

# BANANA VARIETIES TESTED FOR SIGATOKA DISEASE RESISTANCE UNDER IRRIGATED CONDITIONS IN PAPUA NEW GUINEA

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## ABSTRACT

Fourteen introduced varieties of banana were tested for their resistance to Sigatoka disease and yield potential under irrigated conditions in the seasonally dry lowlands of Papua New Guinea. Varieties FHIA 02 and FHIA 18 showed extreme resistance to Sigatoka disease while the Australian common variety Williams was highly susceptible to the disease. FHIA 25 showed high resistance to the disease and produced the highest yield of 38 kg/bunch. Other good yielding varieties with high resistance to Sigatoka disease were FHIA 17 and SH 3436 with 20-21kg/bunch. The varieties most preferred by tasters as dessert bananas were SH 3436, Pisang Ceylan and Yangambi. Pisang Ceylan and Yangambi had bunch yields of 17kg and 13kg respectively and also showed high resistance to Sigatoka disease. The disease resistant varieties that are most preferred by the tasters will establish well in the country once introduced into farm production. These high yielding varieties will greatly boost banana production in the country and thus contribute to food security and income earning opportunities for the rural people.

**Keywords:** Banana, varieties, Sigatoka, resistance, susceptible, consumer preference

## INTRODUCTION

Bananas is important source of energy and is a major food crop for millions of people in the tropical world. Most people in West and Central Africa obtain their food energy requirements from banana. Banana is essential export commodity for countries of Central and South America, and the West Indies. In Papua New Guinea (PNG), banana is the second most important staple food crop in terms of consumption and ranks third only to sweet potato and taro in production (Kambuou 2001). It is grown widely throughout the country and is a dominant staple crop in the Amele area of Madang, the Gazelle Peninsula of East New Britain, the Markham valley of Morobe and the coastal areas of Central Province. Stover (1987) reported a serious threat to banana production throughout the world from the Sigatoka leaf-spot disease complex, especially black Sigatoka caused by the fungus *Mycosphaerella fijiensis*. The disease complex is present in PNG and can cause up to 40 percent yield reduction in banana production, especially in high rainfall areas. The purpose of this study was to investigate resistance to Sigatoka disease, the re-infestation rates and yield potentials under irrigated conditions at Laloki, Central Province, of eight newly created hybrid varieties<sup>2</sup> from breeding programmes and six international common varieties of banana introduced from Queensland, Australia.

Consumer preferences for these bananas were also assessed.

## MATERIALS AND METHODS

### Study Site

The study was conducted at the Dry Lowlands Research Programme, Laloki Station of the PNG National Agricultural Research Institute from 30<sup>th</sup> November 1998 to November 2001. Laloki Station is situated 25 kms from Port Moresby and located at an altitude of 30 m.a.s.l. The local climate is characterized by a marked dry season with day SE winds from May to October. The wet season with variable NW winds extends from December to April. The average annual rainfall is 1,100.00 mm. The soil is mostly alluvial clay and the topography of the area varies from slightly rolling to flat. The tested varieties were planted adjacent to the PNG National Banana Germplasm field collection for easy access to Sigatoka spore inoculation.

### Sigatoka Resistant Banana Varieties under Investigation

Table 1 gives the Sigatoka resistant hybrids derived from international breeding programmes and the

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<sup>2</sup>The term varieties is used here in a wide sense to cover both newly created hybrids for testing and established international varieties.

international common varieties of bananas that were used in the study. Variety Williams is a common commercial variety in Australia, susceptible to sigatoka disease but most favored as a dessert banana. It was included in the study as a control and on-going source of inoculation by the fungal spores.

