Proc. Fla. State Hort. Soc. 107:13-14. 1994.

PSOROSIS-LIKE AGENTS PREVALENT IN RIO-GRANDE GUMMOSIS-AFFECTED RUBY RED GRAPEFRUIT GROVES AND GRAPEFRUIT BUDWOOD SOURCES[1]

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Abstract. **Budwood was collected from healthy-appearing and Rio-Grande Gummosis (RGG)-affected Ruby Red grapefruit trees from 5 different groves, 13-40 years of age, in the Indian River region of Florida. Similar collections from trees used as scion sources for grapefruit propagation were made at 6 different nurseries. Indexing of the budwood on Madam Vinous sweet orange seedlings under a cool night, warm day temperature regime resulted in the appearance of oakleaf and mild vein-clearing patterns, indicative of infection with a psorosis-like agent, for 75% and 15% of the budwood from the commercial production and scion groves, respectively. We conclude that some Florida grapefruit budwood sources are contaminated with a psorosis-like agent that has resulted in widespread distribution of the agent in Florida's commercial grapefruit.**

Rio-Grande gummosis (RGG) is considered to be a disease of unknown or uncertain etiology (4). This disorder affects the bark and wood of mature citrus trees and is usually more prevalent in grapefruit than in sweet orange. The disease is characterized by cracks in the bark which release a yellow gum. Gum pockets form beneath the bark, and the internal wood may become infiltrated with the gum. Trees affected with RGG become less thrifty, with the large limbs or scaffolds having bark cracks or scaling. The etiology of RGG is undetermined. A fungus, *Physalospora rhodina* (Berk. & Curt.) Cooke has been isolated from RGG lesions (4), and the disorder has been associated with high chloride in the irrigation water (3). In Florida, this disorder has also been called Florida gummosis (3), in California it has been called ferment gum disease (2). In Florida, RGG is prevalent in the grapefruit groves in the Indian River citrus area. Almost every grapefruit grove over 12 years of age is affected (R. Sonoda, unpublished).

The symptoms caused by RGG closely resemble the bark scaling symptoms caused by psorosis. Psorosis differs in that less gumming is induced from the bark cracks, and callus tissue is formed beneath the bark cracks (10). Casual inspection of grapefruit trees affected with RGG raised our suspicions that psorosis might be involved in at least some of the instances which are commonly being referred to as RGG.

We report here the first results of a survey conducted to determine if graft-transmissible agents may be involved in RGG of grapefruit in the Indian River citrus area.

Material and Methods

In the initial survey, 5 grapefruit groves were located in the Indian River area which were affected by RGG. The age of these groves ranged from 13 to greater than 40 years (Table 1). At each location, 5 budwood sticks were collected from each of 5 healthy-appearing trees (no RGG symptoms), and from 5 RGG-affected trees. The bud sticks were stored overnight on ice and used the next day to inoculate Madam Vinous sweet orange seedlings as indicator plants. Three budchips from each budstick was inoculated using a T-graft into one Madam Vinous indicator plant. Five Madam Vinous indicator plants were inoculated for each field tree sampled. The bud take was checked after 21 days. The inoculated indicator plants were maintained in a greenhouse with a 18-20 C night/ 35-40 C day temperature regime. Plants were observed for appearance of symptoms 3 to 4 times per week.

A second survey involved young groves (7 to 12 years old) that were propagated from registered Ruby Red grapefruit budwood and showed RGG symptoms. Instead of indexing the groves, the registered budwood scion trees used for propagation of these groves were indexed. Inoculation and indexing were performed as previously described, except that Swingle citrumelo or Carrizo citrange seedlings from clones immune to citrus tristeza virus were used as indicators in addition to Duncan grapefruit and Madam Vinous sweet orange.

Results

The results of the initial survey of healthy and RGG-affected trees are summarized in Table 1. Several of the Madam Vinous indicator plants expressed either oakleaf-like patterns or mild vein-flecking or vein clearing typical of psorosis-like agents; these symptoms are less conspicuous that the severe ringspots and flush dieback caused by citrus ringspot, a member of the psorosis virus group. Most of the virus-like symptoms occur in the indicator plants in the first growth flush after inoculation. Symptoms developed in the young leaves, were apparent for 4 to 10 days, then disappeared as the leaf matured. Continued observation of the indicator plants over

Table 1. Results of a survey of 5 different grapefruit groves in the Indian River area affected with Rio-Grande gummosis (RGG). Budwood was collected from either healthy appearing or RGG-affected field trees at each location and indexed for psorosis-like agents on Madam Vinous sweet orange indicator plants.

