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Black Leaf Streak of Banana

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Black leaf streak (BLS) is caused by the plant-pathogenic fungus *Mycosphaerella fijiensis*. This problem, also known as black Sigatoka, is the most important disease of banana (*Musa* species) worldwide. In Hawai'i it occurs most severely in high-rainfall areas. The disease only affects banana and through reduced photosynthesis and defoliation can severely reduce banana bunch yield and fruit quality.

Depending on factors such as cultivar, location, cultural practices, and fungicide(s) selected, up to 24 fungicide spray applications per year may be needed to produce acceptable banana yields at large plantations in Hawai'i. However, with a sufficient fertilizer plan and the use of sound cultural practices, the average backyard grower can cope with BLS fairly well.

This publication discusses black leaf streak disease of banana in Hawai'i and the practices most useful for its management.

About the host

Bananas are members of the plant family Musaceae. The banana is a large, perennial, monocotyledonous herb 6–30 ft tall, arising from a large, subterranean rhizome (usually called its corm). Banana is native to the Indo-Malesian, Asian, and Australian tropics, although bananas and plantains are now found throughout the tropics and subtropics.

Musa species are grouped according to their "ploidy," the number of chromosome sets they contain, and the relative proportion of *Musa acuminata* (A) and *Musa balbisiana* (B) chromosome sets in their genome. Most of the familiar, seedless, cultivated varieties (cultivars) of banana are triploid hybrids (AAA, AAB, ABB). Diploids (AA, AB, BB) and tetraploids (AAAA, AAAB, AABB, ABBB) are rare, being mostly experimental hybrids. There is a great diversity among native banana varieties in the Pacific, particularly from Papua New Guinea and the Solomon Islands.

All photos by S. Nelson unless otherwise noted.

The pathogen

The fungus, *M. fijiensis* M. Morelet (anamorph: *Paracercospora fijiensis* (M. Morelet) Deighton) infects leaves of host plants (banana and plantain) and may develop locally distinct strains that vary in virulence and in other traits, such as resistance to certain fungicides.

Disease cycle and epidemiology

Dissemination. Ascospores and conidia are dispersed by rainwash and rainsplash and aerially by winds or wind-driven rain.

Inoculation. Ascopores and conidia land on leaf surfaces.

Infection and pathogen development. Spores germinate, sending infectious germ tubes through leaf stomata. The infections most often occur on the lower surface (where the more numerous stomata are located) of the youngest leaves of the plant

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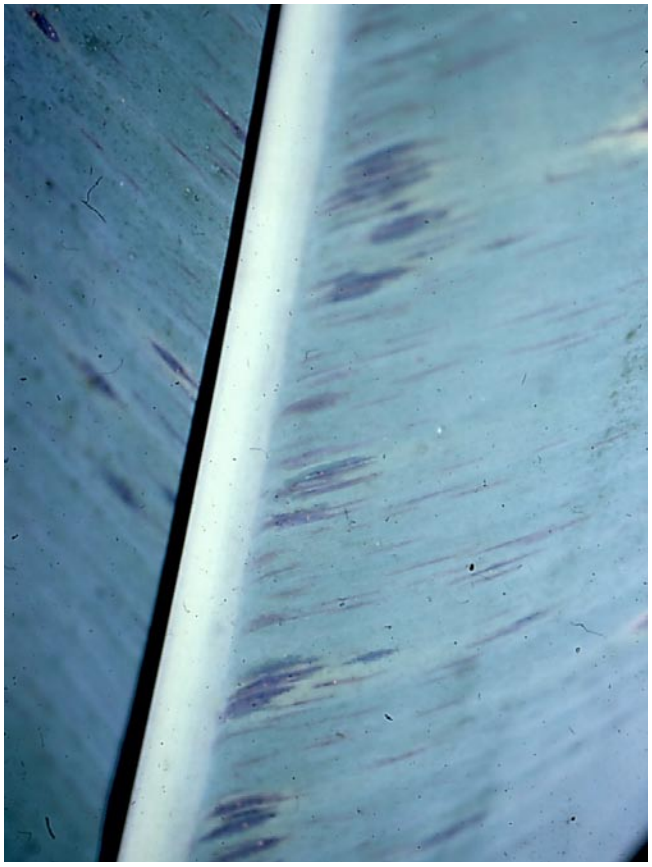

