

Trials of FHIA Banana Varieties for Resistance to Black Leaf Streak in Pohnpei FSM



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ADAP





Contents of presentation

- ➔ 1. Introduction and objectives
- 2. Banana hybrids, varieties, and reference clones evaluated
- 3. Experimental design and data collection
- 4. Results and conclusions
- 5. Acknowledgements

The International Musa Testing Program

(IMTP) is a collaborative effort coordinated by Bioversity International to evaluate, elite *Musa* varieties in various locations around the world.

The bananas were produced by breeding programs, as well as promising germplasm from the International Musa Germplasm Collection in Leuven, Belgium.

IMTP Objective: to identify banana and plantain hybrids that are resistant to the main pests and diseases that affect banana production, and also meet local preference requirements.


Our involvement and funding. We at UH-CTAHR and in Pohnpei (COM-FSM) became involved in the IMTP project via funding provided by the ADAP project (Agricultural Development in the American Pacific) starting about the year 2000.

Our experiments. By 2001, we had two, replicated banana variety experiments, including some FHIA bananas, planted in Pohnpei and we had begun data collection.

Objective. Our objective was to examine the performance and disease resistance of the varieties under Pohnpeian conditions, and determine their level of acceptance to the Pohnpeian palate (taste).

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Banana varieties chosen for our trials

- Reference clones¹

Akadahn

Grand Naine²

Utin Menihle

Yangambi Km 5²

- FHIA varieties³

FHIA-01 ('Goldfinger')

FHIA-02 ('Mona Lisa')

FHIA-03 ('Sweetheart')

FHIA-17

FHIA-18

FHIA-23

¹From Pohnpei COM-FSM (suckers);
Known BLS reactions for comparison

²From tissue culture (RGC-SPC)

³The Regional Germplasm Center (RGC)
of the Secretariat of the Pacific Community
(SPC), Suva, Fiji (tissue culture)

FHIA bananas - Fundacion Hondurena de Investigacion Agricola

Hybrid	Genome	Qualities*	Uses
FHIA-01	AAAB	Highly resistant to BLS; resistant to Race 1 FW; tolerant to BN; Resistant to CR; tolerant to drought; tolerant to cold temperature; female parent is 'Dwarf Brazilian'	Pome-type, apple flavor dessert banana; also green cooking
FHIA-02	AAAA	Highly resistant to BLS; resistant to CR	Sweet, similar to Cavendish
FHIA-03	AABB	Resistant to BLS; resistant to Race 1 FW; drought resistant; highly vigorous; semi-dwarf; tolerant to marginal conditions; one parent is 'Bluggoe'	Cooking banana, also for dessert
FHIA-17	AAAA	Resistant to Race 1 FW	Dessert banana Can be cooked
FHIA-18	AAAB	Resistant to BLS; long shelf life; few skin blemishes	Sweet acid (apple flavor) dessert banana
FHIA-23	AAAA	Tolerant to BLS; one parent is 'Highgate' (a 'Dwarf Bluefields')	Dessert

*BLS = Black Leaf Streak; BN = Burrowing Nematode; CR = Crown Rot; FW = Fusarium Wilt

FHIA-01 'Goldfinger' (AAAB)

Dessert and cooking banana



FHIA-02 (AAAA)

Dessert banana



FHIA-03 (AABB)

Dessert/cooking banana



FHIA-17 (AAAA)

Dessert banana



FHIA-18 (AAAB)

Dessert/Cooking banana



Reference clones

Variety	Genome	Qualities*	Uses
Akadahn (Pohnpei variety)	AAA Red/Green-red subgroup	Susceptible to BLS; drought tolerant; resistant to BN	Dessert High in carotenoids
Grand Naine	AAA Cavendish subgroup	Susceptible to BLS; grows well at high elevations in Hawaii	Dessert
Utin Menihle	AAB Silk/Manzano/ Amorosa/ “true apple”/Silk Fig	Susceptible to BLS; very susceptible to FW and CW	Dessert
Yangambi Km 5	AAA Ibota subgroup	Highly resistant to BLS; resistant to BN and CW	Dessert or cooking

*BLS = Black Leaf Streak; BN = Burrowing Nematode; CR = Crown Rot; FW = Fusarium Wilt; CW = Corn Weevils

Yangambi Km 5 (AAA)

Dessert banana



Yangambi

Grand Naine (AAA)

Dessert banana



Akadahn (AAA) Red-green/red subgroup- Dessert banana




Utin Menihle (AAB) Silk/Manzano

Dessert banana



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Location - Pohnpei



6 55 N, 158 15 E

Federated States of Micronesia

Site 1: COM-FSM AES Farm Site in **Palikir**
(Disease monitoring began November 2001 until February 2005)



Site 2: State Agricultural Site in **Pohnlangas**, Madolenihwm (Disease monitoring began in December 2001 until February 2005)

Experimental design

- Two locations
- Randomized complete block (4 blocks)
- 10 varieties
- 5 plants per experimental unit (plot)

Border plants: BLS-susceptible variety was planted around field and between blocks in the field, to promote disease development and to provide some wind protection.

