



# Ornamental Pests of Hawai'i

## Fungal and Nematode Associations and Symptoms on *Protea* and *Leucospermum* spp.

**At A Glance:** This publication was developed to assist growers and producers in becoming more familiar with the common symptoms of plant diseases observed in Hawai'i's fields, and to complement pathogen analyses from plant samples.



### Introduction

Plants in the Proteaceae family are native to South Africa and Australia (Crous et al, 2013). *Protea* spp. (*Protea*) and *Leucospermum* spp. (Pincushion), commonly referred to as "protea," are important crops grown for floriculture production in Hawai'i. The cut flower protea industry is a valuable market in the state of Hawai'i, producing \$655,000 in sales in 2020 (USDA NASS, 2021). Although these plants may be considered relatively low maintenance and easy to grow compared to other cut flowers in the state, leaf spots, stem cankers, and dieback reduce the quality and yield of these desirable cut flowers.

In 2021, a pest and pathogen survey was conducted at the Maui Agricultural Research Center (MARC) and at 10 commercial protea farms across Maui County; 140 symptomatic plant samples were collected, sent, and analyzed at the USDA Agricultural Research Service (ARS), Daniel K. Inouye U.S. Pacific Basin Agricultural Research Center (PBARC) in Hilo, Hawai'i. More than 30 fungal genera were isolated and identified via morphological and molecular methods, including *Alternaria*, *Amycosphaerella*, *Anthostomella*, *Aureobasidium*, *Buergenerula* or *Microsphaeropsis*, *Calonectria*, *Cladosporium*, *Clonostachys*, *Colletotrichum*, *Diaporthe*, *Didymella* (*Phoma*), *Epicoccum*, *Fusarium*, *Hymenochaete*, *Mucor*, *Mycosphaerella*, *Nectria*, *Neofusicoccum*, *Neopestalotiopsis*, *Nigrospora*, *Pallidocercospora*, *Penicillium*, *Pestalotiopsis*, *Phaeosphaeriopsis*, *Preussia*, *Pseudoascochyta*, *Pyrenophora*, *Saccharata*, *Talaromyces*, *Teratosphaeria*, *Trichoderma*, *Xylaria*, and other genera from *Xylariaceae*. In addition, one plant-parasitic nematode, *Meloidogyne* sp. (root-

knot nematode) was identified from symptomatic protea roots and soils via Baermann funnel extractions. This summary will focus on the most common disease symptoms observed and the most frequently associated fungal and nematode genera affecting *Protea* and *Leucospermum* spp. in Maui County, which include *Neofusicoccum*, *Alternaria*, *Cladosporium*, *Saccharata*, *Mycosphaerella*, *Epicoccum*, *Diaporthe* (*Phomopsis*), *Colletotrichum*, *Pestalotiopsis*, *Nigrospora*, and *Meloidogyne*. This publication was developed to assist growers and producers in becoming more familiar

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with the common symptoms of plant diseases observed in Hawai'i's fields and to complement pathogen analyses from plant samples.

## Background

Plant disease is a process or change that occurs over time. For disease to occur, a susceptible plant host, a pathogen, and a favorable environment must occur at the same time. Disease symptoms – the host's response to the pathogen – include detectable changes in color, shape, or function such as leaf spots, cankers, dieback, wilting, defoliation, and flower drop. Signs of disease include the physical evidence of the causal agent (i.e., fungal fruiting bodies, bacterial ooze, or cyst nematode females). Many symptoms are not unique to a particular disease and can be caused by a variety of pathogens.

Before a microorganism can be considered the causal agent of disease, pathogenicity must be proven using Koch's postulates and the following criteria must be met: 1) the microorganism is present in diseased plants, but not found in healthy plants; 2) the microorganism is isolated from the diseased plant and grown in pure culture; 3) healthy plants inoculated with the pure cultured microorganism develop the same disease; and 4) the microorganism re-isolated from the inoculated diseased plant is the same as the original microorganism.

Although the literature describes historical reports of fungi attributed to disease symptoms of Proteaceae around the world, this does not necessarily mean that the fungi isolated from symptomatic plants are pathogenic or disease-causing organisms here in Hawai'i. Additional testing is required to confirm pathogenicity and prove Koch's postulates to distinguish between primary pathogens that affect healthy plants and cause disease, and opportunistic pathogens that colonize plants that are already weak due to water or nutrient imbalances, environmental or insect damage, or disease. Although the fungi described in this bulletin are associated with leaf spots, cankers, and dieback that affect the value and marketability of protea crops in Hawai'i, it is unlikely they cause rapid plant mortality.