The first symptoms of black leaf streak on older plants are minute chlorotic flecks on the undersurface of the third or fourth fully expanded leaf. The flecks develop into narrow rusty brown streaks that often have truncated ends and have sides that are sharply limited by the leaf veins, lending a streaky appearance. On some cultivars, the streaks are less well defined and have diffuse margins. During early stages, the streaks are visible only from the lower surfaces. Symptoms of black leaf streak disease on young banana suckers differ from the symptoms on mature plants. On suckers, streaks rarely form; instead there are circular leaf spots ranging in color from black to brown to grayish, depending on the stage of plant and lesion development.

during and immediately after unfurling. Older leaves are not readily infected. Infection requires either a film of water on the leaf surface or relative humidity greater than 91%.

Symptom and disease development. The first symptom (chlorotic flecking) appears about 15–20 days after infection. After a susceptible cultivar is heavily infected, there is rapid evolution of symptoms from streaks to spots (10–15 days), which is often accompanied by extensive leaf death.

Pathogen reproduction. Conidia, ascospores, and other fungal structures are produced in lesions.

Pathogen survival. The fungus survives on dead banana leaves as spores or mycelium and as infections on wild banana plants.

Conditions favoring disease development include periods of high humidity, frequent heavy dews, intermittent or frequent showers, and crowded, undernourished populations of banana plants.

Disease symptoms

The appearance of disease symptoms on leaves is dynamic: lesions undergo changes in size, shape, and color as they expand and age.

Older plants

- Initially there is minute chlorotic flecking appearing first on the underside of the third or fourth fully expanded leaf. Flecks later develop into darkened, narrow streaks (1–2 X 10–20 mm), maroon to rusty brown in color.
- Chlorotic streaks appear on the upper leaf surface; streaks correspond to the streaks on the underside of the leaf; streaks are narrow at first, dark red, brown, purplish or black in color.
- Streaks enlarge lengthwise and darken to give the characteristic black streaking of the leaves. Conspicuous yellowing of adjacent leaf tissue may also occur. Streaks widen and cross over leaf veins. Lesions may coalesce.
- Mature lesions have a whitish to tan centers and dark margins; they are often surrounded by bright yellow, diffuse chlorotic halos.
- Large areas of the leaf may become blackened and water-soaked.
- All banana leaves can be completely destroyed by the disease (100% necrosis).
- Fruits may ripen prematurely or precociously on infected plants

Juvenile plants

The spots on leaves of some young suckers are initially rounded (i.e., they do not start or occur as narrow, vein-delimited streaks) and are often surrounded by a conspicuous yellow margin.

Symptoms of black leaf streak disease on young banana suckers (above, left) differs from the symptoms on mature plants. On water suckers (young plants not attached directly to a living mother plant), streaks rarely form; instead there are circular leaf spots ranging in color from black to brown to grayish, depending on the stage of plant and lesion development.

On some varieties such as Cavendish types, leaves of young banana suckers naturally have maroon-colored blotches that should not be mistaken for symptoms of black leaf streak disease. These blotches are not present on leaves of older plants.

Integrated pest management (IPM) of black leaf streak

The principal objective of banana farming is to grow plants that produce a sufficient number of disease-free banana leaves, by the time of flowering, required to fill out nicely sized bunches of fruit. If a farmer can get about 10 or more BLS-free banana leaves by the time a banana plant flowers, a nicely sized bunch should be harvested. To achieve this, growers integrate a variety of practices. The four pillars of black leaf streak integrated management are

- education and training
- cultural practices and weed control
- plant nutrition
- fungicide sprays.