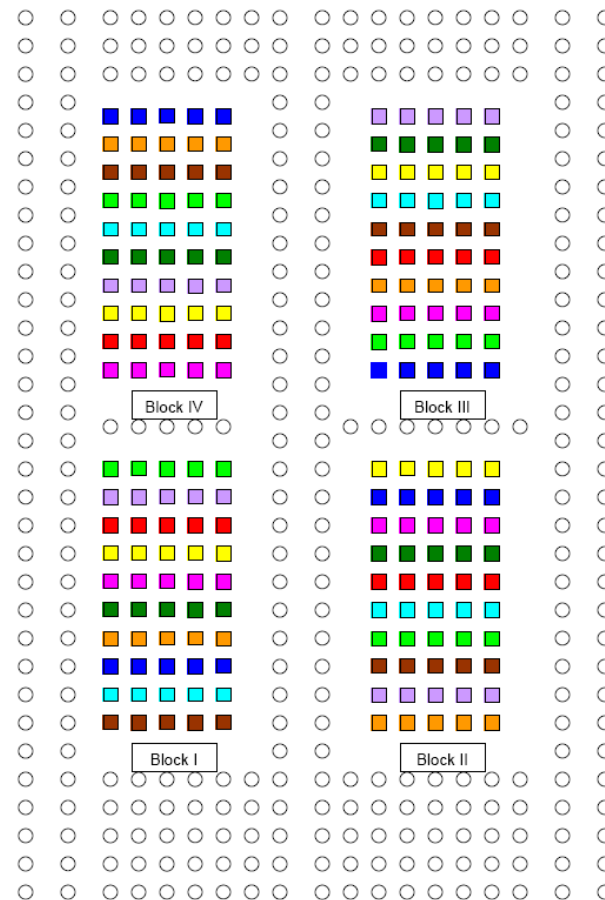
Outer border plants: Utin Ruk (ABB/BBB, 'Saba')
(surrounded field)

Inner border plants: Utin Menihle and the Akadah
(between experimental blocks)

SITE # 1

Palikir

BLOCK	I	II	III	IV
ROW	Variety			
1	G Naine	FHIA-01	FHIA-03	Yangambi
2	Menihle	FHIA-18	FHIA-02	FHIA-17
3	FHIA-03	G Naine	Yangambi	Akadahn
4	FHIA-01	FHIA-02	FHIA-01	FHIA-18
5	FHIA-23	Menihle	FHIA-17	FHIA-23
6	Yangambi	FHIA-17	G Naine	Menihle
7	Akadahn	FHIA-23	Menihle	FHIA-02
8	FHIA-17	Yangambi	Akadahn	G Naine
9	FHIA-18	FHIA-03	FHIA-23	FHIA-01
10	FHIA-02	Akadahn	FHIA-18	FHIA-03



Site #1

SITE # 2

Pohnlangas

BLOCK	I	II	III	IV
ROW	Variety			
1	Menihle	FHIA-23	FHIA-23	G Naine
2	Akadahn	FHIA-18	Yangambi	FHIA-23
3	G Naine	Akadahn	FHIA-17	Menihle
4	FHIA-17	Yangambi	FHIA-18	Akadahn
5	FHIA-02	FHIA-17	Akadahn	FHIA-18
6	FHIA-23	FHIA-01	FHIA-03	FHIA-17
7	FHIA-18	Menihle	G Naine	FHIA-01
8	FHIA-01	FHIA-03	FHIA-02	FHIA-02
9	FHIA-03	FHIA-02	FHIA-01	FHIA-03
10	Yangambi	G Naine	Menihle	Yangambi

