A NEW ROOT WEEVIL IN TEXAS CAUSES SYNERGISTIC EFFECT WITH *PHYTOPHTHORA* IN CITRUS

M. Skaria1, Hong-qin MIAO1,2, J. V. French1, N. Solis-Gracia1 and R. Thokala1

1 Texas A&M University-Kingsville Citrus Center, 312 N. Intl. Blvd. Weslaco, TX 78596. E-mail: m-skaria@tamu.edu

2 Institute of Plant Protection, Hebei Academy of Agriculture and Forestry Sciences, Baoding 071000, P. R. China

ABSTRACT

The citrus root weevil (= the sugarcane rootstalk borer weevil), *Diaprepes abbreviatus* (L.), new to the state of Texas has caused many orange trees to die rapidly. This condition was prevalent in one orchard; however, some trees in another orchard in the vicinity and in surrounding residential lots were also found dead. Affected trees and apparently healthy trees were uprooted and the root system was examined. Extensive weevil feeding damage on root bark and severe root rot symptoms were observed. The root rot associated with the weevil damage is caused by fungus *Phytophthora.* In 2001, a survey in 20 citrus orchards (13 orange orchards and 7 grapefruit orchards) was conducted across the Lower Rio Grande Valley (LRGV) to further confirm the identification result and learn the whole disease occurrence. In 2002, another survey in 312 dooryard properties was carried out in the LRGV. Through the surveys, overall disease occurrence was demonstrated by describing the trees into dead, declining, missing, newly replanted and apparent healthy. *Diaprepes abbreviatus* (L.) was identified and confirmed for the first time in Texas. Root system examination and *Phytophthora* detection around the weevil damaged area on the roots showed that *Phytophthora* disease associated with root weevil(s) was the main cause for the rapid tree declining and death in the LRGV of Texas.

INTRODUCTION

In 2000, many orange trees in the LRGV of Texas showed rapid decline and death. Trees first appeared stressed by showing severe leaf wilt, rolling and yellowing with defoliation and subsequent death within 4-5 weeks (Fig.1&2). Initial investigations to identify the casue(s) of tree death were unsatisfactory. After pulling out the diseased trees and washed with a hand gun sprayer, the roots showed extensive insect feeding damage (channeling), together with symptoms of root rot. Thus, an insect-disease complex was suspected. A root weevil, *Diaprepes abbreviatus*, was introduced into Florida in 1964 and now is considered as the worst long-lasting threat to the citrus industry in that state. This weevil has the ability to feed on different hosts. Moreover, the reproducing capacity of *D. abbreviatus* is extremely high, a female can produce over 20, 000 adults in four years. A root rot disease of citrus can be caused by *Phytophthora* spp. *Phytophthora* foot rot and gummosis of the trunk are well-recognized. The purpose of this study was to generate information on the incidence and severity of this problem in the LRGV of Texas; find out the main cause(s) of the problem and develop some possible control strategies.

Fig.1. (left) A typical symptom of an infected tree with an apparently 'healthy' tree next (left and right).

Fig.2. (right) Trees reached this stage in 4 to 5 weeks after the initial symptoms of decline.

MATERIALS AND METHODS

1. Preliminary detection of the causal agents of tree decline and death was done by pushing out the trees and washing the roots with a handgun sprayer. The root channels and root rot were examined.
2. Efforts to identify the root weevils included: (1) Sieving/inspection of soil around the trunk for the presence of weevil larvae. (2) An attempt to trap adults in 'Tedders traps' (Fig. 7).
3. Examination of young citrus foliage for the presence of adults and/or feeding damage on leaves.
4. Isolation and detection of *Phytophthora* from the weevil feeding channels on roots and soil. A baiting technique using citrus grapefruit leaf pieces was used to trap *Phytophthora* spp.
4. To better understand the incidence and severity of *Phytophthora* disease associated with root weevil(s) in citrus, two surveys in citrus orchards and dooryards across the LRGV of Texas were conducted. A total of 20 orchards and 312 dooryard properties were chosen at random. In each orchard and dooryard, trees that were dead, declining, recently replaced, removed and apparent healthy were recorded and mapped. Meanwhile, 5 to 11 soil and root samples from each orchard, one soil and one root sample from each property were collected and tested for the presence of *Phytophthora* and weevil feeding damage.

