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Plumeria Rust

Scot Nelson
Department of Plant and Environmental Protection Sciences

Plumeria (*Plumeria* spp.) is a popular landscape plant and is important to Hawai'i's floriculture and nursery industries. It is widely grown on farms and in various public and private settings either as a specimen ornamental, for shade, or in plant groupings. In 2006, 15 plumeria farms in Hawai'i sold over 12 million flowers with total receipts of $372,000. The average annual sales value of plumeria flowers in the state over the past 5 years was about $505,000. These fragrant, beautiful flowers are used primarily in making lei.

In 1991, a leaf disease of plumeria became established on the island of O'ahu and rapidly spread throughout the state, affecting most plumeria trees. This now familiar fungal disease, plumeria rust, is known by its conspicuous, powdery, yellow-orange lesions on leaves. Most plumeria cultivars grown in Hawai'i are susceptible to the pathogen and have numerous powdery spore masses on the underside of leaves. Leaves can turn brown and fall from the plant as early as two months after the springtime flush of new leaves is infected by the fungus.

This publication discusses plumeria rust in Hawai'i and suggests integrated methods for managing it, including fungicide applications, if needed.

The host

Plumeria spp. (common names frangipani, melia [Hawaiian], temple tree), are members of the Apocynaceae (dogbane family). They grow as small ornamental trees in parks and residential and commercial landscapes in Hawai'i. Plumeria cultivars also adorn roadways and public lands throughout the state and in certain plantations are cultivated for flowers to make lei and floral arrangements. Plumeria grows well in hot, dry areas and is common in Hawai'i up to about 2000 ft elevation. These popular plants bear their clusters of beautiful, fragrant flowers of various colors and sizes from May to November in Hawai'i.

The shade and fragrance of these plants make them ideal specimen trees in landscapes. Native to the West Indies, the two principal species grown in Hawai'i are *Plumeria obtusa* (Singapore plumeria) and *P. rubra* (plumeria, temple tree). However, more than 100 cultivars and hybrids have been developed, and many of these are growing at UH-CTAHR research stations on the islands of O'ahu and Hawai'i. Some of the less common species appear to have some resistance to the rust pathogen (Table 1).

The pathogen

The plumeria rust pathogen is the fungus *Coleosporium plumeriae* Pat. In some locations worldwide, only uredinia are present on the undersides of leaves. The powdery, bright yellow or yellow-orange urediniospores are elliptical to sub-globose and echinulate. When telia are produced, they form later on diseased leaves. They are found among the uredinia on leaf undersides and are punctiform, erumpent, and smooth. They are not easily rubbed from leaves. Teliospores are smooth, oblong or club-shaped, orange-yellow, oily, and refractile. Basidiospores produced from teliospores are smooth-walled and ellipsoid. Spermagonial and aecial stages of this rust fungus are unknown.

Distribution of plumeria rust

Plumeria rust was first recorded on *Plumeria alba* on the West Indies island of Guadaloupe in 1902 and later spread to Central America.

The rust was first reported on O'ahu in 1991, but where it came from and how it arrived is unknown. It has since been reported on plumeria on all of the main islands of Hawai'i.

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Table 1. Plumeria species or cultivars and their reaction to plumeria rust on the island of O'ahu, Hawai'i.*

Highly susceptible	Moderately susceptible	Moderately resistant	Highly resistant
All *Plumeria rubra* types	*Plumeria obtusa*	*P. obtusa* var. *sericifolia*	*Plumeria stenopetala*
P. obtusa–P. rubra hybrids		*Plumeria pudica*	*Plumeria caracasana*
		Plumeria alba	One accession from Puerto Rico (cultivar 'San Germain')
			CTAHR also has some unknown *Plumeria* species that are resistant, but these not yet available for release to general public.

*Information from Richard Criley (UH-CTAHR)

More recently, plumeria rust was found in Sri Lanka, Thailand, Taiwan, India, and Africa. It has also been reported from the Caribbean Islands, Central America, Mexico, northern South America, the United States, Australia, Bahamas, Barbados, Canada, Indonesia, Panama, Puerto Rico, and many island territories and nations in the Pacific, such as Micronesia, American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Samoa, Solomon Islands, Tokelau, Vanuatu, and Wallis and Futuna.

Disease symptoms

The undersides of infected leaves show numerous tiny, raised, yellow-orange, powdery rust pustules (uredinia). The pustules may emerge sparsely on the upper surface of heavily diseased leaves. Spores are easily rubbed from the leaves. The pathogen does not infect stems or flowers.

Yellow spots are visible on the upper leaf surface, opposite to the infected sites on the lower surface. As lesions age, enlarge and coalesce, these yellow areas develop into sunken, angular and grayish to brown spots. When leaves are severely diseased, they may dry, curl, become distorted, and fall. Premature defoliation can approach 100 percent.

Pathogen infection and survival

Most infections are caused by windborne urediniospores that stick to moist leaves under wet or humid conditions. Spores germinate on leaves, penetrate the surface, and grow as fungal hyphae that infect cells inside the leaf. Successful infections erupt back through the epidermis

Plumeria rust spots on the upper leaf surface are initially small yellowish flecks that can later coalesce and turn into brown, necrotic areas. The yellow spots correspond to lesions bearing spores on the undersides of the affected leaves.