Design: Randomized Complete Block

Blocks: 4

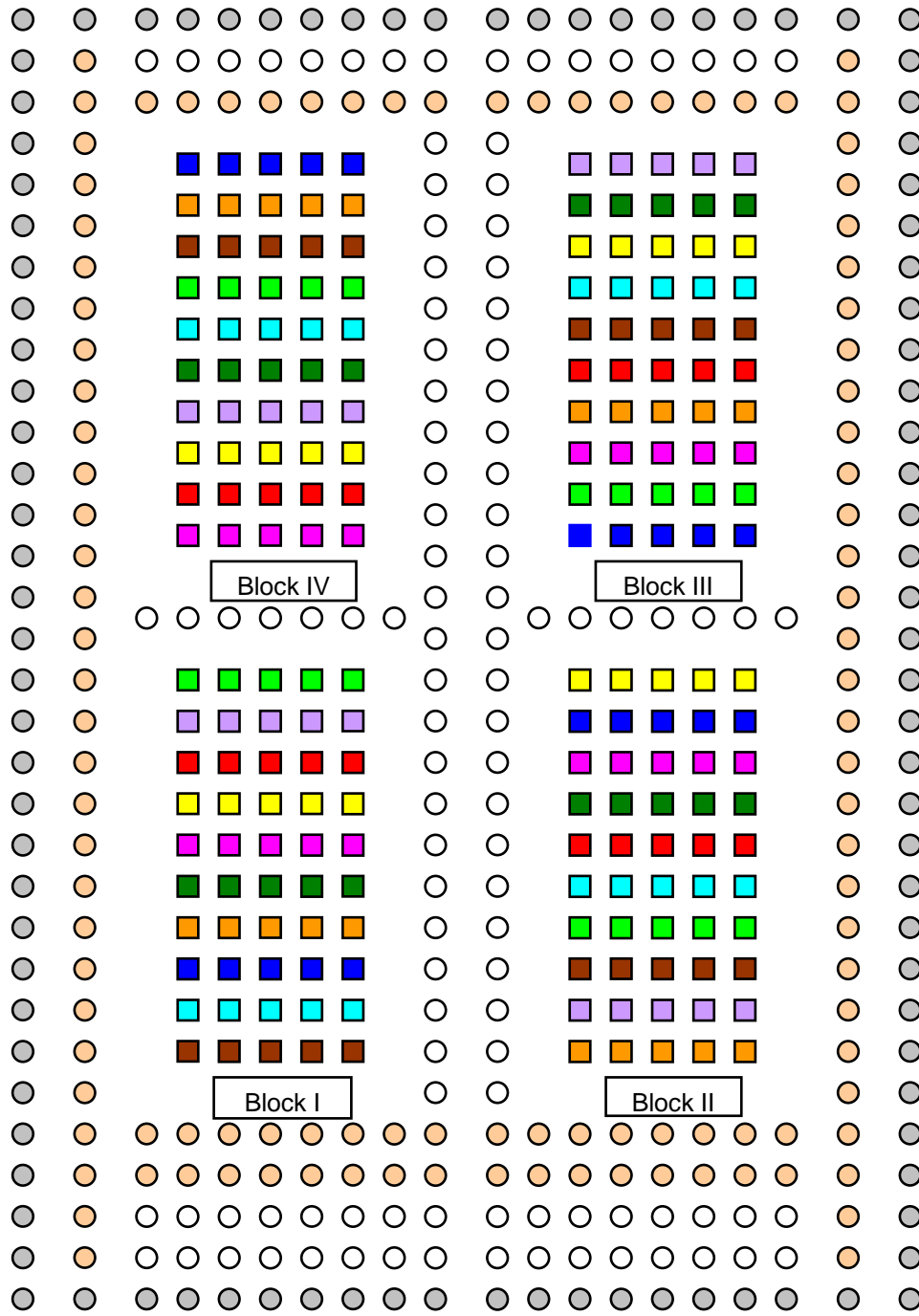
Varieties: 10

Plants per variety per block: 5











Border rows: Utin Ruk (outer)

Akadahn, Utin Menihle (inner)




Plot Layout Site 1: Palikir, Pohnpei



KEY to VARIETIES

- | | |
|---|---|
|  Akadahn |  FHIA-18 |
|  FHIA-01 |  FHIA-23 |
|  FHIA-02 |  Grand Naine |
|  FHIA-03 |  U. Menihle |
|  FHIA-17 |  Yangambi Km 5 |

BORDER PLANTS

- | |
|--|
|  Akadahn |
|  U. Menihle |
|  Utin Ruk |

Plants: 6-foot spacing
Rows: 7.5-foot spacing (968 mats/acre)

Data collection

Nov 2001 – Feb 2005

- **Black Leaf Streak disease severity*** (international rating scale, visual estimates)

Plant Height: at flowering and at harvest

Plant girth: at flowering and at harvest

Tallest suckers: at flowering and at harvest

Number of suckers: at flowering and at harvest

Number of functional leaves: at flowering and at harvest

Bunch weight*

Weight of hand 3 (or hand 4 if hand 3 was damaged)