Education and training

Farmers can read information and scouts can be trained to monitor disease symptoms. Successful integrated management of any plant disease can require a thorough understanding of the host plant, the pathogen and the disease environment. For more local information about this disease and about banana cultivation and pests, please refer to the following information resources:

Species profile (*Musa* sp.). 2006. S.C. Nelson, R. Ploetz, and A. Kepler. www.agroforestry.net/tti/Musa-banana-plantain.pdf.

Banana and plantain—An overview with an emphasis on Pacific Island cultivars. 2007. R.C. Ploetz, A.K. Kepler, J. Daniells, and S.C. Nelson. www.traditionaltree.org/Banana-plantain-overview.pdf

Banana bunchy top virus. 1997. S. Ferreira, E. Trujillo,

Lesions associated with leaf midribs reflect depleted fungicide ingredients in the leaf tissues due to translaminar flow. On mature banana leaves where triazole fungicides or translaminar fungicides are used to control black leaf streak, lesions appear first at the leaf midrib as the fungicide moves within tissues to distal parts of the leaves. As lesions expand and age, they develop tan colored centers but retain dark colored margins and may be surrounded by intensely yellow halos.

and D. Ogata. www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-12.pdf.

Banana rust thrips damage to banana and ornamentals in Hawaii. 2002. A. Hara, R. Mau, R. Heu, C. Jacobsen, and R. Niino-DuPonte. www.ctahr.hawaii.edu/oc/freepubs/pdf/IP-10.pdf.

Banana bunchy top brochure: Symptoms and management. 2005. Banana Action Group. www.ctahr.hawaii.edu/banana/downloads/brochure1.pdf.

Banana bunchy top in Hawaii: Online video. S.C. Nelson and L. Richardson. www.ctahr.hawaii.edu/banana/video.asp.

Banana bunchy top website. S.C. Nelson. www.ctahr.hawaii.edu/banana.

Banana ripening and bunch management. 2004. S.C. Nelson. www.ctahr.hawaii.edu/nelsons/banana/ripeningbunchmanagement.pdf.

Banana bunchy top poster. www.ctahr.hawaii.edu/nelsons/banana/BBTVposter.ppt.

Banana pest management strategic plan. www.ipmcenters.org/pmsp/pdf/HIBananaPMSP.pdf.

Cost of banana production in Hawaii. Kent Fleming. www2.ctahr.hawaii.edu/oc/freepubs/spreads/banana$.xls

Banana cultivar synonyms in Hawaii. 2007. A.K. Kepler and F. Rust. www.ctahr.hawaii.edu/nelsons/banana/BananaSynonymsHawaii.pdf.

Typical symptoms of black leaf streak disease on banana leaves in Hawai‘i (see also the photo on p. 1). Dozens of lesions coalesce to form large, blighted areas of the leaf. Usually, a significant amount of yellowing of the affected banana leaf tissues occurs as they senesce prematurely and turn various shades of brown and gray. Ascospores of the pathogen form in numerous perithecia within the tan-colored centers of the lesions. Presence of moisture on banana leaves aids the processes of spore dispersal and infection.

In areas with high rainfall, necrotic banana leaves turn very dark in color as the dead tissues becomes waterlogged. Hundreds of smaller black leaf streak lesions coalesce to form large, blighted areas on banana leaves.

Stagnant air and high relative humidity in the banana canopy favor the development of black leaf streak disease. A recommended periodic IPM practice for managing the disease ("de-trashing") is to cut off severely diseased leaves with more than 50 percent of the leaf area damaged; therefore, the leaf in this photo should be cut off.