The main variants measured were total bunch weight, number of hands per bunch, number of fingers per hand, finger diameter, finger length and pest and disease scores. Other variants recorded were number of days to flowering and to harvest of the first crop, and plant heights at the flowering and harvesting

**Table 1. List of Sigatoka Resistant International Banana Varieties**

Assigned Numbers	Varieties Derived from Breeding Programmes	Common Varieties
V88		Kluai Khai Bonng
V529	SH 3640	
V548	FHIA 03	
V549	FHIA 23	
V550	FHIA 17	
V560		Pisang Lilum
V601	SH 3436	
V621	FHIA 18	
V827		Pisang Berlin
V904		Williams
V905		Pisang Ceylan
V934	FHIA 02	
V944	FHIA 25	
V1030		Yangambi

### Banana Plantlets in the Nursery

The banana materials were introduced as tissue cultured plantlets with 10 vials of each variety. The cultured plantlets were de-flasked on arrival, washed in tap water to separate the small plantlets, then sown into peat moss media in seedling trays. The trays were maintained under humid conditions in the nursery for one month to harden the plantlets. After a month the plantlets were transplanted into polythene bags and maintained in the nursery for another two months before they were planted out in the field. The seedlings were hand watered three times a week during the hardening stage in the nursery.

### Design, Field Planting and Data Collection

The study had a randomized complete block design with four replicates and the 14 banana varieties as treatments. Plants were planted 1.5 m within rows and 2 m between rows. The gross plot area was 24 m<sup>2</sup> (6 m x 4 m) and the net plot area of 9 m<sup>2</sup> (4.5 m x 2 m) was harvested for analysis. Each plot contained 28 plants of which, 10 plants were harvested for analysis.

stages. Pest and disease scores, ranging from 0 (no infection) to 5 (severely infected) were recorded at monthly intervals after one month from planting through to harvest. Detailed recording of number and area of leaves infected with fungal spores was also done but results are not reported here. Data on finger lengths were obtained from the average of ten fingers from the third oldest hand of the bunch. Finger diameter measurements were taken from cross section cuts of the middle fingers of the third oldest hands.

### Consumer Preference Test

After banana bunches were weighed they were allowed to ripen. The ripe banana fruits were given to 20 programme staff to taste for consumer preference. Tasters were able to express their like or dislike of the banana according to their individual taste. A scale of 1 - 5 was used for taste preference; score of 1 for 'dislike alot' and 5 for 'like very much'.

### RESULTS

Results from the analysis of variance showed differences between the bunch yields of the varieties.



FHIA 25 gave the highest yield of 38 kg/bunch while Pisang Lilum, a common variety, gave the lowest yield of less than 2 kg/bunch. All hybrids from the breeding programmes yielded over 10 kg/bunch. The only two common varieties that yielded over 10 kg/bunch were Pisang Ceylan and Yangambi. The overall results of the yield performance are presented in Table 2 and Figure 1.

**Table 2. Banana Varieties and Bunch Yields**

Varieties	Mean Bunch Yield (kg/bunch)
Pisang Lilum	1.53 a
Kluai Khai Bonng	4.18 a
Pisang Berlin	7.97 b
Williams	8.55 b
SH 3640	10.40 bc
Yangambi	12.65 cd
FHIA 23	15.95 de
FHIA 02	16.90 ef
FHIA 18	17.10 ef
Pisang Ceylan	17.17 ef
SH 3436	19.52 fg
FHIA 17	20.72 g
FHIA 03	24.25 h
FHIA 25	37.57 i

Means with the same subscript are not significantly different from each other at  $P < 0.05$ . LSD = 3.447.

susceptible. The resistant varieties did not show any sign of disease re-infestation in the ratoon suckers (Table 3).

Consumer preference tests showed that more people like the taste of varieties Pisang Ceylan, Yangambi and SH 3436 when these are ripened as dessert bananas. The least liked banana was FHIA 18. A summary of the findings of the consumer preference test is given in Table 3 and Figure 2.