Number of hands per bunch

Number of fingers per hand, weight of fingers

Number of days to flowering

Number of days to harvesting

Taste and acceptance*

* The **focus of today's presentation**, plus a calculated variable, "plant health index"

Disease - Black leaf streak

Pathogen – *Mycosphaerella fijiensis*



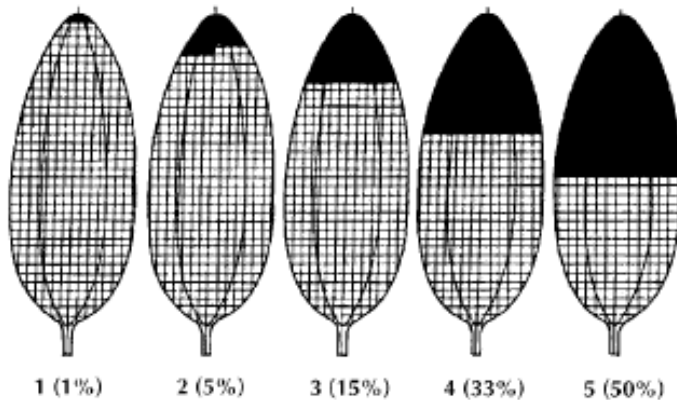
Spots, streaks and blighted leaf tissue



Beginning at 7 months after planting, each living leaf was rated monthly for disease severity based on a 1-6 rating scale.

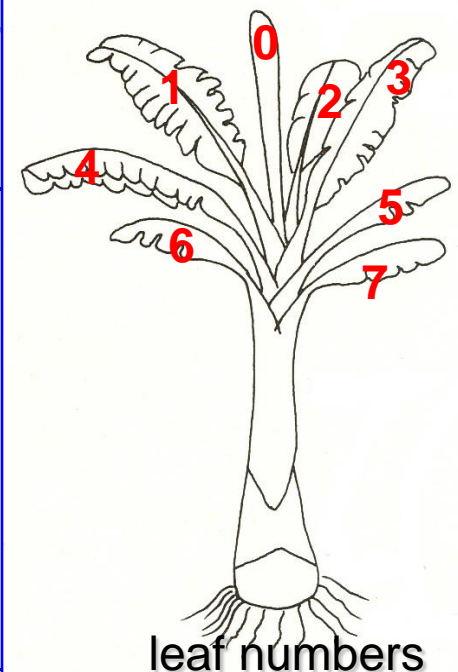
Disease assessment scale

- ⊕ Logarithmic, categorical scale (6 disease categories)
- ⊕ Visual estimate for each leaf
- ⊕ International rating system for black leaf streak (Sigatoka)
- ⊕ Banana leaves numbered from top of plant down



Key:

- + = youngest completely unfurled leaf
- 0 = no symptoms
- 1 = less than 1% of lamina with symptoms (only streaks and/or up to 10 spots)
- 2 = 1 to 5% of lamina with symptoms
- 3 = 6 to 15% of lamina with symptoms
- 4 = 16 to 33% of lamina with symptoms
- 5 = 34 to 50% of lamina with symptoms
- 6 = 51 to 100% of lamina with symptoms
- = missing leaf or dead leaf hanging down the pseudostem (when a leaf is missing or dead and hanging down the pseudostem, it should not be included in the infection index calculations).



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Comparison of banana varieties in the black leaf streak trial in Pohnpei for mean **disease severity (%)*** (Site 1, Palikir).

<u>Variety</u>	<u>Disease Severity (%)</u> *	<u>Duncan grouping</u>
Utin Menihle	25.77	A
Grand Naine	24.20	B
Akadahn	19.47	C
FHIA-17	17.88	D
FHIA-18	17.27	D
Yangambi Km 5	15.75	E
FHIA-23	15.16	EF
FHIA-02	14.72	EF
FHIA-01	13.99	F
FHIA-03	13.83	F

*mean disease severity per plant per rating date

Conclusions:

- FHIA-3 AND FHIA-1 had the least amount of disease.
- Utin Menihle had significantly more disease than all other varieties, with Grand Naine following close behind.
- In general, non-FHIA varieties had more disease than FHIA varieties, with the exception of the variety Yangambi Km 5.

Comparison of banana varieties in the black leaf streak trial in Pohnpei for mean **disease severity (%)*** (Site 2, Pohnlangas).