Fig.3. Initial laboratory tests did not produce meaningful results. Therefore, the entire root system of several trees were dug out.

Fig. 4. Trees were pushed out, washed with a pressure washer and examined for root weevil and *Phytophthora.*

Fig.5. (left) Several trees were brought to the Citrus Center for further studies.

Fig.6. (right) Trenches were made in the *D. abbreviatus* affected orchard, and soil samples were collected from different soil depths for *Phytophthora* assays.

Fig. 7. 'Tedders traps' were placed under 12 affected trees. The first adult *D. abbreviatus* in Texas was trapped in the above trap.

Fig.8. Some palm trees in the orchard were also examined for the presence of root weevil.

RESULTS & DISCUSSION

1. Orange trees showed a higher disease incidence and severity than grapefruit trees (Table 1). Severe root rot and weevil feeding channels on entire root system were observed more often in orange trees than in grapefruit trees (Fig. 9).
2. Citrus root weevil (*Diaprepes abbreviatus)* was found and identified in Texas. In an orange orchard, a legless white larva and an adult of root weevil were found and identified to be *D. abbreviatus* (Fig. 10, 11, 12). This result led to a quarantine program, which covers a approximately 275m radius around the orchard.
3. *Phytophthora* widely existed in the tested orchard soil and it was detected up to the depth of 1.8m from the surface. It was detected in both feeder roots and large roots of the trees with different symptoms (Table 2, Fig. 13).
4. Both large roots and feeder roots with weevil feeding damage showed higher *Phytophthora* infection rates than those without feeding damage (Table 3, Fig. 14).

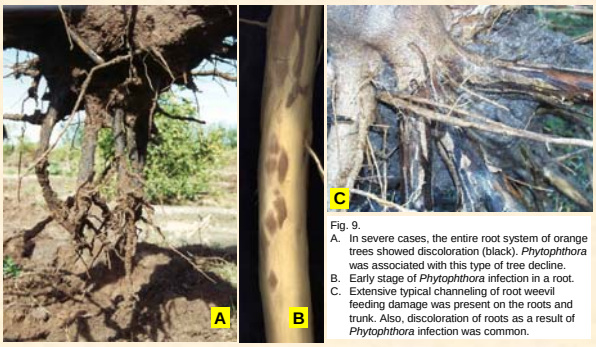

Fig. 9.
A. In severe cases, the entire root system of orange trees showed discoloration (black). *Phytophthora* was associated with this type of tree decline.
B. Early stage of *Phytophthora* infection in a root.
C. Extensive typical channeling of root weevil feeding damage was present on the roots and trunk. Also, discoloration of roots as a result of *Phytophthora* infection was common.

Table 1 . Surveys of Diseased Trees Related to the *Phytophthora* – Root Weevil Complex in the Lower Rio Grande Valley of Texas

Place	Host	No. of trees surveyed	No. (%) of declining trees	No. (%) of dead trees	No. (%) of missing trees	No. (%) of newly replaced trees
Orchard	Orange	14,936	758 (5.1%)	134 (0.9%)	364 (2.4%)	59 (0.4%)
	Grapefruit	6,337	125 (2.0%)	22 (0.3%)	17 (0.3%)	51 (0.8%)
Dooryard	Citrus	312	16 (5.1%)	25 (8.0%)	/*	/
	Others		26 (8.3%)	55 (17.6%)	/	/

*: not applicable

Fig.10. A weevil larva feeding on the root tissue.