Disease assessment

Some farmers take disease management actions, such as making fungicide applications, on the basis of the intensity of BLS disease observed on plants in the field. These farmers have scouts that record plant growth and disease levels weekly on plants of similar age groups (i.e., just before flowering). An estimate of disease intensity is obtained and recorded, such as "the youngest leaf with spots" or "the number of leaves between the first leaf with a streak and the first leaf with a spot." Some farmers use a disease assessment scale to estimate visually the percentage of leaf area diseased. It is also useful to count the number of leaves on a plant without disease. At least 10 disease-free leaves are usually needed to realize very good bunch yields in Hawai'i. Therefore, some farmers manage the crop with the primary goal of getting x-number of healthy leaves at the flowering stage.

Cultural practices for black leaf streak management

Avoid planting bananas in bowl-like depressions in the landscape, and avoid planting in areas with poor drainage or heavy clay soils. Good water drainage in fields will reduce disease levels greatly by minimizing the relative humidity in the canopy and the leaf wetness duration.

Some banana cultivars can resist black leaf streak. But resistance is poor among many commercially important types of bananas, including export dessert AAA, AAB plantain, highland AAA and AAB dessert cultivars. And, clones with resistance to BLS may be intolerant of other banana pests such as burrowing nematodes (*Radopholus similis*) or Fusarium (Panama) wilt disease. Of the two most commonly planted commercial banana varieties in Hawai'i (Cavendish types and Dwarf Brazilian, locally called "apple banana"), the Dwarf Brazilian is more tolerant of (or less affected by) black leaf streak disease. In some locations there exist naturalized populations of bananas that are relatively tolerant of BLS. These "gulch bananas" bananas are often not common commercial cultivars.

An AAA dessert banana with a high level of resistance to BLS is 'Yangambi Km 5'. A number of BLS-resistant hybrids were developed in Honduras by Fundacion Hondureña de Investigacion Agricola (FHIA). In tests conducted in Pohnpei using these hybrids, FHIA-01 ('Goldfinger') and FHIA-03 ('Sweetheart') performed very well. FHIA-25 is also resistant and is very palatable.

The choice of a planting system can affect relative humidity in banana canopies and fungicide coverage for leaves. In Hawai'i, farmers use either single-row or multi-row planting systems for banana. Roads between rows of plants or between sets of adjacent rows are for tractors or vehicles to move through the field for spraying or harvesting. If BLS disease intensity is expected to be high in a region, a single-row planting system might allow the best natural control of black leaf streak disease by providing best aeration and sunlight exposure to plants.

Single- or double-row planting systems allow best fungicide coverage for bananas and have superior air flow and reduced relative humidity levels within the canopy. More roads per acre (between rows) within a banana field will help it dry out more quickly after a storm. Regardless of planting geometry, growers in Hawaii strive to achieve about 650–700 planting units per acre; any more than that can create more BLS disease severity and control problems.

Wind management within a banana crop is another issue, and can be addressed at planting or by choice of location. A roughly north-south orientation of roads in Hawai'i is preferred to east-west at many locations for good field aeration by winds. And, when spraying fungicides, do not go with the prevailing wind when spraying, rather it is best to go across the wind to minimize drift over the applicator. Therefore, with a north-south orientation of roads in the field, spray applicators can take advantage of the trade winds to avoid or minimize exposure to the chemicals.

Regular leaf sanitation in the form of "de-trashing," the practice of regularly removing severely diseased banana leaves from the banana plant, can be as effective as using fungicides without practicing sanitation. De-trashing should be done weekly with a long pole having a sharp blade attached to one end. Moving through the field, identify banana leaves with at least half of their area diseased, and cut off these leaves or the severely diseased portion of leaves. Do not allow dead banana leaves to remain attached to plants. All dead leaves should be removed, as they can harbor the pathogen that infects living leaves above. Benefits of de-trashing include

- removal of fungal spores from close proximity to the youngest, most susceptible, apical leaves of the plant
- increased air flow in the canopy
- reduced relative humidity in the canopy
- more efficient use of fertilizers
- better penetration of spray applications into the banana canopy and more effective fungicide spray applications
- reduced premature or precocious ripening (diseased leaves emit ethylene gas, which can ripen fruits in the field prematurely).

