

Banana Bunchy Top Disease, a New Threat to Banana Cultivation in Hawaii¹

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Symptoms of banana bunchy top disease (BBTD) were first recognized in Hawaii at Punaluu, Oahu by F. Cruz (personal communication) in July 1989. The presence of this virus disease was subsequently confirmed by R. Dietzgen (personal communication) of the Department of Primary Industries, Queensland, Australia, using monoclonal antibodies, developed in Taiwan (Su and Wu 1989), in an enzyme-linked immunosorbent assay (ELISA). This disease was a new Hawaii State Record.

WORLD DISTRIBUTION OF BBTD

Bunchy top disease was first reported in Fiji in 1889, and is believed to have been imported there with plants from Tanna, New Hebrides, about 1886 (Simmonds 1931). The virus is probably endemic to Southeast Asia, but is now known to occur in Egypt, Australia, India, Taiwan, Congo, Sri Lanka, Antilles, Papua New Guinea, New Caledonia, Canary Islands, Philippines, Guam, Samoa, Tonga, Saipan, Tinian, Kiribati, Northern Mariana Islands, Tuvalu, and other Pacific island groups (Stover 1972).

BBTD is a systemic disease that can infect all species of *Musa*. There is no known cure for infected plants and all propagative parts of the plant will become infected. The virus is only known to be transmitted by the banana aphid, *Pentalonia nigronervosa* Coquerel, which has been known to be established in Hawaii since 1924, but was probably here earlier (Zimmerman 1948). The source of the virus found in Hawaii is unknown, but it probably came with infected plant material smuggled into the state.

SYMPTOMS

Recognition of the symptoms of BBTD is crucial to its control. Certain "key" symptoms, easily visible with the naked eye, allow rapid field diagnosis that can be quite reliable if done by trained inspectors. The most obvious of these is the "bunching" of the terminal leaves; this is also referred to as "strangles," "curly top," and "cabbage top" (Fig. 1). Poor development of the young petioles produces a rosette appearance. The apical leaves are erect, narrow, and brittle when crushed in the hand. Leaf margins may also appear "wavy" and yellow.

Undersides of petioles of infected plants often exhibit dark green longitudinal streaks. Symptoms of the leaf veins are best viewed from the underside in direct sunlight. Leaf veins proximal to the midrib are dark

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FIGURE 1. A mat of banana plants in Waimanalo showing typical symptoms of banana bunchy top disease.



FIGURE 2. Stunted fruit on a banana plant infected with banana bunchy top disease.

green; thus, in many cases, they can be seen extending into the white area along the midrib. This symptom is known as "hooking." In healthy plants, this area of the midrib is normally free of blemishes. Veins in the central area of the leaf may also be darkened intermittently, producing an appearance like written Morse Code.

Fruits produced by infected plants will usually be stunted and may not emerge completely from the leaf cluster at the top of the pseudostem (Fig. 2). Plants infected when they are very young may not produce fruit at all.

DISTRIBUTION OF BBTD ON OAHU

Since the original detection of BBTD in Punaluu, Oahu, many infected plants from residential areas throughout Honolulu, and from two farms in windward Oahu at Waimanalo and Kahaluu, had been reported (Fig. 3), as of December 19, 1990. It should be noted that the three discoveries at Hawaii Kai, Makakilo, and Pearl City appear to be isolated cases of plantings of previously infected plants, rather than cases where existing plantings were infected by aphids from nearby infected plants. Infected banana mats found in other residential areas all had other infected mats in their vicinities. These areas include Pacific Heights, Alewa Heights, Kalihi, Liliha, Nuuanu, Pauoa, Papakolea, Punchbowl, Manoa, Kapahulu and Kaimuki

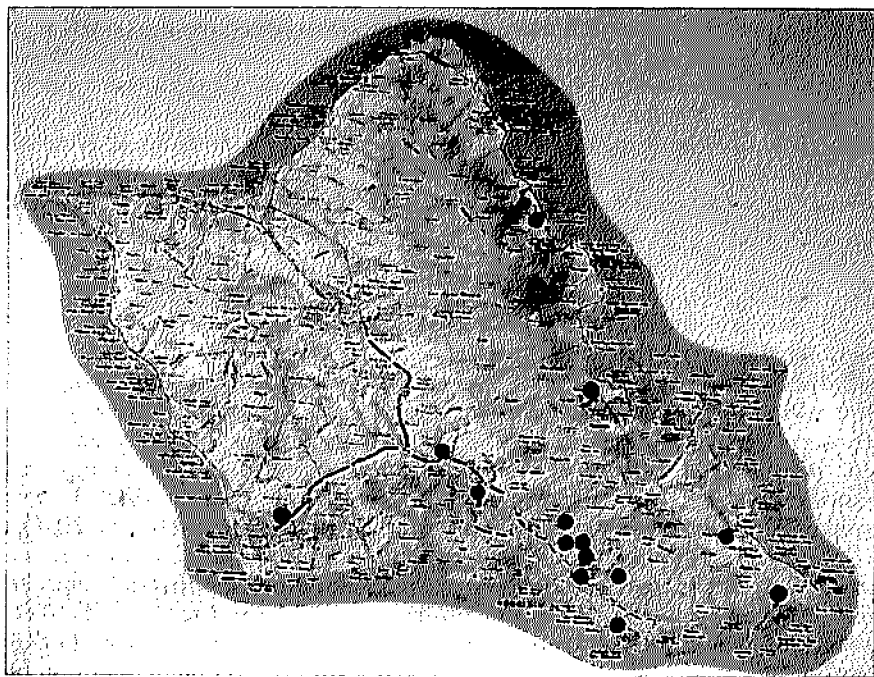


FIGURE 3. Distribution of banana plants on Oahu found to be infected with banana bunchy top disease as of December 19, 1990. Darker dots indicate three isolated sites where infected planting material was probably used.