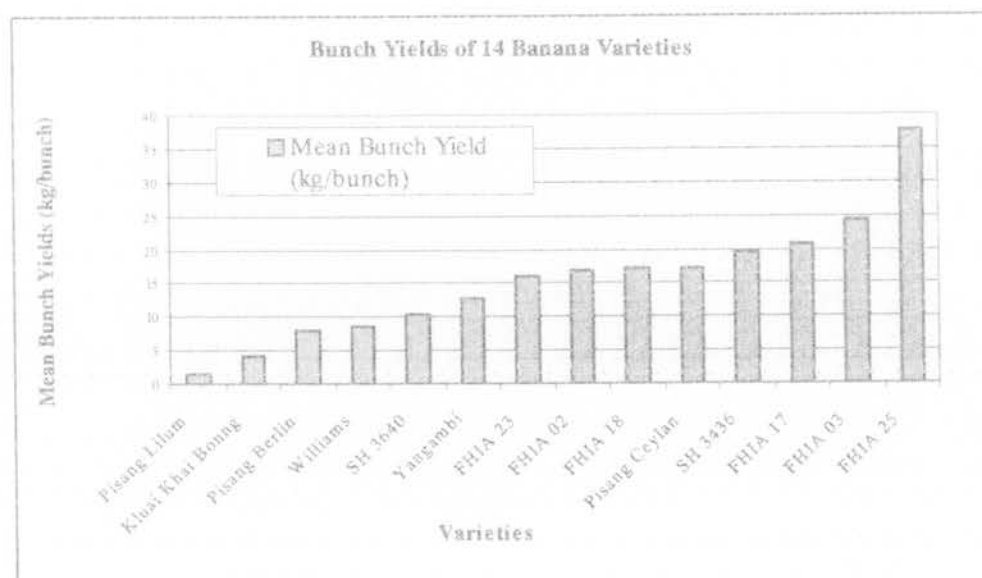
Varieties Kluai Khai, Pisang Lilum, Pisang Ceylan and SH 3640 are early maturing types while most breeding programme hybrids are medium to late maturing.

## DISCUSSION

### Yield Performance and Sigatoka Resistant Varieties

Results of bunch yields Table 2 showed that hybrids from the breeding programmes produce higher yields than most common international varieties under irrigated conditions at Laloki. FHIA 25 produced the highest yield of 37.6 kg/bunch, which is statistically higher than the other varieties. FHIA 03 and FHIA 17 yielded significantly higher than the remaining varieties with 24.3 and 20.7 kg/bunch respectively. FHIA 25

**Figure 1.**



FHIA 02 and FHIA 18 showed extreme resistance to Sigatoka disease. The other breeding programme hybrids showed high resistance to the disease as well. Variety Williams showed high susceptibility to the disease. Pisang Berlin and SH 3640 were also

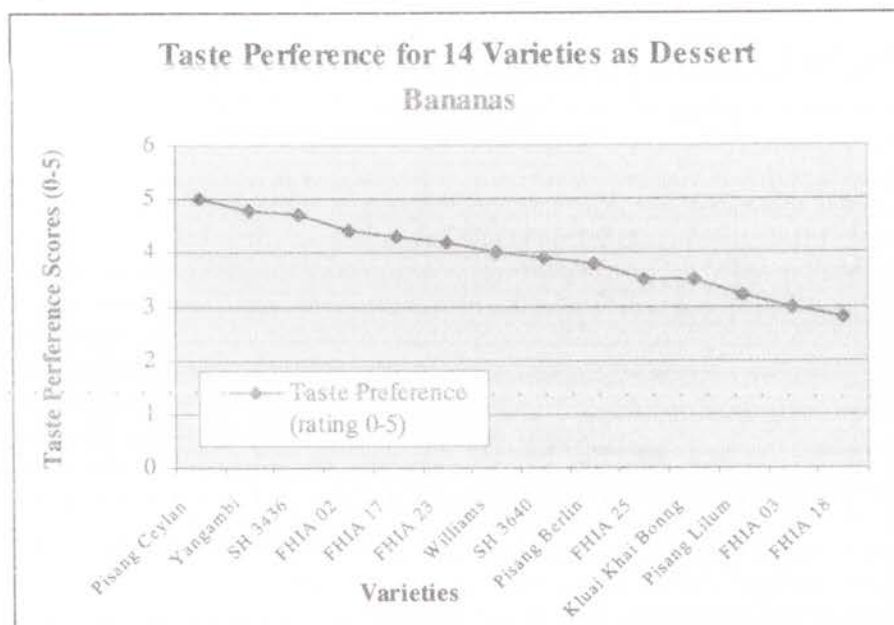
and FHIA 03 are both medium maturing hybrids, a trait that farmers would prefer. FHIA 17 is a good yielder but has a late maturing habit. There was no statistical difference between the yields of the two common varieties Pisang Ceylan and Yangambi and