According to Crous et al, 2013, multiple species of *Neofusicoccum*, *Pestalotiopsis*, and *Colletotrichum* are recorded as fungal pathogens of Proteaceae flower crops in Australia, California, Hawai'i, and South Africa (Taylor, 2001). In 1999, Swart cited that *Alternaria* (spp.) were reported to cause a serious leaf spot disease on protea crops in Hawai'i (Protea disease letter, 1993). *Phomopsis* is known to cause stem and branch cankers and dieback disease of *Protea* spp. in South Africa (Orffer & Knox-Davies, 1989) and require wounds (i.e., pruning, harvesting, etc.) to enter plants and cause disease symptoms (Greenhalgh, 1981).

Less severe pathogens of protea crops include *Cladosporium*, *Saccharata*, and *Epicoccum*. *Cladosporium* was reported as a common leaf spot fungus, but not a serious pathogen of protea in Australia, California, and Hawai'i (Crous et al, 2013). *Saccharata*, found in Australia, South Africa, Spain, California, and Hawai'i (Taylor, 2001), is generally considered an opportunistic fungal pathogen associated with leaf tip die-back and spots (Crous et al, 2013). *Epicoccum* causes leaf spot disease and stem and branch cankers in Hawai'i, and is associated with wounding (Crous et al, 2013).

## Symptoms Associated with Fungal Genera Recovered from *Protea* and *Leucospermum* Spp. in Hawai'i.

### *Alternaria* sp.

Symptoms: gray leafspots; dieback.



***Cladosporium* sp.**

Symptoms: yellow scabs on leaves, stem scab, marginal leafspot with tan center and dark brown-black border, or small red spots.

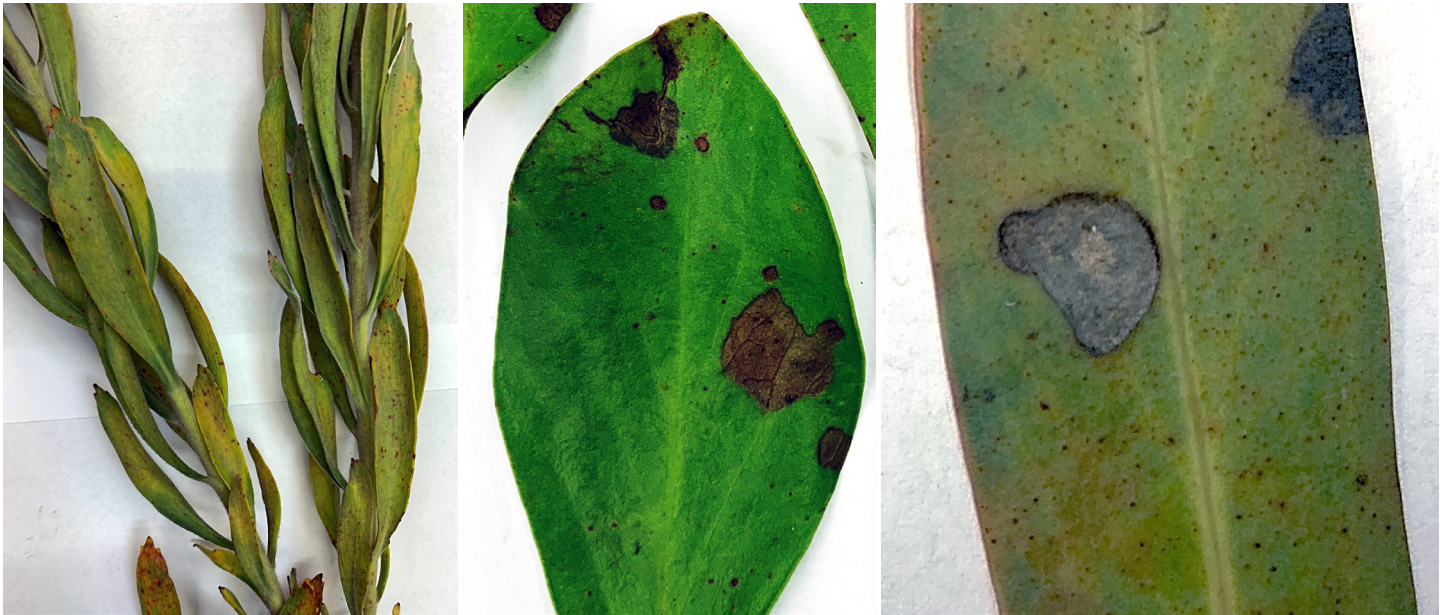
***Colletotrichum* sp.**

Symptoms: stem canker-slightly discolored area beneath canker, tip dieback.