(Fig. 3). The rather shocking news of the wide distribution of BBTD suggests that the disease has been on Oahu for at least a few years. Knowledge of the biology of its vector, the banana aphid, will help to explain the spread of this disease.

BANANA APHID, THE VECTOR

Pentalonia nigronervosa is the only known vector of BBTD according to Waterhouse and Norris (1987). These authors provide detailed information on the biology of this insect, which I have summarized here. The species is parthenogenetic and viviparous. Adults are known to produce about two young per day and may produce up to 50 offspring in their lifetimes. Each of the four nymphal instars lasts 2 to 4 days. The life span of adults ranges from 27 to 37 days. Alate females may not be produced in new colonies until after 7 to 10 generations of apterae. In regions without cool winters, up to 30 generations, with four lots of alatae, may be produced per year. The aphids cluster on the terminals of suckers and larger plants (usually in lower numbers), and also at the base of the pseudostem, as deep as 7 to 8 cm below the soil. They may also be found on the fruit. Ants are known to be associated with this aphid in Hawaii, apparently to collect honeydew. Nymphs are known to be better vectors of BBTD than adults. They require a minimum of 17 hours feeding time to become infective and must feed for 1.5 to 2 hours to infect a healthy plant. A newly infected plant will begin to show symptoms about one month after infection. Genera with species known to be alternate hosts of this aphid (Waterhouse and Norris 1987) that grow in Hawaii include *Alpinia*, *Heliconia*, *Zingiber*, *Hedychium*, *Phaeomeia*, *Colocasia*, *Lycopersicon*, *Strelitzia*, *Alocasia*, *Arum*, *Amomum*, *Costus*, *Calladium*, *Calla*, *Dieffenbachia*, *Elettaria*, *Ravenala*, and *Opuntia*, and several ferns.

BBTD CONTROL METHODS

There are several methods that have been, or can be, used to try to control the spread of BBTD. In Hawaii, an inter-island quarantine was obviously the most important first step. A 120-day interim quarantine on the movement of banana plants from Oahu was put into effect by the Hawaii Department of Agriculture (HDOA) until a permanent quarantine can be established. Physical removal of infected mats by grubbing is a very labor intensive method of control that is effective in small plantings. Larger farms require heavy equipment to use this technique effectively. The HDOA is presently roguing infected mats by grubbing in residential and wayside areas. Periodic inspections of farms are made and infected mats are marked for the farmers to rogue. This technique has been used to control BBTD successfully in other countries such as Australia (Allen 1975). Stover (1972) states, "Without a bunchy top control programme, bananas cannot be grown on a commercial scale. In peasant agriculture, with small holdings, however, an effective programme is difficult to enforce and it is likely that bunchy top will continue to cause serious losses."

A more efficient method of roguing is through the use of herbicides. Beaver (1982) reported relatively rapid kill of infected mats with picloram in Guam. Wooden pins impregnated with 6 mg of picloram were pressed into the pseudostem, using four or fewer pins per pseudostem. Mats were killed within 21 days using this technique. Regupathy (1980) reported complete kill of mats with 2,4 — Dichlorophenoxyacetic acid. The HDOA has begun preliminary tests of chemical roguing techniques to determine their suitability for farms and residential areas in the state.

Control of the vector is an indirect method of controlling BBTD but it is nonetheless important. A quarantine exemption under Section 18 of the Federal Insecticide Fungicide and Rodenticide Act was granted for farmers to use diazinon on banana trees for aphid control until September 30, 1990. Use of this chemical as a long term chemical control method is being considered by HDOA. Control of ants around the mats of bananas is also advisable since ants have been implicated in the movement of aphids and in protecting them from natural enemies (Hely et al. 1982).

Biological control of *P. nigronevosa* is also being seriously considered. One recorded parasite of this aphid is already present in Hawaii, but has never been reared from the aphid here. This is the aphidiid wasp, *Lysiphlebus testaceipes* (Cresson), which is known to attack other species of aphids in Hawaii (B. Kumashiro, personal communication). Waterhouse and Norris (1987) list the known natural enemies of *P. nigronevosa*. Most of these are non-specific predators, but at least one species of *Aphidius* (*A. colemani* Viereck) was considered "worth attention." The HDOA has initiated exploration in Southeast Asia for natural enemies of *P. nigronevosa*. All natural enemies sent to Hawaii will be given host specificity tests under quarantine conditions and results will be reviewed by advisory committees of the Board of Agriculture prior to any releases.

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