**Table 3.** Reaction to Sigatoka Disease, Consumer Taste Preference, Bunch Yields and time to Maturity

Variety	Sigatoka Resistance	Taste Preference (rating 0-5)	Yield/bunch (kg)	Time to Maturity
Pisang Ceylan	HR	5.0	17.2	E
Yangambi	HR	4.8	12.7	M
SH 3436	HR	4.7	19.5	M
FHIA 02	ER	4.4	16.9	M
FHIA 17	HR	4.3	20.7	L
FHIA 23	HR	4.2	16.0	L
Williams	HS	4.0	8.6	L
SH 3640	S	3.9	10.4	E
Pisang Berlin	S	3.8	8.0	L
FHIA 25	HR	3.5	37.6	M
Kluai Khai Bonng	-	3.5	4.2	E
Pisang Lilum	-	3.2	1.5	E
FHIA 03	R	3.0	24.3	M
FHIA 18	ER	2.8	17.1	M

**Keys:** ER = extremely resistant  
 HR = highly resistant  
 R = resistant  
 HS = high susceptibility  
 S = susceptible

E = early maturity  
 M = medium maturity  
 L = late maturity

**Figure 2.**

the other four recent hybrids (FHIA 23, 02, 18 and SH 3436). The two common varieties also showed high resistance to Sigatoka disease. The Australian commercial variety Williams from the Cavendish subgroup ranked fourth last (8.6 kg) in terms of bunch yield and showed high susceptibility to Sigatoka

disease. Studies conducted in North Queensland, Australia, also showed higher bunch yields from FHIA 03 (31.5 kg/bunch), FHIA 17 (41.3 kg/bunch) and FHIA 23 (35.1 kg/bunch) as compared to variety Williams with 29.1 kg/bunch (Daniells and Bryde 2001). It is likely that the recent hybrids yielded much higher than



the common varieties due to hybrid vigor and their resistance to Sigatoka disease. These hybrids are tetraploids (AAAA /AAAB/AABB) with robust pseudostems and are capable of producing heavy bunches.

### Relationship between Bunch Yields and Sigatoka Resistance

Table 3 showed some relationship between high yields and resistance to Sigatoka disease. Highly resistant varieties produce higher bunch yields than those susceptible to the disease. The trend showed that Sigatoka disease contributes to the lower bunch yields of the susceptible banana varieties. This finding is confirmed by a study conducted in the Democratic Republic of the Congo in 1996 that reported yield loss of 76 percent in plantain bananas due to Sigatoka disease (Ngongo 2002).

### Panelists Taste Response

The high yielding hybrid varieties FHIA 03 and FHIA 25 were disliked by 30 percent of the 20 panelists. They were disliked as sweet table bananas. They may taste better if cooked or fried but this would reduce versatility of use. Results from studies carried out by the international collaborators in the International Network for the Improvement of Bananas and Plantains (INIBAP) indicated that FHIA 03 produced good texture and excellent taste when fried as chips (Dadzie 1998). Variety Pisang Ceylan was most liked by all tasters who suggested its release to the farming community. The other banana that was liked by 95 percent of the panelists was variety Yangambi. SH 3436, FHIA 02, FHIA 17 and FHIA 23 were liked by 70-80 percent of the panelists. The FHIA hybrid that was most disliked by the panelists was FHIA 18 (90% of the people). Daniells (2001) reported FHIA 18 to be a dessert banana which may not be suitable for cooking or frying purposes.

### Re-infestation Rate of the Disease

Visual observations showed no signs of re-infestation by the disease of ratoon suckers of varieties that are resistant to Sigatoka disease. However, these varieties were cropped for one season only and under irrigated conditions that may not have been conducive to disease development. At this stage it may be too early to draw any meaningful conclusions as to re-infestation rates.

### CONCLUSIONS

This investigation gave new insight into the yield performance under irrigated conditions in the seasonally dry Laloki lowlands of PNG of some

international varieties of bananas that had been bred for Sigatoka resistance. Most of these varieties out yielded the common international varieties and also showed high resistance to the disease that is capable of reducing bunch yield by up to 70 percent. Banana is the second most important staple food crop and the introduction of high yielding Sigatoka resistant hybrids into the production systems of the country would greatly boost household banana production, thus contributing to food security and income generating opportunities for the rural population.

The high yielding disease resistant international varieties that are liked by the panelists would become established once introduced into local production. These promising introduced banana varieties will also enrich or further broaden the already rich genetic resource base of PNG bananas.

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