Fig.11. Wing covers of *D. abbreviatus* was found in soil.

Fig.12. An adult and a larva of *D. abbreviatus* from Texas.

Table 2. Association of *Phytophthora* in Trees with Different Symptoms

Place	Host	Tree type	Soil positive # / total tested # (%)	Feeder roots positive # / total tested # (%)	Large root positive # / total tested # (%)
Orchard	Orange	Declining	49/57 (86.0%)	13/55 (23.6%)	7/57 (12.3%)
		Dead	8/8 (100%)	3/8 (37.5%)	4/8 (50.0%)
		Healthy looking	22/24 (91.7%)	3/23 (13.0%)	2/24 (8.3%)
	Grape-fruit	Declining	39/39 (100%)	12/38 (31.6%)	4/39 (10.3%)
		Dead	1/2 (50%)	0/2	0/2
		Healthy looking	14/14 (100%)	3/14 (21.4%)	2/14 (14.3%)
Dooryard	Citrus	Declining	20/26 (76.9%)	12/19 (63.2%)	8/45 (17.8%)
		Dead	27/45 (60.0%)	6/15 (40.0%)	6/21 (28.6%)
	Others	Declining	6/18 (33.3%)	1/11 (9.1%)	0/10
		Dead	17/56 (30.4%)	1/27 (3.7%)	4/34 (11.8%)

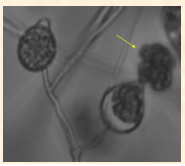

Fig.13. Sporangia of *Phytophthora parasitica* in a water culture with a citrus leaf bait. The arrow points the releasing spores.

Table 3. Association of *Phytophthora* and Root Weevil(s)

Place	Host	Feeder roots positive # / total tested # (%)		Large root positive # / total tested # (%)	
		With feeding channels	Without feeding channels	With feeding channels	Without feeding channels
Orchard	Orange	2/2 (100%)	18/84 (21.4%)	9/25 (36.0%)	4/64 (6.3%)
	Grapefruit	1/2 (50%)	14/52 (26.9%)	4/27 (14.8%)	2/28 (7.1%)
Dooryard	Citrus	No samples	12/28 (42.9%)	9/25 (36%)	5/61 (8.2%)
	Others	No samples	2/38 (5.3%)	1/3 (33.3%)	4/44 (9.1%)

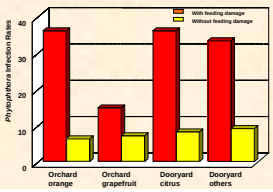

Fig.14. Results of *Phytophthora* assays from large roots with and without weevil feeding damage damage.

CONCLUSIONS

1. *Phytophthora* associated with root weevil(s) was the main cause for the citrus tree decline and death in the LRGV of Texas.
2. Citrus root weevil, *Diaprepes abbreviatus* was found in Texas for the first time. A quarantine program is in effect in the surrounding areas.

REFERENCE

1. French, J.V. and M. Skaria. 2000. Citrus root weevil identified. Texas A&M University-Kingsville Citrus Center Newsletter. Vol. 18 (6).
2. Skaria, M. and J.V. French. 2000. Loss of citrus trees associated with root weevil and *Phytophthora* fungus. Texas A&M University-Kingsville Citrus Center Newsletter. Vol. 18 (5).
3. Grimm, G.R. and F. Alexander. 1973. Citrus leaf pieces as traps for *Phytophthora parasitica* from soil slurries. Phytopathology 63:540-54.
4. Woodruff, R.E. 1964. A Puerto Rican weevil new to the United States (Coleoptera: Curculionidae. Fla. Dep. Agric. Div. Plant Ind. Entomol.Circ. 30:1-2.
5. Woodruff, R.E. 1985. Citrus weevils in Florida and the West Indies: preliminary report on systematics, biology, and distribution (Coleoptera: Curculionidae), Fla. Entomol. 68:370-379.