***Diaporthe/Phomopsis* sp.**

Symptoms: pinpoint red spots, spots with concentric rings, light brown spot-papery appearance, dieback.



***Epicoccum* sp.**

Symptoms: dark black-brown spot with red-pink halo, elongated marginal necrosis with tan center and multiple brown leaves at stem tip.



***Mycosphaerella* sp.**

Symptoms: red spots with apical twisting, tip-dieback.

***Neofusicoccum* sp.**

Symptoms: discolored pith, dieback.



***Nigrospora* sp.**

Symptoms: gray-black marginal leaf spot, pinpoint leaf spots, and reddish colored leaves with red spots.



***Saccharata* sp.**

Symptoms: leaf tip necrosis gray, distinct black line between healthy and diseased.





## List of Common Symptoms Attributed to Multiple Fungi Associated with *Protea* spp. and *Leucospermum* spp.

Several fungi produce similar disease symptoms in plants. The table below illustrates disease symptoms attributed to multiple fungal genera recovered from protea in Hawai'i. Some symptoms may be the result of mixed populations of various recovered genera. In these cases, it is difficult to determine which fungus caused the initial disease symptom without the completion of Koch's postulates. As several fungi produce similar disease symptoms in plants, we recommend that producers submit samples for pathogen identification prior to developing management strategies. Early and accurate detection is crucial. Contact your local CTAHR Extension agent for more information.

### *Meloidogyne* sp. (Root-Knot Nematode) Symptoms on *Leucospermum* and *Protea* spp.

Parasitic nematodes are microscopic roundworms that infect plant roots. Symptoms of nematode damage include chlorosis, stunted growth, and root galls. In Hawai'i, *Meloidogyne incognita* (Root-knot nematode) affects many ornamental crops including protea (Sipes & Myers, 2018).

Generally, enlarged, swollen root galls indicate parasitic nematode infestations. Root-knot nematodes can still be present in the soil and feed on plant roots without the formation of visible root galls. For this reason, growers are advised to submit soil and plant roots samples for analysis to determine if parasitic nematodes are present. Contact your local Extension agent and refer to the management publication, Ornamental Pests of Hawai'i: Disease Management of Protea and Leucospermum spp. [ADD LINK WHEN HAVE], for more information.

### Conclusion

Numerous fungi were isolated and identified from symptomatic protea plant samples from Maui County, Hawai'i. *Neofusicoccum*, *Alternaria*, *Cladosporium*, *Saccharata*, *Mycosphaerella*, *Epicoccum*, *Diaporthe/Phomopsis*, *Colletotrichum*, *Pestalotiopsis*, and *Nigrospora* fungi are associated with the disease symptoms outlined above. These fungi contribute to leaf spots, stem canker, and die-back that impacts the appearance, yield, and value of protea cut flowers. *Meloidogyne* sp. (root-knot nematode) detected in protea roots in Hawai'i often inhibit plant growth and reduce flower production.

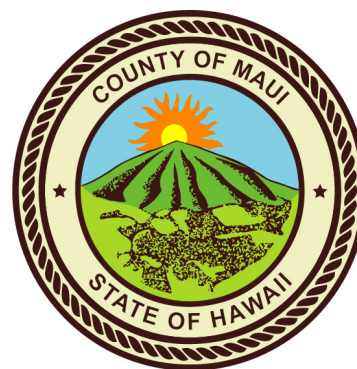
When assessing plant disease in the field, producers and enthusiasts can refer to this document as a guide to the

common fungal and nematode symptoms affecting Proteaceae flower crops in Hawai'i. However, the identification of pathogens or diseases from visual symptoms alone may not be accurate. To verify the causal agent prior to developing management strategies, it is recommended to collect and submit symptomatic plant samples for pathogen identification. For more information, please refer to the disease-management publication listed above.

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**Table 1. Fungal Associations and Symptom Descriptions on Protea Crops Grown in Hawai'i**



**Brown Leaf Spot**



**Marginal Leaf Necrosis**



**Stem Canker**



**Translucent Spots**



## Disclaimer

Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that also may be suitable.

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