De-suckering, known as "pruning" is the removal of unwanted banana suckers from each production unit. Pruning is done biannually or annually on well managed farms. Suckers arise from the mother plant. A mother plant and her set of suckers of various ages are referred to as a "mat" of plants, which is the production unit. In Hawai'i, the most efficient banana production is realized when the production unit consists of one mother plant bearing fruit, one plant that is nearing maturity but has not yet flowered, and one or two smaller suckers with only a few leaves. Any additional plants in the production unit are considered a waste of fertilizer and resources. Therefore, the unwanted suckers must be pruned. "Directional pruning" is the selection of certain suckers to retain in the field. If growers strive to select suckers to retain that are on the side of the mother plant that is in the direction of the plant row, then the line of plants will all "walk" in the same direction over the years, preserving the integrity of the roads in the field. For black leaf streak disease management, the benefits of pruning include

- increased air flow in the canopy
- reduced relative humidity in the canopy
- more efficient use of fertilizers
- better penetration of spray applications into the banana canopy and more effective fungicide spray applications.

Tall weeds create unacceptably high levels of relative humidity in the banana plant canopy; therefore, weeds should always be kept in check where BLS is a problem.

Windbreaks, although useful during periods of high winds, can create humid, shaded conditions in banana fields and therefore represent a risk for BLS disease de-

Some FHIA (Fundacion Hondurena de Investigacion Agricola) bananas possessing resistance to banana diseases. Not all of these bananas hybrids are available in Hawai'i.

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

velopment. Often, the disease is more severe on banana plants that are next to a row of tall trees.

Plant nutrition

It is very important to maintain an adequate level of banana plant nutrition to minimize the effects of BLS disease. Undernourished plants are more susceptible to infection and also succumb more rapidly to disease. The objective is to have banana plants growing as quickly and possible, to "outgrow" the effects of the disease as symptoms "climb up" the plant. In Hawai'i, banana growers try to produce plants with 10 or more healthy (disease-free) leaves at time of flowering, because after flowering there are no more leaves produced on banana plants.

High-production banana farming in Hawai'i, as recommended by expert farmers in high-rainfall areas, generally requires (in pounds per acre per year): nitrogen 300–650, phosphorous 60–120, and potassium 600–700. Primary fertilizers for banana production in Hawai'i are

- "Banana Special" (13-3-37), general N-P-K fertilizer, about 200 lbs/acre/month
- urea (sulfur-coated or poly-coated)
- potash, KSO or KCL
- lime and/or dolomite (fields limed to pH 5.5–6.5 up to twice per year
- borax (Solubor)
- zinc sulfate
- sulfur.

Crop logging is the periodic monitoring of soil and banana leaf tissue nutrient levels to help a grower make decisions on the type, rate, and interval of fertilizer applications. Crop logging for banana consists of selecting banana leaf samples for tissue analysis. Here is the crop logging procedure for Hawai'i:

- Select a plant (or plants) that is (or are) almost ready to flower. This could be a randomly or arbitrarily selected plant or a plant from a problematical part of a field.
- Select the third leaf from the top of the plant for tissue analysis.
- From the center of the leaf and adjacent to the leaf midrib, cut out rectangular pieces of leaf, about 2 x 4

Table 1. Recommended range of fertilizer elements in banana leaf tissue

Element	*Symbol*	*Recommended range**
Nitrogen	N	2.8–3.1%
Phosphorous	P	0.18–0.20%
Potassium	K	3.2–3.5%
Calcium	CA	0.6–1.0%
Magnesium	Mg	0.3–0.6%
Sulfur	S	0.22–0.25%
Iron	Fe	50–100 ppm*
Manganese	Mn	30–100 ppm
Copper	Cu	10–15 ppm
Zinc	Zn	25–40 ppm
Boron	B	15–25 ppm

*ppm = parts per million

inches each.
- Submit the tissue to the University of Hawaii at Mānoa, College of Tropical Agriculture and Human Resource, Agricultural Diagnostic Service Center.