Location	Tree Condition	Age of Trees	Trees positive/ Trees tested
1	Healthy	13	3/4
	RGG-affected	13	3/4
2	Healthy'	20-28	3/5
	RGG-affected	20-28	5/5
3	Healthy	18	3/5
	RGG-affected	18	4/5
4	Healthy	>40	4/5
	RGG-affected	>40	5/5
5	Healthy	24	4/5
	RGG-affected	24	4/5

[1]Florida Agricultural Experiment Station Journal Series No. N-01022. The authors gratefully acknowledge the support of a grant from the Florida Citrus Production Research Marketing Order Program which made this research possible.

a period of several weeks while maintaining the indicator plants to a single stem indicated that once a plant showed virus-like symptoms, they recurred on subsequent growth flushes. However, symptoms were more evident in the shock flush, the first flush produced after inoculation. Of the 48 trees indexed, regardless of whether the field tree was healthy-appearing or affected with RGG, 79% were positive for psorosis-like agents. A total of 71% of the healthy-appearing field trees were affected by psorosis-like agents compared to 88% for the RGG-affected field trees.

The results of the second survey of registered scion Ruby Red grapefruit trees are not yet complete. However, from the first 55 trees indexed, 8 have been positive in both Madam Vinous and Duncan grapefruit indicator plants for psorosis-like agents. The symptoms appearing on indicator plants are like those obtained in the initial survey: oakleaf patterns on young leaves which disappear as the leaf matures and vein flecking in young leaves.

Discussion

Psorosis was the first citrus disease recognized to be caused by a graft-transmissible agent (5) and the first disease to be diagnosed by the use of a seedling index (11). It was present in most of the old-line budwood sources, and was reported in Florida in 1896 (9). Psorosis-like agents are a complex of viruses which produce similar symptoms on biological indicator plants. These symptoms include oakleaf patterns, leaf flecking, and occurrence of bark scaling, gumming and dieback. Virus diseases causing similar psorosis-like symptoms on indicator plants include psorosis A, psorosis B, citrus ringspot, concave gum, impietratura, and cristacortis (7, 10). Seed transmission of psorosis has been reported through *Poncirus trifoliata* and *P. trifoliata* hybrids (8). Psorosis and psorosis-like agents are limiting factors of citrus production in parts of Argentina where the disease is naturally spread by unknown means (8,10). A recent review of psorosis and psorosis-like agents has been published by Roistacher (8).

Finding a high incidence of psorosis-like agents upon biological indexing of several healthy and RGG-affected grapefruit trees from different groves was unexpected (Table 1). Also worrisome is the 15% incidence of psorosis-like agents which were detected upon biological indexing of the first 55 registered Ruby Red grapefruit trees. While these registered scion trees were initially identified by tracing back to the propagation sources from RGG-affected groves in the Indian River, these registered scion trees are located throughout the state. Propagations from the affected trees are planted throughout the citrus industry in Florida. The finding of psorosis-like agents by biological indexing on indicator plants from trees sampled in groves having a history of RGG does not indicate that psorosis-like agents are the cause of RGG even though the trunk and limb symptoms caused by the 2 disorders are similar. The experiments to prove this are being planned and prepared, but since it often takes 3 to 15 years for the bark cracking and gumming associated with RGG to occur, it will take an equal number of years for the relationship of psorosis-like agents to RGG to be confirmed. It is possible that grapefruit groves planted in other regions of the Florida industry will eventually develop bark scaling typical of psorosis 3 to 15 years after planting because these groves have been propagated with psorosis-infected bud sources.

Psorosis-like agents should not be in Florida citrus, especially in registered scion trees. The Florida Citrus Budwood Registration Program (FCBRP) was established in 1952 with the expressed purpose of eliminating psorosis in Florida citrus (6). Under the present guidelines under which the FCBRP operates (1), there are no requirements for recurring indexing for psorosis-like agents by the use of biological index under recommended temperature regimes (7) or by the use of laboratory diagnostic techniques which are commonly accepted (7). Instead, there is a requirement for a spring flush inspection procedure for scion trees (1). While it is recommended that known psorosis positive trees in the vicinity be checked for occurrence of symptoms for a reference for the spring flush inspection, the psorosis-like agents which have been discovered by the use of indicator plants under defined temperature conditions may not produce psorosis-like symptoms under field conditions in Florida in the spring. Also, frequently only a few leaves will show psorosis-like symptoms. The few leaves showing good psorosis-like symptoms are difficult to find on a field tree which is 2 years or older (this is analogous to looking for the proverbial needle in the haystack).

What can be done to prevent further propagation of psorosis-like agents in Florida? The implementation of the Quality Tree Program with its recommendation for recurring indexing for important graft-transmissible agents and requirement that it be mandatory for all citrus propagated in Florida would accomplish this. It is also imperative that the FCBRP be provided with greenhouses capable of maintaining the required temperature regime needed for adequate psorosis indexing. At the present, the program does not have this capability.

The high incidence of psorosis-like agents in the first survey of field trees (Table 1) may be an indication of natural spread of psorosis such as occurs in Argentina and other parts of South America. Additional research is needed to explore this possibility. If natural spread of psorosis-like agents is occurring in Florida, additional indexing for psorosis may be needed in the proposed mandatory Quality Tree Program.

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