<u>Variety</u>	<u>Disease Severity (%)</u> *	<u>Duncan grouping</u>
Grand Naine	24.35	A
Utin Menihle	23.88	A
Akadahn	18.94	B
FHIA-02	16.09	C
FHIA-01	16.05	C
FHIA-18	15.78	C
Yangambi Km 5	15.39	C
FHIA-17	15.18	C
FHIA-03	14.59	CD
FHIA-23	13.59	D

*mean disease severity per plant per rating date

Conclusions:

- FHIA-23 had the least amount of disease, with FHIA-03 performing well.
- Grand Naine and Utin Menihle had significantly more disease than all other varieties.

Comparison of banana varieties in the black leaf streak trial in Pohnpei for mean **plant health index*** (Sites 1 & 2 combined).

<u>Variety</u>	<u>Plant health index*</u>	<u>Duncan grouping</u>
FHIA-01	1.67	A
FHIA-03	1.58	A
FHIA-02	1.48	AB
FHIA-18	1.35	BC
FHIA-23	1.2	CD
Yangambi Km 5	1.10	D
FHIA-17	1.01	D
Akadahn	0.61	E
Grand Naine	0.54	E
Utin Menihle	0.5	E

***plant health index** = (leaf number / disease severity). A high value means there are a relatively high number of leaves (a large numerator) with relatively low level of disease (a small denominator)

Conclusions:

- FHIA-01 and FHIA-02 had the greatest plant health index.
- Utin Menihle, Grand Naine and Akadahn had the lowest plant health index.
- Non-FHIA varieties had lower plant health index values than the FHIA varieties.

Comparison of banana varieties for mean **bunch weight*** (Sites 1 & 2 combined).

<u>Variety</u>	<u>Bunch weight*</u>	<u>Duncan grouping</u>
FHIA-03	36.4	A
FHIA-01	34.1	A
FHIA-18	27.6	BC
FHIA-17	27.4	BC
FHIA-23	26.7	BC
FHIA-02	23.7	CD
Yangambi Km 5	23.5	CD
Grand Naine	18.3	DE
Utin Menihle	16.3	DE
Akadahn	12.6	E

*bunch weight: expressed in pounds per bunch per plant

Conclusion: FHIA-01 and FHIA-03 had the best yield.

Summary of the Numerical Evaluation - Taste and Acceptability (Pohnpei)

<u>Variety</u>	<u>Taste*</u>	<u>Acceptability*</u>
FHIA-18	2.9	3.8
FHIA-02	3.0	3.6
FHIA-03	3.0	3.6
FHIA-23	3.0	3.7
Yangambi Km 5	3.0	4.4
Utin Menihle	3.0	4.2
FHIA-01	3.2	3.7
Grand Naine	3.2	3.1
FHIA-17	3.3	4.2
Akadahn	4.3	4.0

Legend:

- 5 – Excellent
- 4 - Very Good
- 3 – Good
- 2 – Fair
- 1 - Poor

* = average of all replications

CONCLUSIONS:

- ♦ The bananas that consistently performed well in Pohnpei for **disease resistance**, **plant growth** and **yield** were

 **FHIA-01 ('Goldfinger')** and **FHIA-03 ('Sweetheart')**

- ♦ FHIA-03 is both dessert and cooking type and Pohnpeians like the taste of the bananas.
- ♦ Pohnpeians also liked the taste of FHIA-17 and FHIA-23 but the performance of these bananas in our trial was poor.

Note: A full report from this experiment is in preparation.

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Thank you!

- Dr. **Singeru Singeo** and Mr. **Jim Hollyer** of ADAP (Agricultural Development in the American Pacific)
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- Dr. **Mary Taylor** and the **SPC** (South Pacific Commission)
INIBAP (International Network for the Improvement of Banana and Plantain/Bioversity International)
- Dr. **Angela Kay Kepler**, Mr. **Frank Rust**, and Dr. **Jeff Daniells** (photographs, variety information)

OUR OTHER BANANA WORK DURING THE PAST YEAR

★ Banana Pest & Disease Image Gallery

www.ctahr.hawaii.edu/nelsons/banana

37 pests and diseases

262 photographs

Links to more than 11 free banana publications and other sites

★ 2006 HBIA Conference Proceedings

www.ctahr.hawaii.edu/nelsons/HBIA

★ Two new publications:

(1) [Species Profile \(*Musa spp.*\)](#) (2006) S. C. Nelson, R. Ploetz, A. K. Kepler

<http://www.agroforestry.net/tti/Musa-banana-plantain.pdf>

(2) [Banana and Plantain – An Overview With and Emphasis on Pacific Island Cultivars](#) (2007) R. C. Ploetz, A. K. Kepler, J. Daniells, and S. C. Nelson

<http://www.traditionaltree.org/Banana-plantain-overview.pdf>

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Mahalo!