The advantages of crop logging include the following:
- The practice provides a quantitative basis for plant nutrition decision-making.
- It allows early detection of problems.
- One can verify suspected problems and interactions.
- The practice can result in improved banana yield and quality.
- Fertilizer use patterns are optimized.

Chemical management of BLS (fungicides)

Most farmers in BLS-prone regions of Hawai'i use one or more fungicides to manage the disease. The most commonly used products, used alone, in rotations, or in combinations, include the active ingredients mancozeb, maneb, fenbuconazole, azoxystrobin, tebuconazole, and petroleum distillates (oils) (Table 3).

Petroleum distillates work very well in combination with sanitation (de-trashing). Growers often either mix or rotate fungicides with different modes of action, such as tank mixes of protectant type fungicides (e.g., mancozeb or manzate) with systemic fungicides (e.g., fenbuconazole or tebuconazole) (see below).

Choice of mist blower can influence fungicide applications. Fan sizes for tractor-drawn mist blowers come in different sizes. Experience in Hawai'i indicates that 31-inch diameter fans provide superior disease control compared to 28-inch fans. Backpack mist blowers provide inferior coverage and control of BLS compared with tractor-drawn mist blowers. Weekly disease scouting and recordkeeping are important aspects related to timing of fungicide sprays. Well-timed sprays can reduce costs. Fungicide spray applications are scheduled based on the data collected, usually a disease intensity rating scale.

It is important to use a "spreader sticker" such as Latron B to enhance fungicide coverage of leaves and adhesion to leaf surfaces.

Even where fungicides are applied regularly in banana plantations, if the environment is very favorable for disease development, plants may be largely defoliated before harvest, reducing bunch weight and fruit quality.

Managing or preventing fungicide resistance

Fungicide resistance occurs when a product is no longer effective at controlling a disease due to a shift in the genetics of the target pathogen organism. Fungicide resistance is due to natural selection of spores with less sensitivity due to either mutation or sexual recombination. It can be a very serious problem where fungicide resistance develops in a plant pathogen population.

Types of fungicide resistance are (1) single-step, major-gene (one type of gene mutation is responsible; there is a sudden and marked loss of effectiveness; there are clear-cut sensitive and resistant populations; the developed resistance tends to be stable in the pathogen population); and (2) progressive, multiple genes (a number of genes are involved in a stepwise fashion; there is a gradual observed decline in control; there is a range of sensitivity in the pathogen population; the population reverts to more sensitive population with less intensive use of product).

Phenomena associated with fungicide resistance are (1) cross-resistance (the resistant population automatically and simultaneously becomes resistant to other products that have similar chemical relationships or mechanisms); (2) multiple resistance (resistance occurs when a population develops separate mechanisms of resistance to more than one product; resistance arises from independent mutations selected from exposure to each of the products); and (3) negative cross-resistance (a rare condition in which change in resistance in one product results in sensitivity to another).

In Hawai'i, the primary risk of fungicide resistance development in populations of the BLS pathogen in banana crops is where triazole fungicides (e.g., Enable and Elite) are used repeatedly and/or against label instructions.

Leaf lamina sample to be analyzed for nutrient content in a crop-logging program Photo: Howard Hirae

Mist-blower rig for fungicide applications

Preventing resistance development in fungi

Do not use a fungicide product in isolation. That is, apply the product(s) as: (1) a tank mixture with one or more different fungicides, or (2) as a component in a fungicide rotation. Do not alternate or tank-mix with fungicides to which resistance has already developed in your population. Examples of tank mixtures are

- Dithane + oil
- Abound + Enable or Elite (triazoles)
- Dithane + (triazole)
- all of the above plus Latron 1956, which "dries hard"
- Manex II + Superior 70 oil.