Table 2. Some fungicides registered in Hawai‘i for management of plumeria rust.*

Product names	Active ingredient(s)	Formulation
Eagle 40WP	mycobutanil (40%)	wettable powder
Eagle 20EW	mycobutanil (19.7%)	emulsion in water
Heritage	azoxystrobin (50%)	water dispersible granule

*Table 2 contains examples of product names and active ingredients and/or formulations. Application of a product in greenhouses, shade-houses, outdoor nurseries, etc., must be consistent with label directions. Data are from the Hawaii Pesticide Information Retrieval System (HPIRS). Before using a fungicide on a large scale, conduct a small test to see if there is any damage to the plants.

Erumpent rust pustules on the underside of a leaf contain powdery masses of orange fungal spores.

The surface of this leaf is almost completely covered with thousands of rust pustules.

to create uredinial sori full of powdery spores that are dispersed to new infection sites on the same or other leaves. The pathogen survives on infected leaves and leaf debris. *C. plumeriae* adapts to changing environmental conditions by creating more distinct and fit progeny through sexual reproduction.

Pathogen host range and plumeria susceptibility and resistance

The pathogen is only known to infect *Plumeria* spp. Alternate hosts of *C. plumeriae* have not been found at any location where the disease occurs. At least eight species of plumeria are susceptible to *C. plumeriae*: *P. acuminata*, *P. acutifolia*, *P. alba*, *P. clusioides*, *P. rubra*, *P. obtusa*, *P. pudica* and *P. variegata*. However, the host reactions among other plumeria species and hybrids range from highly susceptible to highly resistant (Table 1). Planting location may also affect disease severity, with more disease appearing in warm, moist environments.

Although most plumeria types are highly susceptible to the disease in Hawai‘i, some are less susceptible and retain green leaves for many weeks longer than more susceptible cultivars or species.

Initially, plants of *P. obtusa* showed some tolerance to the rust in Hawai‘i, with only isolated pustules on leaves, whereas cultivars of *P. rubra* were more severely

Leaves of diseased trees turn yellow before they turn brown, curl, and fall from the tree.

Leaves of diseased trees turn yellow before they turn brown, curl, and fall from the tree.

attacked. However, in more recent years the relative resistance of *P. obtusa* has diminished, possibly due to adaptation by the pathogen to it.

Host reactions to plumeria rust in Hilo, Hawai'i (2008)

All of the approximately 100 plumeria cultivars and hybrids growing in the UH-CTAHR collection in Hilo, Hawai'i, were susceptible to infection in 2008 (S. C. Nelson, unpublished data). However, some plumeria cultivars and hybids were highly susceptible and suffered faster leaf colonization and leaf abscission than a few of the less susceptible cultivars. For example, leaves of most cultivars in the collection showed rust lesions shortly after leaf emergence in early May, 2008. By July 26, highly susceptible cultivars such as 'Rainbow HAES 3-2' and 'Red Moragne' already showed significant leaf spotting, yellowing, necrosis and defoliation. Less susceptible cultivars such as 'Moragne 18' and 'Kimo' had developed only minor leaf symptoms. By the end of August, however, all cultivars showed significant disease symptoms, including premature defoliation.

Integrated management

Host selection. Plant resistant *Plumeria* species or hybrids.

Sanitation. Pick up fallen leaves and destroy them, or remove and destroy severely infected leaves from trees early in the season. The pathogen can survive on fallen leaves, which are are a source of new infections.

Choice of planting location. Planting in drier, less humid areas may reduce infection and disease development.

Fungicide sprays. Use approved fungicides when

As disease progresses, the rust lesions may appear as large, tan-colored spots or blights on the upper surfaces of severely affected plumeria leaves.

Susceptible (in foreground, yellowed leaves, 'Big Yellow') and resistant (in background, green leaves, 'Morange 18') plumeria cultivars growing in Hilo, Hawai'i in early July 2008.

Defoliation of leaves from a susceptible variety can occur within 8 weeks after the yearly leaf flush.

necessary; follow label instructions and rotate between fungicide products with different modes of action to inhibit the development of fungicide resistance in populations of *C. plumeriae* (Table 2).

Biological control. There are a number of reported fungal hyperparasites of *C. plumeriae* as well as an insect predator (a midge). Although these agents are not likely to eradicate the disease, they can reduce it. However, sprays of fungicides or insecticides on plumeria foliage may interrupt the life cycles of these biological control agents.

Weed control. To reduce relative humidity and increase air flow in the plumeria canopy, prevent tall weeds from growing near plumeria trees.

Plant spacing and intercropping. Avoid over-crowding of plumeria plants. Wider spacing will enhance aeration in the canopy and the drying of leaf surfaces after rainfall. Intercrop plumeria with non-hosts of *C. plumeriae*. Avoid extensive monocropping of susceptible *Plumeria* species or hybrids.

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