705). Brill Nijhoff.
5. Pegg, K. G., Coates, L. M., O'Neill, W. T., & Turner, D. W. (2019). The epidemiology of Fusarium wilt of banana. *Frontiers in plant science*, 10, 1395.
6. Segura-Mena, R. A., Stoorvogel, J. J., Garcia-Bastidas, F., Salacinas-Niez, M., Kema, G. H. J., & Sandoval, J. A. (2021). Evaluating the potential of soil management to reduce the effect of *Fusarium oxysporum* f. sp. *cubense* in banana (*Musa* AAA). *European Journal of Plant Pathology*, 160(2), 441-455.