A "block spraying" program rotation was developed by the Hawai'i banana industry for prudent use of the effective triazole fungicides:

- Jan. 16–Mar. 1: "non-triazole" period (mancozeb, maneb, azoxystrobin, oil)
- Mar. 2–May 31: "triazole period" (fenbuconazole, tebuconazole); no more than 4 applications
- Jun. 1–Sep. 30: "non-triazole" period (mancozeb, maneb, azoxystrobin, oil)
- Oct. 1–Jan. 15: "triazole period" (fenbuconazole, tebuconazole); no more than 4 applications.

Apply only when necessary (or just before) and restrict application numbers.

BLS disease monitoring is very important for fungicide timing and conservation.

Example from the Dithane M-45 label: "Dithane M-45 fungicide is a broad-spectrum, protectant fungicide. If not applied on a routine protectant spray schedule, crop should be scouted on a weekly basis. Fungicide application should be made at the recommended label use rate and spray schedule, at first sign of disease, report of disease in the area, or during environmental conditions favorable for disease development."

Example from the Abound (azoxystrobin) label, concerning resistance management: "Do not apply more than 2 sequential sprays of ABOUND Flowable before alternating with a fungicide that has a different mode of action. Do not make more than 8 applications of ABOUND Flowable or other stroliburin fungicides per acre per year."

Example from the Enable 2F label, concerning resistance management: "Do not apply more than 8 times (0.72 lbs. Active) per acre per year."

On the Elite label, there are no specific recommendations concerning resistance management, but the same instructions as for Enable 2F may be appropriate, as both are in the same class of fungicides (triazoles).

Maintain recommended dose

Use enough water to get thorough coverage. Set spray equipment to get good coverage (amount, rate of travel through field). Use of a surfactant in spray solutions will improve disease control and product performance. A typical tank mixture and spray rate for controlling black leaf streak disease in Hawai'i using contact ("protectant"), surface-acting fungicides is as follows. One could also add a triazole fungicide at the recommended rate:

Table 3. Fungicides registered for banana in Hawai'i (2006). Products in bold are effective for controlling banana black leaf streak in Hawai'i. They are all commonly used, either alone (and in rotation) or in various tank-mix combinations. The triazole fungicides (febuconazole, tebuconazole) are reported to be the most effective. As systemic fungicides, the triazole fungicides provide the longest duration of disease mitigation after application, but they also pose a risk for development of fungicide resistance if they are overused.

Common name	***Product names***
copper hydroxide	Kocide, Champion, Champ, Bac-Stop, Nu-Cop
copper oxide	Nordox
tetraamine copper	Liqui-cop
mancozeb	**Dithane, Penncozeb, Manzate, Mankocide, Mancozeb, Lesco**
maneb	**Maneb, Manex**
fenbuconazole	**Enable**
azoxystrobin	**Abound**
tebuconazole	**Elite**
thiabendazole	Decco Salt No. 19
brewer's yeast extract	Keyplex 350 OR
K-bicarbonate	Kaligreen
hydrogen peroxide	Oxidate, Storox
fosetyl-Al	Aliette
phosphorous acid	Fungi-phite
K-phosphate	Nutrol LC
petroleum distillates (oils)	**Superior 70, Saf-T-Side, Sunspray Ultra-Fine, Biocover, Spray Oil, Year Round Horticultural Oil, Glacial Spray Fluid, Purespray Green**

*Table from Kawate, M. 2006. Banana pesticide update, in: Proceedings of the 37th Annual Hawaii Banana Industry Association Conference.

12-gallon-per-acre mix consisting of the following:
Manzate flowable, 2 qt/acre
Superior 70, 1 gal/acre
Latron (spreader/sticker), 3 oz/acre

Minimize the eradicant use of systemic fungicides: "Be proactive."

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